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Expecting the Unexpected Macroeconomic Volatility and Climate Policy

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Abstract: Problem statement: Analysts have been comparing a policy scenario with a baseline scenario of future economic conditions without the policy, to estimate the emissions reductions and costs of a climate policy. Both scenarios required assumptions about the future course of numerous factors such as population growth, technical change and non-climate policies like taxes. **Approach:** The purpose of this study was to examine the effects of unanticipated macroeconomic shocks to growth in developing countries or a global financial crisis on the performance of three climate policy regimes: A globally-harmonized carbon tax; a global cap and trade system and the McKibbin-Wilcoxen hybrid. The G-cubed dynamic general equilibrium model has been used to explore how the shocks would affect emissions, prices, incomes and wealth under each regime. **Results:** It has been found that a global cap and trade regime will significantly change the way growth shocks will otherwise be transmitted between regions while price-based systems such as a global carbon tax or a hybrid policy will not. Moreover, in case of a financial meltdown, a price based system will enable significant emissions reductions at low economic cost whereas a quantity target base system will lead to loss of the opportunity for low cost emission reduction because the target is fixed. **Conclusion:** The results of this study have explored these issues by examining the effects of shocks that have actually occurred in the past decade: A surprising surge of economic growth in developing countries and a global financial crisis. Quantity based approaches such as a global permit trading regime tend to buffer some kinds of macro-economic shocks: Carbon prices rise and fall with the business cycle. However, price-based approaches such as a global carbon tax or a McKibbin Wilcoxen Hybrid would provide stronger firewalls to prevent adverse events in one carbon market from causing a collapse of the global system.

Key words: Global financial crisis, climate regime, G-cubed, Kyoto protocol, GDP growth and carbon emissions

INTRODUCTION

The global financial crisis, a looming global recession and deep turmoil in credit markets drive home the importance of developing a global climate architecture that can widths and major economic disruptions. A well-designed global climate regime and the attendant domestic implementation policies undertaken by participating countries need to be resilient to large and unexpected changes in economic growth, technology, energy prices, demographic trends and other factors that drive costs of abatement and emissions. Ideally, the climate regime would not exacerbate macroeconomic shocks and would possibly buffer them instead, while with standing defaults by individual members. Because climate policy must endure indefinitely in order to stabilize atmospheric concentrations of greenhouse gases, all sorts of shocks will occur at some stage in the policy's existence. Anticipating such shocks may mean rejecting policies that might reduce emissions reliably in stable economic conditions but would be vulnerable to collapse with consequent deterioration in environmental outcomes in volatile conditions[1].

Macroeconomic volatility is the practical manifestation of an issue that has received considerable attention in the theoretical literature on the design of environmental policies: Uncertainty about the costs and benefits of reducing emissions.

In particular, macroeconomic shocks can cause the cost of regulation to be much higher or lower than anticipated. Unexpectedly stringent and costly regulations may become political lightning rods. Recent world events, for example, highlight the fact that economic surprises can subject governments to enormous pressures to relax or repeal taxes or other policies perceived to impede economic growth. For a climate policy to survive future shocks, therefore, it must have dynamic consistency: It must be optimal for each government to continue to enforce the policy even when confronted with sharp departures from the conditions expected when the governments undertook the commitments.

All else equal, a climate regime that exacerbates downward macroeconomic shocks or depresses the benefits of positive macroeconomic shocks would be more costly and less stable than a system that better handles global business cycles and other volatility. The stability of the policy has important environmental implications for two reasons. First, collapse of the policy could set back progress on emissions reductions for years. Second, decisions of economic actors depend on their expectations of future policy and this dependency affects the performance of the policy itself.

In the case of climate change[4], a system that is more robust to shocks and is thus more likely to persist, would increase the expected payoffs of investments in new technologies and emissions reductions relative to a system that is less robust. In particular, a system of rigid and ambitious targets may seem the most environmentally rigorous approach, but if the rigidity decreases the probability the agreement would be ratified, or reduces compliance, or limits long term participation, households and firms will take that into account in their investment decisions. They will invest too little in abatement and alternative energy technologies, causing the system to be less effective in practice that one with more flexibility. If governments try to compensate for low credibility by imposing more a stringent target, they could inadvertently worsen the incentives for investment by further reducing the program's credibility. This all points to the central importance of establishing a regime that is credibly robust to changing economic conditions.

This study uses the G-Cubed model to explore how shocks in the global economy propagate differently depending on the design of the climate policy regime.

