SELECT COMMITTEE ON THE SCRUTINY OF NEW TAXES

LEGISLATION COMMITTEE

Inquiry into Carbon Tax Pricing Mechanisms

SUPPLEMENTARY SUBMISSION

SUBMISSION NUMBER: **25**

SUBMITTER: **Warwick McKibbin**

Australian National University

8 August 2011

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Shon Fletcher
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Dear Shon

I would like to make a submission to the parliamentary inquiry into the Carbon Tax Pricing Mechanisms. I have been doing research on carbon pricing since 1991 and have published a number of papers in this area. Attached are several papers:

McKibbin, W., Morris A., and P. Wilcoxen (2009) "A Copenhagen Collar: Achieving Comparable Effort Through Carbon price Agreements" in *Climate Change Policy: Recommendations to Reach Consensus*, The Brookings Institution, September. p26-34.

McKibbin W. (2009) "A New Climate Strategy Beyond 2012: Lessons from Monetary History" 2007 Shann Memorial Lecture, Lowy Institute Issues Brief.

McKibbin W. and P. Wilcoxen (2007) "Managing Price and Targets" in *Climate Change: Getting it Right* Committee for Economics Development of Australia pp 76-85.

McKibbin W, (2007) "Climate Change Policy: From national to International" 2006 Sir Lesley Melville Lecture. Lowy Institute for International Policy *Perspectives.* Also published in *The Australian Economic Review vol 40, no 4, pp410-20.*

McKibbin W. (2005) "Sensible Climate Policy", *Issues Brief*, February, The Lowy Institute for International Policy Sydney.

Yours sincerely

Professor Warwick McKibbin
Director, RSE

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Inquiry into Carbon Tax Pricing Mechanisms

SUPPLEMENTARY SUBMISSION ATTACHMENT

SUBMISSION NUMBER: **25**

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A COPENHAGEN COLLAR: ACHIEVING COMPARABLE EFFORT THROUGH CARBON PRICE AGREEMENTS

Warwick McKibbin, Adele Morris, and Peter Wilcoxen
Brookings

EXECUTIVE SUMMARY:

The recent economic downturn makes voters uneasy about commitments that could raise energy costs and unemployment, even though the next agreement under the United Nations Framework Convention on Climate Change (UNFCCC) would likely not take effect until 2013, beyond the predicted duration of the current recession.

The downturn may make emissions targets harder or easier to achieve. Carbon emissions have likely fallen, so achieving a given target may now be easier. On the other hand, investment in emissions reductions will be more costly if credit markets continue to sputter and large government deficits crowd out private investment.

The UNFCCC process has focused on developed country commitments exclusively as reductions from historical base year emissions. However, baseline emissions trends vary widely, and achieving similar targets can require very different efforts by different countries. These differences have greatly hampered climate cooperation.

Here we propose that the treaty supplement emissions targets with a price collar. The collar includes an initial price floor and price ceiling per ton of carbon equivalent emissions and an annual real growth rate for both. All major economies must show a price on emissions of at

least the price floor even if they comply with their target. This prevents targets from being unexpectedly lax. Parties also cannot benefit from targets above expected emissions, such as those for the former Soviet Union under the Kyoto Protocol. The price floor also lowers the downside risk of low-carbon innovation.

Under our proposal, parties may exceed their targets if their price on emissions hits the price ceiling. This prevents the cost from becoming politically infeasible and accommodates developing countries like China that are uncomfortable with hard emissions caps. Developing countries could adopt a price floor without a target or price ceiling at first, and then transition to commitments more like those of industrialized countries.

We provide an example for the U.S. that shows that the price collar can have a negligible expected impact on the outcome that matters for the climate – cumulative emissions.

IMPLICATIONS OF ECONOMIC CRISIS FOR CLIMATE NEGOTIATIONS

The recent financial crisis and global economic downturn complicate climate negotiations under the United Nations Framework Convention on Climate Change (UNFCCC). Perhaps the greatest effect of these developments is political. Policymakers in the U.S., Australia, Canada, and elsewhere face resistance from voters uneasy about domestic measures that could raise energy costs and unemployment. Automakers and other manufacturers fear that a cap-and-trade program could worsen their competitiveness and drive jobs overseas. Although a well-designed cap-and-trade bill will indeed raise fossil energy prices, the effects on output and employment over the long run should be modest. Further, both the draft bill in the U.S. Congress and the next UNFCCC agreement would likely not take effect until 2012 or 2013, beyond the predicted duration of the current recession.

The downturn may make a given commitment harder or easier for the U.S. and other developed countries to achieve depending on how several factors play out. Data are not yet available, but it is likely that the economic downturn has reduced carbon emissions. Anemic economic growth could persist for several years, so achieving a given emissions target may require less abatement than previously expected. On the other hand, significant emissions reductions will require a high level of investment in new capital. This investment will be hampered if credit markets continue to sputter and if large government deficits crowd out private investment through higher real interest rates. The downside of the downturn will be even worse for low carbon investment if foreigners retreat from U.S. assets because they fear inflation or an eroding U.S. dollar.

THE NEED FOR A BETTER BASIS FOR NEGOTIATIONS

The UNFCCC talks scheduled for December 2009 in Copenhagen are meant to establish country-level commitments from the expiry of the Kyoto Protocol at the end of 2012 through 2020 and global emissions goals through 2050. But even as diplomats prepare for the new agreement, tensions around the formula for those commitments pose an important threat to success at Copenhagen and indeed the long term prospects for stabilizing the

climate. This tension is clear from the failure of the G-8 to set a base year for its agreed 80 percent reduction of emissions by 2050.

One of the greatest conflicts is the call for industrialized countries, particularly the U.S., to cut emissions deeply in the coming decade. The E.U. has called on the U.S. to take a target of 25 percent below 1990 levels by 2020 (about 35 percent below 2005 levels). India and other developing countries say the U.S. should cut emissions 40 percent below 2005 levels by 2020. These demands dampen prospects for agreement given that the climate bill passed recently by the U.S. House of Representatives seeks 17 percent below 2005 levels by 2020 for covered emissions. The Senate shows no appetite to strengthen targets as it now takes up the measure. The U.S. could not accept a target more stringent at Copenhagen without risking the treaty's defeat domestically. One clear lesson from the Kyoto Protocol is that little environmental progress is made by making concessions internationally that are infeasible domestically.

The demise of the Protocol in the U.S. was driven both by the stringency of the U.S. target of 7 percent below 1990 levels and the exemption of major developing countries from emissions constraints. In his March 13, 2001 letter to then-Senator Chuck Hagel announcing the withdrawal of the U.S. from the Kyoto treaty, President Bush cited both the potential effects of the Protocol on energy prices and its exemption of "80 percent of the world." Since Kyoto, the international process has grappled with these issues. The UNFCCC's 2007 Bali Plan of Action calls for the Copenhagen agreement to ensure the "comparability of efforts" across developed countries while "taking into account differences in their national circumstances."

The experience of Kyoto illustrates the challenge of achieving "comparable efforts." The Kyoto targets were primarily reductions relative to 1990. However, different industrialized countries had very different patterns of economic growth and emissions from 1990 to 1997, when the Protocol was negotiated, and to 2008 when the treaty would take effect. For example, the U.S. economy grew by about 9 percent from 1990 to 1997, with emissions growing as well, albeit at a lower rate. In contrast, emissions in the United Kingdom and Germany fell substantially in that period due to changes in coal policy (in the U.K.) and the collapse of the Soviet Union and annexation of East Germany into West Germany. Yet, despite those important differences, many negotiators erroneously assumed that similar targets meant similar levels of effort. Based on modeling by Batelle in the late 1990s, Figure 1 below shows the relationship between projected emissions for 2010 under business as usual conditions and the Kyoto Protocol target for six groups of countries. The higher the bar, the tighter the target. The chart shows that although the U.S. target was one percentage point less stringent than the E.U. (7 percent reduction vs. 8 percent reduction relative to 1990 levels), the U.S. target required significantly more emissions reductions relative to business as usual to achieve than the E.U. target. As shown by the yellow bars in Figure 1 for the former Soviet Union (FSU) and Eastern Europe, ignoring post-base-year events can lead to "hot air," targets that are looser than expected emissions.

We see some of the same challenges to achieving comparable effort at Copenhagen. The E.U. routinely expresses its pledge relative to 1990 levels whereas President Obama proposes a 14 percent reduction relative to 2005 levels. Japan also prefers a 2005 base year. But just as in 1997, highly varying rates of baseline economic growth, fossil fuel use and

availability, land use and agricultural sources and sinks, and historical energy intensity make it impossible to gauge the effort required to achieve a commitment by looking only at a gross emissions target relative to a historical base year's emissions. The focus on base years particularly alienates rapidly industrializing countries such as China and India that will be expected to take on binding emissions obligations eventually if not in 2013. Equal percentage departures from historical base year emissions might seem fair, but ignoring those baseline differences could impose quite different costs per capita, percentage GDP losses, and marginal abatement costs across countries. Thus the problem of crafting commitments at Copenhagen is as much a problem of the "optics" of the target formulation as it is the actual level of emissions.

But even if parties negotiated emissions levels rather than reductions, they are not assured of comparable efforts because many things that affect the burden of achieving the target can happen between the year of negotiation and the commitment period. The recent financial crisis and global economic downturn are clear reminders of the volatility in the underlying economic environment in which parties make these emissions commitments. Additional uncertainties include unanticipated economic growth, technology breakthroughs, prices for renewables and natural gas (a lower emitting alternative to coal), and political instability. To properly protect the climate, the international regime should endure through any number of economic and political fluctuations.

A PRICE COLLAR FOR MAJOR ECONOMIES

Here we offer a way to ensure the comparability of efforts based on achieving comparable price signals on carbon. Similar price signals mean that countries will undertake similarly expensive measures to control pollution. This not only promotes transparently comparable effort but also helps lower the overall cost of achieving a particular level of climate protection.

Under our proposal, all major parties need to show at least a minimum level of effort, and they can emit more than their target emissions if they can show a high level of effort. Specifically, in addition to a cumulative emissions target for the 2013 to 2020 period, major economies would agree on three things, known collectively as the "price collar":

1. a starting floor on a ton of carbon equivalent emissions for 2013
2. a starting price ceiling on a ton of carbon equivalent emissions for 2013
3. an annual rate of growth in the price floor and ceiling that reflects the real rate of interest, such as 4 percent.

To comply with their treaty obligations, Parties must demonstrate two things. First they must show that they have imposed a price on carbon equivalent emissions at least at the agreed floor price over most or all of the commitment period. Second, Parties must show that their cumulative emissions are no higher than their announced target OR that their domestic price on emissions has reached at least the ceiling price over a reasonable proportion of the commitment period.

This approach has several advantages. The price ceiling allows parties to comply even if their target turns out to be unduly stringent. The price floor ensures that no Party's

commitment is unduly lax and prevents Parties from benefiting from overly generous target formulations (such as the hot air from the FSU under the Kyoto Protocol). The approach accommodates developing countries like China that are uncomfortable with hard emissions caps but might be open to imposing a carbon tax. One approach would be to allow such countries to adopt a price floor without a target or price ceiling at first, and then transition to commitments more like those of industrialized countries. Developed countries also need not agree on a common price collar, as long as they were comfortable with any differences, but competitive concerns would provide some incentive to converge.

Several implementation details would be required. First, the UNFCCC would have to develop guidelines on demonstrating compliance with the price collar. This would include methods of verifying price signals and how long they were in effect. The treaty must also ensure that excess emissions are reasonably proportional to the duration over which the price ceiling obtains; a long duration of prices at the ceiling must accompany high excess emissions.

Parties can implement their commitments as they see fit domestically, including through a tax or cap-and-trade system that provide transparent price signals. Regulatory measures would require special provisions to demonstrate their equivalence to a price signal. For example, countries could calculate a shadow price on emissions analogous to the way the World Trade Organization converts trade protection policies into tariff equivalents. Parties could count towards their price signals any existing fossil energy taxes, but such credit would have to be net of any subsidies to fossil energy or other greenhouse gas emitting activities. Parties can control any revenues generated by their domestic climate policy and can use it to offset other tax burdens if they see fit.

The domestic mechanics of the price collar could work in a number of ways. For example, a central bank of carbon could intervene by buying or selling permits to keep the price within bounds. This is similar to the open market operations of the Federal Reserve in short term money markets. Alternatively the government could place a reserve price on allowances that it auctions.

Establishing comparable national price targets across countries means that trading of permits across countries is unnecessary, adding to the system's robustness by avoiding a fragile international regime based on a common allowance market. McKibbin and Wilcoxen (2002) and McKibbin, Morris and Wilcoxen (2009) explain the advantages of coordinated national institutions over global institutions for creating a robust policy regime.

In our approach, the price floor on gross fossil energy emissions ensures that no party can use terrestrial sinks alone to meet its commitments. However, the agreement should specify how parties will account for land-based carbon stock changes at the same time targets are set. Another important element of the agreement is the level of technology transfer and financial assistance to developing countries. Given the complexity of developed country commitments, these issues are best handled separate from the target-setting negotiations.

AN ILLUSTRATIVE PRICE COLLAR FOR THE U.S.

To illustrate, we modeled both a target scenario and a target plus price collar scenario for the United States. We used the G-Cubed intertemporal general equilibrium model, a widely used model of the global economy. First we estimated a "reference scenario" that reflects our best estimate of the likely evolution of each region's economy without concerted climate policy measures, calibrating to the relationship between economic growth and emissions growth in model's regions over the recent decade. We then included the climate policies announced by various governments and two policy scenarios for the U.S.

The first policy scenario is a target path for the U.S. It is an approximation of the Obama Administration's (OA) proposed targets for 2020 and 2050 of 14 percent and 83 percent reductions, respectively, from 2005 emissions levels. Details appear in Table 4 of McKibbin, Morris, Wilcoxen and Cai (MMWC) (2009). The "OA targets" scenario assumes a cap-and-trade program with a linear path of emissions caps from 2012 to 2020, and then another linear path from 2020 to 2050. The second policy scenarios supplements the target path with a price floor and ceiling that are $10 and $35 respectively per ton of CO_2 emissions in 2012, and both rise at 4 percent annually.

Figure 2 shows the allowance prices that emerge in the scenarios. The dark blue path labeled "OA Targets" is the price of a ton of carbon dioxide that would emerge if the economy is required to achieve the "OA Targets" in each year, without allowing banking and borrowing. Figure 2 also shows the price floor (in green) and price ceiling (in orange) defined above. The brown line (labeled "Price") shows what would happen in the OA target scenario with a price collar in place. In range between the price floor and the price ceiling, the "OA Targets" path and the "Price" path coincide.

The price floor triggers briefly at the start, during which time the government would remove some permits from the market. Over the subsequent decade the permit price stays within the price collar. By 2023 the strong demand for permits causes the market allowance price to hit the ceiling and the government offers additional permits at the ceiling price as described above (this is similar to McKibbin and Wilcoxen (2002) Hybrid proposal). By 2042, the price ceiling rises above the market price of allowances and emissions no longer exceed the annual cap.

Figure 3 shows annual U.S. CO_2 emissions for the policy scenarios relative to the reference scenario. Emissions under the price collar largely remain on the OA Target path for a decade but once the period of expensive reduction is reached – where the upper price collar is breached - emissions rise above the target for several decades.

Figure 4 shows the effects of this on the cumulative emissions path. Both the OA target path and the Price collar achieve significant emission reductions relative to the Reference scenario. A key insight from this example is that introducing the price collar can have a negligible expected impact on the outcome that matters for the climate – cumulative emissions.

CONCLUSION

Allowing for a price collar (i.e. a cap and floor on costs) within a long run cumulative emissions target is an effective and politically viable way to move international negotiations on climate policy forward. The economic uncertainty surrounding target commitments is enormous, and combining a clear cumulative emissions target with a price collar optimally balances the environmental objective with need to ensure that commitments remain feasible. Using plausible assumptions, the example in this paper illustrates how a price collar does this.

The fixation on reductions from historical emissions as the only meaningful form of commitment has greatly hampered negotiations on climate commitments, especially for developing countries where the uncertainty about the future and the cost is greatest. In contrast, the price collar can ease major developing countries into the system by allowing them to adopt only a price floor in the early years. It also offers a transparent and verifiable assurance of the comparability of effort across countries.

Including verifiable actions along with an emissions goal is an important improvement over the Kyoto Protocol because it demonstrates compliance during, as well as after, the commitment period.

FIGURES

Figure 1. 2010 Projected Emissions relative to Kyoto Protocol Targets

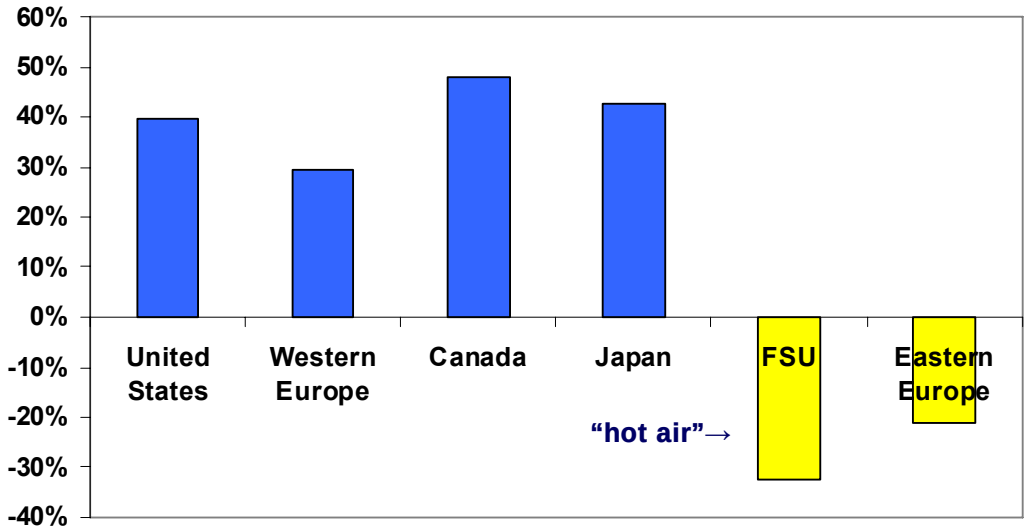


Figure 2. Price per ton of CO_2

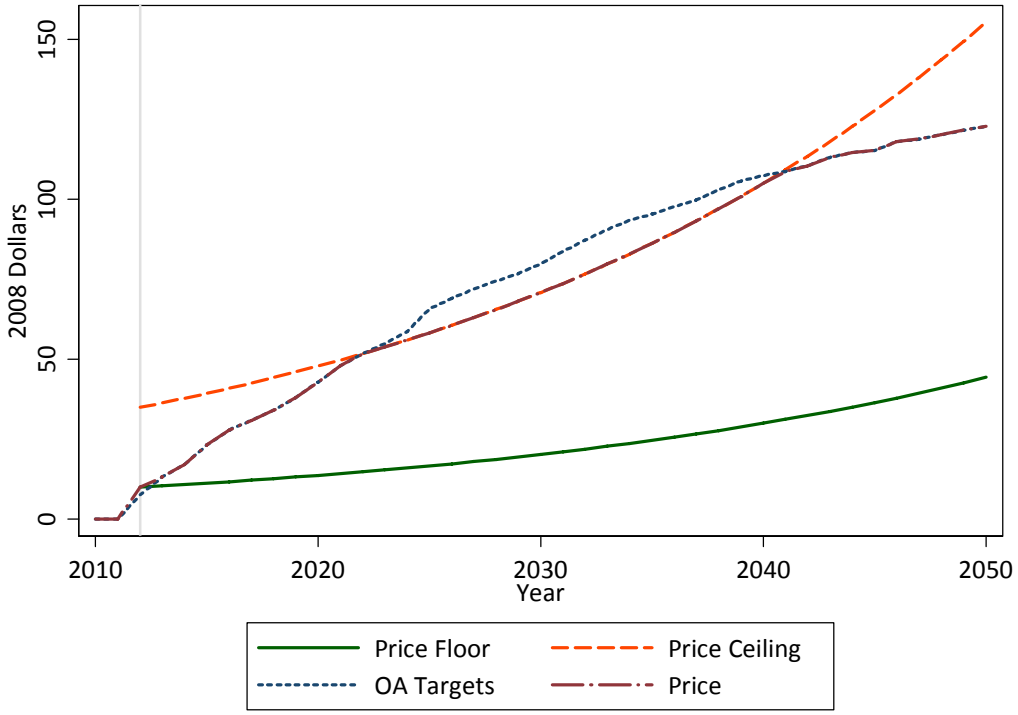


Figure 3. U.S. CO_2 Emissions Relative to Business as Usual

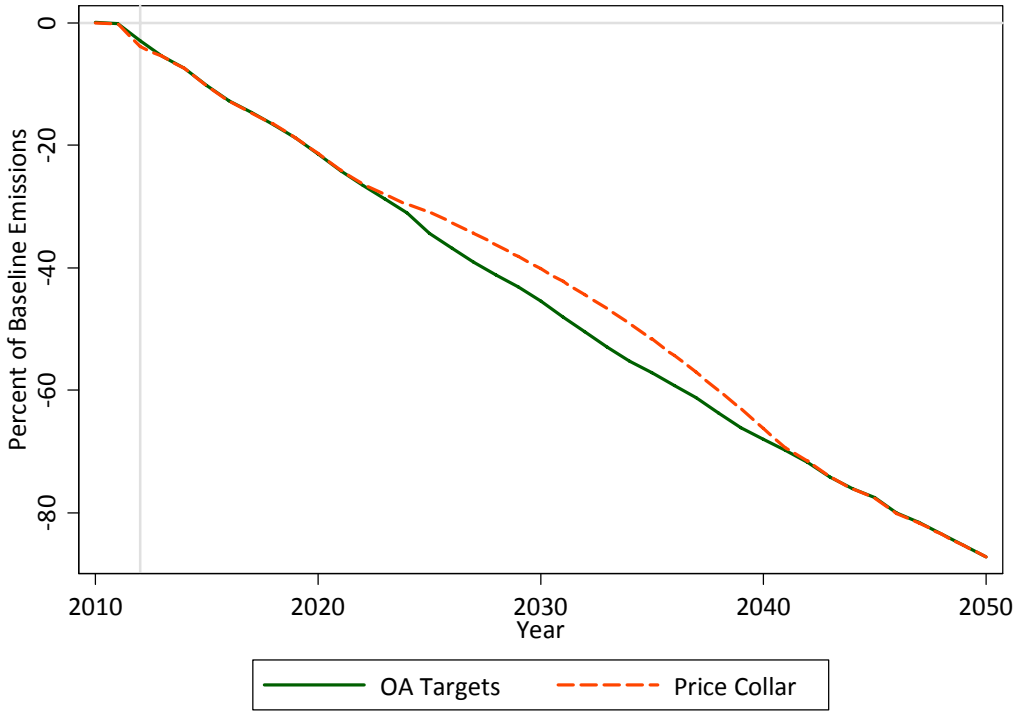
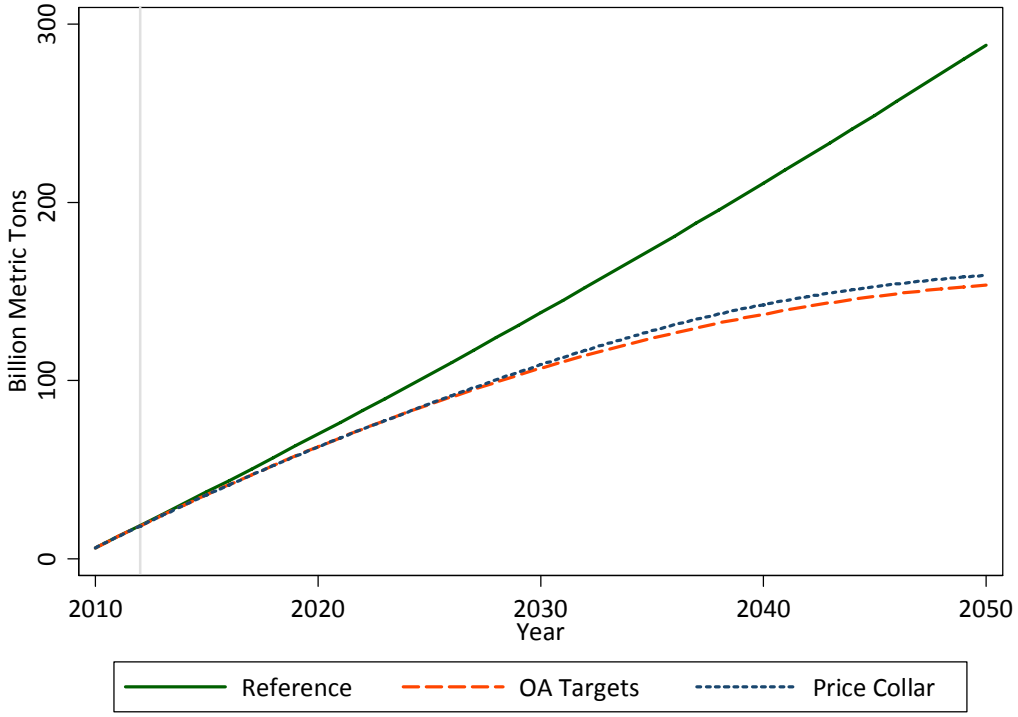


Figure 4. Cumulative U.S. Emissions of CO_2



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PERSPECTIVES

The 2007 Shann memorial Lecture

A New Climate Strategy Beyond 2012: Lessons From Monetary History

Warwick J McKibbin

August 2009

The Lowy Institute for International Policy is an independent international policy think tank based in Sydney, Australia. Its mandate ranges across all the dimensions of international policy debate in Australia – economic, political and strategic – and it is not limited to a particular geographic region. Its two core tasks are to:

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A New Climate Strategy Beyond 2012: Lessons from Monetary History*

The 2007 Shann Memorial Lecture

Warwick J. McKibbin
CAMA, Australian National University,
The Brookings Institution and
The Lowy Institute for International Policy

24 July 2009

Keywords: Climate change; emissions trading, carbon tax, Hybrid; Kyoto; Copenhagen

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A New Climate Strategy Beyond 2012: Lessons from Monetary History

Warwick J. McKibbin

Abstract

The Kyoto Protocol was the outcome of many years of multilateral negotiation and political compromise with the ultimate aim of reducing the risk of dangerous climate change. Unfortunately, most of the countries that ratified the Kyoto Protocol have not taken effective action to curb greenhouse gas emissions with many Kyoto countries not looking likely to reach their targets. There is also a lack of enthusiasm from major developing countries to take on the binding targets that form the basis of the Kyoto Protocol Approach. This has raised serious doubts about the viability of the Kyoto policy of committing countries to targets and timetables especially as a model for the current negotiations. As the science becomes more compelling that action is needed to curb greenhouse gas emissions, countries are beginning to look for more sustainable alternatives for the period beyond 2012.

This lecture outlines the key features that are needed in a new climate change framework beyond Kyoto drawing on lessons from monetary history. Using the analogy to the way modern central banks run monetary policy it outlines an alternative to the Kyoto Protocol which is a system of national climate policies coordinated around a common global price for carbon.

1. Introduction

This lecture is in honour of one of Australia's great economists and policymakers of the early twentieth century. Edward Owen Shann made many contributions to the economics profession and to policy development in Australia[1]. One of his many contributions was relating economic history to existing economic policy problems of the 1930s and using this insight to develop practical policy solutions. Although climate change was not one of the areas of debate in the 1930s (although Svante Arrhenius had raised the issue as early as 1895) it is clearly a high priority in Australia today and in need of practical policy development. In the spirit of Shann there are key lessons to be learnt from history in how to design a national and global climate policy framework. Outlining these lessons and providing a practical policy framework is the goal of this lecture.

History contains some important lessons that are relevant for climate policy. Firstly, what we have learnt from monetary history is that common currencies don't last, which suggests that for similar reasons a global carbon market won't last. Money like emission permits are merely the promises of a government – not a physical commodity. Secondly there is no gain from short run interest rate volatility in targeting longer run goals of inflation and unemployment and for the same reasons there are no gains from short run carbon price volatility when the carbon price is an instrument which is set to achieve a long run goal of stabilization of carbon concentrations. Thirdly, time consistency really matters in designing policies which require long term investment by the private sector. It is a very good idea to tie the hands of future governments to prevent them from changing policy after businesses and households have committed to an investment strategy. This constraint on policy revision can be achieved by creating balancing constituencies within an economy to prevent the government from reneging every time they think it is in their own self interest. Fourthly, it is critical to get the institutional design of the policy framework right – a key to this is to build independent institutions with clear goals to implement climate policy. I believe it is not a good idea to put climate policy in the hands of either Treasury, or the Climate Change Department. It should be put it in the hands of an independent institution like a Central Bank of Carbon. Fifth, the whole debate in the 20th century about the transfer problem

[1] See Snooks (1988).

and the Dutch disease issues caused by attempting to transfer large amounts of wealth between economies is very relevant for the climate issue. Mixing climate policy (the need to reduce global emissions at low cost) with attempts to have big income transfers from one part of the world to another part of the world or from one part of society to another part of society for political or ideological purposes undermines the climate policy regime and makes climate policy very much harder to implement. It is critical to take the transfer problem seriously into account when you are designing global policy. Attempting too many achieve goals with a limited number of policy instruments usually fails.

Finally I want to point out how I think you should design climate policy, to deal directly with each one of these issues that history has taught us in the evolution of non climate policies. What I propose is not a perfect approach but I think it is an approach that deals with some of these core issues pretty effectively and much better than recently published reports on climate policy design for Australia[2].

2. The Climate Policy Problem

What do we know? We know quite a lot but there is still much that is uncertain. We know that climate is a complex system that is always changing. We are not dealing with a situation that usually concerns most economists where we are in a steady state and we are trying to just prevent perturbations around a steady state. Climate policy is dealing with something that is continually changing and never reaches a steady state. This is a very difficult policy environment.

