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LEVELING THE CARBON PLAYING FIELD

International Competition and US Climate Policy Design

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Preface

Climate change is one of the most far-reaching economic challenges of our times. Unchecked, it threatens the welfare of people around the globe. Mitigating the worst of its impacts will require mobilizing capital and technology in innovative ways that will transform the global economy. The good news is that if we do it right we can generate technologies and markets that will not only leave us a cleaner, more secure world but also create vibrant new industries and jobs.

Faced with a challenge of this scale, there is a strong case for developing efficient and consistent climate policy globally. Every effort should be made to do so. But politics is always a balance of the visionary and the prosaic. Differences between countries in level of economic development, historic responsibility for greenhouse gas emissions already in the atmosphere and projected growth in emissions in the years ahead mean that climate policy will probably take different forms in different parts of the world.

In the United States, growing public awareness of the impacts of climate change has prompted states and cities to take action locally and the US Congress to start drafting major federal climate legislation. Producers of steel, cement, and other energy-intensive goods worry that such legislation, by introducing a price for carbon, will cause them to lose investment or market share to foreign competitors that do not face similar costs at home. US lawmakers, with an eye on possible job losses, have responded with proposals to either limit the price of carbon these producers face or impose similar costs on imports of carbon-intensive goods from their competitors.

This book, a collaboration between the Peterson Institute for International Economics and the World Resources Institute, looks at methods to maintain a level playing field for US industry under domestic climate policy. Through an assessment of the economics and trade flows of key carbon-intensive industries, the authors evaluate a number of proposals included in current legislation. They argue that, given the limited role of exposed sectors in the US economy, measures need to be targeted rather than comprehensive. Efforts to contain costs for carbon-intensive manufacturing, if not properly considered, can harm other industries and raise the cost of reducing emissions for the economy as a whole. There are a range of policy options, however, that reduce costs for the economy as a whole while achieving the desired environmental goals.

Using trade measures to impose similar costs on carbon-intensive imports would create both winners and losers domestically and, if imposed unilaterally, would have limited success in leveraging other countries to adopt comparable climate policy. If properly tailored, however, trade measures can create incentives for foreign companies to clean up their act. All options need to be assessed according to whether they help or hurt the prospects for ultimately creating an effective and fair international regime—the only sure way in the long term to address both climate change and competitiveness concerns.

Happily, increasingly ambitious policy in countries such as China, and the launch of a new and more inclusive process for international climate negotiations in December 2007, give hope that real international cooperation will be possible. The authors lay out types of international agreements that would be more successful in addressing US competitiveness concerns than unilateral trade measures. Many are already being considered as part of a multilateral climate framework.

Looking forward, the international trading system will likely play an important role in meeting the climate challenge, both in creating incentives to reduce emissions and delivering the technology required to do so. This book aims to help policy makers better understand the options before them and their broader implications, and to help identify policies that will be successful both in creating a level playing field for industry and reducing greenhouse gas emissions more broadly.

JONATHAN LASH
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April 2008

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The Institute is funded by a highly diversified group of philanthropic foundations, private corporations, and interested individuals. About 30 percent of the Institute's resources in our latest fiscal year were provided by contributors outside the United States, including about 12 percent from Japan.

The Institute's Board of Directors bears overall responsibilities for the Institute and gives general guidance and approval to its research program, including the identification of topics that are likely to become important over the medium run (one to three years) and that should be addressed by the Institute. The director, working closely with the staff and outside Advisory Committee, is responsible for the development of particular projects and makes the final decision to publish an individual study.

The Institute hopes that its studies and other activities will contribute to building a stronger foundation for international economic policy around the world. We invite readers of these publications to let us know how they think we can best accomplish this objective.

■ ■ ■

The World Resources Institute (WRI) is an environmental think tank that goes beyond research to find practical ways to protect the Earth and improve people's lives. Its mission is to move human society to live in ways that protect the Earth's environment and its capacity to provide for the needs and aspirations of current and future generations.

Because people are inspired by ideas, empowered by knowledge, and moved to change by greater understanding, WRI provides—and helps other institutions provide—objective information and practical proposals for policy and institutional change that will foster environmentally sound, socially equitable development.

WRI organizes its work around four key goals:

- People and Ecosystems: Reverse rapid degradation of ecosystems and assure their capacity to provide humans with needed goods and services.
- Access: Guarantee public access to information and decisions regarding natural resources and the environment.
- Climate Protection: Protect the global climate system from further harm due to emissions of greenhouse gases and help humanity and the natural world adapt to unavoidable climate change.
- Markets and Enterprise: Harness markets and enterprise to expand economic opportunity and protect the environment.

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Executive Summary

As political momentum surrounding climate change builds in the United States, policymakers are taking a fresh look at national climate policy and America's involvement in multilateral climate negotiations. And as in years past, the potential economic impact of any US effort to reduce greenhouse gas emissions stands as a central question in the Washington policy debate. Of particular concern is the effect climate policy would have on carbon-intensive US manufacturing. Many of these industries are already under pressure from international competition, particularly large emerging economies such as China, India, and Brazil that are not bound to reduce emissions under the current international climate framework. As the US Congress takes up domestic climate legislation, policymakers are looking for ways to avoid putting US carbon-intensive manufacturing at a competitive disadvantage vis-à-vis countries without similar climate policy, lest a decline in industrial emissions at home is simply replaced by increases in emissions abroad.

While this objective would be best achieved through a harmonized international climate policy, the differences between countries in level of economic development, political conditions, obligations stemming from historic emissions, and responsibilities arising from future emissions mean harmonization is still a long way off. The question then, in the design of domestic US climate policy today, is how to level the playing field for carbon-intensive industries during a period of transition—where trading partners are moving at different speeds and adopting a variety of policies to reduce emissions—and how to do so in a way that does not threaten the prospects for a broader international agreement down the road.

Gauging the Impact on International Competitiveness

Climate policy, by imposing a cost on greenhouse gas emissions, has the potential to negatively affect carbon-intensive manufacturing industries that compete with foreign producers, either at home or abroad, and for which energy (particularly carbon-intensive) is a significant share of total production costs. In the United States, five industries fit this bill: ferrous metals (iron and steel), nonferrous metals (aluminum and copper), nonmetal mineral products (cement and glass), paper and pulp, and basic chemicals. Together these five account for more than half of all carbon dioxide (CO_2) emissions from the manufacturing sector, though their direct emissions account for less than 6 percent of the US total. Under a domestic cap-and-trade or carbon tax regulatory regime, these industries could see a decline in output and lose market share to foreign competitors if they are unable to reduce emissions and must pass carbon costs on to downstream consumers.

While the degree of impact is a topic of considerable research and debate, the fate of these industries has become a key consideration in domestic policy design. Yet it is important to keep in mind that these five industries combined account for only 3 percent of the country's economic output and less than 2 percent of nationwide employment. Many options for protecting carbon-intensive manufacturing do so at the expense of other industries or by increasing the cost to consumers of reducing US emissions overall. Climate policy creates economic winners as well as losers in the international marketplace. Incentives to develop low-carbon technology and services at home help make US firms more competitive in carbon-constrained markets abroad. Options for safeguarding the competitiveness of US carbon-intensive manufacturing should be addressed in the context of their broader economic effects.

