Climate Policy and Uncertainty: The Roles of Adaptation versus Mitigation

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ABSTRACT

This paper focuses on the aspects of uncertainty surrounding climate change and what a realistic policy that deals with this uncertainty would look like. Any sensible response to climate change should consist of both mitigation and adaptation. Because of the long time periods involved, mitigation and adaptation are inseparable issues. Measures to reduce emissions today will only change the climate many years into the future and will therefore impact on the extent of future adaptation.

There are two aspects of adaptation addressed in this paper. The first is the need to provide the appropriate incentives for individual responses to climate change – this requires clear establishment of property rights across a wide range of areas from managing water to pricing energy use. It also requires appropriately regulated markets for individuals to manage a range of different types of risk. The extent to which individuals have an incentive to invest in adaptation depends on the nature and clarity of the policies put in place for current and future mitigation. Greater policy uncertainty changes the incentives for investment in adaptation.

The second part of the paper focuses on implementing an adaptable policy framework that can respond to information on climate change. Like individual adaptation, the key to a durable system for policy is the importance of establishing property rights and providing a mechanism for managing risk caused by changes in policy. This draws extensively on the book by Warwick J. McKibbin and Peter Wilcoxen, "Climate Change Policy After Kyoto: A Blueprint for a Realistic Approach" published in December 2002 by the Brookings Institution. Drawing on this book, the paper outlines important insights that economic theory offers for the design of sustainable climate policy in an uncertain world. We outline a clear framework that will reduce greenhouse gas emissions (mitigation) while guaranteeing that short-run costs of compliance will not be excessive, and encouraging adaptation of the economic structure to deal with future mitigation. It also allows flexibility in adjusting policy settings when new information about various aspects of climate change becomes available.

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1. Introduction

In the climate change debate, the overwhelming amount of analysis has focused on mitigation actions rather than adaptation. Mitigation is the act of reducing the cumulation of greenhouse gases in the atmosphere (whether by reducing the emission of these gases or increasing the absorption through creation of sinks). Adaptation is the process of changing behavior in response to actual or expected climate changes. Both activities are likely to be important as responses to potential climate change. The difference between choosing between these responses to climate change is analogous to the decision to wear seat belts versus installing anti-lock breaks on a car. The anti-lock breaks help to reduce the likelihood of an accident (mitigation) whereas the seat belts help to prevent catastrophe if there is an accident (adaptation). With both options available few sensible people would choose only one or the other since they both act to minimize the risk of serious injury.

Why both mitigation and adaptation are likely to play a role in formulating sensible and low cost approaches to climate policy is because of the inherently uncertain nature of climate change. This paper focuses on why mitigation and adaptation are both important in responding to climate change. The importance of uncertainty in designing policies in response to the possible implications of climate change is outlined in section 2. In section 3 we examine what features are important in designing climate change policy to encourage both low cost mitigation and adaptation strategies. In Section 4 we then outline the McKibbin-Wilcoxen Blueprint[1], which is an approach to climate policy that has been designed specifically to deal with the fundamental

[1] Se McKibbin and Wilcoxen (1997,2002a,2002b).

aspects of uncertainty and managing risk, in a way which the Kyoto Protocol fails to do. A summary and conclusion of how sensible policy should be designed is presented in section 5.

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. Each year, worldwide fossil fuel use adds about six billion metric tons of carbon to the atmosphere, and the concentration of carbon dioxide is now about 30 percent higher than it was at the dawn of the Industrial Revolution.

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 but the intrinsic complexity of the climate makes it impossible to know precisely what will happen with any degree of confidence. Even if 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].

Figure 1 shows the various estimates of the costs of mitigation generated by the leading economic models used by the IPCC[4]. These estimates are based on the Kyoto Protocol of 1997 rather than the highly diluted Kyoto Protocol that has emerges post the Marrakesh and Bonn negotiations[5]. 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 wrong. A robust strategy would consider all the various combinations of alternatives. Suppose the problem is small but avoiding it is cheap, or suppose the problem is enormous and avoiding it is very expensive. A prudent policy would avoid both

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[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] Se Bagnoli et al (1996) for some examples involving changes in productivity projection.
[4] Based on the results presented in Weyant (1999).

extremes and would be a combination of mitigation and adaptation strategies where possible at low cost.