We observe that average temperatures have risen roughly 0.7 degrees in the past century - we are observing rising temperatures. We do see both natural variability and human induced climate change co-existing, so to unravel how much is human induced and how much is natural variability is quite a complex question. Figure 1 shows the temperature variability from the Vostok Ice Core Samples for the past 425,000 years. The past 10,000 years contains the human

[2] The Garnaut Review or the White Paper – which were both published after this lecture was given.

footprint.

We know that we are pumping enormous quantities of greenhouse gases into the atmosphere. This is clearly seen in Figure 2 where we reached more than 7 gigatonnes per year by 2002. This is not a sustainable situation unless you have a minority view about the link between human source greenhouse emissions and temperature changes. Perhaps it will one day be shown that there is no clear link between human greenhouse gas emissions and climate change but it is clear that to do nothing involves considerable risk – at a minimum an insurance policy is needed for the climate issue just in case the large body of scientific knowledge in the Intergovernmental Panel on Climate Change (IPCC)[3] is correct.

The biggest problem I see at the moment is that there is an enormous vacuum in policy, globally as well as nationally in most countries and this vacuum is causing significant economic losses. Even if you are skeptical about human induced climate change, the 'do nothing option' is actually becoming very costly because to do nothing on a policy framework means that investment in energy infrastructure is not being undertaken because of the uncertainty about climate change policy. There are investments in a whole range of different technologies that aren't being undertaken and everybody is waiting for the policy framework to be put in place. Thus even if you are a skeptical that doesn't mean do nothing, because to do nothing actually costs. You need to take out insurance.

What else do we know from the climate science? Firstly, scientists makes it clear that it is not greenhouse gas emissions in any year that matter but the accumulation of these emissions in the atmosphere over time. These accumulations are known as concentrations. Science doesn't tell us exactly what concentrations should be to avoid dangerous climate change. There are different views amongst the scientific community as to what is the level of concentrations at which dangerous climate change occurs, whether is might be 350, 450, 550 or even higher or lower parts per million. Science really doesn't tell us exactly what concentration target we should aim for but there is a pretty convincing argument out there that we need to be heading in a

[3] See IPCC (2002,2007)

direction where we are trying to avoid concentrations of 450 parts per million. I should stress that this number has changed a lot since I started working in this area 18 years ago but it is a good starting point for a system that allows this number to change over time as evidence accumulates. This lack of scientific certainty is not of comfort to those trying to design a policy regime based on targets and timetables for emissions.

The bottom line is that we need science to guide us in the policy formulation, but science can't tell us exactly what we should be doing. However suppose we actually did know the precise global concentration target. Suppose scientists agreed that we cannot go past 450 parts per million, science doesn't tell us how precisely to get there – do we cut emissions or increase sequestration? How quickly should emissions be cut? The profile of emission reductions to hit a given concentration target is not a scientific question. Science doesn't tell us whether we should cut sharply now, and then do very little, or cut mostly later but then do a whole lot[4]. The issue of costs and benefits of different strategies are economic or moral questions posed in the context of risk management.

Thus the actual profile of emissions reductions is not given to us by science but science informs us.

However, suppose that we did know what the global emissions profile should be exactly, science tells us absolutely nothing about what a national emissions target should look like because the way you divide up that emissions pie globally across countries is not a scientific decision. It's partly an economic question, where an economist would propose choosing the least cost emissions abatement opportunities to hit the global target. It's partly a moral or ethical question about who should bear the burden of the cuts. The precise cuts that each country individually should undertake is not a scientific question. Any national study which starts with the idea that science tells us that as a nation we have to cut emissions by a certain percentage is actually not based on any of the science that I am aware of. Therefore the entire climate change issue at the national level becomes an issue of not just science but of economics and morality, of

[4] One qualification is if there is a critical threshold where the flow might be critical in a given year.

politics and a whole range of other issues that combine to makes it a very difficult policy debate often dominated by religious zeal. This is not a good environment to formulate a sensible long term policy framework.

What are the implications of this complexity? Many economists who initially start working on climate policy start with the idea that a "cap and trade" emission trading market would be a good approach. Cap and trade is based on the idea that we know what the annual cap should be, or we know what the cap should be over a period of time but in fact that's really an assumption rather than an implication of science. We know from science what we need to do more broadly - we need an approach that moves towards a global concentration target that is uncertain. But this target is likely to vary over time as we get more information on the entire complex climate system. Within the global concentration target one of the key issues from an economics point of view is to try and equalise the cost across countries and minimise the costs over time[5], but this doesn't look like the current approach in international negotiations. The essence of the focus should be on how to design a global system that achieves the scientific goal but at minimum global and relative cost across countries. Just to stress again that science does not give us a national emissions target and timetable framework, yet that tends to be the sort of framework that the Garnaut Review and Stern Review[6] and others are premised on.

3. What Needs to be Done?

What should climate change policy focus on? Climate change policy, in my view, should focus on managing risk and dealing with climate uncertainty. That's the essence of the climate problem. We don't know how much to cut, but we think we should be cutting significantly. We want to manage the risks to the environment, to the economy, to a whole range of issues and most importantly we have to design systems, markets in particular, that let us deal with uncertainty. Again it isn't about picking arbitrary targets and hitting the target no matter what.

[5] It is the role of economists to highlight tradeoffs. For a dollar spent on greenhouse emission reduction that is a dollar less spent on the reduction of poverty or disease. If we can achieve the same concentration outcome for a much lower price who would deem this unimportant?

[6] See Stern (2006) and Garnaut (2008)

That's a political argument, that isn't a scientific argument and it's certainly not an economic argument. The focus then should be creating a system that enables all of society to manage risk - it's not just that the government should bear all the risk in my view. We need to create markets so that individuals and corporations can make decisions using markets and other mechanisms to manage their own risk. That's important when we are trying to deal with the sort of energy system development and deployment that is needed. Fundamental to this is creating long term institutions and clear property rights over carbon emissions, globally and nationally, that steer the global economy to a low emissions future.

The institutional structures have to be thought about very, very carefully. When constructing a global system, my view is that starting from the top down and making countries undertake action is just not going to work. You have to start with countries taking action that they see is in their own self interest and then knit these national or regional policies together into a global system with an overarching framework that helps sustain the national actions. The idea that you get uniform global agreement and consensus has not worked and is unlikely to work in the future despite politician's optimism about the Copenhagen conference in December 2009. They were also optimistic in 1997 when the Kyoto Protocol was negotiated and global emissions are much higher today than almost anyone predicted.

Pricing Carbon is a Necessary but not Sufficient Condition

At the base of the climate policy issue, there's a whole range of different policies that are required. The carbon prices need to be at the core in my view, because the carbon price is a way of co-ordinating all of the decisions, of all of the agents, all over the world who are making carbon emitting and carbon abating decisions. Yet the carbon price has to be designed and implemented very carefully. There is no doubt that the short term carbon price is a cost to the economy. If we change the price of carbon tomorrow, it will be costly. On the other hand the long term carbon price is, in my view, an opportunity for the economy. People appear to get these two time dimensions mixed up either because they don't understand the key issue of investment incentives or for their own self interest. You hear a lot of people argue that there should be a carbon price today that is high because that's the only way to stimulate renewable

energy. My view is that a high initial carbon price is going to hurt the economy, and what matters for renewable energy sources is actually not the price of carbon today, it's the price of carbon that people expect over the next 20, 30 or 50 years. You've got to focus on the balance between costs and opportunities in the time dimension much more than are usually debated. In fact, everybody is focusing, in my view, too much on the short run. What we need to do is to set very clear long term carbon prices for the global economy that enable individual countries to manage their own domestic costs of carbon abatement to suit their own national and global self interest.

The importance of prices can be seen in Figure 3 which shows GDP, CO2emissions and energy use in the United States from 1960 to 1990 with each variable expressed as an index of 1 in 1960. It is clear that before the early 1970s energy use and CO2 emissions where rising faster than GDP. That is energy intensity in the US economy was rising. In the early 1970s something fundamentally changed the relationship between GDP growth and energy use. This was the first and second oil price shocks. What was important about this event was not that energy prices change but that they changed in a way that most people thought was permanent – the world was thought to be running out of oil. As it turned out this was premature but the impacts on the energy price shocks on spurring new technology was permanent as can be seen from the permanent improvement in energy intensity of GDP.

There are many ways to put a price on carbon. One way is a carbon trading market. Firstly, you create a regulation that a carbon emitter requires a permit to emit carbon. But there are very many different ways of creating a carbon trading system. Firstly, the government could limit the supply of permits and so you create a fixed amount of carbon. You let the market determine the price because carbon permits are scarce, and that's what determines the carbon price. A cap on emissions is what you call a cap and trade permit system. There are various different versions depending on whether you allow banking and borrowing of permits so that the cap is not binding in a given year. An alternative approach is to set a price at which you can buy permits from the government and let as many permits be bought from the government in a particular year. This approach is the equivalent of a tax, but you can still regard it as a permit trading system, although it's really a tax.

The advantages of the "cap and trade" approach is that once you've got the cap then you know exactly what the environmental outcome will be. The disadvantage is that you don't know what it's going to cost, and in fact, you could end up with a lot of volatility in the short term carbon market, because you have no flexibility in the supply of permits. The advantages of a tax is that you know exactly what the carbon price will be, but you don't know what the emissions outcome will be in any year. Volatility in short term carbon markets is good for financial market participants that thrive on making money out of reducing volatility at a price but does nothing for the environment or the economy.

There are a few other differences between these alternative ways to price carbon which are of a longer term nature. The beauty of a carbon market where you allocate the permits is that the allocation in itself creates constituencies that change the nature of the interaction between the private sector and the government. The problem with a tax is that if you are trying to generate some long term carbon price, it is not clear what the tax will be in the future if the government hasn't pre-committed to what the tax profile will be. Once you get into the difference between national markets and global markets, again there are attractions from a theoretical economic point of view to allow global permit markets to emerge. In our modeling, the Australian carbon price for any sort of plausible target that is being discussed, tends to be much higher per unit of

carbon, than say an American carbon price or Chinese carbon price. If you only have a national market in Australia, it could be very expensive to reduce carbon in the Australian economy when you could buy permits from an offshore market and therefore lower your abatement costs. The idea of using a global market is to reduce the costs in Australia if it proves difficult to hit an annual emissions target. This is the essence of the argument in the Garnaut review and the White Paper. Countries with high marginal abatement costs can buy permits from countries with low marginal abatement costs. By doing this trading you reduce the costs within your economy and a global market for carbon emerges with a common price. This is nice efficient outcome. The price of carbon in any part of the world would end up being exactly the same. Now trading is good in theory and even in our modeling work we demonstrate it can have significant impacts on reducing the costs of abatement, but it doesn't actually solve the problem of uncertainty. Even though you can pick a target for Australia, and if it turns out to be too expensive, you can actually trade offshore, it doesn't reduce the global cost of the target that is picked for the world. In other words you can shift the global costs around but you can't reduce the global costs under a standard cap and trade ("where" flexibility is possible but not "when flexibility").

There are also some serious problems associated with the allocation of permits. Trading permits across borders is transferring resources from one country to another through the trading mechanism. If an Australian buys a permit offshore they are actually transferring wealth to other markets. A third problem with trading across countries is that there is a lot of short term price volatility possible and the European trading system is a great example of how markets can trade from 36 Euros down to 2 Euros just because of some information that is revealed to the market. Shocks in one market would be transmitted instantly to all markets that are linked.

There are no gains in my view from short term permit price volatility – the gains and the price discovery is at the long end and not the short end of the time scale. It's really critical who gets the rights to emit in each trading period, and if you just create a series of national markets like the European system, or like a system in Australia, where you might have a 5 year or a 10

year horizon, you run into this re-allocation of property rights continuously and it's a waste of resources in terms of rent seeking activity.

4. Lessons from Monetary History

There are some historical lessons to be learnt about linking markets and let me draw out these lessons. In our modeling work in the mid-1990s Peter Wilcoxen and I leading a team at Brookings[7], discovered that there may be a problem with cross border emissions trading that depending on how you allocate permits. It is possible that once you start trading, if there are some big transfers from one region of the world to another region of the world, this can lead to large fluctuations in real exchange rates and large fluctuations in trade balances. This volatility can destabilise the global trading system. These effects are related to the Dutch disease and the classic transfer problem debates.

Trading emission permits is not just trading pieces of paper. Trading permits are transferring resources from one part of the world to another part of the world. Why is that a problem? Well, it's a problem if you look at the experience of the United Kingdom when they discovered North Sea oil in the 1970s. Suddenly the UK had a comparative advantage in oil. It had to shift resources from the manufacturing sector to the oil sector, so manufacturing industries in the UK had to be restructured. Because of a lot of stickiness in the real world, the UK ended up with an adjustment problem. The UK was better off in aggregate because they had increased wealth, but you had serious adjustment problems in getting the resources from the non-traded sectors to the oil industry.

There could be a serious problem if we gave China or India an enormous volume of permits, which some people want to do, and then buy back from those countries, because this changes the comparative advantage of these economies from labour intensive manufacturing economies to carbon abating economies. Within these economies the shift in comparative advantage could be a very significant economic shock. Again Keynes wrote about this after

[7] See McKibbin. Shackelton and Wilcoxen (1999) and McKibbin, Ross, Shackleton and Wilcoxen (1999).

World War 1[8], how can German reparation payments be transferred out of Germany to the rest of the world without causing a major disruption to the global trading system. This may or may not be a problem in practice in the climate change debate because it depends on how you allocate the permits. It depends on how the world economy evolves and how the carbon price changes over time. It depends on a lot of things, which we really aren't very good at predicting but none can be ruled out. Thus the system of global emissions trading is vulnerable.

The second lesson that emerges from experience relates to the observation that there is not a single world currency. Countries have tried periodically to move towards a single world currency but this attempt has failed to varying degrees at the global level although there have been some notable regional successes – so far. I believe that there is not going to be a single world permit market because emission permits are very similar to money. An emission permit is not a physical commodity like a pork belly. There is not a physical quantity of these things which are real. Permits are promises of government to hit an emissions target in the same way that a unit of money is a promise of a government to maintain purchasing power. The value of that promise depends on the government's credibility and because different governments in the world have different degrees of credibility and different incentives over time to debase their currencies, then you are going to have problems with governments reneging on these carbon trading markets and debasing the global currency. We have seen the consequences in the past. The world attempted to have a common global currency (a dollar standard) after the end of the Second World War in the Bretton Woods system. When it finally unraveled in the early 1970s due to uncertainty about the value of the anchor currency (the US Dollar) it was a significant shock to the global economy.

The third lesson from monetary history is how many countries have converged in the way they run monetary policy. Economists used to think that you could target the quantity of money and then let short term interest rates fluctuate. This would lead you to a good outcome with the quantity of money tying down the price level. Policymakers discovered very quickly that this nice theory actually didn't work very well in practice. In addition there were substantial costs

[8] Keynes (1929)

from short term interest rate (or price) volatility. The gains to policy came from tying down expectations about the policy goal. In different countries now the target for monetary policy tend to be inflation, or inflation over the cycle, or other nominal targets, but policy is implemented through manipulating the short term price of money while gradually adjusting to the long term goal. This is exactly the insight and lesson that we should learn for climate policy.

Climate policy should have a short run price goal, which is the price of carbon to the economy, and a long run quantity goal which is atmospheric carbon concentrations. The economy would then move from the short term to the long term in the same way that monetary policy works. Transparency, but flexibility in minimizing costs in transitioning from the short run to the long run is critical. We have learnt a lot about how to create a global monetary regime and you don't do it by having a big meeting every year where everyone makes a promise and then everyone goes back to their economies. You have national or regional monetary systems that are working in the national or regional self interest and you co-ordinate these across countries to internalise the global externalities. It is obviously the case that the externalities related to climate change are orders of magnitude bigger than the externalities from monetary policy but the UNFCCC framework is the right way to deal with these.

It is clear from the discussion so far that climate policy is more like monetary policy than it is like trade policy. The world and Australia needs a system where there are clear concentration targets, not necessarily annual timetables for emissions. There needs to be an independent agency at the national level charged with reaching those targets free of political interference but managing the costs of adjustment from where we are to where we want to be. There needs to be a very clear long term price for carbon, because just as it's the long term interest rate that drives investment, not the short term interest rate, it is the long term carbon price that will drive greenhouse gas reducing investment. It's the long term carbon price that will drive technologies, not the short term carbon price, but we need to control the short term carbon price in the same way that we control the interest rate to minimise the economic disruptions in the economy. Thus the entire argument that people make when they say that if Australia doesn't have a carbon market today, at $35 per tonne you might as well forget it, I think is completely

the wrong way to think about it. I care much less about what the price of carbon is today. I care much more about what the market says the price of carbon will be in 10, 20, 30 or 40 years into the future.

5. The McKibbin Wilcoxen Hybrid for National and Global Action

So far I have drawn an analogy between climate policy and monetary policy but how can this be implemented? The answer is contained in a book and many articles published jointly with Professor Peter Wilcoxen. Although not usually described using a monetary analogy it is actually close to the way you would implement this idea in practice. The McKibbin Wilcoxen Hybrid is the monetary approach to climate change although it is usually described as a hybrid of emissions trading and carbon taxes. It is a cooperative approach you can implement as a series of national systems that are plugged together. It can also be implemented as a global system if you can get all the countries in the world to agree to take coordinate action.

How does the McKibbin-Wilcoxen hybrid work? Firstly, the aim is to impose a long term concentrations goal - we don't discard targets for concentrations, we only discard timetables. We argue that a particular concentrations target is where we are trying to get, but we are not quite sure when we are going to get there. We also propose a way to distribute this target across countries (where flexibility) and across time (when flexibility). Secondly, we use this emissions commitment to price in a market a long term carbon target within each national jurisdiction and that's what we want to drive energy investment decisions. At the same time we control short-term costs. The whole problem of trading off the costs with the environmental benefits is at the core. We also want to create markets, which currently don't exist, where you can enable corporations and households to manage their own climate risks. If a company wants to go and build a gas fired power station in the LaTrobe Valley, putting in some fairly interesting new technology, they can have a way of hedging that investment so they can proceed despite the risks. If the carbon price rises dramatically in the future because we need to cut emission more quickly than expected, there is no blockage to closing that investment down and cashing in the long term carbon rights and moving to a different technology platform.

Components of the McKibbin Wilcoxen Hybrid

What are the components of the policy? We first create what we call long term permits. These long term permits are a bundle of annual permits with different dates for each annual permit. The annual permits embodied in the long term permits get smaller and smaller over time, so effectively the permits eventually disappear. The rights you are creating are a diminishing right to a resource and the supply of these is fixed at the national long term target. These long term permit reflects this target. An example of a long term permit is given in figure 4. The right to emit in the first year in 90% of current emissions with the annual permit each subsequent smaller than the pervious year. The long term permits are allocated freely to households and to industry. The government gets no revenue from this allocation process whatsoever, these rights are like real estate contracts, they are out there in the community owned by vested interests throughout the society and they are traded in a long term market. They are owned by consumers and firms who can sell them to generate the revenue needed to reduce their emissions. Why is that important? It's important because you want to create a constituency throughout society who own the rights to the carbon, who want to object any of the governments backsliding on future policy commitment. You also want those who reduce emissions to gain financially from doing so.

Think of these long term permits as similar to a government bond. They are like a government bond which gives you an annual coupon that gets smaller every year. As a company owning these emission rights, if you do nothing to change your emissions then you are eventually going to run into a problem because the long term permits you have been given for free (and less than current emissions) effectively disappear over time. The total initial emission for an economy in 2010 would be set 10% below current emissions so you already face a shortage. There is scarcity designed into the market. Each one of the annual coupons embodied in the long term permit can only be used in the year in which it is stamped and then it disappears. This gives you the long term pre-committed ex-ante target of the Australian government. By 2100 these long term permits are gone.

The second component of the policy, which is critical, and this is where the central bank of carbon has a key role, is that you also allow the central bank of carbon, to print annual permits in order to maintain a pre-announced price of carbon. This is the annual price that will apply five years at a time. Every five years the price is reset given the observed emission reductions or as part of a global agreement on the carbon price. If an emitter cannot get enough emissions from their long term allocation they can go to the central bank of carbon and get an annual permit for a fixed price.

What this means is that you have a permanent elastic supply of these annual permits at a fixed price. This acts like a safety valve. In the US debate it is called a "safety valve". In the Australian debate, this is what I presume the government and the White Paper and the Garnaut Review mean by holding the price fixed at a low rate initially, because I don't know how you have a quantity target and a price target in a system unless you do it in the way proposed n the Hybrid by providing additional permits if needed. This means that in any given year a company can reach their legal emissions requirement, either by using an annual coupon from the long term permit or buying an annual permit from the central bank. That's why the policy is called a hybrid, because it is permit trading of the long term permits but with a carbon tax effectively implemented in the form of an annual permit. The payment to the central bank of carbon is a tax, and thus you can satisfy your emissions from either source. Since we have scarcity in the long term permits from the very beginning, the annual price of permits will most likely be the fixed pre-announced price of annual permits, unless there is a miraculous innovation that drives the price down below that annual price – which would be very good news given the deep cuts proposed in the target path.

An example for Australia is shown in Figure 5 where the line of diamonds is the diminishing target path for the economy as a whole. The red triangles are the years in which annual prices are reset - this occurs every five years. The line of pink square boxes are an example of what actual emissions might look like in a world where the cost of reducing emissions to reach the target are greater than the initial permit prices shown in Figure 7. The sale of annual permits which is the difference between the long term target and the actual emissions

are contained in Figure 6. Over time the annual price of permits is raised until the emissions path is reached. The price of annual permits is shown in Figure 7. The value of a long term permit over time is shown in figure 8. Note that even starting at $10 per ton of CO2 reducing emissions with a permanent change in behavior frees up a long term carbon right worth $1100 per ton. Consider the impact on an innovator. Suppose you are making investment decisions about some technology that may be worthwhile to invest in now, but you really need a threshold of $50 per tonne of carbon to make the investment worthwhile. If you can look out along the yield curve of carbon prices generated in the long term market and the associated derivative markets you might see that by 2020 or by 2040 the price of carbon is expected to be $80 per tonne. At this price the new technology would be viable. If it turns out when you get to the future date, that the price is much lower than expected you can take a short position in this market to bankroll the technology, and if the price ends up collapsing you can close down the technology and trade in your assets and still make money out of the venture. Therefore this approach would encourage a lot of investment in alternative technologies to reduce emissions because you are managing the risk of investing in these technologies.

Importantly the value of long term permits are the present value of the bundle of short term permits contained in the long term permit. Suppose that the annual permit price starts at $10 per tonne. A lot of people argue that at $10 per tonne nobody is going to do anything. However because these permits have been given out to all of society, if you have some sort of industrial process, where you can reduce one tonne of carbon, in a standard carbon market you would save $10. In a McKibbin Wilcoxen market you have that carbon right for 100 years, you don't save $10 you save possibly $1100 because the saving is the present value of something that's been saved forever. The hurdle rates of return by using these long time frames in this way are transformational. This approach totally changes the cost/benefit analysis for all sorts of different technologies, significantly changing the incentives people have to reduce their abatement, because usually if you reduce a unit of carbon today, it's a permanent reduction in carbon and should be rewarded that way.

At a national level, the Hybrid approach controls the short term cost of carbon abatement policy because we don't know what the rest of the world is doing, and if the rest of the world has

done nothing, we can keep the price low until they undertake serious action. But if there was a global agreement and countries implemented policies to reach that agreement there would be an international agreement to step up the short term price over time, based on where global concentrations were heading. Thus you can implement this price stepping approach either through national action or through a global agreement.

The way I see the global system evolving is that each country will inevitably have its own system. It might be a carbon tax in a Scandinavian country. It could be a McKibbin-Wilcoxen in the US and EU but the commonness of the system is that you have a uniform price at the short end. Now why is that an efficient outcome? Well, because there are no gains from trade and an American company has no gains by buying from a European company because they can go and buy the permits from their own government. Therefore you end up with an efficient market without cross-border transactions, and therefore you can partition policy in the US, you can partition the EU, you can partition Japan. Partitioning or building firewalls between these permit market are important because if there is a shock, i.e. Japan pulls out of the system, it doesn't change the price of permits in the other systems. Under a global carbon market you would destroy the market and thus a global permit market is much more vulnerable to collapse from the actions of individual countries[9].

Bringing in Developing Countries

One of the big problems in international climate negotiations is how to bring in developing countries? Particularly when developing countries are legitimately arguing that they don't want to bear the same costs as industrial countries. What you can do within the Hybrid framework is to offer to negotiate in the international forum a much bigger allocation of long term rights than a developing country currently emits. What that means is that the short term price of carbon in a developing country would initially be zero because they are not facing a constraint today and the firewall between markets is binding. However the developing would be facing a transparent constraint in the future. Thus the long term carbon price in a developing economy will be non-zero. Eventually short term price would rise over time until they are equal

[9] See McKibbin Morris and Wilcoxen (2008) for a detailed analysis of this point.

to the price of carbon in developed economies. This is differentiation based on the level of development, but the actual catch up in price is based on capacity to pay which is determined by the allocation.

6. Summary of difference between standard approaches and the Hybrid

There are a couple of critical differences between the hybrid approach and the standard cap and trade approach or a carbon tax. Firstly, the hybrid creates long term returns to short term actions. If you own the rights for carbon for 100 years and you change something you do today, the benefit is the present value of a 100 year return. That totally changes the hurdle rates of return for different technologies. It also enables finance of innovations because you can negotiate with a bank or a venture capitalist with a technology where the investment in this technology can be hedged in the long term permit market (or a derivative market). Secondly the Hybrid creates constituencies within the domestic economy who own the long term rights to carbon in the economy. It isn't owned by the Treasury, it's owned by a lot of corporations and individuals in superannuation funds. Thus any government that tries to tinker with the future of carbon policy is going to face the wrath of the voters. For example you don't get too many Australian political parties running on the proposition that they are going to take all real estate contracts and cancel them and reallocate the real estate. Under a Hybrid with clear property rights there is a constituent balance which you don't achieve in a taxed based system and you don't achieve it from an allocation system of short term rights.

Summing up - climate change policy is a serious issue that all countries have to deal with. It is dealing with the climate change uncertainty that matters. Any effective policy will be a major change to the Australian economy. Missing markets need to be created. These are not short term carbon markets nor a new tax. The key is a long term market in trading climate uncertainty. It is also important to understand that there is still a great deal of uncertainty about where world policy is actually heading. If you did take a Garnaut or CPRS type approach where you commit to a precise target or a range of targets on the off-chance that you would be able to

trade your way out of the target by buying cheap permits offshore if it is too expensive, but the permit market doesn't develop offshore, what do you do? You may have locked yourself into an international agreement with no safety valve. Relying on the development of a global trading system without a safety valve domestically is a very risky policy.

The final point to stress is that it is critical to get away from this idea that we know exactly where we want to go and that there are no trade offs in getting there. That's called religion. But we have to deal with trade off between the environmental benefit of taking action and the economic costs of getting there. If we don't acknowledge that, we will not get an international agreement because it's the cost part of the negotiations where the international agreements are failing. Developing countries have bigger problems to deal with, from their own perception, than climate change, but they are willing to be part of the international process if it constructed in the right way.

7. Conclusion

Economic history has a lot to teach policymakers on how to design effective climate policy at the national level within a global cooperative agreement. It is time to move in this direction of building a transparent, credible, national or regional focused policy framework, with flexibility to adjust in a clear way over time towards a global concentration goal. The almost religious focus on targets and timetables no matter what it costs is the biggest hurdle to overcome in the climate change policy debate. There are better ways to generate carbon prices than what is currently being proposed. One such approach – the McKibbin Wilcoxen Hybrid has been the focus of this Lecture.