Evaluating the Domestic Policy Response

In considering measures to level the playing field for carbon-intensive US manufacturing under a domestic climate regime, policymakers seek to (1) prevent a decline in output by US producers in the face of higher costs, (2) guard against "emissions leakage" (migration of US industrial emissions to other parts of the world) from a loss of market share to more carbon-intensive foreign producers, and (3) create incentives for other countries to reduce emissions. This book evaluates the effectiveness of a wide range of policy options in achieving these goals as well as their impact on other industries, the overall environmental effectiveness and economic efficiency of domestic climate policy, and the prospects for reducing emissions internationally.

Cost Containment Mechanisms

One way to level the playing field for domestic carbon-intensive producers is to reduce the cost of complying with climate policy. Adopting a market-based regulatory mechanism like cap-and-trade or a carbon tax goes a long way toward ensuring that emissions reductions are achieved at the lowest cost possible, both to carbon-intensive manufacturing and the economy as a whole. Within a cap-and-trade system, including the ability to bank and borrow emissions allowances and use offsets can further reduce costs for individual firms without weakening the environmental effectiveness of the policy overall. Free allocation of emissions allowances also maintains the integrity of the domestic cap but may not prevent emissions leakage to other countries. Manufacturers may choose profits over market share by basing the price of their products on the cost of allowances on the market, even if they received their allowances for free. Free allocation of emissions allowances to nontraded sectors, such as electric power, neither enhances international competitiveness nor guards against emissions leakage.

Other measures reduce costs for carbon-intensive manufacturing but do so at the expense of overall emissions reductions. Price caps in particular are an incredibly blunt instrument if safeguarding the competitiveness of vulnerable industries is the goal. With all of the complexity of a cap-and-trade system and no environmental certainty, price caps create a safety valve for 94 percent of US emissions sources, which are not at risk of losing market share to international competition. Under a carbon tax, credits can be targeted specifically at the less than 6 percent of emissions emitted directly from the five carbon-intensive industries that most need them, though emissions reduction goals for these sectors are compromised in the process.

The most successful cost containment mechanisms, in terms of safeguarding the competitiveness of carbon-intensive manufacturing without sacrificing environmental goals, may be those that reduce other costs within the firm. As opposed to free allocation of emissions, which protect profits more than employment levels, and carbon tax credits, which increase emissions, using allowance auction or carbon tax revenue to reduce healthcare costs, decrease payroll taxes or reduce other labor-related costs for vulnerable industries creates incentives for firms to both maintain employment levels and lower emissions. The cost of such relief is a fraction of the amount of foregone revenue that would result from the free allocation of emissions allowances considered under most proposals and justified on competitiveness grounds.

Trade Measures

The second approach to leveling the playing field for US industry is to impose similar costs on foreign producers at the border. Trade measures can be used under either a cap-and-trade or carbon tax system, though their design and implementation differ within each system. European policymakers first put forward the notion of imposing border tariffs on imports from countries that are slow to reduce emissions and targeted them at the United States. But as the United States starts drafting its own climate policy, the discussion of trade measures is focused clearly on China. Advocates of such measures claim they will both protect domestic industry and provide US negotiators with the leverage of market access to force developing countries to the bargaining table. As designed, and if taken unilaterally, such measures will likely fail on both counts.

While policymakers have China in mind when considering the use of trade measures, only 14 percent of cement, 7 percent of steel, 3 percent of aluminum, 4 percent of paper, and less than 1 percent of basic chemicals imported into the United States come from China. Canada is the largest source of imports in all carbon-intensive industries considered in this book except one (Trinidad and Tobago is the largest for chemicals), with Europe and Russia not far behind. In most proposals, the imposition of border tax adjustments or allowance requirements is conditioned on whether the trade partner has enacted domestic climate policy "comparable" to that in the United States. Europe and Canada, the two largest sources of carbon-intensive imports, would likely pass this test with flying colors. And among developing countries that are less likely to have adopted "comparable" policy at home, many have industries that are cleaner, on average, than those in the United States. As opposed to relatively carbon-intensive Chinese producers, many firms in Latin America and oil-exporting countries have newer and more efficient equipment and use low-carbon energy sources like hydropower and natural gas. Leveling the carbon playing field via trade measures, while good from a climate standpoint, would put some industries in the United States at a competitive disadvantage.

In addition, the threat of losing access to the US market for carbon-intensive goods alone provides little leverage in inducing a change in the policies of other countries. While China accounts for 32 percent of global steel production, only 8 percent of the 353 million tons produced in 2005 was exported. Less than 1 percent was sold to the United States. The US market accounts for 3 percent of Chinese aluminum production, 2 percent of paper production, and less than 1 percent of both basic chemicals and cement. Most of the demand for carbon-intensive products comes from developing countries, China in particular. The United States accounts for only 10 percent of global demand in the five most carbon-intensive industries, the imported share of which accounts for less than 3 percent.

That said, trade measures could, if properly tailored, create positive incentives for foreign firms to reduce carbon emissions individually even if the measures do not provide enough leverage to convince their governments to do so through policy. Under most proposals, the carbon embedded in imported goods would be assessed using a national average for the country of origin. As exporting firms from countries such as China are often the best in class, such calculations create little incentive for exporters to get cleaner. Assessing embedded carbon at a firm, rather than nationwide, level would avoid this trap but would require the voluntary participation of the exporting company or its home government in tracking and monitoring emissions. Fortunately, the prospects for eliciting such international participation are more promising than many believe.

Options for International Cooperation

It is unlikely that multilateral negotiations will produce a perfectly harmonized international climate policy within the same timeframe as the implementation of climate legislation in the United States. Yet while developing countries are reluctant to agree to the same type of absolute caps on emissions expected of the developed world under a post-Kyoto framework, there is considerable scope for other forms of commitments that could, in fact, be even more successful in leveling the carbon playing field internationally.

China, the source of much of the concern in the US climate policy debate, is working aggressively to curb the growth and improve the efficiency of its carbon-intensive industries, out of local environmental and energy security concerns. Policy actions taken already include changes in tax policy equal to the imposition of a $50 per ton carbon tariff applied to exports of Chinese steel. Building on these steps, international agreements to reduce industrial emissions from key sectors, whether through product standards, emissions targets, or a direct tax, would be more successful in addressing competitiveness concerns and reducing emissions than trade measures imposed unilaterally. Indeed, during the last round of climate negotiations in Bali, Indonesia, in December 2007, industry-level agreements garnered support from developed and developing countries alike.

The rules and institutions of the international trading system may well have a role to play in leveling the carbon playing field in the years ahead. If approached multilaterally and in conjunction with a broader international climate framework, trade policy could create additional incentives to reduce greenhouse gas emissions. To be successful, a trade regime that included climate considerations would require the willing participation of both developed and developing countries. Such multilateral involvement would promote an accurate assessment of embedded carbon both by product and by producer, so that low-carbon goods and production processes were adequately rewarded. Absent broad multilateral action, the use of trade measures to address competitiveness concerns and emissions leakage will have only limited success and could put considerable strain on the international trading system we rely on to boost economic growth in developing countries and deliver the technology required to make that growth green.