G-Cubed divides the world economy into ten regions: The EU, Japan, Australia, the rest of the OECD, Former Soviet Union states, China, India, other developing countries and oil exporting developing countries. We examine two kinds of shocks relevant to recent experience: (1) a positive shock to economic growth in China, India and other developing countries and (2) a sharp decline in housing markets and a rise in global equity risk premiums, causing severe financial distress in the global economy. We analyze the effects of each shock on key economic indicators for the first decade after the shock occurs. We compare the results from the three climate regimes and draw inferences about which approaches may offer participants the strongest incentives to sustain participation in the regime in the context of these economic disruptions.

The three regimes we consider are a system of targets and timetables, a globally coordinated tax on carbon and a hybrid of the two. The "target and time-tables" approach we consider is a system of internationally tradable permits for carbon emissions. The globally-coordinated carbon tax sets a common price on carbon in each economy, with each government collecting revenue within its national boundary. The hybrid is a system of national long term permit trading systems with a globally-coordinated maximum price for permits in each year.

In each scenario, we hold climate and broader economic policy rules constant. The fiscal deficit of each economy is held at its baseline level, as are tax rates, so changes in tax revenues will result in corresponding changes in government spending. The behavior of each region's central bank follows a region-specific Henderson-McKibbin-Taylor rule with a weight on out-put growth relative to trend, a weight on inflation relative to trend and a weight on exchange rate volatility.

The weights vary across countries with industrialized economies focusing on controlling inflation and output volatility and developing countries placing a large weight on pegging the exchange rate to the US dollar. We find that although the climate regimes appear to be similar in their ability to reduce carbon emissions efficiently, they differ importantly in how they affect the transmission of economic disturbances between economies. In particular, a quantity target with annual cap global emissions can cause unexpectedly high growth in one country to reduce growth in other economies if the rise in the global carbon price caused by higher growth has a larger negative impact on other economies than the transitional spill over of growth through trade. This effect is absent in the price-based regimes of the global carbon tax and the Hybrid. We believe this change in the transmission of growth has important implication for international relations. Second, in the case of the global financial crisis we find that the quantity target approach misses an opportunity for significant additional low-cost emissions reductions. The global carbon tax and the Hybrid both enable a significantly larger emissions reduction for the same cost due to slower economic activity. On the other h and, the cap system is counter-cyclical: Carbon prices fall as the world economy slows, which acts to dampen the economic slowdown.

MATERIALS AND METHODS

We use a global economic model called G-Cubed to explore the uncertainty in costs for different countries. Table 1 summarizes the G-Cubed model. G-Cubed is a widely-used dynamic intertemporal general equilibrium model of the world economy with 10 regions and 12 sectors of production in each region. It produces annual results for trajectories running decades into the future. We begin by generating a baseline projection with an emissions reduction path as set out in detail in McKibbin and Wilcoxen[3].

Along this path we consider three regimes. The first is a global cap and trade system for carbon dioxide emissions. Under this policy, we assume that each country is allocated permits based on its emissions trajectory expected before the growth shock. The second regime is an optimal global carbon tax calculated to give the same global emissions as the cap and trade system. The third regime is the McKibbin Wilcoxen Hybrid which also has a common global price for carbon but is implemented at the national level.

All three regimes are normalized so that they start with the same carbon prices in each economy and the same global emissions outcome. We assume in each case that the regimes are in place when the shocks hit.

We solve the model under each regime with and without the unexpected shocks and examine the differences between the paired simulations. Under the shocks presented here, the global carbon tax and the Hybrid are both carbon taxes at the margin, so for clarity we report a single set of results under the heading "Price-Based policy". In contrast, the cap and trade system is listed as "Permit System".

Table 1: Overview of the G-cubed model (version 80J)

Regions	
	United States
	Japan
	Australia
	Europe
	Rest of the OECD
	China
	India
	Oil exporting developing countries
	Eastern Europe and the former Soviet Union
	Other developing countries
Sectors	
Energy:	Electric utilities
	Gas utilities
	Petroleum refining
	Coal mining
	Crude oil and gas extraction
Non-Energy:	Mining
	Agriculture, fishing and hunting
	Forestry/wood products
	Durable manufacturing
	Non-durable manufacturing
	Transportation
	Services
Other:	Capital producing sector

The main difference between the price-based policies and the cap and trade permit system is that the latter is less flexible: In the face of unexpected shocks, the rigid constraint on emissions drives sharp changes in carbon prices, which cause corresponding changes in other variables. Under the price-based systems, in contrast, the carbon price remains fixed at its announced trajectory and emissions can adjust.