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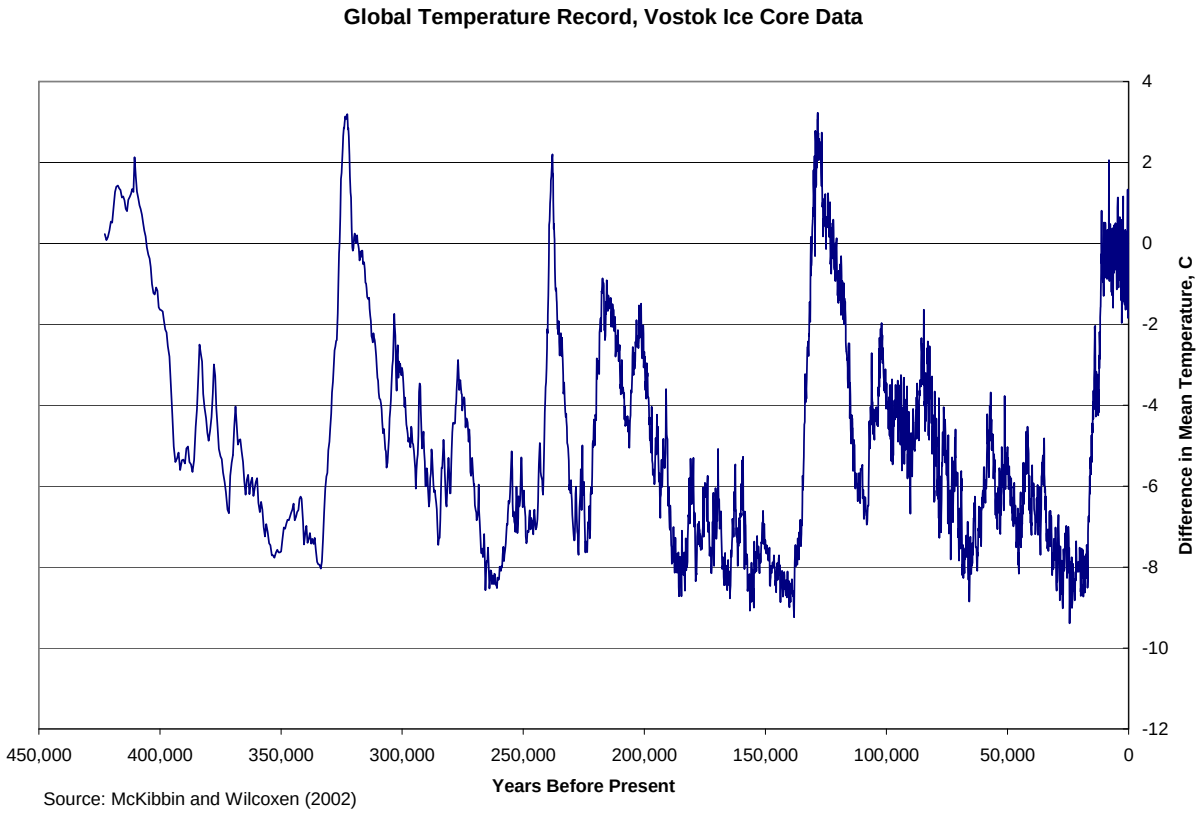
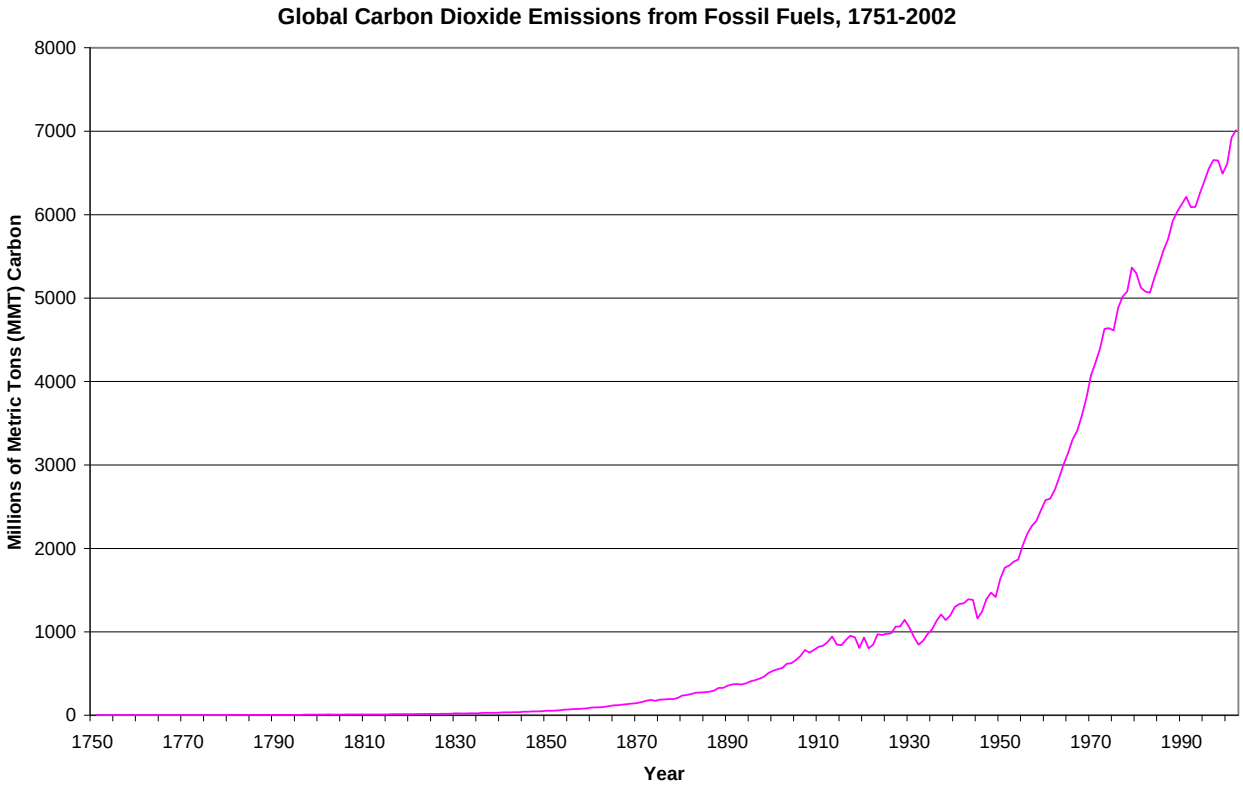
Figure 1



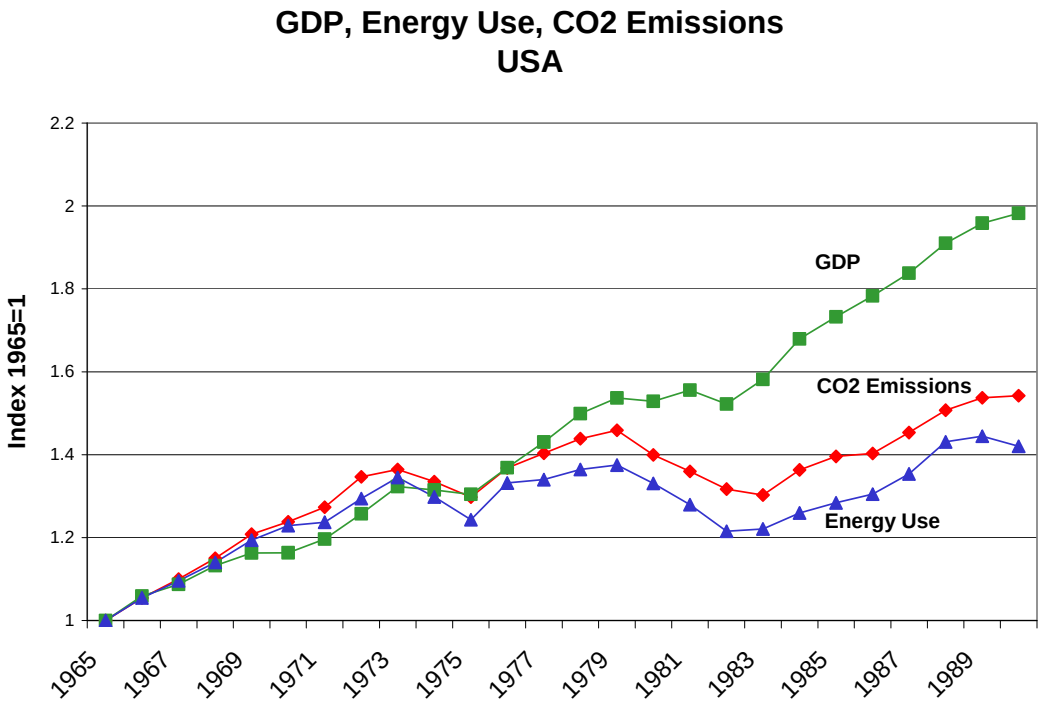
Source: McKibbin and Wilcoxen (2002)

Figure 2



Source: McKibbin and Wilcoxen (2002)

Figure 3



Source: Bagnoli, McKibbin and Wilcoxen (1996)

Figure 4: A Long term permit

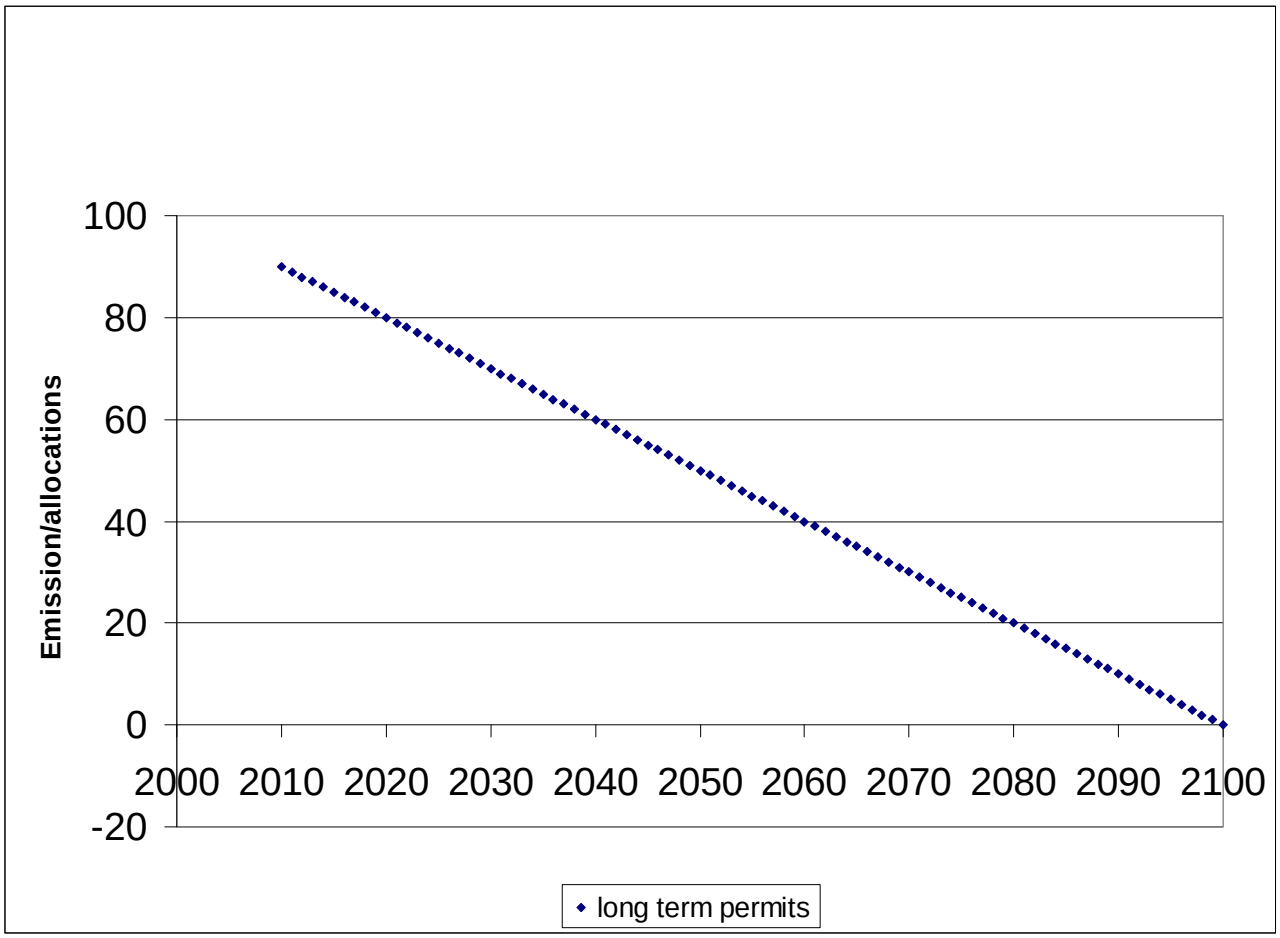


Figure 5: Emissions and long term permits in Australia

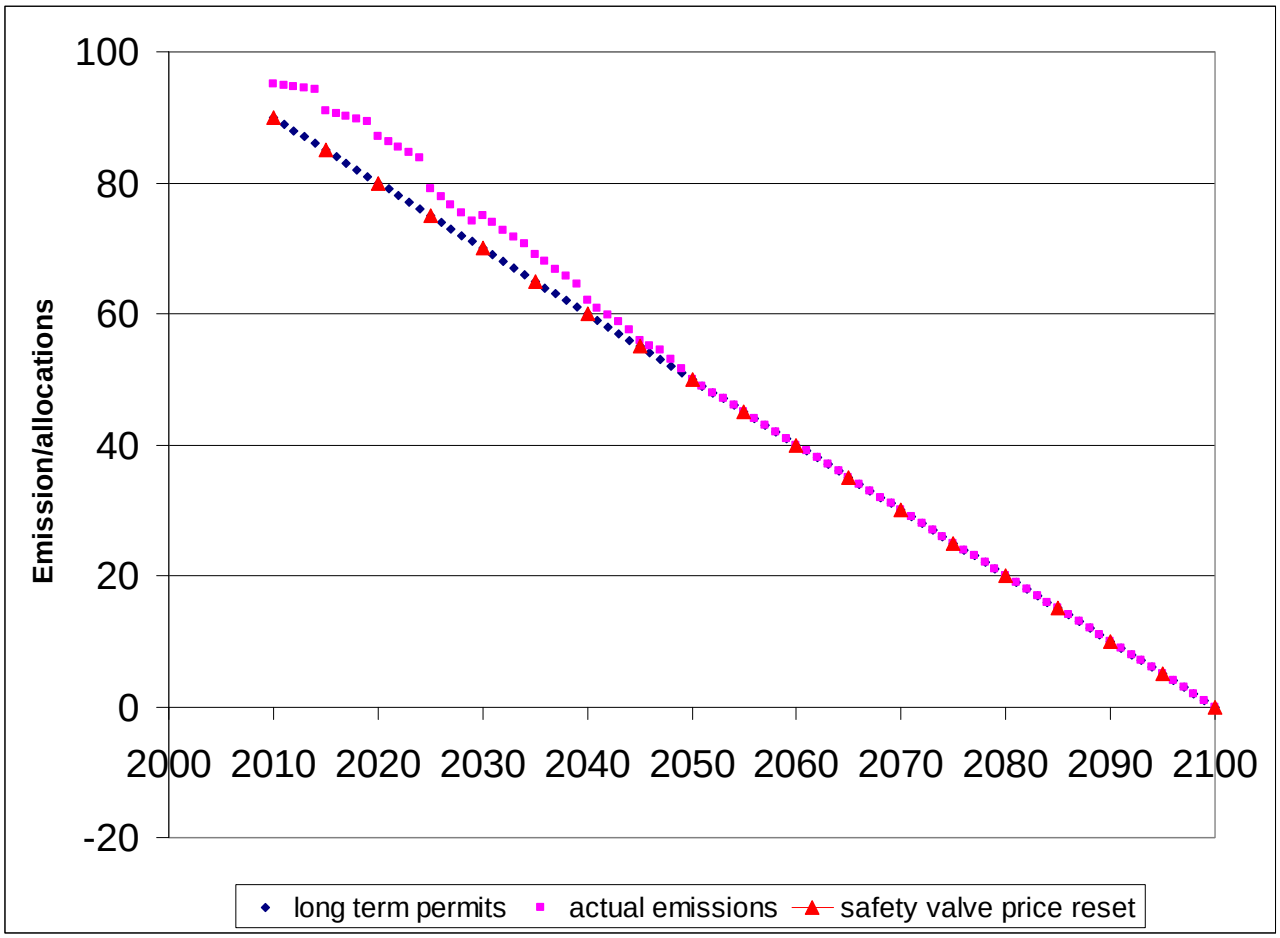


Figure 6: Annual permit sales

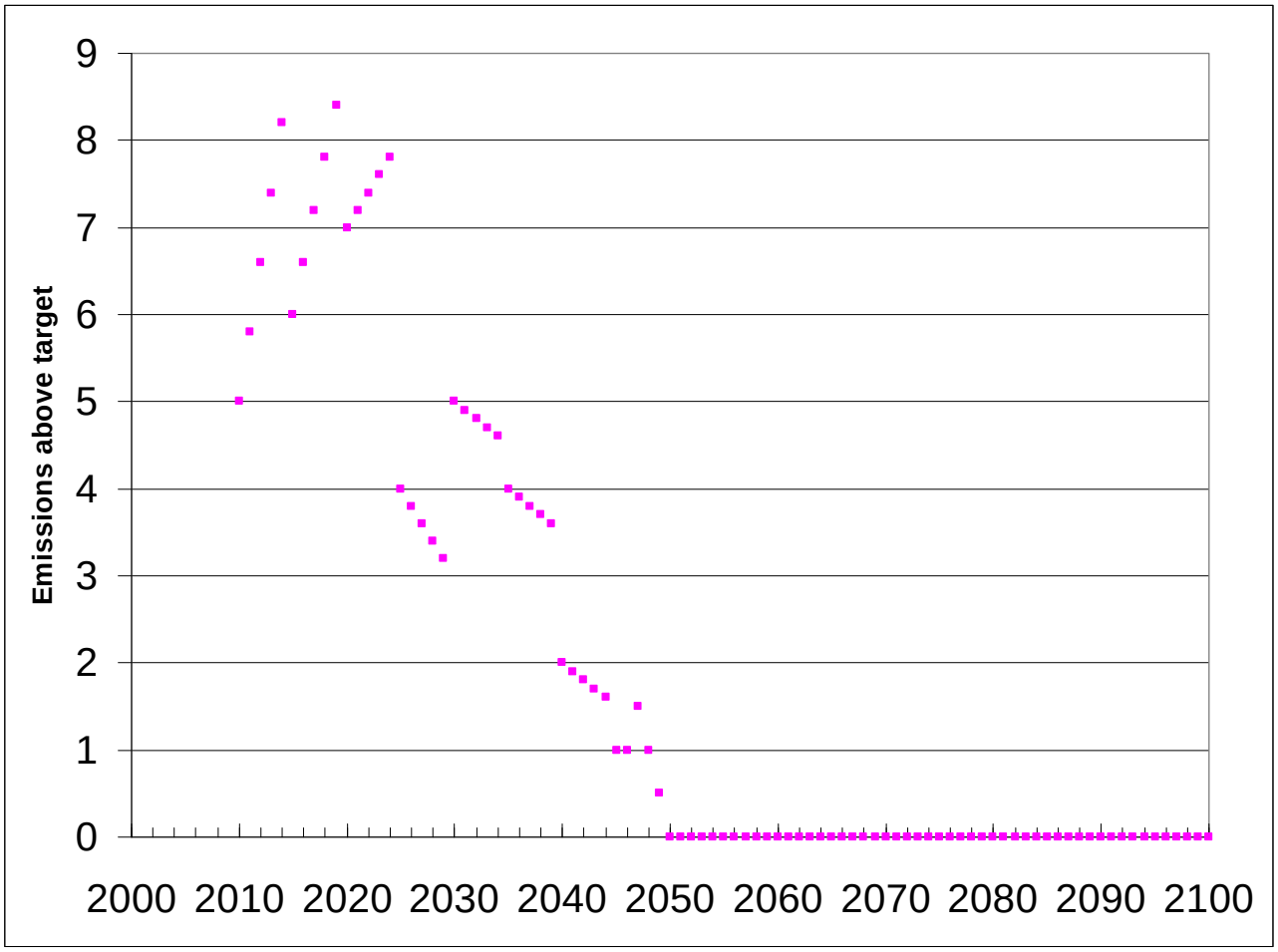


Figure 7: Annual permit price

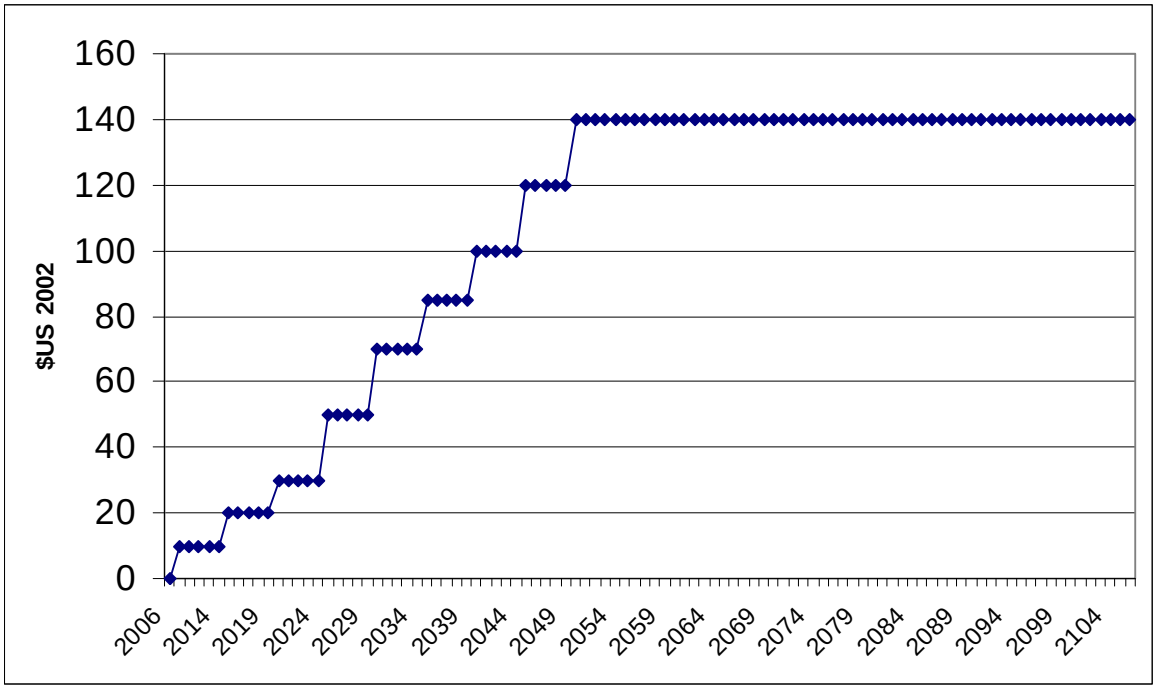
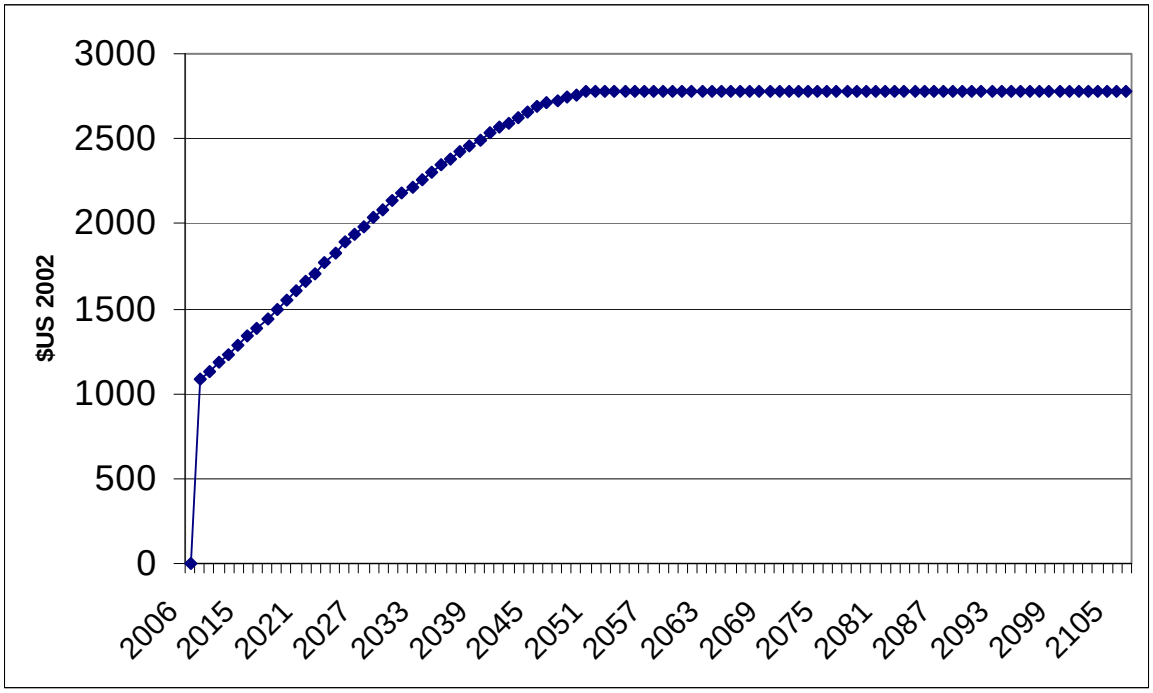


Figure 8: Stylized value of long term permits (assuming r=5%)



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SELECT COMMITTEE ON THE SCRUTINY OF NEW TAXES

LEGISLATION COMMITTEE

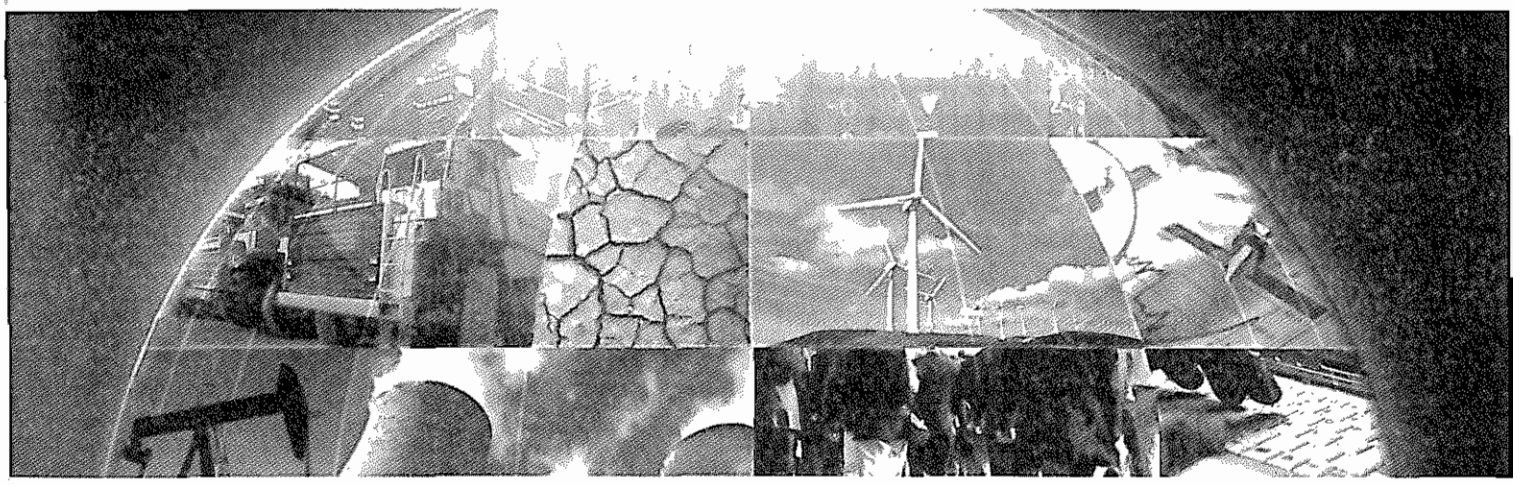
Inquiry into Carbon Tax Pricing Mechanisms

SUPPLEMENTARY SUBMISSION ATTACHMENT

SUBMISSION NUMBER: **25**

SUBMITTER: **Warwick McKibbin**

CLIMATE CHANGE GETTING IT RIGHT



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COMMITTEE FOR ECONOMIC DEVELOPMENT OF AUSTRALIA

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managing price AND

Why a hybrid policy is better for Australia

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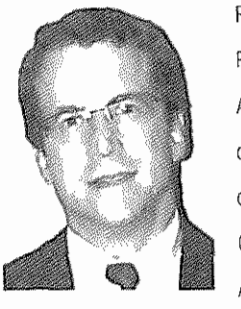

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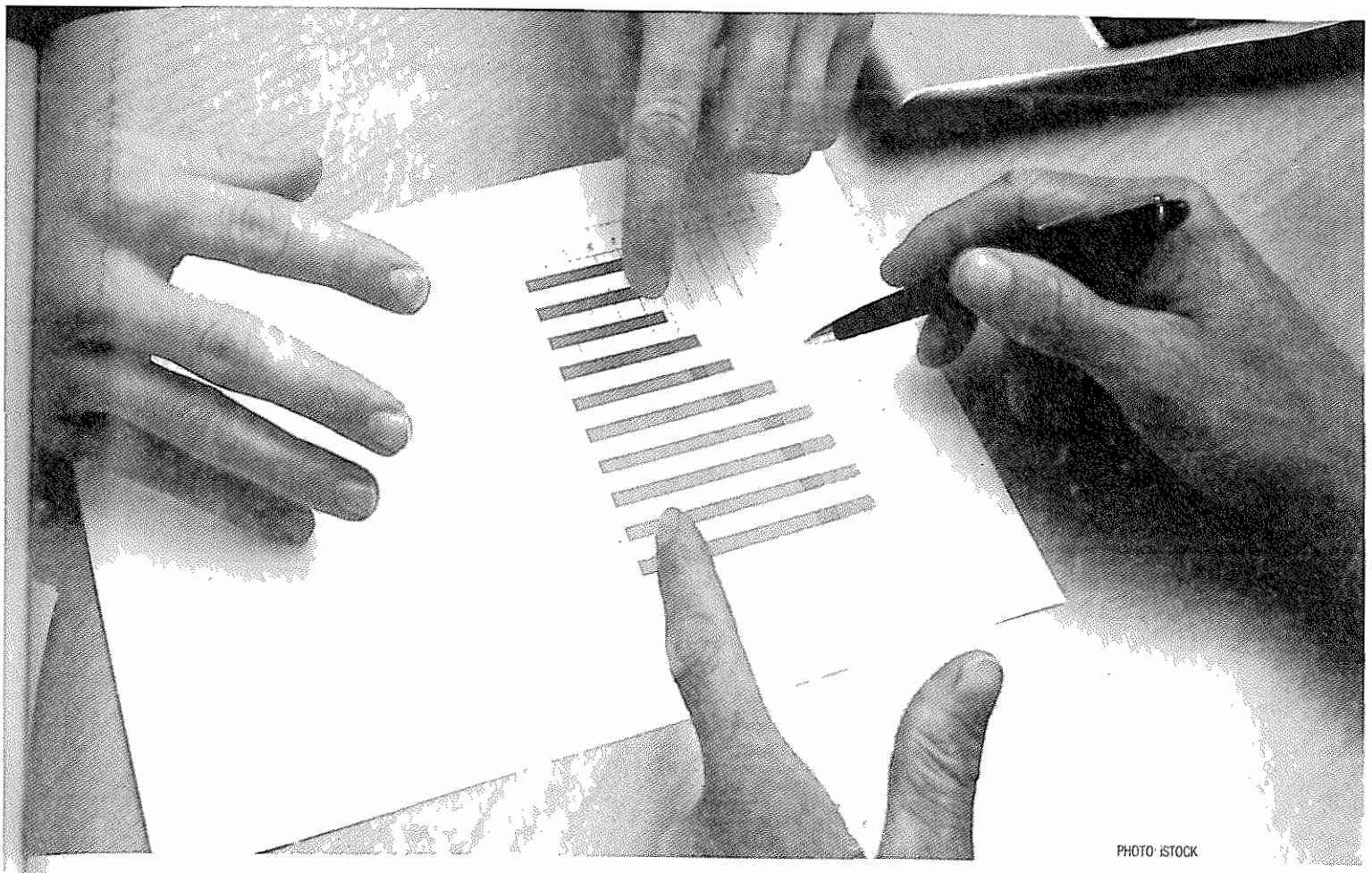


PHOTO: iSTOCK

and use of large-scale intertemporal general equilibrium models. He is a co-author of the Jorgenson-Wilcoxen model, a 35-sector econometric general equilibrium model of the US economy that has been used to study a wide range of environmental, energy and tax policies. He is also a coauthor of G-Cubed, an eight-region, twelve-sector general equilibrium model of the world economy that has been used to study international trade and environmental policies. He has published more than 50 papers and has co-authored two books: one with Warwick McKibbin on the design of an international policy to control climate change, and one with Peter Dixon, Brian Parmenter and Alan Powell on the design and construction of large-scale economic models. Dr. Wilcoxen's past positions include: Associate Professor of Economics, the University of Texas at Austin; Assistant Professor of Economics, the University of Texas at Austin; Visiting Fellow, the Brookings Institution; Visiting Scholar, Harvard University; and Senior Research Fellow, the University of Melbourne in Australia. His research has been funded by the Environmental Protection Agency, the Department of Energy, the US Geological Survey, and the National Science Foundation.