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1

Introduction: How Climate and Competitiveness Fit Together

> *The Senate strongly believes that the proposals under negotiation, because of the disparity of treatment between Annex I Parties and Developing Countries and the level of required emission reductions, could result in serious harm to the United States economy, including significant job loss, trade disadvantages, increased energy and consumer costs. . . .*
>
> — Byrd-Hagel Resolution (S Res 98), July 1997

During the final year of climate negotiations leading up to the signing of the Kyoto Protocol in December 1997, the US Senate, on a vote of 95–0, unanimously passed the Byrd-Hagel resolution—sponsored by Senators Robert Byrd (D-WV) and Chuck Hagel (R-NE)—voicing concern that a US commitment to cap greenhouse gas emissions would be unfair and ineffective unless developing countries took similar steps. The sense of the Senate instructed the US administration not to sign onto the protocol unless it mandated "new specific scheduled commitments to limit or reduce greenhouse gas emissions for Developing Country Parties within the same compliance period." The agreement that emerged from Kyoto did not meet that test and was never submitted to the US Senate for ratification.

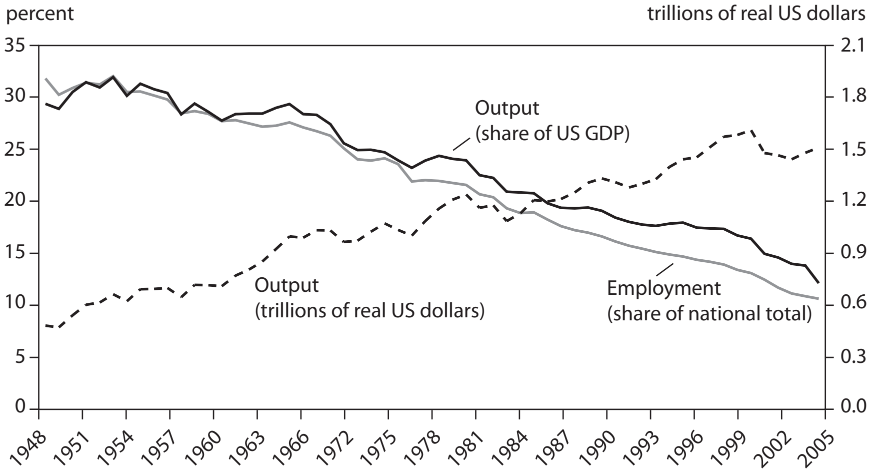
In the decade since the Kyoto Protocol was signed, attitudes toward climate change in the United States have shifted dramatically. The Fourth Assessment Report from the Intergovernmental Panel on Climate Change (IPCC), released in 2007, brought a new sense of certainty that the Earth's temperature is warming as a result of human activity. Discussion in the press, through documentary film and by advocacy groups, has expanded public awareness of the policy challenge global climate change presents. In state houses around the country, legislators have begun tackling those policy issues at a local level, and strong popular support for nationwide action has prompted dozens of hearings in both the House of Representatives and Senate. Yet as the US Congress starts drafting federal climate legislation, many of the same concerns raised about the Kyoto Protocol are still front and center in the policy debate. Specifically,

- concern that a climate regime that omits greenhouse gas emissions caps on some large emitters will be *environmentally ineffective,* as rapid growth in major emerging economies will render emissions reductions in the United States irrelevant; and
- concern that the US economy will suffer from the *loss of investment, market share, and jobs* in industrial sectors sensitive to the additional cost of reducing carbon emissions.

Progress made in international climate negotiations suggests that post-Kyoto agreements (to take effect in 2013) will ask more of developing countries than the Kyoto Protocol did. Yet commitments will likely vary considerably by country, given differences in levels of economic development, political conditions, obligations stemming from historic emissions, and responsibilities arising from future emissions. The question for US policymakers drafting legislation today is how to address domestic concerns during a period of uncertainty about the shape of the multilateral framework to come. Of particular concern is the effect climate policy would have on carbon-intensive US manufacturing. Many of these industries are already under pressure from international competition, particularly large emerging economies such as China, India, and Brazil that are not bound to reduce emissions under the current international climate framework. As the US Congress takes up domestic climate legislation, policymakers are looking for ways to avoid putting US carbon-intensive manufacturing at a competitive disadvantage vis-à-vis countries without similar climate policy, lest a decline in industrial emissions at home is simply replaced by increases in emissions abroad.

In considering measures to level the playing field for carbon-intensive US manufacturing industries under a domestic climate regime, policymakers seek to (1) prevent a decline in output by US producers in the face of higher costs, (2) guard against "emissions leakage" (migration of US industrial emissions to other parts of the world) from a loss of market share to more carbon-intensive foreign producers, and (3) create incentives for other countries to reduce emissions. This book evaluates the effectiveness of a wide range of policy options in achieving these goals as well as their impact on other industries, the overall environmental effectiveness and economic efficiency of domestic climate policy, and the prospects for reducing emissions internationally.

Figure 1.1 Manufacturing's declining role in the United States, 1948–2005



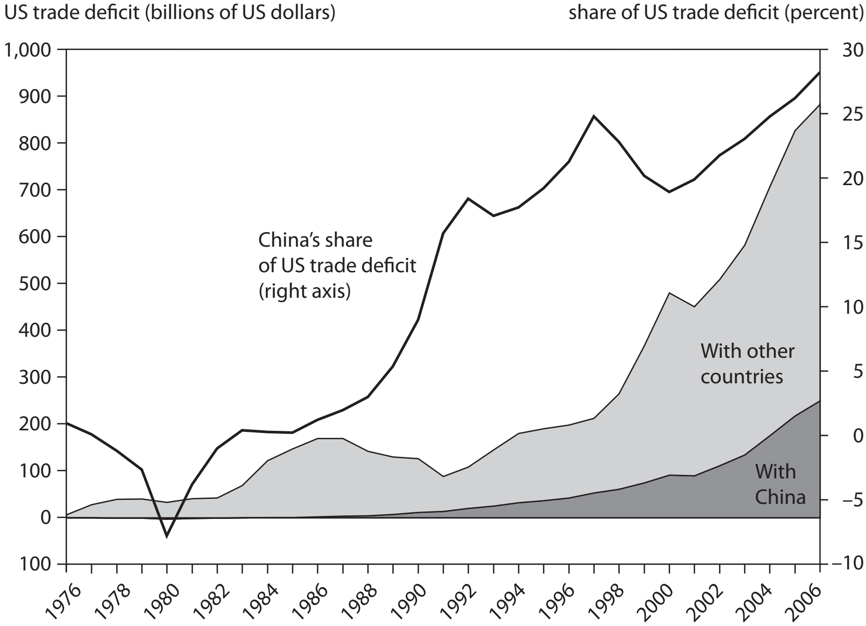
Sources: US Department of Commerce, Bureau of Economic Analysis, Industry Economic Accounts, 2007; US Department of Labor, Bureau of Labor Statistics, Current Employment Statistics Survey, 2007.

Background

Several recent studies have attempted to quantify the impact of various US climate policy scenarios on the US economy. Estimates of the change in overall economic output in 2030 range between 0.5 percent above and 1.5 percent below the projected baseline, depending on how the policy is designed (Paltsev et al. 2007; EIA 2007a, 2007b; Murray and Ross 2007; Aldy 2007). The cost incurred by assigning a price to greenhouse gas emissions will not be distributed evenly, and policymakers are concerned that the manufacturing sector will be particularly hard hit.

