IMPACTS OF CARBON TAXES

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Summary

Carbon taxes are a market-based approach to reducing carbon dioxide emissions. The direct loss in economic welfare from imposing carbon taxes to achieve a given reduction in emissions has been estimated for many economies under various assumptions using a number of types of models.

Economy level estimates have been derived from “bottom up” and “top down” models. While “bottom up” models suggest technological possibilities, “top down” models are usually regarded as providing more reliable estimates of welfare losses.

Losses in economic welfare have also been estimated using “top down” models of the global economy. Simulations of Annex B countries simultaneously reducing emissions show that the international trade and investment repercussions tend to increase the size of the overall welfare loss. Non-Annex B countries overall also suffer welfare losses as a result of Annex B abatement. Carbon dioxide emissions from non-Annex B countries also increase as result of Annex B abatement.

Simulations have also been undertaken of an Annex B emissions trading scheme that is roughly equivalent to a uniform carbon tax being applied to all Annex B countries. Emissions trading would reduce the welfare losses of both Annex B and non-Annex B countries as well as reducing the increase in non-Annex B emissions.

A number of variations on standard modeling assumptions have been studied. These include the possibility that the direction of technological change may respond to movements in relative prices, the possibility that OPEC may respond to reduced Annex B demand for oil by restricting supply, and the possibility of using carbon taxes to displace other taxes that depress economic activity.

1. Introduction

Carbon taxes are monetary penalties on the emission of carbon dioxide. Economic activities giving rise to carbon dioxide emissions include the combustion of fossil fuels (coal, natural gas, oil, and derivative fuels), cement manufacture, land clearing, and various cultivation practices. Carbon taxes on fossil fuels have been studied most extensively. A tax based on the carbon content of the fuel would serve as an accurate approximation for carbon dioxide emissions when combustion occurs. Since the carbon content of different fossil fuels varies, a fixed tax per unit volume of carbon would result in different taxes per unit volume of the various fossil fuels. In all of the applications discussed below, carbon taxes apply only to fossil fuels.

Interest in carbon taxes has been prompted by concerns about the risk of global warming arising from increased emissions of carbon dioxide and other greenhouse gases. Under the Kyoto Protocol of December 1997, yet to enter into force, the so-called Annex B group of countries has agreed to restrict greenhouse gas emissions to country specific targets over the period 2008 to 2012. A list of Annex B countries and their emission reduction targets is shown in Table 1. Carbon taxes are one of a number of possible policy instruments that could be used by Annex B countries in meeting their target levels. Some countries such as Sweden, Denmark, and Norway have already experimented with carbon taxes.

Country	Greenhouse Gas Emission Reduction Target (percentage of base year or base period)(a)
Australia	108
Austria	92
Belgium	92
Bulgaria*	92
Canada	94
Croatia*	95
Czech Republic*	92
Denmark	92
Estonia*	92
European Community	92
Finland	92

France	92
Germany	92
Greece	92
Hungary*	94
Iceland	110
Ireland	92
Italy	92
Japan	94
Latvia*	92
Liechtenstein	92
Lithuania*	92
Luxembourg	92
Monaco	92
Netherlands	92
New Zealand	100
Norway	101
Poland*	94
Portugal	92
Romania*	92
Russian Federation*	100
Slovakia*	92
Slovenia*	92
Spain	92
Sweden	92
Switzerland	92
Ukraine*	100
United Kingdom of Great Britain and Northern Ireland	92
United States of America	93

* Economies in transition to market economies
(a) The targets relate to total emissions of six greenhouse gases expressed in terms of carbon dioxide equivalent emissions
Source: Kyoto Protocol, 1997

Table 1. Annex B Countries and their Emission Reduction Targets.

Given that the Kyoto Protocol was designed to limit emissions of a number of greenhouse gases in addition to carbon dioxide, the imposition of a carbon tax on carbon dioxide alone (without other instruments) would be an inefficient way for countries to achieve their Kyoto targets. This would need to be recognized in policy design. However, to date, much of the literature has concentrated on taxes on carbon dioxide from fossil fuel combustion.