3. Adaptation Versus Mitigation and the Design of Policy

Figure 2 gives a stylized overview of the issue of abatement versus adaptation. The figure has the temperature now on the left and the temperature at some time in the future with no action shown on the right. Policy 1 of 100% adaptation would have no effect on the temperature in the future. Policy 2 of 100% mitigation would target a temperature in the future and work back to what mitigation actions would be required to achieve that outcome. It is clear that the mitigation policies would face rising marginal costs. Each additional unit of mitigation is likely to cost that much more. Thus there are some low cost mitigation actions initially and then potentially very high cost mitigation actions as the extent of abatement became more ambitious. Coming from the adaptation direction it is clear that the same will also hold. Some adaptation will be very low cost (i.e. taking off a coat) whereas some adaptation actions might be very high cost (i.e. building tide retaining walls). It is clear then that the optimal policy would contain the low cost mitigation strategies as well as the low cost adaptation strategies (policy 3). It is extremely unlikely that either policy 1 or policy 2 would be a sensible approach.

The interesting aspect of these two approaches is that mitigation involves taking some action now whereas adaptation tends to be about taking action in the future as the climate changes. Clearly there can be mitigation throughout the period and adaptation in anticipation of

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[5] See Buchner et al (2001), Bohringer (2001) , Löschel, and Zhang (2002) and McKibbin and Wilcoxen (2003) for

climate change but there is a clear difference in the time frame of actions. The greater the extent of uncertainty, the more likely that adaptation will occupy a larger share of the response relative to mitigation.

Having made the case for a mix of adaptation and mitigation policies it is important to think about what this mix might look like. Before moving to the broad approach that we think is appropriate it is clear that there are some current policies that could be changed in order to generate better greenhouse emission outcomes and raise economic activity. Anderson and McKibbin (2000) demonstrate that removing the distortions in global coal markets through removing a variety of existing taxes and subsidies can potentially have a large impact on reducing greenhouse emissions as well as raising economic wellbeing. In that study the estimated emissions reduction are found to be of the same magnitude as the original Kyoto protocol with all Annex B countries participating. There are clearly some distinct policies that can be implemented now.

In more general terms, economic logic gives some clear guidelines in how to design policies that let the appropriate mix[6] 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, such 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

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evaluations of the extent of changes since the original Kyoto Protocol of 1997.

adaptation activities. There is nothing in the design of the Kyoto targets that effectively deals with this issue of trading off abatement versus adaptation.

What is required is 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. 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 such as in federal and state relations, inconsistent regulatory frameworks within federal government and between federal and state

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[6] "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.

governments. Addressing these issues alone have 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 we outline a practical way to implement these ideas.

4. 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 this off with 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 tradable 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.[7]

The particular hybrid policy we propose (hereafter referred to as the Blueprint) would allow each participating country to issue two kinds of emissions permits: perpetual permits that entitle the owner of the permit to emit one metric ton of carbon every year forever, 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 perpetual and annual permits, equal to the amount of emissions they produced that year.

The number of perpetual 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.[8] It would be up to each government to decide how to allocate its perpetual 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 perpetual permits could be traded among firms, or bought

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[7] 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).

[8] The Kyoto reduction to 95 percent of 1990 emissions would slow climate change but not eliminate it entirely. Atmospheric concentrations of carbon dioxide, and hence global temperatures, would continue to rise. Stabilizing the temperature would require stabilizing the concentration of carbon dioxide, which would require net anthropogenic carbon dioxide emissions to be reduced to nearly zero. See McKibbin and Wilcoxen (2002a) for a discussion of how the Blueprint could be used to reduce emissions below the Kyoto target over the long run.

and retired by environmental groups.[9] 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.

Annual permits would be sold at a stipulated price determined by international negotiations, such as US$ 10 per ton. 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.

Because it has two kinds of permits, the Blueprint is a bit more complicated than a simple 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.

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 perpetual 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 give 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 because it could always buy an annual emissions permit instead. Adopting the hybrid, in other

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[9] 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 perpetual permits would essentially be an emissions quota. Without tradability,

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.

Another advantage 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 perpetual permits will pressure their governments to be vigilant in order

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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 permits.

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.

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. If firms discover that it is very expensive to keep their emissions below their holdings of perpetual permits, the option to buy annual permits allows them to emit more, although at a cost of US$ 10 per ton. 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.

5. Conclusion

In this paper we have argued that both mitigation and adaptation should be part of a sensible climate policy approach. We have argued 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 in our view 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 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 markets 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 economic 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.