Summary

Promising to reach an emissions target on a precise timetable is a popular approach to climate policy – indeed it underlies the Kyoto Protocol. Despite its popularity, there are many problems with this strategy. A better approach is to specify a target but to allow costs to determine the speed at which the target is approached. This can be achieved using a hybrid of targets and emission fees. This paper summarises the targets and timetables approach to climate policy and how it is usually implemented in cap-and-trade permit markets. However, as a basis for domestic policy or for an international climate regime there are major flaws in this approach. We then present the McKibbin Wilcoxen hybrid approach and compare it to the approach proposed by the Prime Minister's Emissions Trading Task Group.

Introduction

Climate change is caused by anthropogenic emissions of greenhouse gases, principally carbon dioxide, and addressing it will require those emissions to be reduced over time. Many people believe that the best way to reduce greenhouse gas emissions is to specify a target for emissions and a timetable for reducing those emissions. This "targets and timetables" approach seems like common sense and, until recently, has been the basis of most of the climate policy debate in Australia and internationally. The Kyoto Protocol, for example, requires that participating countries achieve specified emissions targets over the period 2008–2012. Unfortunately, many aspects of the targets and timetables approach that look so attractive in theory do not work well in an uncertain world.

Setting targets and timetables seems like commonsense because it's a familiar approach that works well in many day-to-day situations. When driving from one part of the country to another, for example, it's natural to set goals for each day's drive. These goals are achievable because of the relative certainty of the driver's information. As a climate policy, however, a targets and timetables strategy is flawed because climate change involves vast uncertainties, especially in the cost of reducing emissions. Any significant climate policy is largely a venture into unknown territory. Establishing a set of emissions targets to be achieved by specific dates makes no more sense than deciding to drive through a sequence of cities on particular dates without a map, and without knowing the distance between the cities or the obstacles that may lie along the way.

The initial step in a targets and timetables program is to establish a sequence of emissions targets and set a timetable over which the former will be achieved. Once the targets have been adopted there are a number of policies that could be used to achieve them: subsidies for emissions-control devices; direct intervention such as mandating the use of particular devices or technologies for controlling emissions; an appropriate emissions tax; or creating markets in emissions rights based on the target. Economists generally agree that a market-based approach is the lowest cost way to implement an emissions target. In recent years much attention has been focused on so-called cap-and-trade mechanisms, under which total emissions are capped but firms are permitted to buy and sell emissions allowances among themselves. The cap-and-trade approach has many attractive features for conventional pollutants, but it has important liabilities for climate policy. In particular, it does not work well in a world of uncertainty.

In this paper we argue that there is a much better approach to climate policy, one that addresses the inherent uncertainties and provides credible, long-lasting incentives for reducing emissions. It is a hybrid approach that combines the best features of two market-based mechanisms used for controlling other kinds of pollution – emissions taxes and tradable permits.

The second section of this paper, "Policy risks", summarises the reasons climate policy is difficult to formulate and why uncertainty must be at the core of policy design. The following section, on carbon trading, outlines the standard way of implementing the approach of targets and timetables in the form of cap-and-trade emissions trading. The problems with the cap-and-trade approach are outlined in the next section titled "The hybrid blueprint", where it is argued that the appropriate short-term policy for Australia is to abate emissions up to a particular cost, rather than to hit a particular emissions target. This can be done via a hybrid of a permit trading system based on long-term permits and a price-based system with a short-term price cap. In the final section we summarise how a hybrid approach could work in Australia and compare the approach we proposed (McKibbin and Wilcoxen 2002) with the approach of the Prime Minister's Task Group on Emissions Trading (2007).

Policy risks

Designing a viable and effective climate policy is very difficult for a number of reasons. First, climate change cannot be entirely prevented, even if worldwide emissions were to cease immediately. The accumulated greenhouse gases from past emissions, largely from industrialised economies, would continue to raise global temperatures for decades to come. Thus, a comprehensive response to climate change will require both mitigation actions – to reduce emissions and decrease the severity of climate change – and adaptation policies to respond to climate change that can no longer be prevented. Second, climate policy is complicated by the extraordinary range of emissions sources, from individuals to major corporations. Third, it is a policy that must cross many jurisdictions – international organisations, national, state and local governments – which makes formulating and coordinating the policy extremely difficult. Fourth, the time scales for climate policy are much longer than most other policy problems. Policies enacted today may not have noticeable effects on the climate until 50 years or more into the future. Finally, the uncertainties surrounding climate change are large, numerous and mostly intractable. There is uncertainty about future emission levels, the impact of these emissions on future carbon dioxide concentrations, how those concentrations affect the timing and extent of temperature change and climate variability (and distribution across regions), what impacts these temperature changes and variability have on ecological systems and the extent of economic damages and economic benefits in different regions at different times. Most difficult of all, climate change could lead to large changes in sea level and other catastrophic events, but the likelihood of these catastrophes is both low and poorly understood. Formulating a policy to reduce the chance of rare but disastrous events is especially challenging.

What should be done given the uncertainty? Fortunately, the conceptual techniques for understanding uncertainty and managing risks are well developed, and they should be at the core of any climate policy. Climate policy should be designed to manage risks, especially taking into account the unusual nature of the risks associated with climate change. For example, the possibility of catastrophic outcomes from climate change needs to be taken into account. It is also necessary to make sure that the costs of mitigation actions are not excessive because there are many other problems competing for society's scarce resources, such as alleviating poverty or controlling preventable diseases. Important trade-offs are involved, hence it is essential to take into account the opportunity cost of the actions taken in policy.

FIGURE 1
PERMIT MARKET EQUILIBRIUM IN LOW- AND HIGH-COST CASES

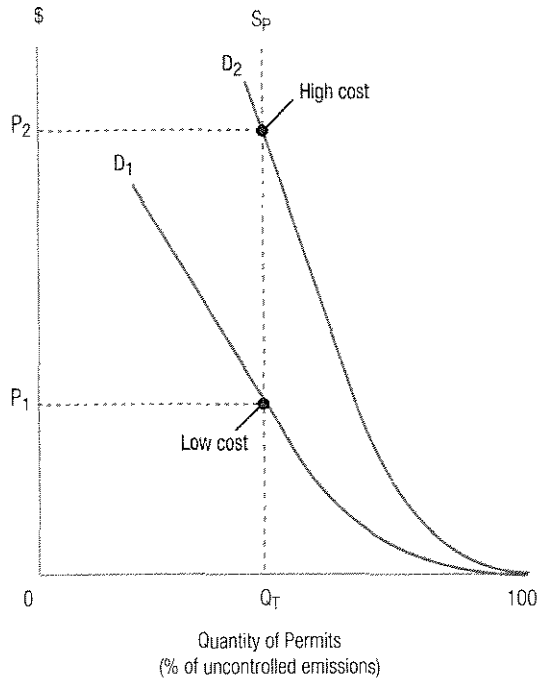
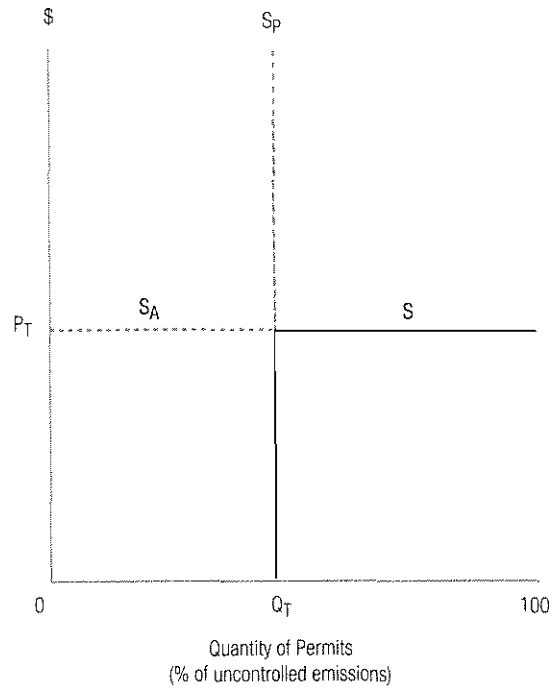


FIGURE 2
SUPPLY OF EACH TYPE OF PERMIT FOR USE IN A GIVEN YEAR



Carbon trading

The idea behind a cap-and-trade permit system is relatively straightforward. A target for emissions is chosen for a given year. Emission permits are then printed and distributed for that year. Legislation is also enacted that requires an emitter of carbon to have permits equal in number to its emissions, and to specify rules for monitoring polluters and punishing violators (for example, the penalty for non-compliance is often a very high fee). Figure 1 illustrates the resulting market for permits. With a cap on emissions fixed at quantity Q_T, market trading will result in a price that depends on the demand for permits. The demand for permits, in turn, will depend on the marginal abatement costs. The higher the marginal abatement costs, the higher the demand for permits at a given price. In Figure 1, if abatement costs are low the demand for permits will be low. The demand curve might look like D1, and the price that the market generates will be P1. However, if the marginal abatement costs are relatively high the demand for permits will be given by curve D2.

This is a conventional cap-and-trade permit trading system. The strength of the system is that the emissions outcome is known and specified explicitly in the policy: it is the target Q_T. However, the price of an emissions permit (often called the price of carbon) will not be known until after the market clears. Moreover, it will move around with shifts in the demand for permits, and can be highly variable. A conventional permit system works well if there is a clear target that needs to be achieved, such as with a "threshold pollutant" that causes damage only when it exceeds a particular level. In this case the way to reduce risk sharply is to set a clear emission target that is not to be exceeded under any circumstances. However, the system does not work well for pollutants that don't have thresholds, such as carbon dioxide. For such pollutants there is no clear distinction between safe and dangerous levels; all emissions contribute equally to the problem.

Moreover, what matters for the climate is the concentration of emissions in the atmosphere. It is not the flow of emissions each year but rather the accumulation of these emissions over time that is important. As a result, it is important to achieve any given amount of abatement as cheaply as possible over time. Reaching a precise target at high cost in one year and then achieving the same target at low cost in another year would be inefficient because it is the sum of emissions in the two years that matters. It would be better to do more abatement in the low-cost year and less in the high-cost year. A conventional carbon-trading market performs poorly in this context because it targets the annual flow of emissions rather than the stock. A better policy would be to have a flow of emissions each year that is determined in a manner allowing for cost-smoothing over time. As will be discussed below, the hybrid approach allows exactly that.

Climate scientists generally agree that if global temperatures are to be stabilised there needs to be a substantial reduction in the flow of emissions. Deep cuts in emissions are required to stabilise temperatures. This is why many of the proposed reductions in emissions are quite steep – perhaps as much as 60 to 80 per cent reductions in the flow of emissions by 2050.[1]

The hybrid blueprint

A hybrid approach to pollution control, which would combine the best features of emissions taxes and tradable permit systems, was first proposed by Roberts and Spence (1976). A hybrid policy for climate change was first introduced by the authors of this paper in 1997 and has been extended and refined (McKibbon and Wilcoxen 2002, 2007). The hybrid we described back in 1997 was relatively simple. A country wishing to control its carbon emissions would issue a limited number of tradable long-term emissions permits, each of which would entitle the owner to emit one ton of carbon per year. A polluter emitting more than its permit holdings in any given year would be required to pay an emissions fee per ton of carbon in excess. In essence, the policy would present polluters with two mechanisms for compliance: buying permits or paying an emissions tax (or any combination of the two). The emissions fee is often referred to as a "safety value" because it would ensure that the costs of complying with the policy were not excessive. The idea of a safety valve has been adopted in the domestic debate in the United States.[2] We subsequently refined the proposal into a unified permit system with two classes of permits: the long-term permits described above, and short-term permits good only for one year and sold by the government for a stipulated price. In addition, the approach was extended to allow for differentiation between developed economies by imposing a tight and tightening constraint on developed economies over time but a loose and tightening constraint on developing countries, and adapted to provide stronger incentives for technological innovation.

All versions of the approach would provide a foundation for a global system of emissions control, but the emphasis would be on coordination of national policies rather than on imposition of an overarching international regime. Coordination would focus on achieving a common world price for carbon rather than implementing a rigid system of targets and timetables. An advantage of this approach is that it would build the global system by starting at national level in a few countries and adding greater coordination and additional countries over time. Moreover, it would not require global consensus and would allow individual countries scope to tailor the policy to meet their own national interests. Most importantly, establishing clear, credible policies at the national level will be essential for encouraging the private sector investments in key energy infrastructure that will be needed to address climate change.

Our approach, which we will refer to as the McKibbin-Wilcoxen Blueprint (MWB), has been widely discussed and extensively refined over the last decade. Moreover, elements of it have been adopted in many alternative proposals.[3] In the remainder of this section, we present a synopsis of the current version of the MWB proposal.

Long-term permits

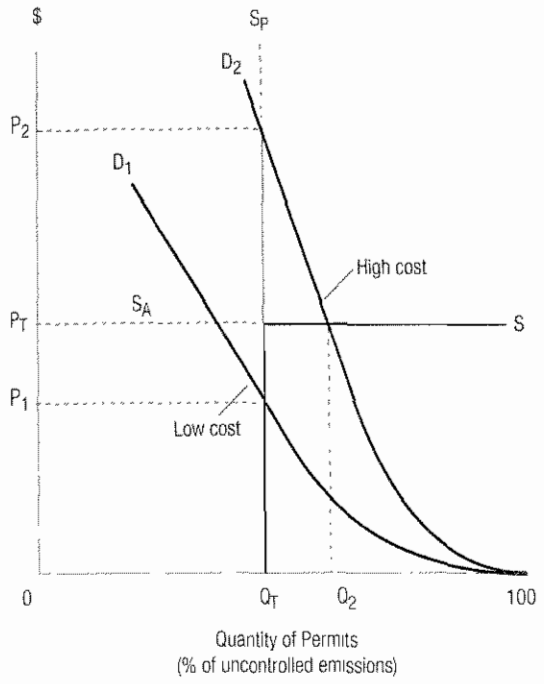
The core of the proposal is to combine a fixed (and declining) supply of long-term permits with a flexible supply of short-term permits that would be valid for only a single ton of emissions in a specified year. For convenience we'll refer to the different types of permits as long-term permits and annual permits. The long-term permits can be thought of as a bundle of short-term permits with differing dates, all packaged together. These long-term permits represent the long-term target for emissions. In practice, the number of long-term permits issued would be less than current emissions and would be declining over time, reflecting the desired target path for emissions. Once issued, the long-term permits could be bought, sold or leased without restriction and each one would allow the holder to emit a pre-specified amount of carbon per year. There would only be a one-off allocation of long-term permits. They could be given away, sold at a set price or auctioned. After the allocation the permits could be traded among firms and households, or bought and retired by environmental groups. Only those activities that emit carbon would require an acquittal of permits at the end of each calendar year. However, anyone could own the permits. The permits would have value because: (1) by law, emitters are required to have an annual permit and there would be fewer available than needed for current emissions; and (2) the number of permits would be diminishing over time, increasing their scarcity value. As a consequence, the owners of long-term permits would form an interest group with a large financial stake in the success of the policy. They would improve the policy's credibility because a large private-sector group with a clear financial interest in the policy would help prevent future governments from weakening or repealing it.

Short-term permits

The other component of the policy, annual emissions permits, would be issued by the government each year for a specified fee, such as $20 per ton of carbon dioxide. There would be no restriction on the number of annual permits sold, but each permit would be good only in the year of issue. The annual permits give the policy the advantages of an emissions tax: they provide clear financial incentives for emissions reductions but do not require governments to agree to achieve any particular emissions target regardless of cost.

Every year emitters within the country would be required to hold a portfolio of permits equal to the amount of carbon emissions they produce. The portfolio could include any mix of annual permits, long-term permits owned outright by the firm, or long-term permits leased from other permit owners. The implications of this can be seen in Figure 2, which shows the supply of permits available in any year. At a price below P the market price of permits is flexible and determined by demand, given the supply of long-term permits. Once the price rises above P_T

FIGURE 3
MARKET EQUILIBRIUM IN LOW- AND HIGH-COST CASES



the market price is determined by the government cap and the supply of annual permits. Figure 3 shows why this is important. If the marginal cost of abatement is low the market delivers a price of P_1. If the demand for permits is high, because it is costly to reduce emissions in the given year, then the price is bounded by P_T.

Investment incentive

Although the policy is more complex than an emissions tax or conventional permit system, it would provide an excellent foundation for large, private sector investments in capital and research that will be needed to address climate change. To see why, consider the incentives available to a firm after the policy has been established. Suppose the firm has the opportunity to invest in a new production process that would reduce its carbon emissions by one ton every year. If the firm is currently covering that ton by buying annual permits, the new process would save it $20 per year every year. If the firm can borrow at a 5 per cent real rate of interest it would be profitable to adopt the process if the cost of the innovation were $400 or lower. For example, if the cost of adoption were $300, the firm would be able to avoid buying a $20 annual permit every year for an interest cost of only $15. Adopting the process, in other words, would eliminate a ton of emissions and raise profits by $5 per year.

Firms owning long-term permits would face similar incentives to reduce emissions, because doing so would allow them to sell their permits. Suppose a firm having exactly the number of long permits needed to cover its emissions faced the investment decision in the example above. Although the firm does not need to buy annual permits, the fact that it could sell or lease un-needed, long-term permits provides it with a strong incentive to adopt the new process. At a cost of adoption of $300, the firm could earn an extra $5 per year by borrowing money to adopt the process, paying an interest cost of $15 per year, and leasing the permit it would no longer need for $20 per year.

The investment incentive created by a hybrid policy increases with the annual permit fee. For example, raising the fee from $20 to $30 raises the investment incentive from $400 to $600. That makes sense: if emitting a ton of carbon becomes 50 per cent more expensive every year, the amount a firm would pay to avoid that cost should rise by 50 per cent as well. Raising the annual fee even further would continue to increase the incentive in proportion, provided that the policy remains credible: a $40 fee generates an $800 investment incentive; a $50 fee generates a $1,000 incentive; and so on.

The critical importance of credibility becomes apparent when considering what would happen to these incentives if firms are not sure if the policy will remain in force. If the policy were to lapse at some point in the future, emissions permits would no longer be needed. At that point any investments made by a firm to reduce its emissions would no longer earn a return. The effect of uncertainty about the policy's prospects is to make the investments it seeks to encourage more risky. Firms will take that risk into account when evaluating climate-related investments and will be willing to pay far less to undertake them as a result. Consider the same investment that would save a firm $20 a year if the policy is in force, but now suppose the firm believes that there is a 10 per cent chance each year that the policy will be repealed. That may sound like a small erosion of credibility, but it can be shown that it reduces the maximum amount the firm would be willing to pay for the innovation from $400 to only $133. The drop in credibility – from 100 per cent confidence in continuation of the policy to 90 per cent – reduces the incentive for investment by two-thirds.

Policy stability

Since the incentives created by the policy increase with the price of an annual permit, a government might try to compensate for low credibility by imposing higher annual fees. For example, suppose a government would like a climate policy to generate a $400 incentive for investment but firms believe that there is a 10 per cent chance the policy will be abandoned each year. For the policy to generate the desired incentive, the annual permit price would have to be $60 rather than $20. That is, the stringency of the policy (as measured by the annual permit fee) must *triple* in order to offset the two-thirds decline in the incentives arising from the policy's lack of credibility. In practice the situation is probably even worse. Increasing the policy's stringency is likely to reduce its credibility further, requiring even larger increases in the annual fee.

FIGURE 4
EMISSIONS AND LONG TERM PERMITS IN AUSTRALIA

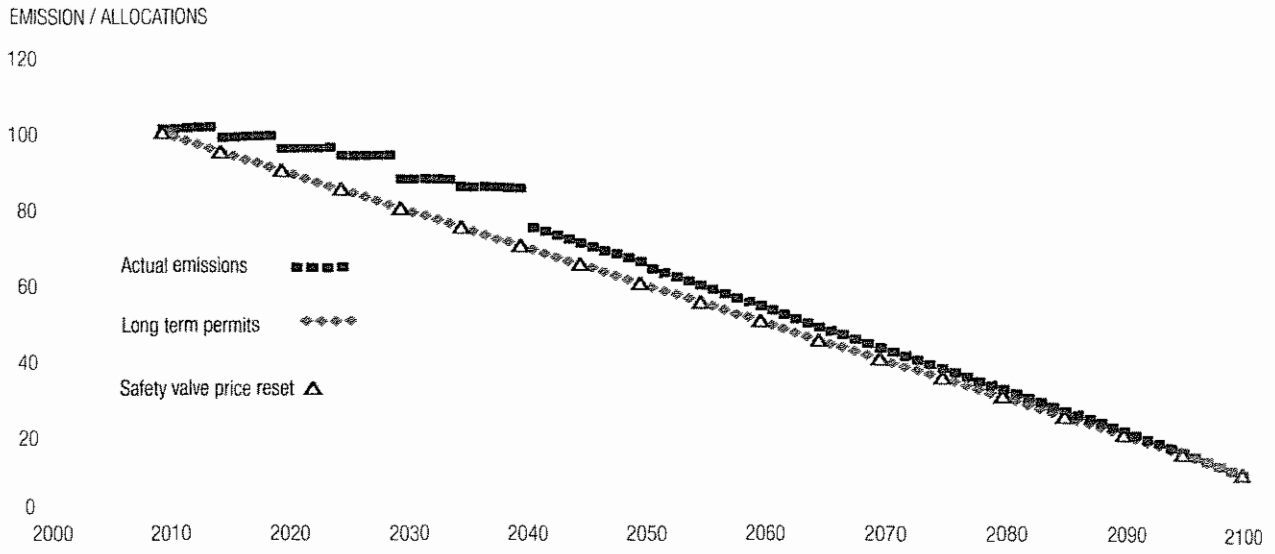
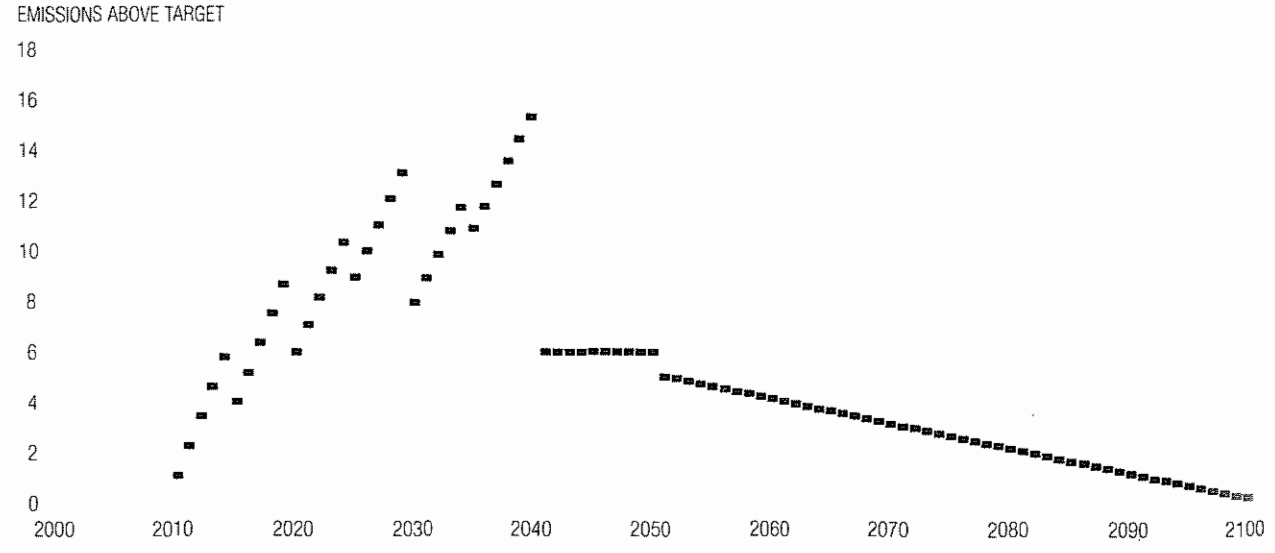


FIGURE 5
ANNUAL PERMIT SALES – AUSTRALIA



For example, suppose investors believe it is probable that the government will abandon the policy rises by 1 per cent for each $20 increase in the annual fee. In that case, maintaining a $400 investment incentive would require an annual fee of $70 rather than $60, which would be accompanied by an increase in the perceived likelihood of the policy being abandoned from 10 to 12.5 per cent. The general lesson is clear and vitally important to the development of an effective climate policy: a modest but highly certain policy generates the same incentives for action as a policy that is much more stringent but less certain. A hybrid policy with a modest annual permit price would generate larger investment incentives than a more stringent, but less credible, emissions target imposed by a system of targets and timetables.

In summary, a hybrid policy combining a fixed supply of tradable long-term emissions permits with an elastic supply of annual permits would be a viable and efficient long-term climate policy at the national level. It would be more credible than many alternatives, especially a carbon tax, because it builds a political constituency with a large financial stake in preventing backsliding by future governments. It thus addresses the inherent difficulty that a democratic government faces in binding future governments to continue carrying out the policy. At the same time, the provision for annual permits allows the hybrid to avoid the inefficiencies and political hurdles that would arise with a conventional system of permits that imposed a rigid cap on emissions. It would provide a strong foundation for investment decisions by the

FIGURE 6
ANNUAL PERMIT PRICE

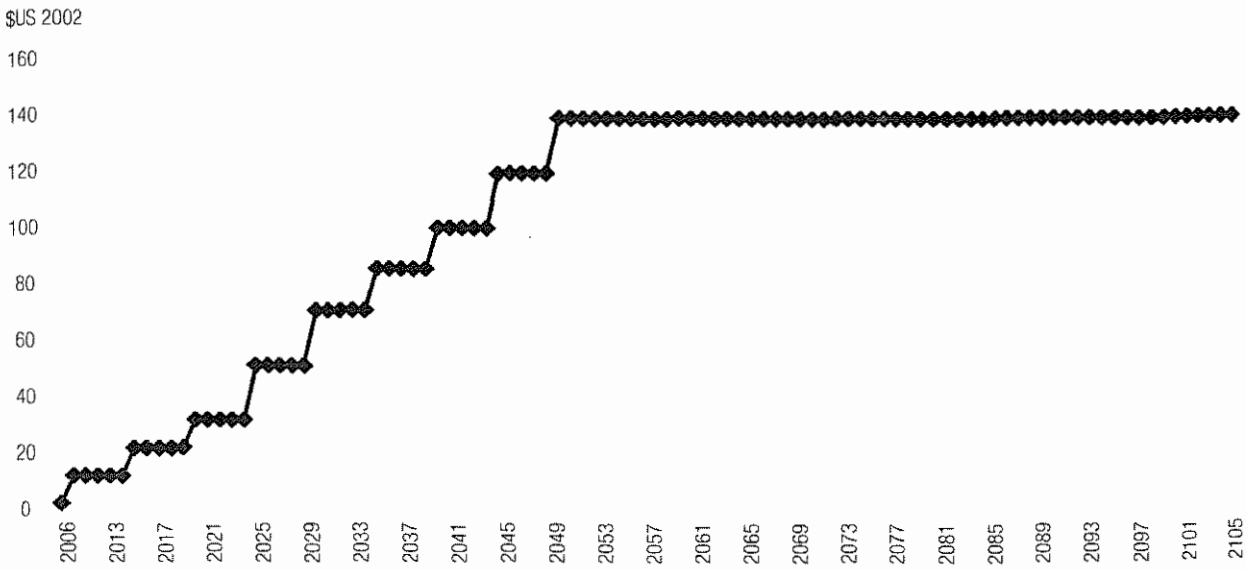
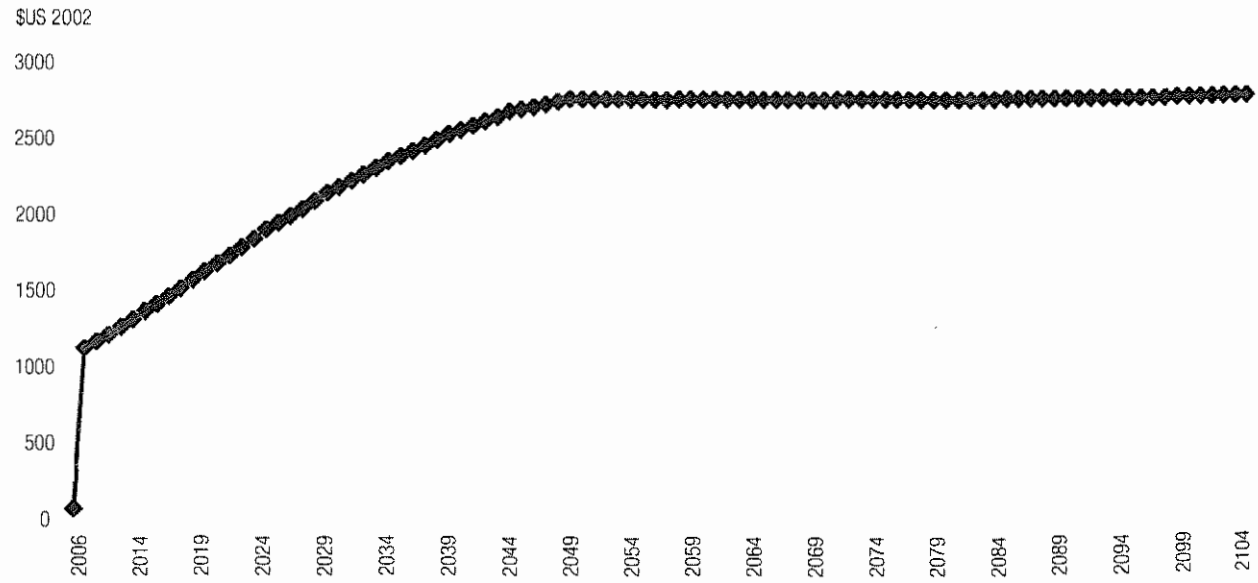


FIGURE 7
STYLISED VALUE OF LONG-TERM PERMITS



private sector because it would create credible, long-term returns for reducing greenhouse gas emissions.