Manufacturing contributed $1.5 trillion to the $12.5 trillion in total US GDP in 2005. While in absolute terms, manufacturing-sector output expanded by 50 percent over the past three decades, its growth was much slower than that of the economy as a whole. As a result, the manufacturing sector's share of US GDP has declined since 1975, from 23.3 to 12.1 percent in 2005 (figure 1.1). Employment in manufacturing has seen both a relative and absolute decline, with the sector shedding 5 million jobs since the late 1970s. The past decade has been particularly rough on US manufacturing, with overall output stagnating and employment falling by 17 percent while nationwide GDP and employment have grown by 37 and 14 percent, respectively.

Figure 1.2 US trade deficit and China's share, 1976–2006



Source: United Nations Comtrade database, 2007.

The expansion of international trade looms large in the public discourse on the fate of American manufacturing. While trade liberalization has added between $800 billion and $1.5 trillion to the US economy as a whole, it has also put domestic industries under increased pressure from overseas competition (Bergsten and the Institute for International Economics 2005). And while technological change may have contributed more to the decline in manufacturing employment in recent years, an expanding US trade deficit is a very visible and politically powerful symbol of the difficulties facing American producers. Of particular concern to US manufacturers is the competitive challenge presented by Asia, in particular China. The US-China bilateral trade deficit has grown from $40 billion to $250 billion over the past decade (figure 1.2), prompting congressional hearings, new legislation, and trade complaints lodged both domestically and with the World Trade Organization (WTO).

The climate debate is taking place against this backdrop of heightened anxiety over globalization in general and US-China trade in particular. While there is growing support for US federal climate policy, a number of manufacturing companies and industrial unions have expressed concern that such policy could disadvantage American producers vis-à-vis foreign competition and put further strain on industries already under significant cost pressure.[1] In addition, the largest source of anxiety for American manufacturers—China—now rivals the United States as the world's largest source of annual carbon dioxide (CO_2) emissions. And while the majority of the emissions added to the atmosphere over the past century came from the industrialized world, the United States in particular, over the next century the majority will come from the developing world, China in particular. If the developed world acts alone, US policymakers fear that their industry, and the corresponding emissions, may just pack up and relocate to countries with lower carbon costs, thus undermining the policy's effectiveness.

In response to these concerns, many policy proposals currently being considered attempt to level the playing field for those manufacturing industries particularly vulnerable to cost increases that would result from reducing greenhouse gas emissions, by either lowering costs for domestic producers or raising costs for foreign producers.

Identifying Vulnerable Industries

Before discussing the policy options for addressing competitiveness and emissions leakage, it is important to clarify which industries in the United States are most vulnerable. To date, analysis on this point has been fairly limited. Charging firms for the CO_2 they emit through a carbon tax or limiting the total allowable emissions through a cap-and-trade system will increase the price of carbon-intensive energy. (For an overview of these two approaches to domestic climate policy, see box 1.1.) The degree to which increased energy costs translate into a decline in industrial output and employment depends on four variables:

1. *energy intensity of production*: The impact of rising energy prices on a given firm is determined, in part, by how significant energy is as a share of total production costs. For relatively energy-intensive industries like steel and cement, energy purchases account for between 10 and 20 percent of total costs, while for transportation equipment (e.g., cars and trucks) and electronics manufacturing, energy accounts for less than 1 percent (table 1.1).
2. *potential for efficiency improvement*: The extent to which increased energy prices translate into higher overall production costs is determined by the firm's ability to improve the energy efficiency of production through technological improvement.

1. Andrew G. Sharkey III, American Iron and Steel Institute, statement before the Environment and Public Works Committee, US Senate, November 13, 2007; Robert C. Baugh, executive director AFL-CIO Industrial Union Council and chair, AFL-CIO Energy Task Force, testimony before the Environment and Public Works Committee, US Senate, November 13, 2007.

Box 1.1 Carbon tax versus cap and trade

When considering limitations on greenhouse gas emissions, policymakers have typically focused on two market-based regulatory mechanisms: taxes and caps with trading.

A carbon tax directly associates a price to the carbon content of fossil fuels—coal, petroleum products, and natural gas—used for electricity generation, transportation, residential and commercial space heating, industrial processes, and other activities. A carbon tax makes carbon-intensive activities and consumption more expensive, encouraging behavioral changes such as fuel switching, reduced consumption, and infrastructure investments in low-carbon technologies. Taxing negative externalities, generally preferred by economists, addresses emissions throughout the entire economy. As a result, a tax incentivizes the most cost-effective reductions available in every sector while minimizing regulatory involvement. Moreover, it provides some economic certainty for industry regarding the cost of the program, as the price of carbon is clearly set at the outset. Economic certainty, however, comes at the expense of environmental certainty: It is unknown how much carbon mitigation will take place at a fixed price. Finally, as it generates revenue for government, a carbon tax helps reduce the tax burden on "goods" such as employment and income, increasing overall economic efficiency. For instance, the United Kingdom's climate change levy is offset against employer taxes on labor, thus lowering the marginal cost of employment.

Another approach is for the government to set a target emissions level (cap) and allow firms to buy and sell (trade) permits under this cap. The government issues pollution permits corresponding to the cap through either free allocation or auction. In comparison to a tax, a cap provides greater environmental certainty, as the government sets the allowed level of greenhouse gas emissions. Conversely, there is less price certainty: Allowance prices are set by the market and fluctuate in line with demand for permits. Initially employed in the United States to reduce sulfur dioxide emissions, such a regulatory approach to carbon mitigation is currently in place in Europe, where the EU Emissions Trading Scheme began in 2005. Where allowances are auctioned, revenue can accrue to the government or can be earmarked to particular expenditures or tax cuts, as with a carbon tax. Where they are allocated for free, increased costs tend to lead to windfall profits in the power sector, as shown by the European Union's experience.

These approaches are not incompatible. A number of countries, particularly in Europe, use both carbon taxes and cap and trade.

Table 1.1 Manufacturing-sector energy demand by industry, 2002

Industry	Share of total manufacturing energy demand (percent)	Energy costs as share of value (percent)	Energy costs per employee (US dollars)
Food and beverage	5.42	1.49	5,324
Textiles	1.18	2.40	4,747
Apparel	0.16	1.01	1,202
Wood products	1.66	1.66	2,930
Paper	10.43	7.27	24,082
Pulp mills		21.73	95,881
Paper mills, except newsprint		9.74	45,037
Newsprint mills		18.89	90,430
Paperboard mills		17.30	76,458
Printing	0.43	1.38	1,914
Petroleum refineries	28.20	7.39	231,865
Chemicals	28.52	4.28	24,268
Petrochemicals		12.39	268,881
Alkalies and chlorine		31.79	146,205
Carbon black		15.50	84,495
Other inorganic chemicals		6.87	24,396
Basic organic chemicals		11.47	67,194
Plastic materials and resins		7.16	43,962
Nitrogenous fertilizers		19.19	152,334
Pharmaceuticals and medicines		0.66	4,356
Nonmetallic mineral products	4.67	5.45	11,347
Glass		6.06	12,255
Cement		16.58	71,296
Lime		23.23	57,016
Ferrous metals	6.47	8.81	30,039
Iron and steel mills		11.62	47,207
Iron foundries		6.44	10,237
Nonferrous metals	2.72	4.79	13,570
Primary aluminum smelters		19.83	83,222
Aluminum foundries		3.51	6,074
Other nonferrous metals		2.87	9,598
Fabricated metal products	1.71	1.77	2,685
Machinery	0.78	0.80	1,792
Computers and electronics	0.89	0.46	1,304
Electrical equipment	0.76	0.68	1,445
Transportation equipment	1.89	0.60	2,396
Furniture and related products	0.28	0.79	1,003

Source: US Department of Energy, Energy Information Administration, Manufacturing Energy Consumption Survey, 2002.