Carbon taxes and tradable permits are what are known as market based policies and may be contrasted with command and control policies. Under a command and control approach the authorities would set limits on carbon dioxide emissions from different activities to meet an overall emission target. Under a market-based approach, market

forces are used to find the least cost pattern of reducing emissions from different activities to meet an overall emission target. Research mainly in the United States has confirmed that substantial cost savings have resulted from the introduction of market-based in preference to command and control policies.

Much research has been devoted to assessing the loss in economic welfare that different economies would suffer from using carbon taxes to achieve a given reduction in carbon dioxide emissions. Different measures of economic welfare have been used in various studies but any environmental benefits from reduced emissions are excluded in all the studies discussed here.

In some studies the change in the economic welfare of a representative consumer is estimated using a measure known as equivalent variation. Equivalent variation is the amount of money a representative consumer would be willing to pay to prevent moving from their consumption bundle with the prices ruling before emissions were reduced to their new consumption bundle at the new set of prices. In many studies, changes in national accounting aggregates such as gross domestic product (GDP) are used as a proxy for more sophisticated welfare measures.

Model simulations to assess these losses in economic welfare have been conducted under a variety of assumptions. Many studies using different types of models have been undertaken for various economies in isolation. Another group of studies have involved the world economy made up of various regional aggregations. Taking account of the international repercussions of carbon taxes may modify estimates of losses in economic welfare based on purely domestic studies.

These international repercussions assume special importance since under the terms of the Kyoto Protocol the effects of all of the Annex B countries simultaneously reducing emissions needs to be considered. International repercussions are also important in assessing the environmental effectiveness of carbon taxes. If emissions are reduced by a limited group of countries, such as Annex B countries, it is possible that reduced emission-intensive production in those countries will create incentives for increased emission-intensive production in other countries. Such a process has been called emission or carbon leakage.In this article the main elements of the theory of carbon taxes, needed to interpret the various empirical studies, is first outlined. A review of these studies is then presented, grouping together studies according to whether they deal with economies in isolation or the global economy. Finally, a number of modifications to the standard modeling assumptions are considered which affect estimates of welfare losses.

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Biographical Sketches

Brian Fisher was first appointed Executive Director of the Australian Bureau of Agricultural and Resource Economics (ABARE) in November 1988. During 1984–85, Dr. Fisher was Chief Research Economist, then Deputy Director, of the former Bureau of Agricultural Economics. He was appointed to the chair in Agricultural Economics at the University of Sydney in 1985, becoming Dean of the Faculty of Agriculture at the University in 1987.

Dr. Fisher has been the government board member on a number of statutory corporations, including the Australian Wool Realization Commission, Wool International, and the Australian Animal Health Council. In 1995 and 1996, he was the Chairman of the Board of the Australian Animal Health Laboratory.

In 1993 Dr. Fisher was appointed one of the experts completing the socioeconomic assessment of climate change for the United Nation's Intergovernmental Panel on Climate Change (IPCC) Second Assessment Report. Dr. Fisher played an integral role in the international climate change negotiations as economic adviser to Australia's negotiating team in the lead up to, and at, the third Conference of the Parties in Kyoto. He fulfilled that role at the fourth Conference of the Parties in Buenos Aires in November 1998, and did so again at the fifth Conference of the Parties held in Bonn in November 1999. He is currently engaged as one of the experts completing the IPCC's Third Assessment Report.

Dr. Fisher has published over 190 papers and monographs. He received the Farrer Memorial Medal in August 1994 and became a fellow of the Academy of Social Sciences in Australia in November 1995. Dr. Fisher holds a Ph.D. in agricultural economics from the University of Sydney.

Mike Hinchy is a Senior Economist at the Australian Bureau of Agricultural and Resource Economics. During the past ten years he has specialized in the economics of climate change, writing numerous papers on emission trading schemes and general equilibrium modeling of the impacts of policies to combat climate change. He has been a contributing author to the Second and Third Assessment Reports of the Intergovernmental Panel on Climate Change. He has published over 60 papers and research monographs. He holds the degrees of B.Ec. (Hon) from the University of Sydney and M.Sc. from the University of Cambridge.