To illustrate how this would work in practice, one possible scenario is illustrated in Figures 4 through 7. In Figure 4, the diamond line shows a long-run emissions target with emissions normalised to 100 in 2010, then declining to 60 units by 2050, and to 10 units by 2100. This target is also the quantity of long-term permits that are issued in 2010 with each long-term permit giving an equivalent annual permit allocation that diminishes over time. The actual emissions in this scenario might look like the broken line above the target path. The curve implies that the price cap was reached in most years and annual permits were issued (since the curve lies above the diamond line). The extent of annual permit sales is shown in Figure 5. Figure 6 shows the path of annual permit prices in this particular scenario. The safety valve price in this scenario has been set to follow a step pattern: increasing every five years but constant between the revisions. The price gradually ratchets up until the long-term target is achieved. Figure 7 shows the value of long-term permits each year. This is the expected future value of annual permit prices. It is clear that even a low initial price, when combined with a rising expected future price, can create a valuable long-term permit. This, in turn, creates significant wealth in the present from activities that will reduce carbon emissions in the future.

Carbon trading in Australia

One of the problems of a cap-and-trade permit trading system is that it requires a careful calculation of the cap. Setting a very tight target could, over time, lead to excessive costs being incurred. Setting too loose a target could, over time, result in excessive emissions and a missed opportunity for rapid, low-cost emission reductions. In determining the optimal target for Australia one option would be to use the percentage reduction in global emissions advocated by the Stern Review. However, this approach is likely to be sub-optimal when costs are taken into account. Numerous studies comparing marginal abatement costs show that Australia is relatively high on the list (that is, it has relatively high marginal abatement costs).[4] Under a global targets and timetables system, international permit trading is usually advocated as a way for high-cost countries to reduce their costs by buying emission reductions from low-cost countries. As a result, the marginal costs of the reduction would be equalised across participating countries. Although marginal costs will be equated, different countries might undertake very different emissions reductions. This key point seems to be ignored in the current policy debate on what unilateral actions countries such as Australia should take, which seems to presuppose equal percentage reductions.

One way around this dilemma is to choose a target without a specific timetable and focus on capping the short-term costs to the economy. This is the approach of the MWB. The long-run target is implemented in the long-term permit market. The cost of getting this calculation wrong in any particular year is limited by the operation of the safety valve, under which the government can print annual permits as needed to cap the short-run price. In a conventional cap-and-trade system the government does not have this capacity and cannot easily smooth out short-run difficulties in achieving the target over time. The only way around this problem is to set a short-time horizon for the emissions target and then renegotiate the target frequently through time. This is indeed the Kyoto strategy. The problem with this approach, however, is that is does not give clear or credible signals about future carbon prices, especially beyond the period of the commitment.

The PM's Task Group

Another approach has been proposed in the recent report by the Prime Minister's Task Group on Emissions Trading (2007). This report is a wide-ranging assessment of climate policy and is far more detailed than the MWB, although the basic idea is the same; that is, to tackle the climate problem by setting a long-run target with a flexible timetable and a short-run safety valve focused on minimising costs through time. However, there are some significant differences in implementation between the two approaches.

The first difference is in the way in which the safety valve is implemented. In the Task Group approach (TGA), the safety valve is a penalty that emitters must pay to the government if their emissions exceed the permits which they hold. The price effect of this is the same as buying annual permits from the government under the MWB approach. However, under the TGA it is a sanction for bad behaviour, whereas under MWB it is a market transaction in annual permits.

The second difference is that rather than setting a long-run goal for emissions and creating assets that reflect this goal and distributing these assets at the commencement of the trading, the TGA sets a goal and creates bundles of annual permits of different dates, which are distributed as a subset of the bundle. Every five years a decision will be made about whether to issue more permits of different duration to relax the constraints. This is similar to a government financing a fiscal deficit by issuing different duration bonds over time. This strategy of not pre-committing to the long-run target is designed to increase flexibility. However, it also undermines the credibility of the future carbon price which is critical for generating the incentives to develop alternative technologies. It is also not clear why this approach is needed since there would be sufficient flexibility in cost containment through the safety valve.

A third difference is the way in which permits are allocated. The TGA proposes an evaluation of the costs of the scheme to affected emitters, in particular those industries whose export competitiveness is harmed by the introduction of the scheme. These industries would receive an initial allocation based on expected costs. Further allocations may be made depending on future cost outcomes. Other permits of different duration would be auctioned. The new allocation through time would be auctioned. Under MWB all long-term permits are allocated to affected industries as well as consumers who would face higher energy bills. The compensation issue does not need to be as finely calculated because by creating such long-term assets that are claims over future emissions, enough wealth is transferred from future generations to current emitters to provide more compensation than required. This is important since it is difficult to precisely calculate winners and losers, defusing potential for the political coalitions that would form to support or oppose the policy.

The Task Group report is an important step forward, because, like the MWB it proposes an approach that can be developed in individual countries and then joined together with other systems to create a global approach.

Conclusion

The policy debate based on targets and timetables for climate policy is quickly being replaced with more flexible approaches in which the speed of reaching a given target is determined by an assessment of the costs and benefits of taking action. The approach of the Prime Ministerial Task Group on Emissions Trading is clearly in

this new mould. This is an important step because it will reduce the likelihood that countries will commit to a system for carbon reduction only to withdraw when costs appear to exceed benefits. There is a debate currently under way in developed countries such as Japan, Canada and New Zealand that have ratified the Kyoto Protocol but are unlikely to reach their Kyoto targets. It's also taking place in developing countries where emissions are rising sharply despite the Kyoto Protocol. Cap-and-trade in these countries is unlikely to work in the climate area in the next few decades because of the uncertainty about what cap to impose. Thus the approach offered by hybrid policies that combine cap-and-trade approaches with a short-run safety valve mechanism to control costs are more likely to dominate the policy debate beyond the 2012 post-Kyoto period.

Disclaimer

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ENDNOTES

1 See the Stern Review (2006).

2 See Kopp et al (1997 1999)

3 See the papers in Aldy and Stavins (2007)

4 See the Energy Journal (1999)

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PERSPECTIVES

The 2006 Sir Leslie Melville Lecture

From National to International Climate Change Policy

Warwick J McKibbin

March 2007

The Lowy Institute for International Policy is an independent international policy think tank based in Sydney, Australia. Its mandate ranges across all the dimensions of international policy debate in Australia – economic, political and strategic – and it is not limited to a particular geographic region. Its two core tasks are to:

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The 2006 Sir Leslie Melville Lecture[1]

From national to international climate change policy

Warwick J. McKibbin

Introduction

It is a great privilege to give the 2006 Sir Leslie Melville lecture. It is a lecture in the name of a great Australian who was a key architect of the Australia in which we live today. It is also a privilege to be invited to give this lecture because of the distinguished people who have delivered it in previous years.

I am very unfortunate to have never met Sir Leslie Melville, although my career has overlapped his in many ways – as I discovered in researching the substantial contributions made by Sir Leslie. His legacy can be found in many areas in which I currently work. Sir Leslie was a prolific writer as an academic but also served critical roles in the development of universities in Australia, both as an academic at the University of Adelaide and later as Vice Chancellor of the Australian National University. Sir Leslie worked in the Commonwealth Bank as Head of the Economics Department and eventually served on the Board of the Commonwealth Bank and later the Reserve Bank of Australia. I worked for 16 years on the staff of the Reserve Bank before joining the ANU as a Professor in 1993. I have recently begun my second term on the Board of the Reserve Bank and serve on a variety of government advisory Boards. It is important for academics to have this life as teachers and researchers, as well as contributing to public policy. This is certainly a tradition established by people such as Sir Leslie Melville. Whether universities will be capable of sustaining the quality of academics was the subject of Max Corden's Melville lecture in 2005.[2] Suffice to say, it is very difficult being an academic in an Australian University today and to contribute to public policy formulation.

[1] This Sir Leslie Melville Lecture was presented at ANU on October 12, 2006. The author thanks Peter Wilcoxen and David Pearce for much helpful collaboration on the theme of this lecture.
[2] See Corden (2005).

Many aspects of Sir Leslie's life have been covered in earlier lectures particularly the first lecture by Ian Macfarlane.[3] One aspect that is relevant for the substance of my lecture is the contribution that Sir Leslie made to the design and establishment of new international institutions such as the IMF and World Bank for dealing with global macroeconomic interdependence. This was the subject of the Lecture by Ken Henry in 2004.[4] Sir Leslie was fully aware that well designed institutions are critical for delivering good policy outcomes.

Although there are many issues today very similar to those that Sir Leslie grappled with[5], some new issues that Australia currently faces are somewhat different to those on which Sir Leslie focused. His role in the Tariff Board was critical to the opening up of Australia, but the issue of tariffs and problems in the macro-economy[6] today has been overshadowed by a host of new problems which require new institutions and new policy approaches. One of these issues is how to deal with the problem of environmental degradation and in particular how to respond to the problem of climate change.

I will spend the remainder of this lecture stressing that climate change policy is a problem in policy-making under enormous uncertainty, the important role that price signals and local actions can play as a basis for global system, and conclude with an outline of what I consider to be the way forward on climate policy both in Australia and globally.

Much of this lecture is from joint work with Professor Peter Wilcoxen of the Maxwell School at Syracuse University through collaboration at the Brookings Institution. We have been colleagues since graduate school and have been working together on climate change issues for more than 15 years.

The climate change policy problem

Climate change policy is a classic case where international cooperation is essential. Climate change is partly caused by the concentration of carbon dioxide in the atmosphere from all sources. Thus to address this problem all major emitting countries will need to be involved in a solution. There are two important sources of carbon dioxide emissions – emissions from natural sources and emissions from human sources. The policy debate has had little to say

[3] See Macfarlane (2002).
[4] See the lecture by Ken Henry (2003).
[5] See Henry (2003) on international architecture and global imbalances and Garnaut (2004) on macro economic policy and commodity price booms.
[6] This topic is well covered in Ross Garnaut's Melville Lecture. See Garnaut (2004).

about the role of natural carbon emissions because the focus has been on reducing human emissions. However a comprehensive approach would not rule out reducing emissions from any source since both manmade and natural sources have the same impact on the climate.

Figure 1 shows the emission of carbon dioxide into the atmosphere from burning fossil fuels since 1750.[7] It is clear that there has been a dramatic change in human induced emissions especially since the Second World War. There is cause for concern that this cannot be sustainable and indeed needs serious attention under a wide range of interpretations of climate science.

The importance of natural climate variability can be seem in Figure 2 which shows the temperature record from the Vostok Ice Core samples for the period from four hundred and twenty five thousand years ago to the present expressed as a deviation from the average temperature in the twentieth century. This is what econometricians call a long run of data! This figure shows that historically the average temperature (from this one location) has varied from -9 degrees Celsius relative to today to +3 degrees Celsius. These large swings in temperature had profound impacts on the earth's ecosystems and life on the planet. The sources of the historical variability in climate are well understood and most of this variability is not related to human activity except for the past few thousand years.

It is important to note that it is not the amount of emissions in any year that matters for the climate but the concentrations in the atmosphere – the emissions over a long period of time that cumulate into concentrations. The atmosphere is like a bath with greenhouse emissions flowing from a tap. Reducing the flow of emissions by turning the tap does not empty the bath but only changes the rate at which it fills. The idea that a policy should target emissions in any given year independently of the cost of doing so rather than focusing on carbon concentrations and smoothing the cost of taking action over time is the key mistake that has stalled the process of formulating a robust policy to tackle climate change.

Dealing with uncertainty and policy design

Designing climate policy is very difficult for a number of reasons. First, there is already committed warming in the system from the long history of previous emissions, mostly by industrialised economies. Thus the response to climate change will require both mitigation to

[7] All figures are at the end of the text.

change future climate change and adaptation to respond to climate change that is not controllable by current policy. Second, climate policy is dominated by geographic reality – there is an enormous range of sources of emissions made by just about every person and corporation on the planet. Third, it is a policy that crosses many jurisdictions – international organisations, national, state and local governments. This makes formulating and coordinating a policy extremely difficult. Fourth, the time scales for climate policy are much longer than most other policy problems. Policies today may not affect the climate for more than five decades into the future. Finally, the uncertainties surrounding climate change are large, numerous and mostly intractable. The uncertainty compounds at each level – there is uncertainty about future emission levels; about how these impact on future carbon concentrations; about the timing and extent of temperature change and climate variability (and distribution across regions); about the impacts of these temperature changes and variability on ecological systems, and the extent of economic damages and economic benefits in different regions at different times. Critically there is the problem of how to formulate a policy to respond to the entire probability distribution of possible outcomes into the future where some events have low and uncertain probability but could be catastrophic.

What should be done given the uncertainty? Uncertainty is not a new concept. Techniques for understanding uncertainty and risk management are well developed. The approach to climate policy should be about managing risk especially taking into account the unusual nature of the risks associated with climate change. For example, some of the science suggests that there is the possibility of catastrophic outcomes from climate change. This fact needs to be taken into account when designing climate policy. It is also necessary to make sure that the cost of action does not exceed the expected benefit of taking action because there are many other problems that need to be urgently addressed in the world, for example poverty reduction and dealing with the large number of people inflicted by preventable diseases. Dealing with these problems also requires scarce resources which otherwise might be devoted to tackling climate change. The tradeoffs involved with addressing climate policy must take into account the opportunity cost of taking action.

The design of a robust and ‘sensible’ climate policy must deal with a range of issues such as: coverage; equity; politics; institutions; economic fundamentals; and flexibility.

a) Coverage

Coverage must be extensive. The policy regime needs to include the major current and future emitting countries but not necessarily all countries. All sectors of the economy need to be included, not just a particular sector. Both the supply side and demand side of energy use and other sources of carbon emissions needs to be addressed.

b) Equity

A climate policy will likely lead to winners and losers. It is important to deal with the distributional issues within countries and between countries in the regime design. However, how individual countries deal with their own issues is up to individual countries.

c) Politics

The regime needs to build constituencies across society that support the climate policy in their own financial self-interest. These constituencies include fossil fuel producers and fossil fuel-intensive industries who potentially face a reduced demand for their products; consumers facing higher energy prices; and politicians who may otherwise have an incentive to reject a policy in support of a narrow constituency.

d) Institutions

It is important to use existing institutions such as legal systems and financial markets rather than attempting to create a new global set of institutions. These global institutions would take decades to design and delay action further.

e) Fundamentals

There needs to be a portfolio of market-based measures and direct policy interventions. For a market-based policy to work there needs to be clear property rights over carbon emissions over a very long period. There need to be incentives to want to reduce emissions because emissions are a valuable asset. There need to be markets that enable individuals and corporations to manage climate risk rather than relying on government to be the sole managers of that risk. There need to be long term price signals consistent with a long term carbon goal that encourage the emergence, adoption and diffusion of existing and new technologies that enable emissions to be reduced wherever possible at low cost.

Both the demand side and the supply side of emissions need to be addressed. Climate policy is not just about technology, although, clearly, technology is a key part of the solution.

f) Flexibility

It is critical that the policy regime is flexible enough to adapt as new information on climate science, climate change and the extent and cost of emission reductions becomes available. Thus flexibility through time is essential. Also, the extent to which emissions are removed at each point in time should depend on relative costs over time and not be based on an absolute target in any given year. Recall that it is the cumulative emissions that matter and not emissions in any given year. The idea of targets with timetables, as embodied in the approach of the Kyoto Protocol, ignores this basic issue.

Flexibility across country participation is also critical. It is not sensible to have a system that collapses if a single country withdraws. The system must also be flexible enough to add

countries over time without debasing the value of carbon and flexible enough that the departure of a country does not undermine the integrity of the policies of the countries that remain in the system.

The role of prices in climate policy

The answer to reducing emissions at low cost and perhaps in very large quantities will involve a portfolio of policies that ultimately need to generate a technological change in the way energy is generated and used.

A core part of this portfolio should be an approach based on markets and incentives. This will be an essential part of the foundation. History provides better evidence than introspection on the role of price change in changing the underlying relationship between economic activity and energy use. Figures 3 and 4 show the paths of energy use, GDP and CO2 emissions from 1965 to 1990 for the United States and Japan expressed as an index of one in 1965.

It is clear that, before the 1970s, energy use and CO2 emissions grew more quickly than GDP in both the US and Japan. After the oil price shocks, the relationship changes dramatically. This demonstrates that a policy under which carbon is priced is likely to encourage a substantial degree of substitution within the demand and supply side of the global economy. The key to a sustainable policy is that the carbon price does not unnecessarily dampen economic activity at the same time as is encourages the degree of substitution necessary to reach the sort of targets pointed to by the scientific community as necessary to stabilise or reduce emissions.

Would Australia leading the world in policy design be costly?

In making the argument that Australia should move first on adopting a sensible climate policy, it is critical to understand what is currently happening globally. Other countries are already adopting policies that effectively put a price on carbon. The European permit trading system is an explicit price but there are other strategies, even in Australia, which are putting a price on carbon. The various schemes such as MRET[8] effectively put a price on carbon by imposing a cost on generators to add renewable energy to the grid, even though they would

[8] The MRET scheme requires the generation of 9,500 Gigawat hours of renewable energy by 2010 (roughly 2% of power).

otherwise choose not to. In this case it is a very imperfect approach because once the target is met there is no incentive for new investment in renewable energy sources.

It is often argued, especially by the proponents of R&D expenditure by government on new clean coal technologies, that there is no point in a market signal before technology is ready to bring to market. Such arguments are made by Montgomery and Smith (2006) for example. This argument is popular amongst groups who benefit either directly or indirectly from government subsidies. However, there are a number of arguments as to why subsidising R&D would only be partially necessary but not sufficient condition for the technological solution to emerge[9]. First I will deal with the arguments for a price signal and then with the arguments as to why it is not necessarily costly to move first in a sensible framework.

The earlier literature on early action to which we contributed using the G-Cubed model was in the context of the Kyoto Protocol. We found, in a study for the Australian Government in 2002[10], that the Kyoto Protocol was a costly approach for the Australian economy and moving first in that context meant the costs came more quickly, although even in that research there were some gains to early action, depending on the scenario being modeled. This argument has been variously re-interpreted incorrectly by various advocates of a Kyoto-style approach.

It has been unfortunate that the debate on whether Australia should take early action has been in the context of Kyoto-style policies. It is quite logical to reject Kyoto as a sensible way forward (which I do), but to advocate early action in the context of a completely different approach in which, if short term costs do rise too quickly relative to expected benefits, they are bounded directly within the policy design.

There are a number of reasons why Australia might gain from undertaking early action policies. The most important is the argument made above that the uncertainties on climate change and the uncertainties about climate policies mean that important investments, particularly in energy infrastructure, are not being undertaken. By creating markets for risk management of long term climate uncertainty there is a real wealth gain for the economy and an incentive for large-scale energy projects to move forward with substantial benefits.

Second, in a forthcoming paper, David Pearce and I show, using the G-Cubed model, that the anticipated changes in carbon prices give a clear signal for investment rates to change, which in the short run can lead to a macroeconomic stimulus to the economy. This effect was also

[9] This is also addressed in Pezzy Jotzo and Quiggin (2006).
[10] See McKibbin (2002).

present in some of the results of the 2002 study on Kyoto. Models such as G-Cubed, that incorporate investment decisions based on expected future returns to capital, can lead to a beneficial anticipatory effect of credible policy announcements. Most models do not have this important channel.

Third, David Pearce and I show that in a world without discounting, if the marginal abatement costs are equal in all periods then it is optimal to undertake equal abatement in each period. Postponing abatement in this world means that costs in the future will rise and the present value of costs for the same amount of abatement will be higher. What might change this argument? With discounting, it will pay to push abatement relatively into the future, but that does not imply that no abatement today will be optimal. If there is declining marginal cost of abatement over time because of new technologies (a common argument of the technology option advocates), this tilts the abatement into higher future abatement but not necessarily no current abatement. It is also not clear that future abatement will be cheaper than current abatement – indeed you could argue that marginal costs of abatement will rise over time for a variety of reasons.

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.

Also, 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 result in an *expansion* effect involving the increased total use of energy, depending on how marginal increases in wealth are spent. 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.

In the absence of an appropriate price signal, new capital that is carbon-intensive may be put in place in sectors not targeted by government policy on R&D. 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 costs of adjustment in installing and

replacing new capital, the new capital spending will tend to increase the marginal cost of abatement.

A final case for early action is the argument that reducing uncertainty by establishing clear long term carbon markets, both to provide a long term carbon price signal and to enable the risk of long term energy investments to be managed, is capable of reducing the cost of capital. As long as any short term carbon price is kept low, it is possible that the gain from lower capital costs can more than offset the cost for fossil fuel-intensive industries of higher short term carbon prices. Thus a well designed set of long term and short term carbon markets can indeed strengthen the case for early action in Australia.

The McKibbin Wilcoxen Blueprint – a hybrid approach

In a number of papers, McKibbin and Wilcoxen (1997, 2002) argue that the approach which best addresses the many facets of the climate change policy problem outlined above is an approach that combines the best features of a tax (i.e. to guarantee short run cost certainty) with the best features of permit trading (i.e. to set a long term emission target and find the least costly way of achieving it). This is called a hybrid approach and in McKibbin and Wilcoxen (2002) it is also called The Blueprint for climate policy.

The approach in principle is quite straightforward. Rather than set a relatively short term target for emissions with a timetable of when these emissions will be met (such as in conventional permit trading approaches), The McKibbin-Wilcoxen Blueprint sets a long term target for emissions over the next hundred years. This target profile is used to create long term carbon emission permits that give rise to an emission permit (or a fraction of a permit if the profile is one of declining emissions over time) each year. These long term permits are fixed in quantity and tradeable in a market which determines a long term carbon price as well as the expected price of carbon at each year into the distant future. The second component of the policy is to allow the federal government to issue as many annual permits in the current year to prevent the annual carbon price from rising above a trigger price. This short term cap on the price of permits is set for a decade at a time.

Over time, as information is revealed on all aspects of climate change and the costs and benefits of abatement, the annual economic cost, which is under complete control of the government, can be varied to approximate expected benefits. The long term permit price guides research and investment decisions on ways of reducing carbon emissions, whether

through alternative energy generation technologies or carbon capture and storage technologies. Any annual permits which the government sells to cap the short run price can be used either to support R&D in carbon abatement or in adaptation technologies. This money could also be put aside in order to buy long term permits in the future if it was deemed that the policy profile needed to be tightened. A loosening of the emissions reduction profile is not necessary because the cap price enables the government to do this if required over time.

This approach gives flexibility in the sense that no international permit trading is required to create an efficient outcome, because the annual carbon price is set by government and would ideally be the same across countries (i.e. efficiency is achieved without trading). National institutions are at the core of the policy. The defection of any one country from the policy does not affect the carbon price in other countries. In addition, countries can enter the international agreement by adopting this policy. This accession has no effect on the carbon prices in other countries. The approach is one of domestic actions and institutions but coordinated globally to build up a global system.

The approach is very similar in many ways to the way that modern monetary policy is implemented in advanced economies. The long term bond rate (long term permit) is the outcome of demand running up against a fixed supply of long term government bonds. The short term interest rate (carbon price) is set by the government by supplying as much liquidity as demanded in the short term money market to generate a fixed interest rate. The long term bond rate is the expected future value of future short term interest rates. So it is with the long term permit price.

A critical aspect of the policy is how the initial allocation of the long term permits is implemented. This should be done to trade off the need to compensate losers from the policy with the need to have constituencies with a strong financial interest in the policy surviving over many decades. It should be done in such a way that future decisions are independent of past output decisions – that is, a once off allocation independent of future emissions decisions. The initial allocation would ideally go to all households as well as all corporations. Industries that are likely to be most affected should receive the largest allocation. This grandfathering of previous decision means that all new decisions involving carbon will be treated equally by existing and new emitters.

The ability of such a system to change the behaviour of all emitters, either through price incentives or the motive of making profits from freeing up previously allocated permits that can be done at low cost, deals directly with the issue of geography .

Countries are not giving up national sovereignty because they each implement the system within their own borders using domestic institutions. For major developing economies, institutional development will be needed but this is needed to enhance the overall development agenda anyway.

This approach deals with each one of the major features that I have argued above needs to be taken into account in designing a global system of coordinated national schemes.

Figures 5 and 6 show an illustrative example of a short term permit market and a long term permit market for the same system in Australia and China. The scenario depicted is one in which prices are expected to rise over time. In figure 5 the annual permit price in Australia is determined at the cap each year, whereas in China a much larger initial allocation of long term permits means that the annual permit price in China takes time before it rises to the price in Australia. This is an economically inefficient outcome in the short term but represents a tradeoff with equity and the need for China to commit over the medium to long term. The long term permit market prices the commitment to the policy in both countries. Thus we have effectively separated the resistance to paying substantial short term economic costs from the need to provide clear long term incentives to innovate in carbon abatement especially in China.

In summary, Australia could adopt this approach before any other countries, with the knowledge that a low short term permit price can be imposed until other countries are also taking effective action but with the long term permit market guiding long term investment decisions. In particular, industry would be able to use the long term market to hedge investment decisions and thus help minimise the riskiness of long term capital investments related to energy generation and energy use. If chosen thoughtfully, the balancing of these two opposing costs and benefits could bring an aggregate macroeconomic benefit to Australia.

Conclusion

Just as the design of the international monetary system and the development of institutions to deal with economic independence were critical in Sir Leslie's world of the 1950s, the current state of deliberations over an international architecture for dealing with global environmental problems needs attention. At the global level, the world has stalled on effective climate policy with a well intentioned, but ultimately faulty Kyoto Protocol, designed by political

compromise rather than as a real plan. Greenhouse gas emissions continue to rise globally, and now desperate governments and concerned citizens are advocating and creating inefficient and counterproductive systems to try and tackle a problem that ultimately needs a large dose of international and national cooperation which overrides jurisdictional rivalries.

There is a way forward based on existing domestic legal, accounting and economic institutions that, combined with international cooperation, could move the world forward from the current stalemate with global climate change policy. The Australian government needs to take leadership of this effort, just as it did in the formation of the international monetary system under the intellectual leadership of people like Sir Leslie Melville. The problems may have changed since Sir Leslie's day but the focus on well designed systems with strong institutions has not changed. It is not just the need for Australia to take action but the need for Australia to demonstrate to the world how to take action on climate change policy that balances effective action with a realisation that costs must be contained in the short run. This is currently the biggest contribution Australia can make to what could be the major policy issue of our generation.