Developing country growth shock: As mentioned above, one of the scenarios we consider is an unexpected rise in growth rates in developing countries (China, India and LDCs in the model). The particular shock we analyze is an unexpected increase in labor productivity growth of three %per year for 16 years, after which growth returns to baseline rates. Only growth rates return to the baseline: The three economies are permanently larger.

RESULTS AND DISCUSSION

Results for a range of variables for all countries are included, which shows percentage deviations from baseline for years 1, 5 and 10 for both the growth shock and the risk shock to be discussed below. Also shown are the differences in percentage deviation between the permit and price systems. Figure 2 shows the change in key economic variables in China due to the shock under two different climate regimes: A global permit trading system ("Permit System" shown by squares) and a price system ("Price" shown by triangles). The rise in productivity expands the effective supply of labor to each economy, rapidly increasing output in each sector and therefore raising GDP. At the same time, the increase in labor productivity raises the marginal product of capital sharply across the Chinese economy. This increase in the return to capital causes a large rise in private investment of close to 20%. The higher investment is financed partly from capital inflows (hence the trade balance worsens) and partly from higher savings, hence consumption take a number of years to rise to the permanently higher level. The lagged adjustment of consumption captures an important historical feature of the Chinese economy. In G-Cubed, the People's Bank of China is modeled as placing a large weight on the exchange rate in its reaction function and small weights on the deviation in growth from trend and the deviation of inflation from the target. To prevent the exchange rate from appreciating, the bank cuts interest rates. There is an initial spike in inflation due to strong demand and the loosening of monetary policy. Carbon emissions rise significantly due to the increase in energy use from higher GDP growth. Under a global cap on emissions, the rise in developing country growth causes the global price of carbon to rise which acts as a slight brake on the growth of all other countries, even including China. This is particularly true for China because it has a low marginal abatement cost: The GDP outcome for China when a binding global carbon target is in place is slightly smaller than when China only has a fixed carbon price. Obviously in the case of a fixed carbon price, emissions rise above the target in the baseline. There is not much flexibility to adjust energy inputs in the short run but in the long run there is substitution away from carbon-intensive activities as the expected future carbon price rises. Although growth is only marginally lower, the emissions pathway over time is significantly different under the two climate policy regimes. This illustrates that expectations about future carbon prices and the credibility of the policy regime can make a big difference in the ability of economies to reduce carbon emissions without large effects on economic growth.

CONCLUSION

The global financial crisis of 2008 has a starkly emphasized a number of important lessons for the design of global and national climate policy. These lessons need to be considered explicitly during international negotiations on a new treaty to succeed the Kyoto Protocol after its 2008-2012 commitment period.

The first lesson is that any policy framework whose costs or benefits depend strongly on forecasts of the future state of the world or national economic conditions is likely to fail because the forecast is likely to be wrong. Countries committing to targets and time tables for emissions reductions are committing to a policy with highly uncertain costs. A global climate framework needs to endure even in the face of the wide variety of shocks that will undoubtedly occur over the coming decades. Thus there must be a mechanism built into the framework that directly addresses the issue of cost uncertainty. Otherwise, it will be much harder to negotiate a broad agreement and the agreement may be vulnerable to collapse under adverse future shocks.

The second lesson is that it is critical to get the global and national governance structures right. There must be a clear regulatory regime in each country and a transparent way to smooth out excessive short-term volatility in prices. A system that enables or even encourages short term financial speculation in climate markets may collapse at huge expense to national economies. A hybrid system provides many of the advantages of a permit system while limiting opportunities for speculation through the annual permit mechanism. It provides a strong mix of market incentives and predictable government intervention.

The third lesson is that since shocks in one part of the world will certainly occur, the global system needs to have adequate firewalls between national climate systems to prevent destructive contagion from propagating local problems into a system-wide failure. A global cap and trade system, or alternative systems such as the Garnaut Review[2], would be extremely vulnerable to shocks in any single economy. A system based on national hybrid policies, on the other h and, would be explicitly designed to partition national climate markets and limit the effects of a collapse in climate policy in one part of the world on climate markets elsewhere.

This study has explored these issues by examining the effects of shocks that have actually occurred in the past decade: A surprising surge of economic growth in developing countries and a global financial crisis. Quantity-based approaches such as a global permit trading regime tend to buffer some kinds of macro-economic shocks: Carbon prices rise and fall with the business cycle. However, price-based approaches such as a global carbon tax (levied at the national level) or a McKibbin Wilcoxen Hybrid would provide stronger firewalls to prevent adverse events in one carbon market from causing a collapse of the global system.

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