3. *ability to switch to low-carbon energy sources*: In addition to reducing the amount of energy required per unit of output, firms can also reduce carbon costs by switching to less carbon-intensive fuel sources.

4. *product demand elasticity*: The degree to which energy price increases not mitigated through efficiency improvements or fuel switching affect performance of a given industry is determined by the firm's ability to pass along costs to consumers. The "demand elasticity" of a given product to changes in price depends on the availability of substitutes—either the same good from a foreign producer or a different but interchangeable good from any producer.

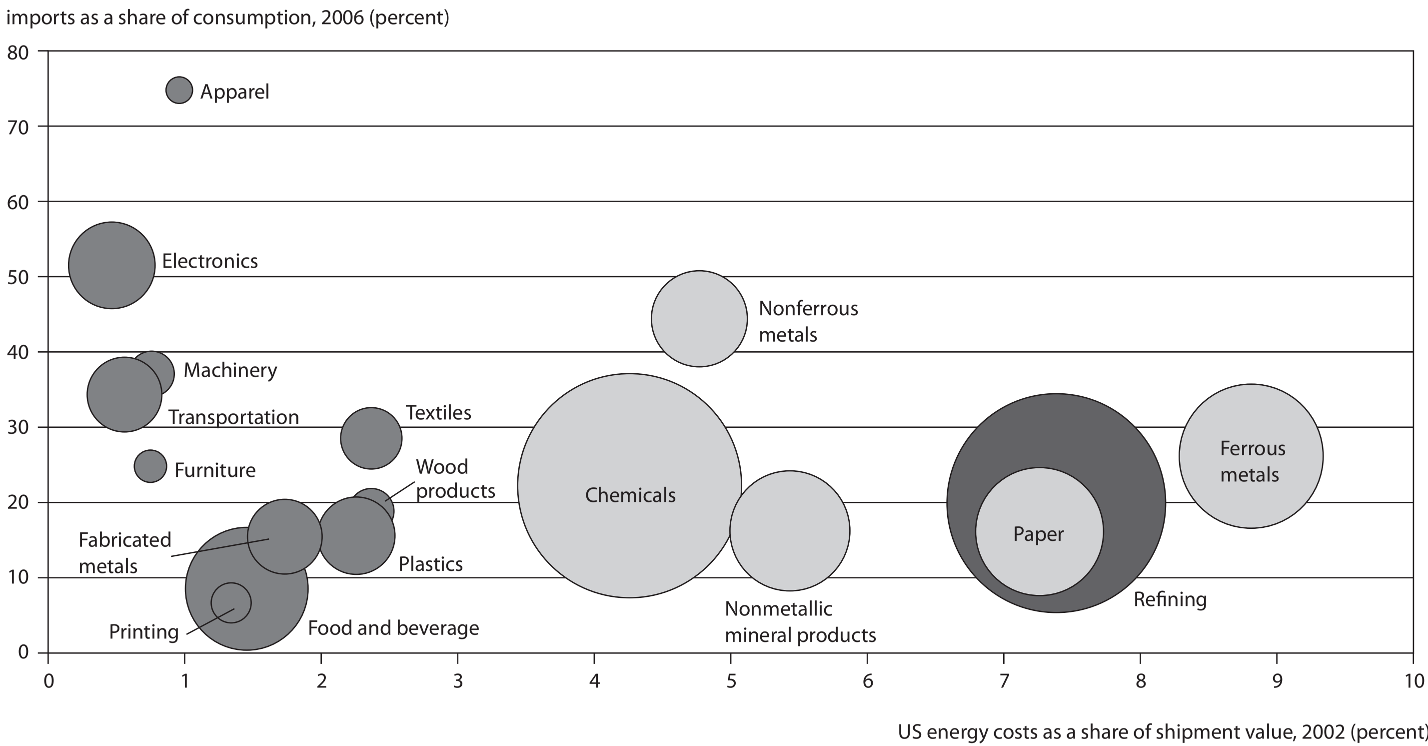
The relative importance of these factors in determining the fate of an industry relies a great deal on timing. In the short term, most firms have limited ability to improve the efficiency of capital stock or switch to alternative sources of energy. How much of the energy cost increase the firm must absorb then depends on the immediate availability of substitutes for the firm's products. Over the medium and long terms, firms have greater ability to seek out lower-carbon fuel sources and develop more energy-efficient technology.

Figure 1.3 provides a rough layout of the exposure to increased carbon costs among manufacturing industries based on two of the four variables listed above. On the X-axis we rank the energy intensity of production in terms of energy costs relative to final sales value. The Y-axis shows the degree to which foreign substitutes are available in the market (measured in terms of imports as a share of consumption), which has direct bearing on domestic firms' ability to pass increased costs on to consumers. In chapter 3, we analyze where these imports come from and how carbon-intensive foreign production relative to US production is for each industry. The size of the bubbles indicates total CO_2 emissions from the industry grouping in 2002.

At the broadest level of industry classification, the six most energy-intensive US manufacturing industries are petroleum refining, paper and pulp, nonmetallic mineral products, chemicals, and ferrous and nonferrous metals. On average, these capital-intensive industries are less exposed to international trade than their labor-intensive peers like apparel, electronics, textiles, furniture, and machinery. That said, there are notable differences among the six: Imports account for more than 40 percent of demand for nonferrous metals, like aluminum and copper, significantly higher than the 13 to 15 percent import dependency in paper, with steel and chemicals in between at 23 and 22 percent, respectively. Even nonmetal mineral products (e.g., cement and glass), despite high weight-to-value ratios, are more exposed to trade than food, plastics, printed goods, and fabricated metals. In volume terms, the United States today imports roughly 25 percent of the cement it consumes.

This book focuses on these carbon-intensive industries, with the exception of petroleum refining, which is treated separately under most policy

Figure 1.3 US industry exposure to climate costs based on energy intensity and imports as a share of consumption



Note: The size of the bubbles indicates the total CO_2 emissions from the industry in 2002.

Sources: US Department of Commerce, Bureau of Economic Analysis, Industry Economic Accounts, 2007; US Department of Energy, Energy Information Administration, Manufacturing Energy Consumption Survey 2002.

proposals.[2] Combined, they account for more than half of all CO_2 emissions from manufacturing in the United States, though a considerably smaller share of total nationwide employment or economic output (table 1.2).

Resources for the Future (RFF) in Washington is engaged in an ongoing effort to quantify the impact of US climate policy on output from these industries through modeling and econometric analysis (Herrnstadt et al. 2007). Two initial studies, using different approaches, find that imposing a $10 per ton charge for CO_2 in the United States, but not in other countries, would result in a 0.5 to 6 percent decline in output from the carbon-intensive industries mentioned earlier. Work done in Europe on the impact of the EU Emissions Trading Scheme[3] shows a slightly lower decline in output, in part due to the use of free allocation of emissions allowances, of 0.3 to 2.1 percent resulting from a $10 per ton price for CO_2 (McKinsey & Company and Ecofys 2006, Carbon Trust 2007, Hourcade et al. 2007). Our study is intended to complement the quantitative work of RFF and others with a qualitative assessment. For the five industries included in our analysis, we evaluate various options for leveling the playing field for domestic producers under US federal climate policy in light of the nature of their energy needs, trends in global supply and demand, current international trade flows, and differences in the carbon intensity of production between countries and firms.