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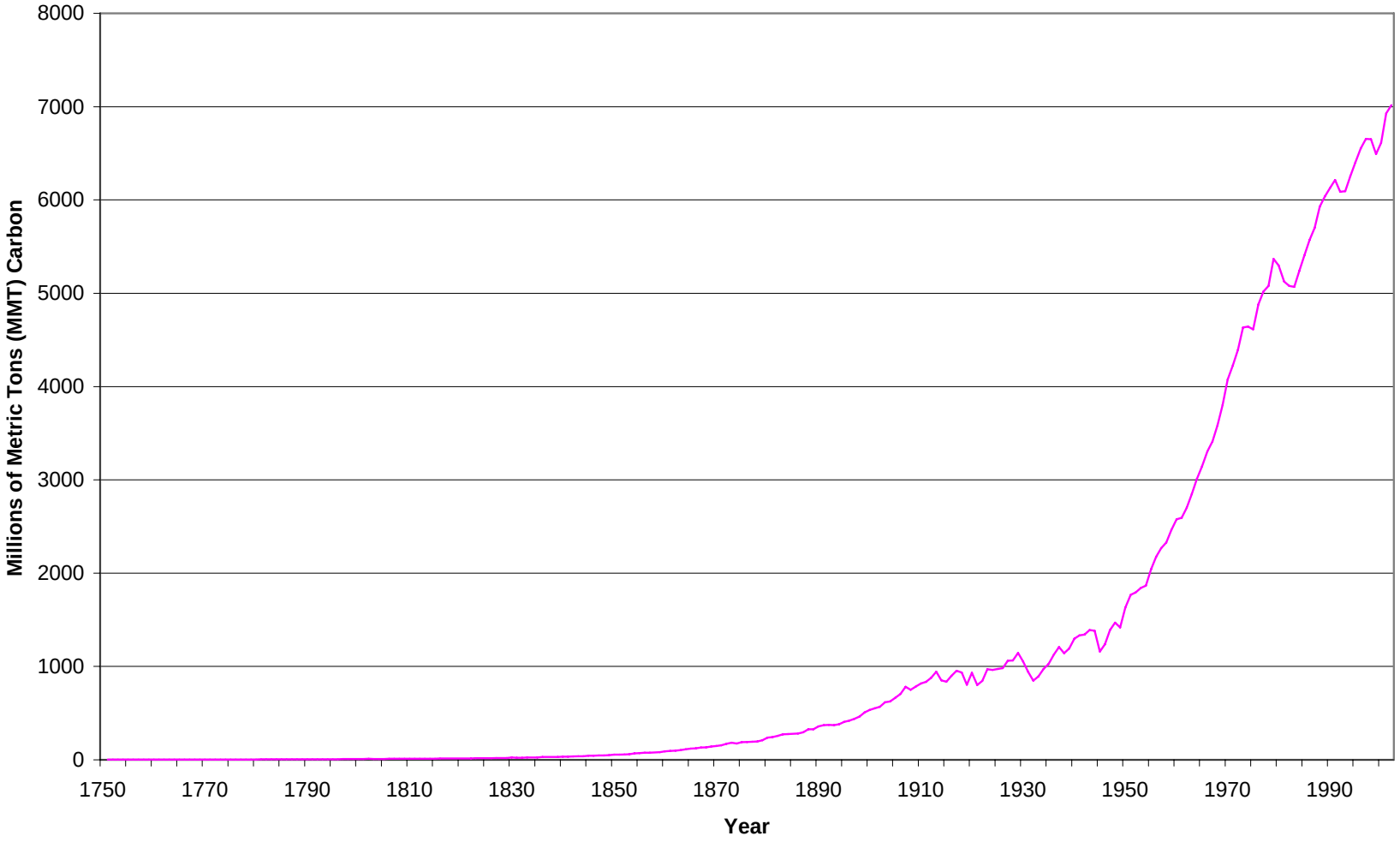
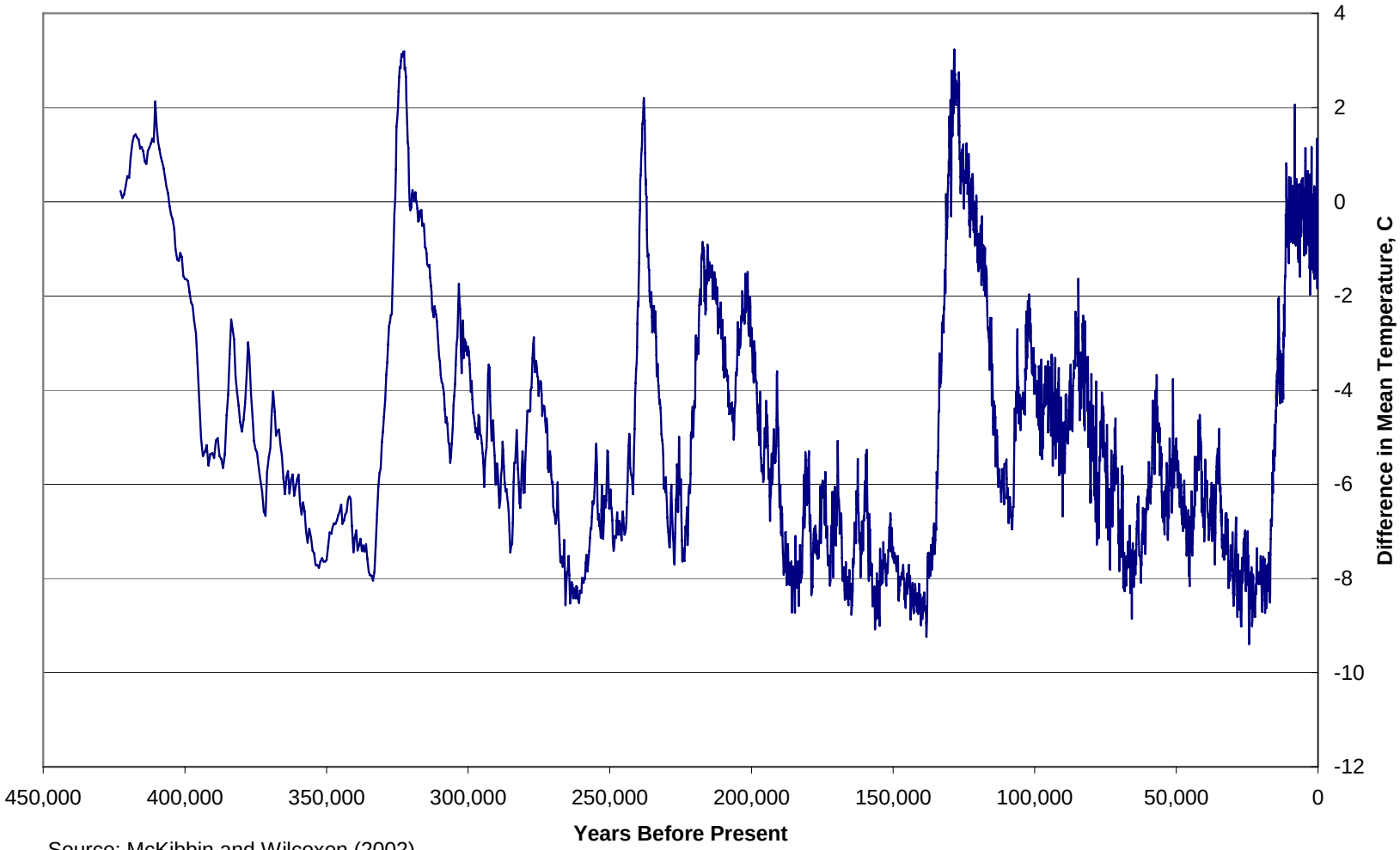
Figure 1: Global Carbon Dioxide Emissions from Fossil Fuels, 1751-2002



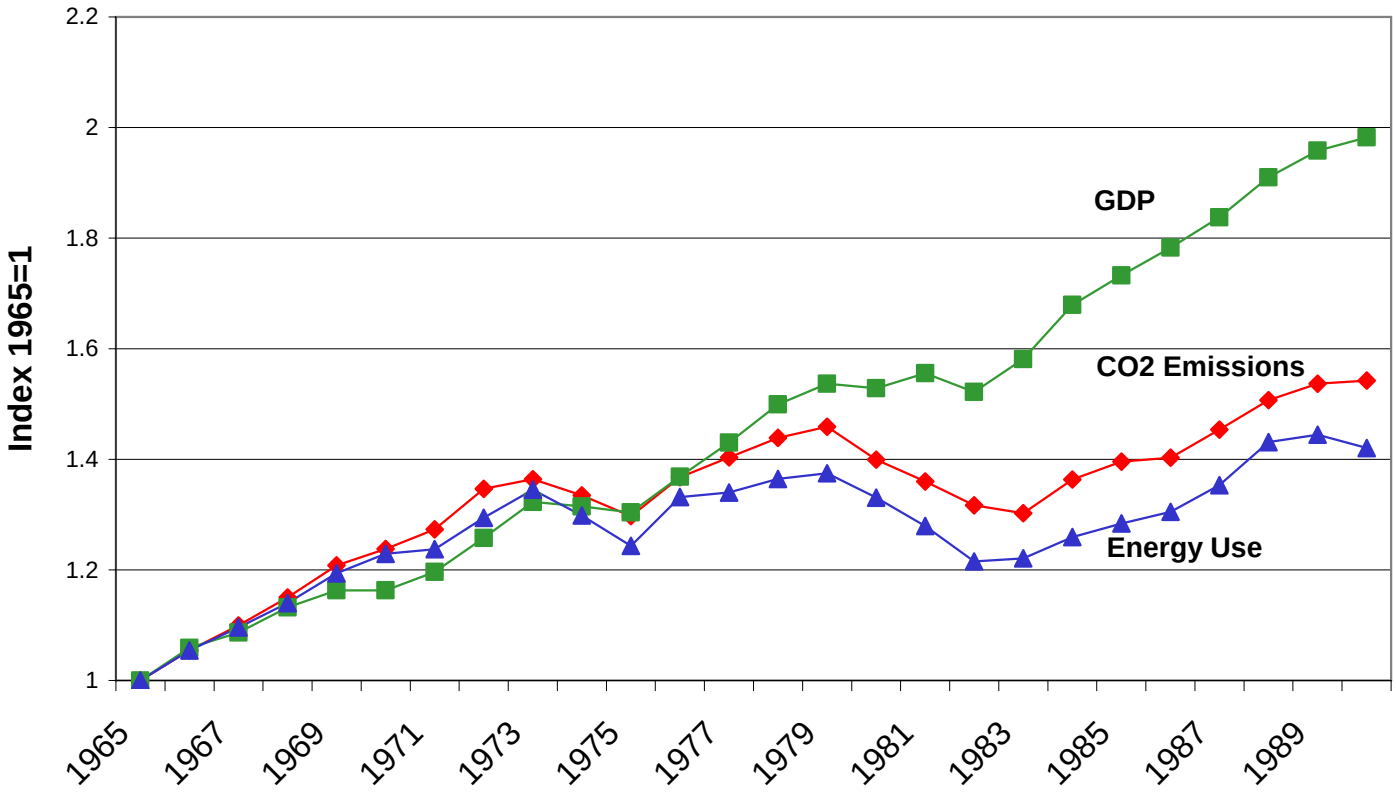
Source: McKibbin and Wilcoxen (2002)

Figure 2: Global Temperature Record, Vostok Ice Core Data



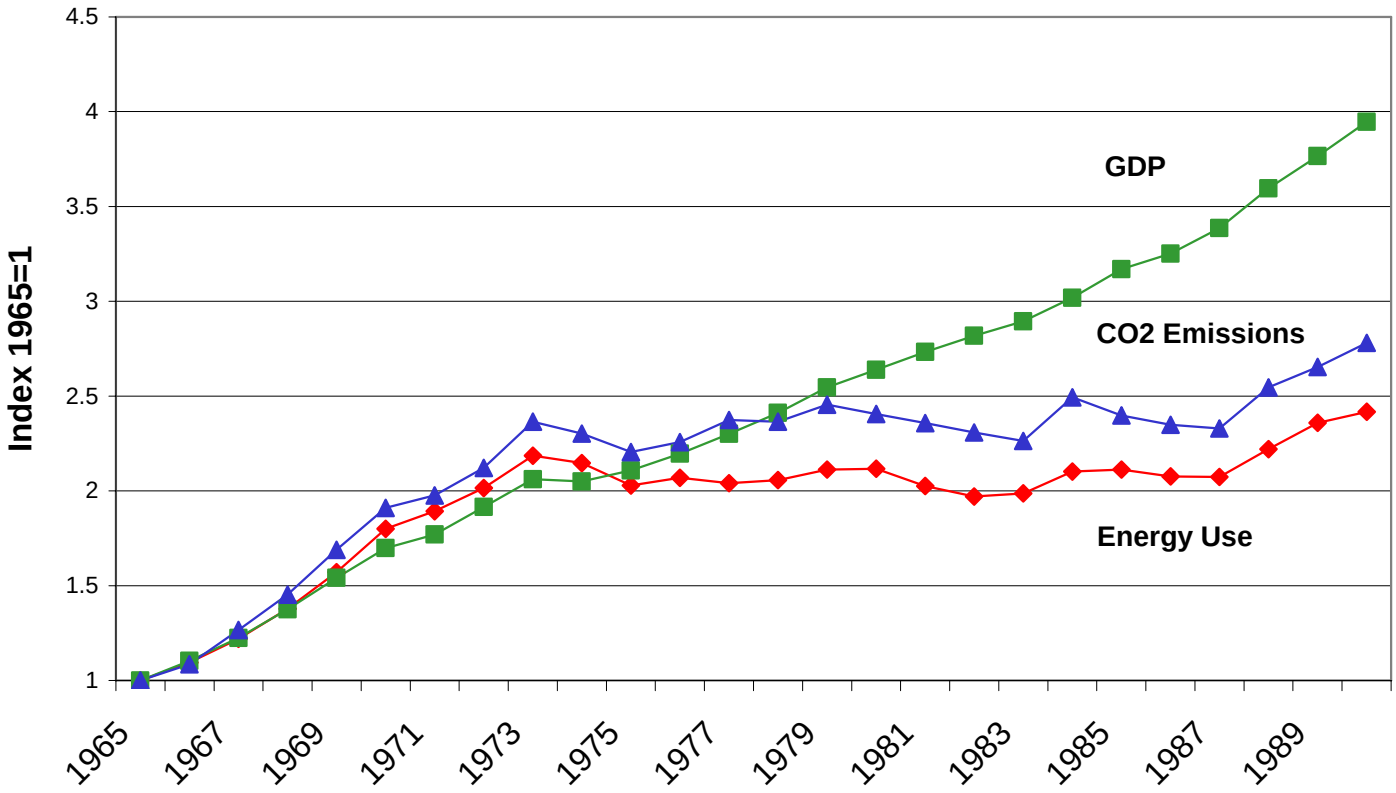
Source: McKibbin and Wilcoxen (2002)

Figure 3: GDP, Energy Use, CO2 Emissions
USA



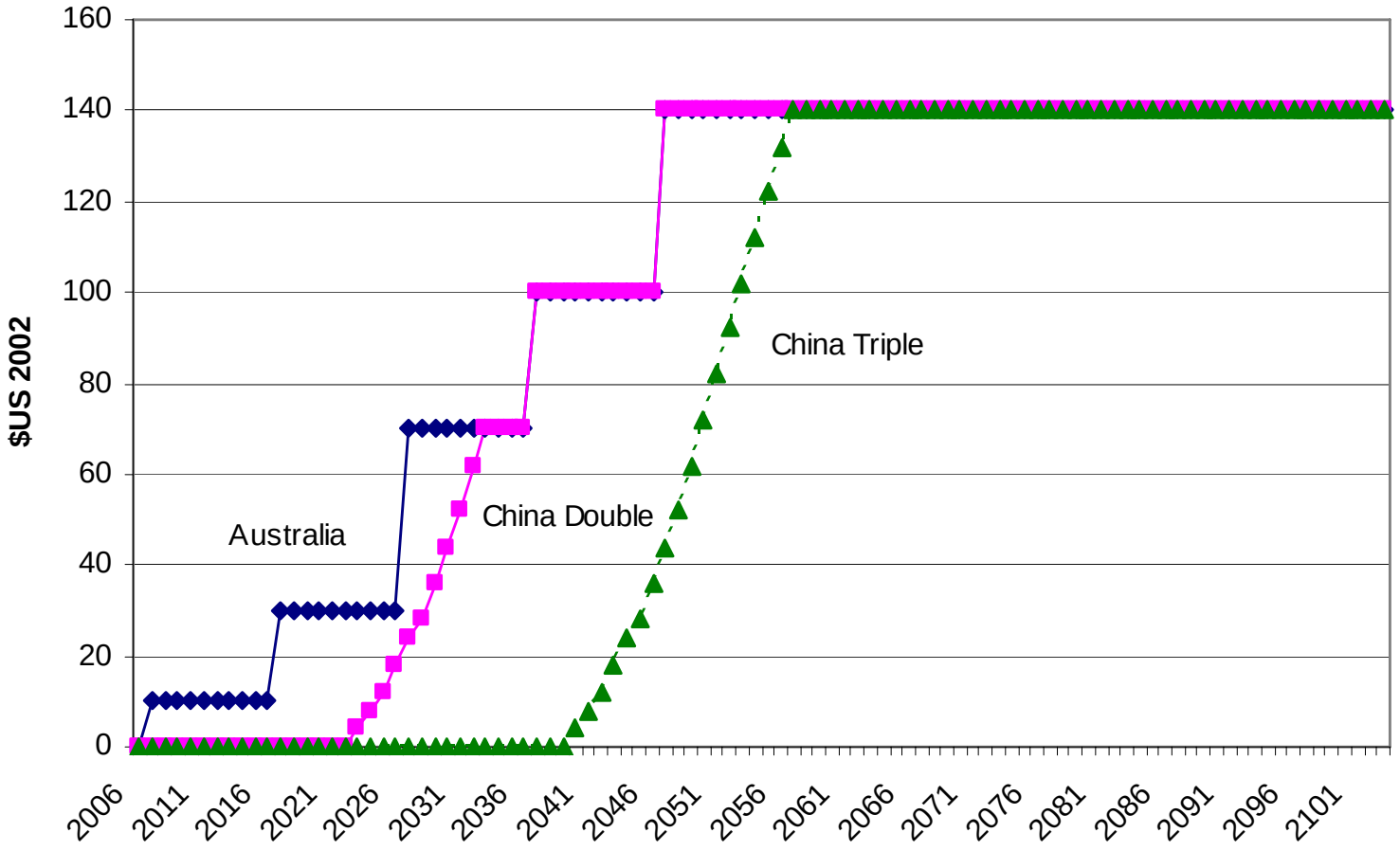
Source: Bagnoli, McKibbin and Wilcoxen (1996)

Figure 4: GDP, Energy Use, CO2 Emissions
Japan



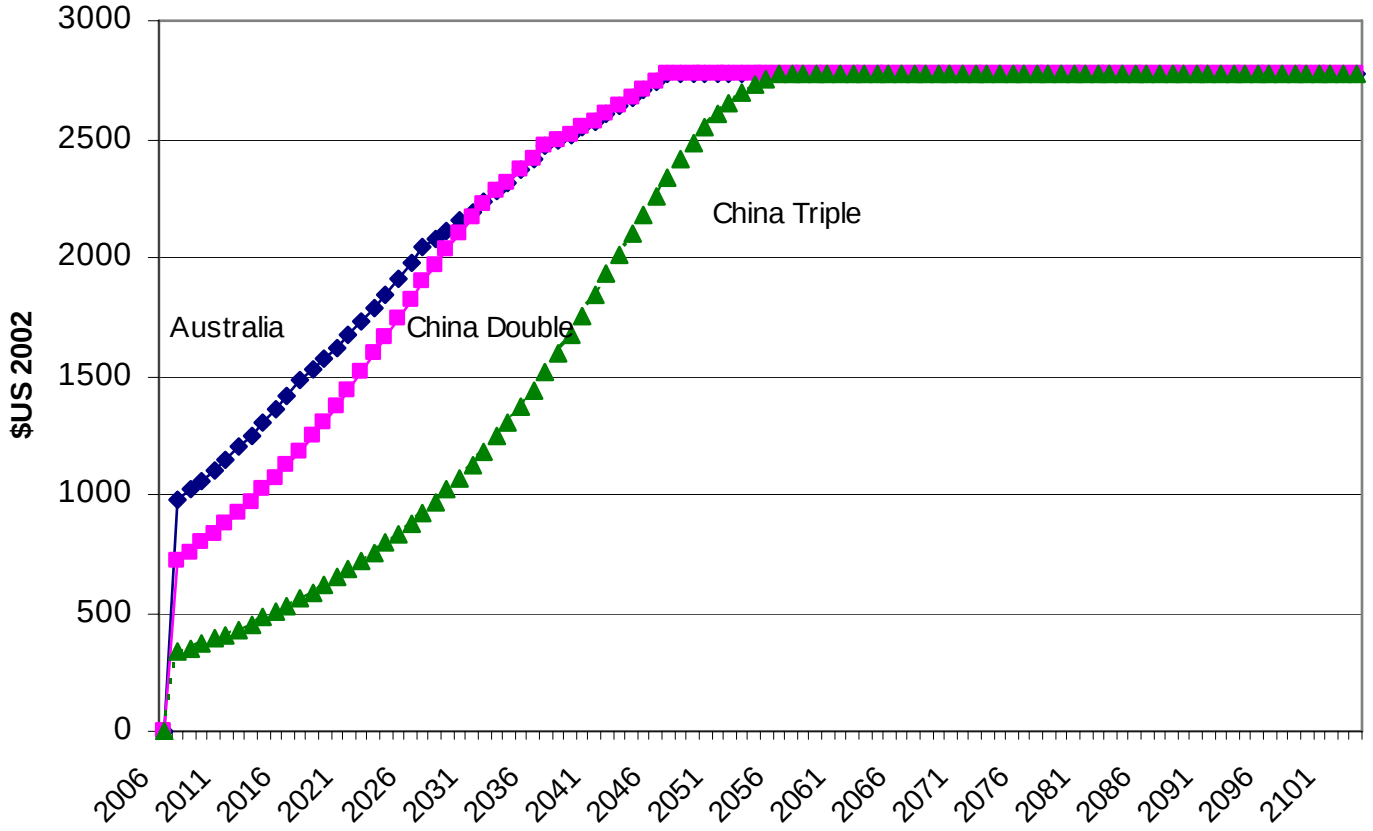
Source: Bagnoli, McKibbin and Wilcoxen (1996)

Figure 5: Annual Permit Price



Source: Author's Calculations

Figure 6: Value of Long Term Permits (r=5%)



Source: Author's Calculations

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FEBRUARY 2005

ISSUES BRIEF

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SENSIBLE CLIMATE POLICY

EXECUTIVE SUMMARY

The Kyoto Protocol enters into force on February 16, 2005. Nearly thirteen years after negotiations began at the Rio Earth Summit and seven years after the Kyoto Protocol was negotiated, this should be a cause for global celebration. Yet the basic tenets on which the Kyoto Protocol are built are flawed and leave it worryingly vulnerable to failure. Already proponents of Kyoto are looking for alternatives "beyond Kyoto". It is no accident that it has taken so long for the Protocol to enter into force with so few of the major future greenhouse emitters effective participants.

Since the world began seriously debating climate change, very little has actually been achieved to noticeably impact on the trend of global greenhouse gas emissions. What is worse, the long period of debate since 1997 has spawned influential lobby groups on both sides of the debate who have an economic and political incentive to complicate the policy decisions. In many countries this has prevented the implementation of a sensible coordinated response to address the potentially serious global problem of climate change.

The debate has been confusing for most non-experts because the question of whether the world should respond to the possibility of climate change has been deliberately entwined with the question of whether the world should embrace the Kyoto Protocol. For an effective and realistic climate policy to emerge these questions must be addressed separately.

This paper focuses on the key problem that policymakers globally need to face about climate change — that is how to manage the uncertainty surrounding all aspects of climate change over very long time horizons. The various uncertainties are summarized and the requirements of a sustainable and realistic global and national response are outlined. The flaws in the Kyoto style approach of setting targets and timetables are summarized and an alternative approach based on designing long run national institutions and clear incentives to mitigate carbon emissions over time and adapt to any emerging climate change, are outlined. This alternative approach is known as the McKibbin Wilcoxen Blueprint. Although created as part of a globally coordinated response it is designed to be implemented in individual countries. Australia could adopt this approach using much of what has been negotiated within the Kyoto framework but moving forward from that and lead the world in the debate on what to do in the post-Kyoto world. It is in the national and global interest for Australia not just to claim that Kyoto targets will be met and focus on local policy. What is needed is for Australia, through international cooperation, to steer the world away from the fundamentally flawed approaches currently being considered.

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The Lowy Institute for International Policy is an independent international policy think tank based in Sydney, Australia. Its mandate ranges across all the dimensions of international policy debate in Australia — economic, political and strategic — and it is not limited to a particular geographic region.

Its two core tasks are to:

- produce distinctive research and fresh policy options for Australia's international policy and to contribute to the wider international debate.

- promote discussion of Australia's role in the world by providing an accessible and high quality forum for discussion of Australian international relations through debates, seminars, lectures, dialogues and conferences.

This Paper was prepared for the Lowy Institute for International Policy and the Australian Academy of Social Sciences. This paper draws substantially on research and ideas developed jointly with Professor Peter Wilcoxen of Syracuse University. It would not exist without his intellectual contributions. The author thanks Allan Gyngell, David Pearce, Mark Thirlwell and two anonymous referees for helpful comments. The views expressed are those of the author and should not be interpret¬ed as reflecting the views of other individuals or institutions named above.

1. Introduction

The Kyoto Protocol enters into force on February 16, 2005. This should be a landmark day for climate policy because it is the culmination of an enormous amount of political negotiation since the Rio Earth Summit in 1992, on what the world should do about the possibility of climate change. The sad irony about the entering into force of the Kyoto Protocol is that it will likely achieve very little in the quest to address the problem of climate change. For a number of reasons outlined below the Kyoto Protocol is so badly constructed that it has set back the quest for sensible and effective policy responses by at least a decade. Probably the best argument for countries outside the small group who have adopted effective targets, to adopt the Kyoto Protocol now that is has entered into force, is that "it is the only game in town". This is a very weak argument in favour of the Kyoto Protocol. It also demonstrates why the Kyoto approach is unlikely to work over the time periods required for effective climate policy actions. The detailed critiques of the Kyoto Protocol are many and are briefly summarized in this paper but the main problem is that the Kyoto Protocol fails to address the fundamental policy problem inherent in climate change — uncertainty about the future and our understanding of the future. Should countries outside the Kyoto targets, such as Australia, jump on the Kyoto ship as it sails into the unknown, or should they pursue independent courses of action? The problem that Australia faces is that even if it followed its own course of action, most of the costs that the Australian economy faces in tackling climate change in a Kyoto framework are caused by the actions of other nations. As a major fossil fuel exporter and important exporter of fossil fuel intensive products, the actions of other countries within the Kyoto Protocol have a significant impact on Australia. In an often misquoted study (McKibbin (2002)), which was a report to the Australian government on whether Australia should ratify the Kyoto Protocol, economic modeling showed that, depending on the precise scenario, a very large part of the cost of the Kyoto Protocol for Australia was found to be caused by the actions of other countries. Whether Australia should or should not ratify was dwarfed by the question of whether Australia should be pushing for a different approach to the Kyoto Protocol because Kyoto itself was found likely to be a costly approach (depending on the scenario about the uncertain future). Clearly the most important thing that Australia and all major emitting countries need to do on climate policy is to cooperate in the design of a global regime to tackle climate change that is a better alternative to the Kyoto Protocol. An approach is needed that is not based on the redundant "command and control" approach to environmental policy that is largely isolated to national environment agencies and environmental groups but which is an alternative that focuses on explicitly trading off the short run costs and long run benefits of environmental policy within a well designed institutional framework that establishes clear long term incentives for action. Most importantly the approach needs to be decentralized to countries, but with countries acting cooperatively in their own interests rather than dominated by a large global bureaucracy. Reports by Institutes and committees populated by those former designers or supporters of Kyoto such as the recent report of The International Climate Change Taskforce (2005) base their well meaning policy proposals on the same fundamental flaw as Kyoto. The problem with these strategies is that they rely on a "targets and timetable" approach with its unbounded cost, hoping (or in some cases confidently predicting) that technological breakthroughs will solve the problem easily and cheaply. It is not the unwillingness of countries to take action that is the problem — but the unwillingness to take action at whatever cost it takes. Whatever people may believe the evidence is clear that the uncertainties that abound in climate policy do not warrant action at unbounded costs.

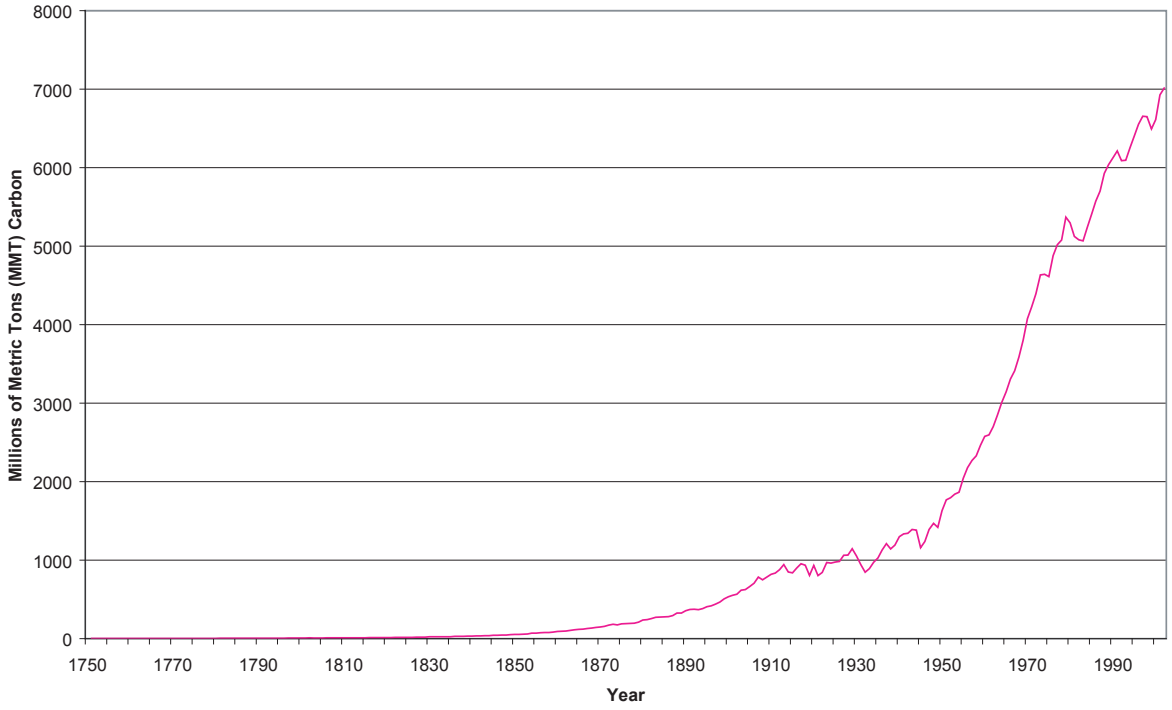
There is a lot of confusion and misinformation in the climate policy debate. For example it is often argued that because Australian carbon emissions per capita are the highest in the world (outside the middle east) that most cuts in carbon should be undertaken in Australia. In fact the reason carbon emissions are highest in Australia is because of the endowments of plentiful, low cost coal. If the goal were to reduce global carbon emissions at lowest cost, it would clearly be best for the most efficient and low cost carbon producers to produce all the carbon emissions and for the rest of the world with high cost energy or low output per unit of energy to stop emitting. This outcome is not easily generated in a "targets and timetables" world with some arbitrary cap on carbon emissions by each country. In a carbon constrained world, common sense argues that Australia would likely be one of the largest carbon emitters simply because it uses carbon cheaply and efficiently. Yet it is easy for vested interests to fund advocates to argue that emissions in Australia must fall no matter what. McKibbin and Stegman (2005) show that emissions per capita are dominated by the endowments of fossil fuels and that there is no evidence historically for convergence of per capita carbon emissions. It hardly seems sensible to target something which is very different to the natural endowments the planet provides unless the cost of achieving sensible global carbon reduction is irrelevant or else dominated by some other domestic agendas. If global carbon emission must fall there is no reason to expect that they should fall in all countries or in a uniform way. If global costs are a consideration, then any reduction in fossil fuel emission should be taken from the most expensive emitters.