We have argued elsewhere and in this paper that an approach such as the McKibbin Wilcoxen Blueprint can be applied to climate policy in particular but also could be adapted to areas in which climate change is likely to impact such as managing water resources and land use. The broad approach advocated in this paper and the specific policies recommended are likely to deliver a low cost mix of mitigation and adaptation strategies. This is a far more promising way to move forward in an inherently uncertain world than approaches such as the Kyoto Protocol which focus on rigid targets and timetable for mitigation.

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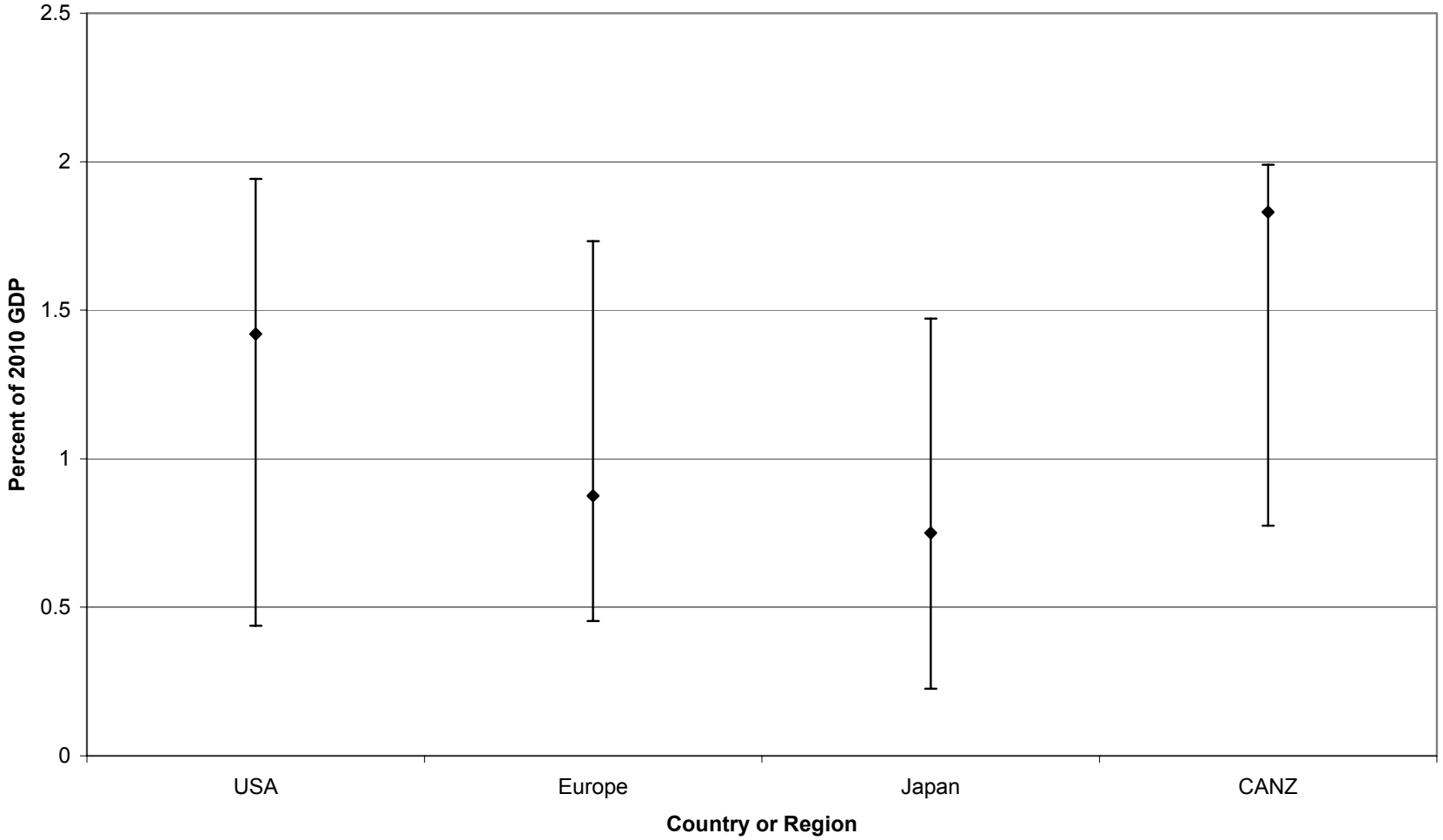
Figure 1: Median GDP Loss in 2010 Under Kyoto Targets, by Region
(Error bars show the range between the 20th and 80th percentiles)



Source: Mckibbin and Wilcoxen (2002a) figure 2.2 page 38 based on Weyant et al (1998)

Figure 2: Combining Adaptation and Mitigation