A Broader View of Competitiveness?

It is important to note that while our discussion, as well as that of the policy community, focuses on the impact of US climate legislation on carbon-intensive industries, it is a fairly narrow interpretation of US competitiveness.

If the world is indeed heading toward a carbon-constrained future, fundamental shifts within the economy to low-carbon energy technologies

2. Under a bill sponsored by Senators Joe Lieberman and John Warner, for example, importers of refined petroleum products are considered regulated entities and are responsible for the greenhouse gasses emitted during the refining process. As such, the competitiveness concerns facing carbon-intensive manufacturing like steel, aluminum, and cement, where imports face no compliance costs unless a trade measure is evoked against the specific country of origin, are less relevant for the refining sector.

3. The European Union launched a cap-and-trade system known as the EU Greenhouse Gas Emissions Trading Scheme (EU ETS) in 2005. It is aimed at reducing CO_2 emissions by capping the level of emissions allowed and distributing tradable allowances to industrial emitters. It is the first of its kind and is the world's largest multicountry, multisector greenhouse gas emissions trading scheme. It covers over 11,500 energy-intensive installations across the European Union, which represent close to half of Europe's emissions of CO_2. These installations include combustion plants, oil refineries, coke ovens, iron and steel plants, and factories making cement, glass, lime, brick, ceramics, pulp, and paper. For more information, see http://ec.europa.eu/environment/climat/emission.htm (accessed March 5, 2008).

Table 1.2 US carbon-intensive industries and key products, 2005

Sector[b]	Direct emissions		Total emissions		Economic output		Employment	
	Million metric tons of CO_2	Share of US total (percent)	Million metric tons of CO_2	Share of US total (percent)	Billions of dollars	Share of US GDP (percent)	Number of workers	Share of US total (percent)
Ferrous metals (steel ingots, bars, rods, plates, sheets, and tubes)	36	0.62	96	1.65	36.7[a]	0.29	250,100	0.19
Chemicals (olefins, aromatics, inorganics, and ammonia)	146	2.50	377	6.48	209.20	1.68	872,100	0.65
Nonmetal mineral products (hydraulic cement)	66	1.14	97	1.66	53.30	0.43	505,300	0.38
Nonferrous metals (aluminum ingots, bars, rods, plates, sheets, and tubes)	15	0.25	75	1.29	24.4[a]	0.20	144,200	0.11
Paper and pulp (paper and paperboard, cut and uncut)	64	1.11	159	2.74	54.60	0.44	484,200	0.36
Subtotal	327	5.62	804	13.82	378.20	3.04	2,253,900	1.69
All manufacturing	631	10.85	1,369	23.54	1,512.50	12.14	14,226,000	10.64

a. Bureau of Economic Analysis' "primary metals" category is split into ferrous and nonferrous metals.
b. Products in parentheses are included in this study.

Note: Standard International Trade Classification Codes of included products (version 2): Steel (672, 673, 674, 675, 676, 677, 678, 679), Chemicals (51111, 51112, 51113, 51122, 51123, 51124, 51211, 52218, 52323, 52213, 52251), Cement (6612), Aluminum (6841, 6842), and Paper (641, 642).

Sources: IEA (2007c); US Department of Commerce, Bureau of Economic Analysis, Industry Economic Accounts, 2007; US Department of Labor, Bureau of Labor Statistics, Current Employment Statistics Survey, 2007.

and more efficient practices will be needed. Past experience in renewable energy and efficient vehicle technologies has seen companies profit from strong regulatory environments at home to build competitive advantage abroad. Loose or uncertain policy structures will not serve US companies well in the medium to long term, as other countries will build markets for the products and services that will be required in a low-carbon world. Such concerns have led many major US companies to call for strong mandatory climate policy.[4]

In addition, policymakers should carefully weigh the cost of measures to protect carbon-intensive industry for the economy as a whole. Certain policy options may shield domestic producers of goods like steel, aluminum, and chemicals but do so at the expense of taxpayers, consumers, or downstream industries that rely on those goods and that compete internationally as well. And building US competitiveness in the low-carbon energy technologies needed to stabilize the climate will require not only a clear domestic regulatory environment but also a significant amount of investment in infrastructure, education, and research and development. The economic and fiscal costs of protecting carbon-intensive manufacturing must be measured against these longer-term strategic goals.

Finally, while there are costs associated with US action to reduce carbon emissions, there are also costs associated with inaction or delay. Estimating the financial costs associated with the impacts of climate change is notoriously difficult, but the United Nations Framework Convention on Climate Change (UNFCCC 2007a) calculates that the cost of adaptation globally will run to tens of billions of US dollars per year by 2030. While the poorest countries will disproportionately feel these impacts, the United States will by no means be immune from significant damage (Ruth, Coelho, and Karetnikov 2007).

Though we focus on leveling the playing field for carbon-intensive industries under various US climate policy scenarios, when possible, we assess legislative options in light of their broader costs and impact on overall US economic dynamism.

Options for US Policy Design

The design of US federal climate policy is still in the early stages. While current proposals adopt a cap-and-trade system, there is also support for a carbon tax (box 1.1). Good analysis of the relative strengths and weaknesses of both approaches abounds.[5] This book remains agnostic as to

4. See, for instance, the US Climate Action Partnership's Call to Action at www.us-cap.org.

5. For a good summary of the discussion on a cap-and-trade system versus carbon tax, see Parry and Pizer (2007).

which regulatory system should or will be adopted. We discuss policy options under both systems for dealing with industrial competitiveness and emissions leakage concerns.

Broadly speaking, the principal policy options currently under consideration to level the international playing field for carbon-intensive industries can be divided into three types:

1. *cost containment mechanisms*: aim to reduce the pressure on carbon-intensive industries by limiting the cost of complying with climate legislation, even if it undermines the stated environmental goal.
2. *trade measures*: do not limit costs on the covered companies but seek to indirectly apply similar costs to competing companies in other countries through the treatment of traded goods at the border, so as to reduce competitive disadvantage for domestic companies and to incentivize international harmonization of standards.
3. *coordinated international action*: seek to reduce the pressure on domestic carbon-intensive industries by encouraging major trading partners to impose similar costs on their companies directly.

We discuss each of these options in the following chapters. Chapter 2 looks at the ability of cost containment mechanisms to protect various carbon-intensive manufacturing industries given differences in the energy needs of each. Chapter 3 evaluates the effectiveness of trade measures in doing the same, given the source of US imports and the carbon intensity of US production compared with major trading partners. Chapter 4 addresses the role international agreements can play in leveling the carbon playing field and the likelihood of reaching such agreements through multilateral negotiations. Chapter 5 highlights key conclusions and offers recommendations for US policymakers in light of the assessment made in this book.

2

Cost Containment Mechanisms

Over time, a market-based regulatory system such as cap and trade or a carbon tax is the most cost-effective means of meeting a given climate goal for the economy as a whole (box 1.1 in chapter 1). The cost of compliance, however, will not be spread evenly throughout the economy, and some industries will find it easier than others to absorb costs or pass them along to consumers. In addition, all climate policy design involves uncertainty, such as the precise emissions trajectory required and the cost of emissions abatement both for individual firms and the economy as a whole. Cost containment mechanisms are designed to reduce the economic impact of climate legislation on certain regulated entities and provide them with flexibility in managing compliance costs.