This paper re-examines the debate on what a sensible climate change policy would look like making the case that costs relative to expected benefits should be more important than precise targets and timetables in any sensible regime[1]. The paper does not take the Kyoto Protocol as given but steps back from this particular debate to explore the issues of what should be done in an ideal world without lobbyists (both for fossil fuels and alternative energy sources), politicians and evangelical environmentalists, who by assumption rule out tradeoffs between costs and benefits. Given the ideal in a system that deals with equity, efficiency and political feasibility, the paper then summarizes what has been done so far. It is natural to compare the Kyoto Protocol to the ideal features of such a system and point to the benefits and flaws. An alternative approach called the McKibbin–Wilcoxen Blueprint is then outlined and its strengths relative to Kyoto are explored. The paper also considers how the current state of negotiations under the Kyoto Protocol might be moved to the Blueprint approach without discarding much of what has been negotiated under the Kyoto banner. It finally considers the issue of what Australia can and should do. It would be a mistake for Australia to take an inward-looking approach to climate policy because most of the impacts on Australia of global climate policy are caused by the actions of other countries. Australia exports $28 billion of energy related exports and these exports are highly vulnerable to actions taken in destination countries. Australia has a national interest in developing a global climate regime that makes more sense than the Kyoto approach. It has little to gain from making its goal to achieve Kyoto targets outside the Kyoto system and be satisfied with that.

2. Uncertainty and climate change

At the heart of the climate change debate are two key facts. The first is the familiar and undisputed observation that human activity is rapidly increasing the concentration of greenhouse gases in the atmosphere. A shown in Figure 1, each year, worldwide fossil fuel use adds about six to seven billion metric tons of carbon to the atmosphere, and the concentration of carbon dioxide is now about 35 percent higher than it was at the dawn of the Industrial Revolution.

Figure 1: Global Carbon Dioxide Emissions from Fossil Fuels, 1751-2002



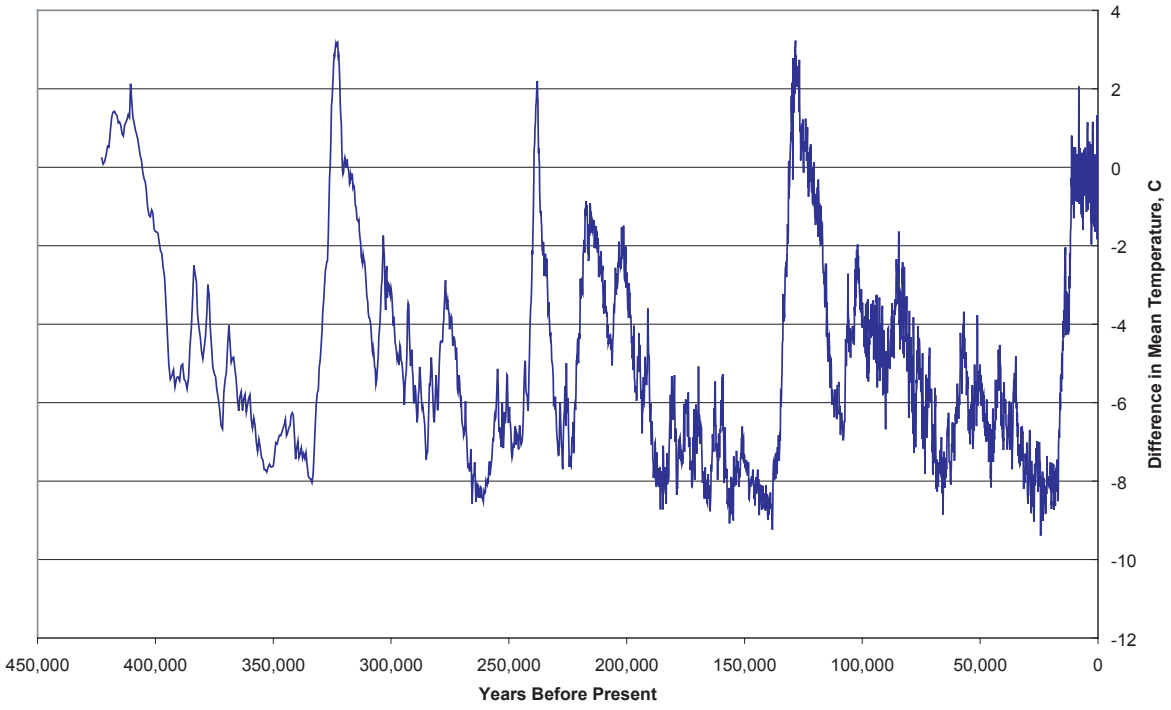
Source: Marland et al (2002) for 1751-2000 and Energy Information Administration and authors calculations for 2001-2002

The second fact, however, is that no one fully understands how the climate will respond.[2] The increase in greenhouse gases could lead to a sharp rise in global temperatures with severe consequences for ecosystems and human societies. On the other hand, it's possible that the temperature rise could be modest, easy to mitigate or adapt to, and far in the future. The most likely outcome is probably somewhere between the two predictions but the intrinsic complexity of the climate makes it impossible to know precisely what will happen with any degree of confidence. Even if we had complete confidence in the projection of climate outcomes, determining the costs and benefits of policies that would limit greenhouse gas emissions is even more difficult. Costs, for example, depend heavily on how fast emissions would grow in the absence of a climate policy: the more quickly emissions rise, the more expensive it will be to reduce them to any given level. The rate of emissions growth, however, depends on factors that are impossible to predict accurately over long spans of time: population growth, educational attainment, productivity growth within different industries, convergence (or lack thereof) in incomes between developing and developed countries, fossil fuel prices, and many others. Plausible alternative assumptions about these factors can lead to vastly different estimates of future emissions and therefore vastly different predictions of the extent of climate change[3].

Some of the uncertainties we face can be seen in the historical record of previous global temperature change shown in Figure 2.

The temperature record shows large fluctuations in

Figure 2: Global Temperature Record, Vostok Ice Core Data



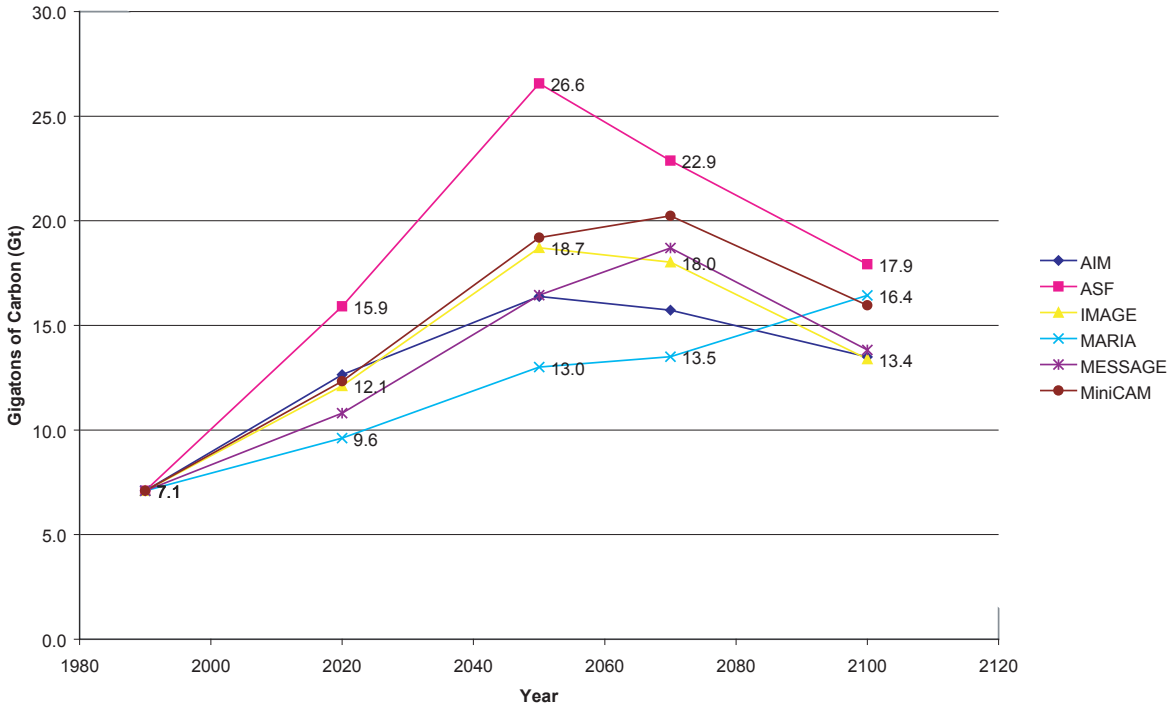
Source: McKibbin and Wilcoxen (2002a) Figure 2.7 from data in Petit et al (2002)

temperatures over the past 450,000 years. It also shows a clustering of high temperatures in recent centuries. Scientists have a reasonably good understanding of what caused these fluctuations but far less understanding of how to predict the future baseline temperatures. The predictions depend on predictions of human activity such as future carbon emissions. Some attempt to undertake these predictions are contained in the Intergovernmental Panel on Climate Change (IPCC) Special Report on Emissions Scenarios (SRES). The profiles of future emissions projected in the SRES have been heavily criticized by various authors including Castles and Henderson (2003). The essence of the Castles and Henderson argument is that economic growth rates are assumed to be far too high compared to historical experience because of mis-measurement of the relative size of countries in the SRES report. This critique of excessively high economic growth rates and resulting high emission profiles has been supported in modeling work by McKibbin, Pearce and Stegman (2004). Despite the importance of this particular critique, it is just one of many problems that point to the inability to project the future over the next century with a great deal of certainty.

Figure 3 shows one set of predictions under common assumptions from six models in the SRES. Twenty years into the future the range of estimates is large. But the fundamental issue is that it is inherently difficult to predict the future and dangerous to rely on the accuracy of predictions to determine the success of policy choices.

It is not only the underlying science and future

Figure 3: Emissions of Carbon Under IPCC Scenario A1B



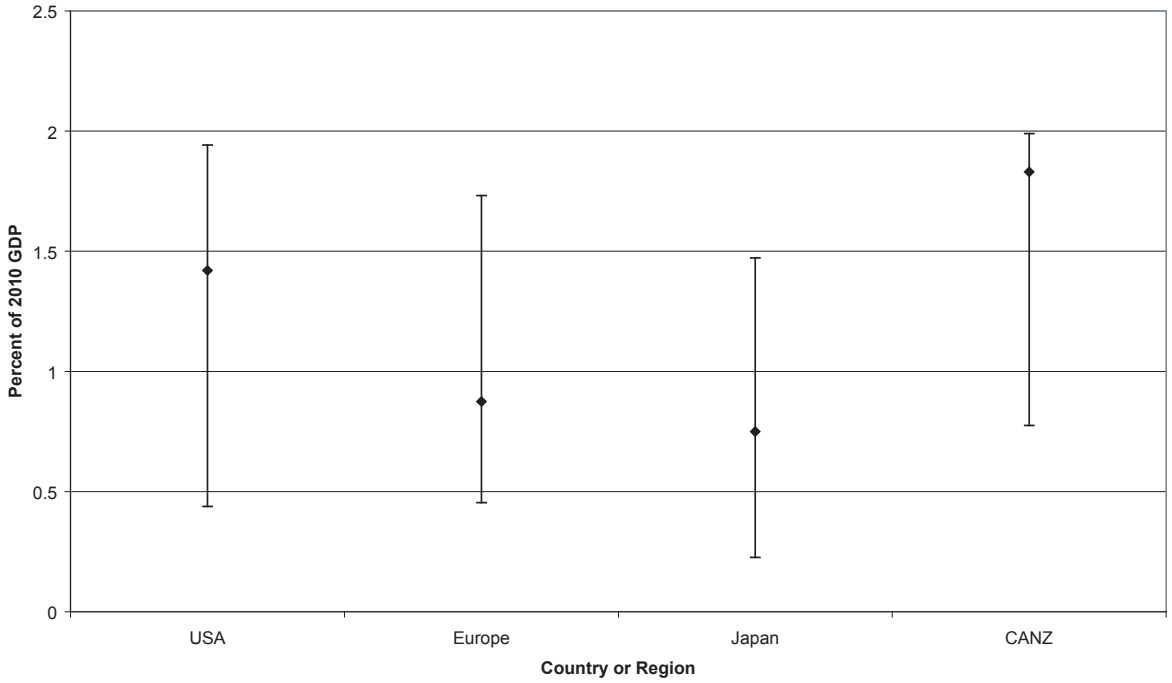
Source: Figure 2.6 in McKibbin and Wilcoxen (2002b) from IPCC (2000).

projections of the world economy that are uncertain. Figure 4 shows the various estimates of the costs of mitigation generated by the leading economic models used as inputs into the IPCC process[4].

These estimates are based on the Kyoto Protocol of 1997 rather than the highly diluted Kyoto Protocol that has emerged post the Marrakesh and Bonn negotiations[5]. For the United States the range of estimate by 2010 of the GDP loss is from 0.48 percent to 1.95 percent with a mean estimate of around 1.4 percent per year. This is a large range and does not cover all possible scenarios since this reports the range of results produced by using only one common scenario across a range of models. The key message from these models is that there is a great deal of uncertainty surrounding the estimates of the costs of mitigation just a decade into the future. This doesn't reflect a problem with the models per se, but reflects the extent of uncertainty in understanding the world economy, possible future scenarios and in estimating the costs or benefits of mitigation.

The standard reaction to this inherent uncertainty has been to generate two extreme responses. The first is to argue that nothing should be done because the problem might be small (or in extreme versions of this approach some people argue that the problem is non existent) and avoiding it might be expensive. The second approach is to argue that something drastic should be done on the argument that the problem might be enormous and taking action might be cheap. Clearly both approaches are likely to be wrong. A robust strategy would consider all the various combinations of alternatives. Suppose the problem is small but avoiding it is cheap,

Figure 4: Median GDP Loss in 2010 Under 1997 Kyoto Targets, by Region
(Error bars show the range between the 20th and 80th percentiles)



Source: McKibbin and Wilcoxen (2002a) figure 2.12 using data from Weyant (1999).

or suppose the problem is enormous and avoiding it is very expensive. A prudent policy would avoid both extremes and would be a combination of mitigation and adaptation strategies where possible at low cost.

3. Features of a sustainable global system

The fundamental problem with climate change policy is that it must deal explicitly with the uncertainty outlined above as well as the uncertainties surrounding the reactions of other countries[6]. The free rider problem in any system involving the "global commons" is a particularly acute problem for the design of climate change policy. Policy makers need to be concerned with the impact of their own actions as well as the likely reactions of other countries to a global agreement. The costs of addressing climate change are uncertain, the costs of climate change are uncertain and the future is inherently uncertain. The fact that there is so much uncertainty doesn't mean that doing nothing is the best policy. It is quite clear that human activity is raising global concentrations of carbon dioxide. While climatologists disagree about how much warming will occur and when it will happen, virtually no one seriously suggests that mankind can continue to emit increasing amounts of carbon dioxide into the atmosphere without any consequences. At the other extreme, the idea that climate change is such an overwhelming problem that it must be stopped, no matter what the costs of doing so, is also untenable given existing evidence. Too little is known about the net effects of climate change, the costs of reducing emissions or the cost of adaptation to draw this conclusion. To pretend that climate policy doesn't need to take costs into consideration is to

guarantee that many governments will ultimately reject any climate change treaty that ignores costs.

There are both political and economic aspects to the issue of sustainability. A policy regime may collapse because of the extreme strain placed on economic adjustment or it may collapse because the incentives facing politicians change, even though economic sustainability is satisfied.

A sustainable climate change policy should meet four basic criteria. First, the policy should slow down carbon dioxide emissions where it is cost-effective to do so. Second, the policy should involve some mechanism for compensating those who will be hurt economically without requiring massive transfers of wealth that could undermine economic stability. Third, since climate change is a global problem, any solution will require a high degree of consensus both domestically and internationally. A system that does not ultimately include developing countries will do little to achieve the goals of the United Nations Framework on Climate Change (UNFCCC). It is not realistic to think that a rigid global centralized regulatory regime for greenhouse policy can ever be implemented. Few countries want to relinquish sovereignty over setting their own polices, especially when the policies in question can have large economic effects. Fourth, the regime must allow new countries to enter with minimum disruption and also allow a core group of countries to continue to participate even if countries exit the system at certain times. A system involving many countries that doesn't survive changing composition over time is destined to fail since the reality is that a country's commitment to that regime is a function of the commitment of political incumbents at any point of time.

Ultimately, to be sustainable over a significant number of years, a climate change treaty must be realistic.

In more general terms, economic logic gives some clear guidelines in how to design policies that let the appropriate mix[7] of mitigation and adaptation strategies emerge over time. The key is to design institutions, regulations and markets which deliver the appropriate incentives for governments, firms and households to respond in a way that reduces the impact of greenhouse gas emissions both through abatement as well as adaptation. This broad principle suggests that mandating fixed targets for carbon abatement by an arbitrary but fixed date, such as followed in the Kyoto Protocol and other targets and timetables approaches, will only give appropriate outcomes if by accident the extent of abatement chosen is consistent with the tradeoffs between effective abatement and adaptation activities. There is nothing in the design of the Kyoto targets that effectively deals with the balancing of costs and benefits of taking action.

What is required are clear regulations on what types of restrictions on greenhouse gas emissions will be imposed. Then property rights over those emissions need to be clearly defined over long time frames consistent with the types of long-term investment decisions that characterize energy generation activities. Thirdly, markets need to be created that allow price signals to be given to households and firms so that they can undertake individual actions in responding to the incentives generated by the market in response to the restrictions imposed by government regulation. These price signals need to be both short term and long term in nature. We would argue that the short term price signals (i.e. the short term costs) should be capped at roughly the perceived benefits of taking action, through government intervention in the short term market. Finally, futures markets are required to enable individuals and companies to manage the risk of climate change and well as the risk of climate change policies.

The role for government in this approach is not to mandate an amount of abatement or an amount of

adaptation at some point in the future because it cannot possibly get this right except with an enormous amount of good luck. A simple cap and trade system overlaying a targets and timetables approach does not solve this problem; it only minimizes the cost, given the target and timetable. Government needs to concentrate on creating and preserving property rights and appropriately regulating markets. It should focus on where public goods exist and where markets may not produce the socially desirable outcomes. It should focus on where there are serious coordination failures, for example such as in federal and state relations, inconsistent regulatory frameworks within central government and between central and regional governments. Addressing these issues alone has a potential for lowering the cost of effective action on climate change.

These broad concepts may seem somewhat esoteric to non-economists but in the next section, a practical way to implement these ideas is outlined.

Finally, it is important that the system that is designed internalizes the individual incentives of governments, firms and households (and voters) within countries to adhere to an international agreement and not "free ride" on other countries. They should be encouraged to adhere to the agreement because it is in their own economic and environmental interest to sustain it. This can be achieved through the creation of assets whose value depends on the agreement and whose value collapses if the agreement is negated. A system that relies completely on severe (but ultimately not credible) compliance mechanisms requiring complex monitoring and enforcement procedures as the only guard against free riding, is less likely to survive than an agreement designed to ensure that individual incentives sustain the agreement through political and economic coalitions within countries.

5. What has been done so far?

International negotiations on climate change policy began in earnest in 1992 at the Rio Earth Summit organized by the United Nations. The result of the summit was the UNFCCC, a non-binding agreement aimed at reducing atmospheric concentrations of greenhouse gases so as to achieve the goal of "preventing dangerous anthropogenic interference with the Earth's climate system."[8] It was signed and ratified by most of the countries in the world, including the United States, and entered into force in 1994.

The Convention's intent was to stabilize emissions of greenhouse gases at 1990 levels by the year 2000 through voluntary measures taken by individual countries. Most of the burden was to be assumed by 40 industrialized countries listed in Annex I to the Convention. In particular, Article 4, Paragraph 2(a) required each of these countries to "adopt national policies and take corresponding measures on the mitigation of climate change" in order to reduce its emissions. Annex I countries were also required to contribute to a financial fund (subsequently merged into the Global Environment Facility, or GEF) to be used to help pay for climate-friendly projects in developing countries.

In the subsequent decade, however, few substantive policies were implemented and global emissions of greenhouse gases rose considerably. From that perspective, the UNFCCC failed to achieve its goal. However, its real contribution was to set up a mechanism under which negotiations could continue as periodic "Conference of the Parties" (COP) meetings.

The first Conference of the Parties, COP 1, was held in Berlin in March and April of 1995. The second Conference, COP 2, was held in Geneva in July of 1996. COP 3 was held in Kyoto in December of 1997. The result of the meeting was the document called the "Kyoto

Protocol," a treaty that formalized the "targets and timetables" approach that had been taking shape since COP 1. The Protocol set explicit emissions targets for 39 countries listed in its Annex B, which included essentially all industrialized countries which were signatories.[9] Each of these countries was to reduce its greenhouse gas emissions so that its total emissions, when converted to a carbon-equivalent basis, did not exceed a specified percentage of its "base period" emissions. For most countries, the base period was 1990 but countries having economies in transition were allowed to choose other base periods during COP 2.[10] Average emissions over the "budget period" 2008-2012 were to be at or below the target.[11] The Annex B limits are shown in Table 1; countries designated as "economies in transition" are marked with an asterisk.

The commitments in Table 1 amount to about a 5 percent reduction below 1990 emissions for the Annex B countries as a group, or about 245 million metric tons of carbon.[12] The Protocol was designed to allow Annex B countries flexibility in meeting their commitments. Some of the flexibility concerns the unilateral actions countries can take to comply with the Protocol. First, the specific policies to be used to reduce emissions were left completely to the discretion of each country. Second, compliance could be achieved by any mix of carbon-equivalent reductions in four individual gases and two classes of halocarbon: carbon dioxide, methane, nitrous oxide, sulfur hexafluoride, hydro fluorocarbons (HFCs) and perfluorocarbons (PFCs). Third, countries could offset some of their emissions by enhancing "sinks" of carbon dioxide: forests or other mechanisms that remove carbon dioxide from the atmosphere. Fourth, reductions in excess of the Annex B commitments could be carried forward and used to count toward compliance in future periods.
The Protocol also provides three mechanisms that allow for flexibility on a multilateral basis. The most important is international emissions permit trading (IET), which is allowed among Annex B countries under the Protocol's Article 17. In addition, Article 6 of the Protocol allows for "Joint Implementation" (JI), a project-based system under which one Annex B country can receive credit for emissions-reducing activities it finances in another Annex B country. The use of emissions trading and JI, however, must be "supplemental to domestic actions," a vague phrase that left open the possibility that quantitative limits could be imposed on the amount of trading and JI.[13]

For the Protocol to come into force it must be ratified by 55 percent of its signatories, and they must jointly account for at least 55 percent of total carbon dioxide emissions in 1990 from Annex I countries. Most of the operational details of the Protocol's international mechanisms — IET, JI and the Clean Development Mechanism (CDM) — were left for future COP meetings to resolve.[14] There was no negotiation over issues of compliance, how institutional structures would work, or on how developing countries might be involved beyond the CDM. Meetings after COP 3 were devoted to working out the operational details of the Kyoto Protocol. Details can be found in McKibbin and Wilcoxen (2002a). For the purposes of this paper, the key issues are the relaxation of targets through changes in allowed sinks.

When the second part of COP6 was convened in Bonn in July of 2001, it was intended to resolve all remaining implementation details of the Kyoto Protocol. The outcome was a package of proposals known as the "Bonn Agreements" which included, among other things, an increase in the sink allowances for forestry and land-use changes that were granted to several countries.[15] The total increase in sink allowances was large and reduced the overall stringency of the protocol by 54.5 million metric tons of carbon. Countries given sink allowances greater than one million metric tons of carbon-equivalent emissions are shown in Table 2. Although the Bonn Agreements were formulated during the second part of COP 6, they were not adopted as official decisions of

the Conference. Instead, further discussion and formal adoption were deferred until COP 7.

COP 7 was held in Marrakech in October and November 2001. It refined and extended the Bonn Agreements in three main areas: (1) defining the "principles, nature and scope" of the international flexibility mechanisms; (2) finalizing the accounting rules for sinks derived from land use changes and forestry; and (3) designing an enforcement mechanism to discourage noncompliance. The result was a document called the "Marrakech Accords" that COP participants hoped would remove all remaining obstacles to ratification of the Kyoto Protocol.

Finally, COP 7 further relaxed the Kyoto emissions target by granting a Russian request that its sink allowance be increased from 17.63 million metric tons (MMT) to 33 MMT. Thus sinks have relaxed the Kyoto targets by roughly 70 MMT, which together with the withdrawal of the United States makes the Kyoto Protocol's targets through 2012 very loose.

The United States withdrew from the protocol in March 2001, a move which was angrily denounced by surprised commentators in Europe and around the world. It was described as arrogant, isolationist, and a "betrayal [by the Bush Administration] of their responsibilities as global citizens".[16] Yet the announcement was really nothing more than a blunt public acknowledgment of a fact that was well known within the policy community: the Kyoto Protocol was already dead in the United States. The U.S. Senate, which must ratify all international treaties by a two-thirds majority, overwhelmingly opposed the protocol and had voted 95-0 against U.S. participation as early as July 1997, five months *before* the protocol was signed.[17] Opposition was so great that the Clinton Administration, which negotiated and signed the protocol, never bothered to submit it to the Senate for ratification. Even if the Bush Administration had enthusiastically supported the treaty — which it did not — there was little it could have done.

What doomed the protocol in the Senate is a critical flaw in its design: it requires each participating industrialized country to agree to achieve a specified emissions target regardless of the cost of doing so.[18] This was also the main factor that doomed the Protocol in Australia. The focus on rigid targets also makes the treaty impractical as a long-term climate policy for the rest of the world as well. Because the costs of reducing emissions are unknown and could be very large, countries with substantial emissions have insisted on increasingly lax targets as a condition for their continued participation. Japan, Canada and Russia, for example, were able to negotiate large increases in their "sink" allowances during COP6bis, held in Bonn, and COP7, held in Marrakech.[19] Between the U.S. withdrawal and the increase in sink allowances, the original Kyoto Protocol has been relaxed substantially. The effect on estimated emissions permit prices in the 2008–2012 period is dramatic. Relative to the original Kyoto agreement, permit prices are likely to be reduced by 14 percent (Bohringer, 2001) to 85 percent (Kemfert, 2001).[20] McKibbin and Wilcoxen (2002) find that as a result of the change in targets the price of Carbon fell from $US64 per ton to $16 per ton by 2010 (under a given scenario about the future). The McKibbin (2002) Report to the Australian Government showed that higher Russian economic growth by just 1 percent raised the likely permit price by 2012 by 50 percent and raised the cost of Kyoto for Europe from 0.8 percent of GDP to 1.1 percent of GDP. There are so many assumptions that might turn out differently in these projections that a range of cost projections is critical and uncertain even about the near future. Surprisingly, when the McKibbin (2002) report was released and even still today, some commentators continue to pick a single year number from one scenario in that report to argue for Kyoto ratification in Australia, when the reality is that the uncertainty about the costs and the

range of possibilities that are the basis of the report are conveniently ignored.

6. Fatal problems with the Kyoto Protocol approach

The fundamental principle on which the Kyoto Protocol is based — setting "targets and timetables" for reducing greenhouse gas emissions — is both economically flawed and politically unrealistic. To ratify the protocol, a developed country must be willing to agree to reduce its emissions to a specified level — typically about 5 percent below the country's emissions in 1990 — by 2008 to 2012 regardless of cost. Australia was able to negotiate a rise of 8 percent from 1990 levels and to have land clearing included which was effectively a major relaxation of the underlying target. Recent predictions are that because of a reduction in land clearing, the target is achievable yet emissions from energy continue to rise unabated (see AGO (2004)).[21] Because costs could be large[22] (perhaps not in the period from 2008 to 2012 but there is enormous uncertainty about future periods), most developed countries will never ratify a treaty based on targets and timetables, or they will insist, as a precondition for ratification, that their targets be diluted through an accounting adjustment which allows credit for activities that absorb carbon (called sinks). Countries that do ratify are unlikely to comply with the Protocol if the constraints become seriously binding. Already our modeling estimates that Japan is 16 percent above its Kyoto target and it is unclear how it can possibly hit the target unless emissions permits are very cheap in the first commitment period. During 1997, at the time of the Kyoto negotiations, one suggestion that made Japan's target look feasible was to build up to 20 nuclear power plants. By 2004 it is not possible to build any new nuclear power plants in Japan given recent crises in the Japanese nuclear power industry. Developing nations, which will become the world's largest emitters in coming decades, have even less incentive to sign on, given the enormous uncertainty about their growth paths and therefore the costs of a binding emissions target.