The cost concerns, and thus the types of cost containment mechanisms considered, vary between a cap-and-trade and a carbon tax system. Under a cap-and-trade system, compliance costs are likely to be volatile, particularly during the early stages of implementation, as shown by the experience of the EU Emissions Trading Scheme (ETS).[1] And as energy prices are the primary driver of emissions allowance prices, carbon markets may experience some volatility in the long term as well. Under a carbon tax system, the price of carbon emissions is more certain, but there is still uncertainty about the initial cost of mitigation. Also, though the price of carbon emissions is clear and established under a carbon tax, concerns about

1. Given the lack of knowledge about the amount of total emissions during the first phase of the EU ETS, which was launched in 2005, carbon prices were quite volatile. During 2005, CO_2 traded at €20 to €25 per ton. Then in the spring of 2006, when EU member states published emissions inventories far below what was originally anticipated, carbon prices fell from €30 to €9 over the course of two weeks. While prices have since recovered and are back in the €20 to €25 range, fluctuations in coal and natural gas prices mean carbon prices have remained volatile.

international competitiveness and flexibility in managing compliance costs still exist.

In this chapter we discuss six mechanisms to contain carbon costs: three that are available under a cap-and-trade system (price caps, banking and borrowing allowances, and free allocation of allowances), one that is available under a carbon tax system (tax credit), and two that are available under both (offsets and exemptions). In addition, we discuss options for reducing costs other than those directly arising from climate policy as a way to alleviate competitiveness concerns. We evaluate each option using the following three metrics (table 2.1):

1. *impact on carbon-intensive industry*: What degree of protection does the mechanism provide for carbon-intensive industries that compete internationally? How does the impact vary between industries?
2. *environmental integrity*: Does the mechanism change the outlook for potential reduction of greenhouse gas emissions?
3. *economic efficiency*: How does the mechanism affect the cost of meeting emissions reduction targets for the economy as a whole?

We also discuss differences in how our five carbon-intensive industries would be affected under each cost containment mechanism. Two factors primarily determine these differences:

1. *direct vs. indirect emissions*: how much of an industry's energy needs are consumed directly in primary form (e.g., coal, oil, and natural gas) rather than indirectly in the form of heat, coke, or electricity.
2. *vulnerability to fuel switching*: the degree to which the industry relies on fuels, such as natural gas, that may see noncarbon cost increases resulting from fuel switching in other sectors in response to climate policy.

Price Caps

A cap-and-trade system has two main models for limiting the price of carbon allowances and thus the compliance cost imposed on companies. The government may make available additional, tradable allowances for purchase at a set price. Alternatively, companies that find that they are not complying with their target under a cap-and-trade system can pay a penalty in lieu of acquiring allowances.[2]

2. Most recently, an explicit price cap has been included in S 1766, proposed by Senators Jeff Bingaman and Arlen Specter. Based on recommendations from the National Commission on Energy Policy, the price cap would allow regulated entities to make "technology accelerator payments" in lieu of submitting emissions allowances. These payments would be set at US$12 in 2012 and would increase at 5 percent over inflation annually during the life of the program.

Table 2.1 Cost containment mechanisms

Mechanism	Domestic regime	Scope of coverage	Degree of protection[a]		Environmental compromise[a]	Cost	
			Corporate profits	Industrial output		Economic[b]	Fiscal[c]
Price caps	Cap and trade only	Economywide	High	High	High	Moderate/ high	Moderate
Banking and borrowing	Cap and trade only	Economywide	Low/moderate	Low/moderate	None	None	None
Free allocation	Cap and trade only	Economywide or industry-specific	High	Low/moderate	None	Low	High
Tax credits	Carbon tax only	Economywide or industry-specific	Moderate	Moderate	Low	Moderate	Low/moderate
Offsets	Cap and trade or carbon tax	Economywide	Low/moderate	Low/moderate	None	None	Low
Exemptions	Cap and trade or carbon tax	Industry-specific	High	High	Moderate	Moderate	None
Reducing noncarbon costs	Cap and trade or carbon tax	Industry-specific	Moderate	High	None	None	Low

a. Assessment of this cost containment mechanism is measured in relation to an economywide cap-and-trade (with full auction) or carbon tax regime.
b. Economic cost refers to the impact of the mechanism on the overall economic cost of emissions abatement in relation to an economywide cap-and-trade (with full auction) or carbon tax regime, in the absence of the mechanism.
c. Fiscal cost refers to the impact of the mechanism on the amount of revenue the policy would have otherwise provided for government.

From the point of view of market function, price control mechanisms are generally undesirable. As noted earlier, carbon markets are likely to be volatile. If allowance volume is increased when prices rise, later price falls are likely to be more dramatic. This acts as a powerful disincentive for companies contemplating emissions abatement investments. The existence of a policy trigger to reduce prices and increase volume creates the opportunity for traders to "game" the market. In general, markets function better with fewer opportunities for political interference.

In terms of industrial competitiveness, a price cap is a fairly blunt instrument, as it reduces compliance costs for the entire economy, not just those industries that face international competition. Direct emissions from our five carbon-intensive industries (those resulting from consumption of coal, oil, or gas inside the plant) account for less than 6 percent of total US emissions (table 1.2).

However, for products like aluminum, as well as some chemicals and types of steel, indirect emissions from the purchase of electricity account for a significant portion of overall carbon costs (table 2.2). Producers of these goods benefit more from a cost containment mechanism that includes the electric power utilities they buy electricity from than one narrowly focused on direct industrial emissions. The same goes for industries that rely on natural gas, like petrochemicals, to the extent that increased carbon costs for utilities encourages fuel switching from coal to gas (table 2.2).

From an environmental perspective, price controls are clearly problematic. Provision of additional allowances means higher greenhouse gas emissions. One of the principal arguments for adopting a cap-and-trade system rather than a more administratively simple carbon tax is that the former ensures an agreed-on environmental outcome. Accordingly, legislators wishing to ensure a specific price outcome should revisit carbon taxes as an alternative to price caps.

Borrowing and Banking Allowances

As noted earlier, price concerns often focus on price spikes and not on long-term average prices. Carbon prices are likely to be volatile, particularly during the early phases of a cap-and-trade system. Furthermore, covered firms will have different investment cycles, and the timing of decisions for optimal capital investment may not line up with the commitment periods in legislation.

Accordingly, many proposals include the possibility for companies to bank and borrow allowances under a cap-and-trade system. Banking allows companies to emit less than their cap and keep the "spare" allowances for compliance in a later commitment period. Borrowing allows

Table 2.2 Natural gas and electricity dependence in US industry (share of total energy demand), 2002 (percent)

Industry	Net electricity	Natural gas[a]
Ferrous metals	16	32
Iron and steel mills	14	32
Iron foundries	32	31
Nonferrous metals	39	34
Primary aluminum smelters	41	29
Aluminum foundries	26	70
Other nonferrous metals	34	45
Chemicals	8	82
Petrochemicals	n.a.	>90
Alkalies and chlorine	22	n.a.
Carbon black	2	23
Other inorganic chemicals	40	40
Basic organic chemicals	4	71
Plastic materials and resins	4	93
Nitrogenous fertilizers	2	97
Pharmaceuticals and medicines	31	52
Paper	9	22
Pulp mills	2	11
Paper mills, except newsprint	8	21
Newsprint mills	40	17
Paperboard mills	6	21
Nonmetallic mineral products	13	40
Glass	21	77
Cement	11	5
Lime	5	8

n.a. = not available

a. Natural gas includes natural gas liquids and liquified petroleum gas.