The issue of costs is crucial. The array of uncertainties associated with climate change, make it impossible to tell whether the benefits of the treaty are worth its costs. Nor is there any evidence that the targets set by the protocol are the optimal levels of greenhouse gas emissions, either for an individual country or for the world as a whole. If anything, cost-benefit calculations based on studies to date tend to suggest that the expected costs exceed the expected benefits, at least for developed countries.

Kyoto's greatest weakness, however, is not the lack of clear cost-benefit justification. After all, governments often face uncertainty when evaluating potential policies. Because the damages caused by climate change could be very large, a prudent legislature might want to adopt a climate policy to hedge its bets, as long as it could keep its costs within bounds. But Kyoto's "targets and timetables" design makes that impossible. Governments that adopt the protocol risk taking on a disastrously expensive commitment—and surrendering part of their sovereignty in the process.

The Kyoto agreement also fails to give governments any incentive to police it and lacks credible compliance measures. Monitoring polluters is expensive, and punishing violators would impose costs on domestic residents in exchange for benefits that will go largely to foreigners. Governments would be strongly tempted to look the other way when firms exceed their emissions permits. Negotiators have tried to devise a strong international mechanism to monitor compliance and penalize violations, but so far have produced only a paper tiger: the Protocol includes no credible deterrent for anything beyond very minor violations.

Nor has Kyoto found a way to include significant

participation by developing countries. Because these countries are responsible for a relatively small share of historical greenhouse gas emissions, they are especially reluctant to incur large costs and give up their sovereignty in a climate change agreement. At present the only incentive for a developing country to undertake a specific emissions commitment is Kyoto's system of international permit trading. If developing countries are given greenhouse gas allowances large enough to exceed their emissions permits, they could earn foreign currency by exporting excess permits. Essentially, developed countries would pay developing countries for abatement. But massive exports of permits risk driving up a developing country's exchange rate and driving down its other exports (similar to the United Kingdom experience when North Sea Oil was discovered — this is called the Dutch Disease or Gregory effect). Accessing a global permit market also risks causing a severe short run structural shock because to be in a Kyoto style permit trading system would almost necessarily require the price of carbon in these countries to be equal to that in industrial countries — a situation which is far from true today.

An international permit trading system which forms an important part of the cost equalization aspect of Kyoto is also problematic. It will be a market with a few large countries that might restrict trade to change the permit price. It is a market where the value of all permits depends on the behavior and institutional weaknesses of all participating countries. It requires strict monitoring and an as yet undetermined enforcement mechanism; otherwise the value of all permits is affected by weakness in any part of the system. A global emissions trading system is not analogous to markets in other commodities because the supply of permits is arbitrary and value only exists because of government fiat — many governments.

Thus Kyoto is unlikely to attract any more participants into its binding target approach. It may work if political will can be sustained over long periods and depending on the future evolution of the global economy but it is just as likely to run into trouble somewhere in the near future. It is dangerous to risk such an important global issue as climate change on the hope that costs turn out to be low and emissions are easily reduced within an arbitrary time frame. Technological innovations, which will ultimately be the answer, do not always arise on a neat timetable.

7. The Blueprint: a realistic "hybrid" approach

The issue of managing uncertainty is fundamental to designing systematic response to climate change. However, uncertainty is not the only issue that the design of a practical climate change policy should consider. Just as economic efficiency is just one aspect that needs to be taken into account, there is also a need to trade efficiency off against a range of other issues related to notions of equity as well as dealing directly with political realities of national self interest and the need to have a sustainable system that will last for many decades. A climate policy's political prospects globally will be substantially better if it does not require large transfers of wealth — either between countries or between households and firms within a country — or the surrender of a significant degree of national sovereignty. Because the system will need to remain in effect for many years, it must be designed to allow new countries to enter with minimum disruption and to survive the exit of some of its participants in extreme circumstances.

Neither of the standard market-based economic policy instruments that occupy a central role in economics textbooks satisfies all of these criteria. An ordinary cap and trade permit system would require participants to achieve a rigid emissions target regardless of cost (i.e. the price of permits or the cost of abatement varies with the demand for permits) An emissions tax, although

fixing the cost of abatement, has the disadvantage of involving potentially huge transfers of wealth either within countries for a domestic system or between countries for an international system, and would be politically unrealistic. However, a hybrid policy, combining the best features of the two, would be an efficient and practical approach.[23]

The particular hybrid policy proposed by McKibbin and Wilcoxen in various papers (1997a, 1997b, 2002a, 2002b) (hereafter referred to as the Blueprint) focuses on a long term goal for emissions reductions but minimizing short term costs in achieving those targets. It does this by focusing on the price of carbon in the short run but guided by information on the expected future price of a carbon target in the long run. They also focus on having the approach implemented on a country by country basis with coordination across countries but no trading of permits between countries. This coordination of national actions is fundamentally different to the Kyoto approach of centralization of actions imposed on all participants.

The detailed policy is outlined in McKibbin and Wilcoxen (2002a). The idea is relatively simple. An analogy to what is required can be found in government bond markets and monetary policy in most countries. The long term government bond is in relatively fixed supply and the market price of these bonds generates a long term interest rate. The short term interest rate is set by the central bank and the quantity of liquidity is determined by demand, given that the supply of liquidity is whatever is required to fix the price (there is no arbitrary quantity constraint). The short term interest rate is fixed. The long term interest rate is determined by the market but it is presumably the expected future short term interest rates. This is an effective example of using markets with a combination of fixed short term prices and market determined quantities and fixed long term quantities with market determined prices.

A similar issue of mixing long term price determination with short term fixed prices can be applied to carbon emissions. There is a very long term target for emissions which we would like priced so that long term investment decisions can be undertaken both using the information in the long term market as well as using the market to hedge decisions in case circumstances change — but we would like guarantee the short term cost to the economy.

To do this McKibbin and Wilcoxen argue that each country would issue two kinds of emissions permits: long term permits that entitle the owner of the permit to emit one metric ton of carbon every year for a long period (even with a declining allowance over time), and annual permits that allow one ton of carbon to be emitted in a single, specified year. Both types of permit would be valid only within the country of issue — unlike the Kyoto Protocol, there would be no international permit trading. Each year, governments would require firms within a country to have a total number of emissions permits, in any mixture of long term and annual permits, equal to the amount of emissions they produced that year.

The number of long term permits each country could issue would be decided by international agreement and could be based on the limits in the Kyoto Protocol — on average about 95 percent of most countries' 1990 emissions. It would be up to each government to decide how to allocate its long term permits: some countries might want to give them to existing fuel users as a form of grandfathering, while others might prefer to sell or auction the permits to raise revenue. Once distributed, the long term permits could be traded among firms, or bought and retired by environmental groups.[24] In addition, the government itself could buy back permits in future years if new evidence on climate change indicates that emissions should be cut more sharply or in extreme circumstances they could change the units of these permits in a uniform way.

Annual permits would be sold at a stipulated price determined by international negotiations, such as US$ 10 per ton of carbon. To put the fee in perspective, in the United States, US$ 10 dollars per ton of carbon is equivalent to a tax of US$ 1.40 per barrel of crude oil, raising the price of a US$ 20 barrel of oil by about 7 percent. There would be no limit on the number of annual permits that could be sold in a given year. Every ten years countries would meet to evaluate the information on emissions, climate change, and climate science and then decide whether or not to change the agreed annual permit price to be in place for the following decade.

It is important that the annual price be denominated in a common unit (for example $US) because the Blueprint is designed to equate the short term marginal cost of carbon in all countries. The long term permit market would likely trade in local currency units in each economy where the long term price reflects the expected future short term prices and expected changes in exchange rates.

Because it has two kinds of permits, the Blueprint is a bit more complicated than a simple cap and trade permit system. However, it has all of the strengths of a traditional permit system and has additional advantages as well. It performs especially well in comparison to the Kyoto Protocol in terms of the economic costs, the certainty of costs, the incentives facing government, households and firms and the ability for individuals to manage the risk of climate change especially as these risks impact on long term investment decisions.

Like the Kyoto Protocol, the Blueprint encourages energy producers to keep emissions steady or, even better, to cut them. Firms that can cut emissions cheaply will do so and then sell unneeded long term permits to those whose emissions are increasing. As a result, emissions in each country will be reduced, and in a cost-effective manner. Unlike the Kyoto approach, the Blueprint also encourages adaptation since it gives clear signals of expected costs of mitigation which can be used by individual firms and households to decide on individual actions for adaptation.

Unlike the Protocol, however, the Blueprint provides an upper limit on the cost of compliance. No firm would have to pay more than US$ 10 per ton to reduce its emissions in the short run because it could always buy an annual emissions permit from the government instead. There is no need for international permit trade because prices are equal in the short run by design (as long as the long term permit target is binding). Adopting the hybrid, in other words, does *not* require a country to make an open-ended commitment to reduce its emissions regardless of cost. As a result, it has a far better chance of ratification in the U.S. or other countries having large carbon emissions. Moreover, that absence of a rigid upper limit on carbon emissions would also increase the possibility of significant participation by developing countries. The hybrid policy would have many other desirable attributes as well. These are summarized briefly below and discussed in more detail in McKibbin and Wilcoxen (2002a,b).

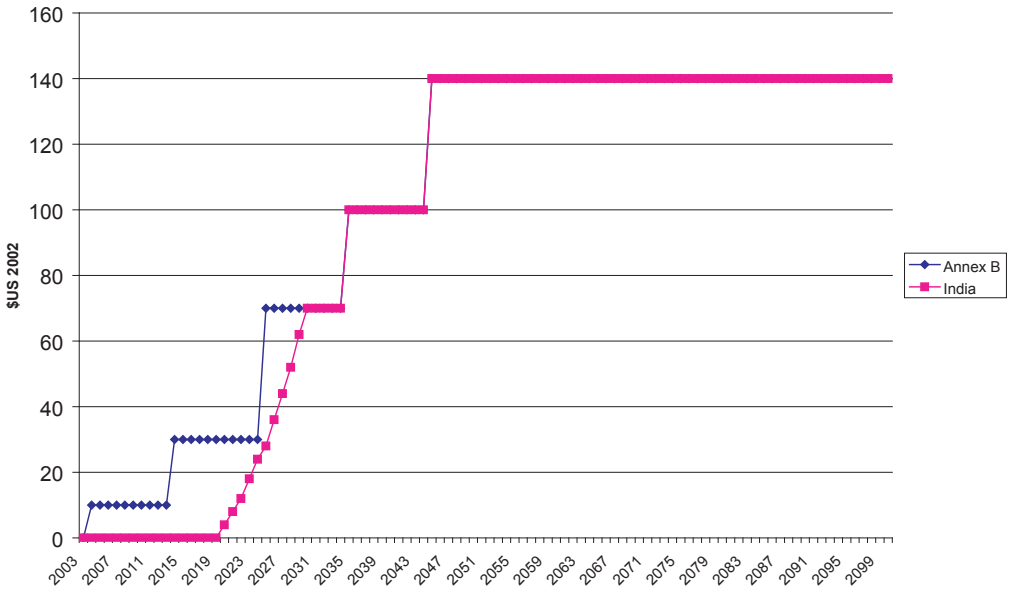
A key strength of the Blueprint is that it would be very stable with respect to changes in the mix of participating countries. Because permit markets are separate between countries — linked only by the common price of an annual emissions permit — the entry or exit of one country from the system would have no effect on the price of permits circulating in other countries. In contrast, a change in list of countries participating in the Kyoto Protocol would cause windfall gains or losses to ripple through permit markets around the world. The defection of a large country would destroy a global permit market — the market only has value because of the promises of participating governments.

Another advantage of the Blueprint is that countries would manage their own domestic permit trading

system independently, using their own legal systems and financial institutions. International cooperation, although helpful, would not be essential beyond the initial design of the system. Monitoring firms to make sure they comply with the policy would be an internal matter for each country. Unlike the Kyoto Protocol, the Blueprint provides incentives for governments to monitor and enforce the agreement within their borders. One incentive is the revenue that could be raised from the sale of annual permits: low compliance would cause a government to sell fewer annual permits that it could have, lowering permit revenue. In addition, and perhaps more importantly, holders of long term permits will pressure their governments to be vigilant in order to maintain the market value of long term permits: low compliance would reduce prices in the permit market. The Kyoto Protocol, in contrast, requires international monitoring and a new international institution to ensure compliance. Moreover, poor monitoring and compliance in one country could debase the entire global permit trading system because it would affect emissions permit prices throughout the developed world.

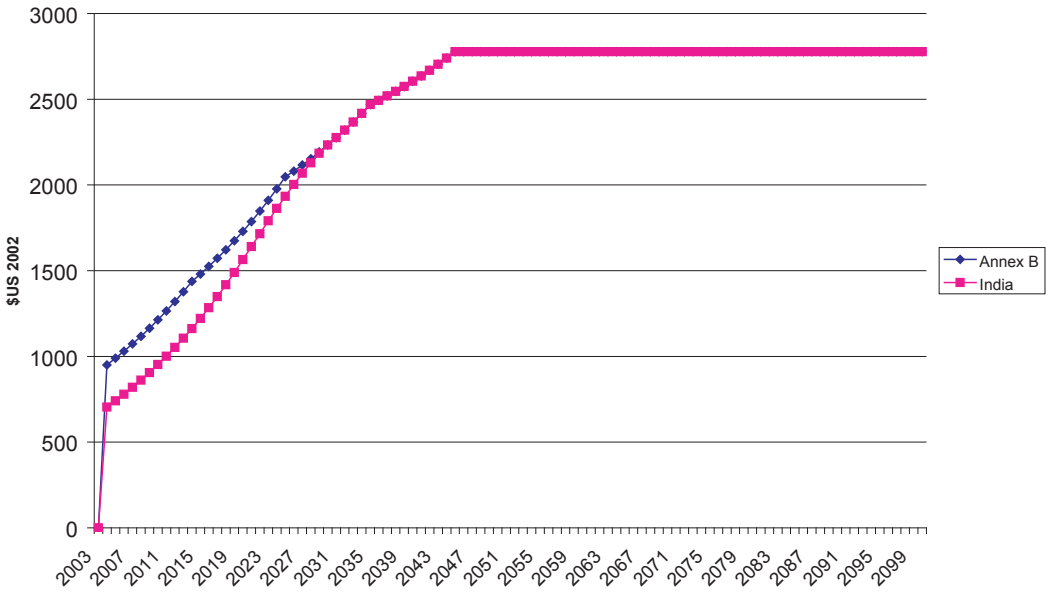
In contrast to Kyoto, developing countries are included explicitly in the Blueprint with long term commitments but no short term costs as outlined in McKibbin and Wilcoxen (2002a). In the case of developing countries, the long term permit allocation would need to be negotiated although we could use the Kyoto targets for developed countries. For developing countries a larger target, perhaps a doubling of emissions would be negotiated. These would then be allocated within the country. Within a developing country like India or China, the annual permit price would be zero while the quantity of long term permits exceeded the amount of carbon emissions in the short run. Over time, as the emissions rose above the number of long term permits the price of annual permits would begin to rise to the world price. This would occur if we allow an allocation

Figure 5: Stylized Annual Permit Price



Source: Figure 6 in McKibbin (2005).

Figure 6: Stylized Value of Perpetual Permits
(Assuming r=5%)



Source: Figure 7 in McKibbin (2005)

of long term permits well in excess of current emissions. However, the price of long term permits would reflect the expectation that the developing country would eventually reach the emission levels that caused the carbon emission constraint to be binding. Thus the long term permit market with positive prices would provide a financial incentive to begin to change the developing country carbon emissions over time even though the annual cost to industry of a carbon permit would initially be zero. McKibbin (2005) gives a more detailed overview of how this would work in India. Figures 5 and 6 show one scenario in which the permit prices rise in each ten year step of negotiations over the common carbon price. Initially annual permits start at $US10 per ton in industrialized economies and eventually rise to $US140 per ton by 2044 as a result of new information that climate change is more serious than expected. While the industrialized economies are facing a tightening carbon constraint, the annual price in India does not rise above zero until 20 years after the commitment and then only gradually rises towards the world price as carbon emissions exceed the long term permit allocation. Thus in this scenario, India's capacity to pay and rate of emissions growth determine when they begin to incur costs towards abatement. However, the firm commitment to eventually take action is priced in the long term permit market from the beginning of the period. In figure 6, long term permits are valuable from the commencement of the policy, as seen from the $705 per long term permit. This price is calculated assuming perfect foresight about the future annual price and a discount rate of 5 percent. The actual value of long term permits, if this approach were implemented, would of course depend on the range of expectations about future carbon prices and future emissions profiles in India, but this example shows how a market for a long term asset, such as the long term permit, can be used to price expected future

carbon prices and give incentives for abatement and adaptation even while the current cost of carbon to industry is zero.

The attractiveness of the Blueprint for creating institutions to aid in economic development in developing countries should not be underestimated. The ability of investors in energy systems to effectively hedge their investment over a long period of time should be very attractive for the development of energy systems in developing countries. Rather than cash transfers, the Blueprint relies on creating institutions and assets to encourage foreign direct investment. The time frame of the assets we propose to be created (by committing to a global climate regime) is currently unparalleled. Developing countries could use this new asset as a way of attracting foreign investment and enhance the development process by creating what is effectively a futures market in energy. This is far more likely to induce foreign investment than the CDM or other similar mechanisms that face very high administrative costs. Critics might argue that the problem with developing countries is the inability to create the sorts of institutions the above scheme would require. This is a problem in the near term but it is easier for developing countries to create property rights and institutions domestically according to the characteristics of that developing country, than it would be to impose within a developing country the types of institutions and property rights that would be required under the Kyoto Protocol for a developing country to be able to sell carbon rights into a global market. The required synchronization of property rights globally in a form reflecting developed countries practices is exactly why it is difficult to see how the Kyoto Protocol could be implemented outside the small group of industrialized countries with similar institutional structures that are already involved.

So far the discussion in this paper has focused on energy-related carbon emissions. However, within countries, land use changes and other gases could be incorporated into the broad framework by allowing these activities to generate annual permits. This would effectively be a transfer of revenue from the government which would otherwise have created the annual permit to hold the price, to activities that reduce overall greenhouse emissions. An important aspect of this extension is that the transfers are within a country. The problem with Kyoto is that these types of transfers are across national borders and immediately cause problems when negotiating which sinks or land clearing is allowed and what is not allowed.

Overall, the Blueprint is a practical and politically realistic approach to both reducing greenhouse gas emissions (i.e. mitigation) as well as giving clear incentives to consider adaptation strategies. The main criticism leveled against the Blueprint is that it does not guarantee precisely how much abatement will take place each year or by a certain time in the future. This is actually one of its main advantages. If firms discover that it is very expensive to keep their emissions below their holdings of long term permits, the option to buy annual permits allows them to emit more, although at a cost of US$ 10 per ton. The long term permit prices give a powerful long term signal to industry and consumers in addition to the short term price signals. As a practical matter, however, the Blueprint would do far more to reduce emissions than a stronger treaty that could never be ratified or enforced. McKibbin and Wilcoxen (2004) find that the Blueprint gives a better outcome for carbon concentrations at a lower cost than Kyoto. More importantly, as assumptions about the future are changed, the expected costs of Kyoto change dramatically whereas with the Blueprint the costs are stable and capped by the annual fixed permit price. This ability of the Blueprint to deal with manifest uncertainty about the future is a significant improvement over Kyoto.

8. Where the world and Australia can go from here

It is clear that both mitigation and adaptation should be part of a sensible climate policy approach (see McKibbin and Wilcoxen (2003)). It is clear that responses will have to be at both the government level as well as at the industry and household levels. Indeed the role for government is to create the environment for individuals to take action on both mitigation and adaptation strategies through clear allocation and protection of property rights and clear restrictions on certain activities. Private markets, with both short-term economic signals constrained by cost considerations and long term economic signals driven by environmental outcomes, should be created. The creation of these markets, which don't currently exist, will enable companies and individuals to take actions to achieve the long run environmental goals at low economic cost in both the short run and the long run. These markets can also be used to provide firms and households with a way to manage risk, which is of fundamental importance given the inherent uncertainty around all aspects of climate change.

One example of how to achieve this in a practical way is through a mix of sensible policies such as the abolition of distortions in the world coal market as advocated by Anderson and McKibbin (2000). Indeed this could easily be extended to world energy markets as well. Another is the McKibbin Wilcoxen Blueprint proposal in which the role of government in designing the market mechanism, imposing regulation and minimizing the short term cost of climate policy is combined with long term signals to encourage individual action for both mitigation and adaptation strategies to emerge as part of individual self interest. If actions by individuals and firms are not encouraged then it is unlikely that there will be an effective and low cost response to the potential of global climate change.

There is a need for the Australian government to act now so that incentives are created for both mitigation and adaptation strategies. In particular the issue of property rights needs to be addressed. This is not just over greenhouse gas emissions but over a range of areas that are likely to be affected by climate change. In particular things such as water use, land use change and a variety of these issues will better be able to adapt to climate change if the principles outlined above are implemented across these areas as well. The success of strategies for mitigation and adaptation will ultimately depend on a combination of government intervention and mechanisms that encourage individuals to undertake their own actions. The issues of risk sharing, abatement, adaptation and transitional assistance will all have to be addressed in the formulation of a sensible policy.

This paper has argued that an approach such as the McKibbin Wilcoxen Blueprint will be particularly effective for developing countries both to reduce future trends in carbon emissions and also as a development mechanism for encouraging foreign direct investment in energy sectors. Because this approach is implemented at the country level and coordinated globally it is feasible for countries to implement the Blueprint individually. If Australia was to formalize the current approach of acting in consultation with the rest of the world, then by implementing the Blueprint it would make an important step forward. Firstly, by demonstrating that a sensible and more attractive approach than the Kyoto Protocol exists and that the Kyoto Protocol can be easily evolved into the Blueprint approach by extending the horizon of targets and creating institutions to sustain the policy. Once property rights are distributed there will be powerful coalitions in support of effective climate action if warranted by evolving information. Politically, the creation of property rights in carbon emissions would be an attractive and possibly valuable asset that the government can distribute to both existing fossil fuel producers and users as well as Australian citizens to compensate for any energy

price increase that might emerge if technological solutions are not rapid in emerging. It would be like the privatization of Australia's major telecommunication company (Telstra) except that the shares (or long term emission permits) are given to stakeholders rather than sold. If energy prices were to rise as a result of the Blueprint, which in fact they should if conservation on the demand side is to be achieved while technological breakthroughs are waited for, the compensation for higher energy prices is built in automatically.

The idea that subsidies to industries to reduce emissions are the way forward is a risky strategy. It focuses all attention on one aspect of carbon emissions which is focused on a small group of industries which received the subsidies. It does nothing to address the demand for energy by households for transportation or other uses. It does nothing to reduce carbon emission if the subsidy is targeted to the wrong technology. Should it be clean coal? Should it be renewables? Who will pay for the subsidies? What will prevent investment in lobbying rather than R&D from being the largest investment in this system? The Blueprint internalizes all of these issues and is a self funding approach in which there is enough compensation to support structural adjustment. It also creates markets for industry and individuals to manage long term climate risk. Subsidies don't and can't do that. Individual responsibility to manage decisions within a clearly defined system of regulation and transparent property rights is what is needed to address climate change and not piecemeal subsidies to some sectors of the economy or arbitrary targets that may or may not be reached because of changing political winds.

Politicians should embrace a system like the Blueprint. It directly addresses the recurring problem of climate change that is unlikely to go away. By establishing property rights over carbon and removing direct subsidies it minimizes the extent of lobbying by industry. It gives the government which creates the property rights the opportunity to allocate this new form of wealth however it wishes. It is unlikely that future governments will change that allocation in the same way that real estate is not frequently redistributed after an election. It compensates fossil fuel intensive industries (and their shareholders) for past carbon investments and creates a market for hedging future investments which creates value in reducing uncertainty. This is particularly important when the future demand for energy in Australia is likely to be rising and key medium term supply decisions need to be made in coming years. And if the Blueprint is shown to be an attractive system that works as well as expected, it would encourage other countries to adopt a similar price based system. In contrast to a country by country carbon target, a global system based on costs and efficiency would benefit an efficient, low cost energy exporter like Australia, even in a world of a tightening carbon constraint.

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Table 1: Kyoto Protocol Emissions Limits or Reduction Commitments

(Percent of 1990 or base period emissions)

Country	Target	Country	Target
Australia	108	Liechtenstein	92
Austria	92	Lithuania*	92
Belgium	92	Luxembourg	92
Bulgaria*	92	Monaco	92
Canada	94	Netherlands	92
Croatia*	95	New Zealand	100
Czech Republic*	92	Norway	101
Denmark	92	Poland*	94
Estonia*	92	Portugal	92
European Community	92	Romania*	92
Finland	92	Russian Federation*	100
France	92	Slovakia*	92
Germany	92	Slovenia*	92
Greece	92	Spain	92
Hungary*	94	Sweden	92
Iceland	110	Switzerland	92
Ireland	92	Ukraine*	100
Italy	92	United Kingdom	92
Japan	94	United States	93
Latvia*	92		

* Country designated as an "economy in transition."

Table 2: Countries Receiving Sink Allowances Exceeding 1 MMT

(Million metric tons of carbon)

Country	Allowance
Canada	12.00
Germany	1.24
Japan	13.00
Romania	1.10
Russia	17.63
Ukraine	1.11

Footnotes

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[1] Drawing extensively on joint research in McKibbin and Wilcoxen (1997a,1997b, 2002a, 2002b, 2003).

[2] For an exhaustive survey of the scientific literature on climate change, see Intergovernmental Panel on Climate Change (2001) and Mckibbin and Wilcoxen (2002a) chapter 2 for a summary.

[3] See Bagnoli et al (1996) and McKibbin Pearce and Stegman (2004) for some examples involving changes in productivity projections.

[4] Based on the results presented in Weyant (1999).

[5] See Buchner et al (2001), Bohringer (2001) , Löschel, and Zhang (2002) and McKibbin and Wilcoxen (2003) for evaluations of the extent of changes since the original Kyoto Protocol of 1997.

[6] This point was stressed by an anonymous referee.

[7] "Appropriate" can be defined more broadly to take into account a range of issues such as economic efficiency (i.e. minimum cost), fairness, and other social and environmental considerations as well as political realities.

[8] For more information about the United Nations Framework Convention on Climate Change (UNFCCC) and the various related meetings that followed it, see the UNFCCC web site: http://www.unfccc.org/.

[9] The Annex B list is a subset of the countries listed in Annex I of the UNFCCC. It excludes Belarus, which had not ratified the UNFCCC by the time COP 3 was held, and Turkey, which requested that it be removed from Annex I at COP 3.

[10] Decision 9 of COP 2 established the base periods for Annex I countries.

[11] Gases other than carbon dioxide are converted to a carbon-equivalent basis using "global warming potentials" established by the Intergovernmental Panel on Climate Change. A country's carbon-equivalent emissions over the five year period 2008-2012 was required to be less than or equal to the specified fraction of base period emissions.

[12] The exact reduction depends on the treatment of land use changes, which had not been finalized by the end of COP6.

[13] The European Union, in particular, was in favor of limiting the degree to which compliance could be achieved by trading and JI. The United States was opposed to any restrictions.

[14] The CDM is a mechanism by which demonstrated reductions in greenhouse emission in developing countries (relative to a business as usual outcome) can generate credits that can be used within Kyoto countries with targets (or Annex B countries).

[15] Sink allowances enable countries to offset a portion of their carbon emissions by enhancing activities, such as forestry, that remove carbon dioxide from the atmosphere.

[16] "World Leaders Criticize Bush on Global Warming," Associated Press, March 30, 2001.

[17] Senate Resolution 98 of the 105th Congress, generally known as the "Byrd-Hagel Resolution" after two of its authors.

[18] This is known as the "targets and timetables" approach and it will be discussed in more detail below.

[19] Sink allowances enable countries to offset a portion of their carbon emissions by enhancing activities, such as forestry, that remove carbon dioxide from the atmosphere.

[20] See Buchner et al (2001) for a survey of estimates.

[21] Land clearing is counted as a carbon emission in total emissions. Thus a reduction in land clearing means a reduction in emissions. This reduces the need to cut energy emissions in order to reach a total emissions target.

[22] Costs are estimated to be less than expected in 1997 before the relaxation of targets and the withdrawal of the US but they are still highly uncertain as argued in section 2.

[23] The economic theory behind regulation under uncertainty is due to Weitzman (1974), and the theory underlying hybrid regulatory policies is due to Roberts and Spence (1976). A hybrid approach to climate change was first proposed by McKibbin and Wilcoxen (1997) and has subsequently been endorsed or promoted by a range of authors and institutions. For further details, see McKibbin and Wilcoxen (2002).

[24] Countries could participate in the Blueprint even if they lacked appropriate markets where permits could be traded. In that case, a firm's allocation of long term permits would essentially be an emissions quota. Without tradability, the country would no longer be guaranteed of reducing its emissions at minimum cost. However, the existence of annual permits would reduce the excess cost caused by an inefficient allocation of permits.

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