Source: US Department of Energy, Energy Information Administration, Manufacturing Energy Consumption Survey, 2002.

companies to overemit today in exchange for deeper cuts later. Borrowing and banking of allowances across compliance periods offer a potentially attractive method for smoothing the costs of compliance over the life of the program.

Banking is uncontroversial in most instances. Since it rewards early overcompliance, it benefits the environment and builds public trust in the system. The only prominent instance in which banking has been disallowed in a trading system has been between the first (2005–07) and second (2008–12) commitment periods of the EU ETS. This was because the Kyoto Protocol did not cover the former commitment period, but it covers the latter. Excessive banking between 2007 and 2008 might therefore have left EU countries at risk of noncompliance with their obligations under the protocol. However, this was a one-off situation: Banking is allowed between subsequent periods of the EU ETS and is almost certain to feature in US and other cap-and-trade legislation.

Borrowing is somewhat more controversial, but in principle, it is just as valid as banking: meeting an obligation over time but shifting it to sit with company investment cycles and technology availability. As long as strong and enforceable requirements to repay any borrowed allowances are included in such a program, the environmental integrity of the cap would be maintained. In fact, several federal proposals include interest on borrowed allowances, which would tighten the cumulative emissions budget of the program every time allowances are borrowed.

However, successful use of borrowing provisions requires a high degree of confidence in the ongoing determination of the government to enforce future targets. If participating companies suspect that they can lobby for weaker future targets by keeping emissions high today, they may attempt to "game" the system by borrowing heavily and counting on relief from sympathetic legislators later or on the ability to escape repayment through bankruptcy. Accordingly, borrowing has been viewed somewhat more cautiously—for instance, it is excluded from the EU ETS.

While banking and borrowing are useful cost containment mechanisms for nearly all carbon-intensive manufacturing industries, they provide the greatest benefit to industries that consume the majority of their energy in primary form (e.g., coal rather than electricity) and have the potential to manage carbon costs through efficiency improvements. Companies producing cement and certain types of steel, for example, whose direct emissions account for most of their carbon costs, would be able to significantly reduce these costs by upgrading their capital stock, provided they are given sufficient flexibility in choosing when to do so. But for industries that rely heavily on electricity or natural gas, or have little potential for efficiency improvement, banking and borrowing provide less relief.

Provided that emissions reduction targets are maintained and firms are not given the opportunity to game the system, both banking and borrowing reduce the cost of emissions abatement for the economy as a whole, not just carbon-intensive industries.

Free Allocation of Allowances

Initial free allocation of allowances in a cap-and-trade system is a complex and contentious issue but has a potential role in defraying the cost of a carbon cap on covered industries. In outlining considerations for allocating emissions allowances under S 280, Senators John McCain and Joe Lieberman list the "need to maintain the international competitiveness of United States manufacturing and avoid the additional loss of United

States manufacturing jobs."[3] The free allocation of allowances, as well as the distribution of allowance auction revenues, could both be used to mitigate the cost of a mandatory cap-and-trade system on carbon-intensive industries.

The assets thus allocated can be vast. The EU ETS in 2006 represented a total asset value of a little under $200 billion, virtually all of which was allocated for free to participating companies. Clearly, the rules for allocating such large assets can create considerable equity issues, but they also have a potential role in making investors whole. Indeed, under the proposed Australian emissions trading system, a calculation will be made as to the decline in asset value for owners of covered installations. Free allocation will then be used as a one-off compensation for this loss, after which allowances will be auctioned.

The ability of free allowances to reduce the compliance costs for carbon-intensive manufacturing varies again by the degree to which that industry relies on electricity and natural gas in meeting its energy needs. For example, while aluminum producers might receive free allowances to cover their limited direct emissions, most of their exposure to the costs imposed by climate policy would come in the form of increased electricity prices. Some proposals attempt to compensate for this by offering a surplus of free allowances that can then be sold to other sectors to help compensate for rising electricity prices.[4] In addition, if climate policy creates incentives for the power generation sector to switch from coal to natural gas, natural gas prices will likely rise for industrial users. Free emissions allowances to cover direct or indirect emissions would do little to reduce the cost of more expensive natural gas for energy-intensive manufacturing.

It is also worth noting that this approach can compensate investors but may not achieve the underlying aim of protecting output and employment levels and reducing emissions leakage. Profit-maximizing manufacturers who receive free allowances would likely raise prices to reflect the cost of purchased allowances regardless of whether they receive free allowances or not (Carbon Trust 2007) because of the opportunity cost of holding free allowances that have value in the market. In the face of inter-

3. See the Climate Stewardship and Innovation Act of 2007, S 280, 42–43, available at http://thomas.loc.gov. In previous years, the allocation of emissions allowances under federal climate change proposals has typically been punted to regulatory agencies. Although some proposals prohibited any allocations to regulated entities (Sanders-Boxer—S 209) and others required consideration of how allocations impact consumers, international competitiveness, economic efficiency, and corporate income and assets (McCain-Lieberman—S 280), legislators avoided detail in their discussion of allocations. In the 110th Congress, however, the allocation of emissions allowances has become a powerful bargaining chip for lawmakers in their attempts to garner bipartisan and business support. The Lieberman-Warner and Bingaman-Specter proposals, the two Senate efforts currently attracting the most attention, both offer detailed guidelines on how allowances should be allocated.

4. See S 2191, America's Climate Security Act of 2007, section 3904, available at http://thomas.loc.gov.

national competition, this preference for profits over market share would result in a decline in domestic production and output levels over time. Some proposals seek to guard against this incentive by linking allowance allocation to production or employment levels on an ongoing basis, rather than just grandfathering in historic production levels. Certain EU countries have tried to shape terms under which companies simply closing capacity in the European Union have to surrender their allowances, but in practice these terms are difficult to define. In addition, providing free allowances to existing producers can help keep older, dirtier domestic production processes in operation while making it more difficult for new companies to bring cleaner production processes into the market.

Two other concerns surround allocation of emissions allowances for purposes of industrial competitiveness. The first is scope. As stated earlier, direct emissions from vulnerable carbon-intensive firms account for less than 6 percent of total US emissions. While the heat and electricity these firms purchase account for another 7 percent, providing free allowances to electric power utilities is a blunt and potentially ineffective tool for managing potential increases in the price of electricity for industry. As in the price of carbon-intensive products, the price of electricity would likely be set at the marginal cost of production—and thus the marginal cost of emissions allowances for utilities. Manufacturers may see no reduction in the price of electricity even if utilities were given a fairly generous allocation of emissions allowances.

And even if prices did fall, manufacturing as a whole accounts for only one-quarter of US electricity demand. The other three-quarters of the customer base of electric power utilities in the United States is not vulnerable to competition from international trade. In addition, distributing emissions allowances free, rather than through an auction, reduces the revenue available for government to increase US industrial competitiveness through other means, such as research and development (R&D) investment or tax reductions. Certain uses of government revenue may, in fact, do more to guard against a loss of competitiveness in carbon-intensive industries than free allocation of emissions allowances (discussed further in the last section of this chapter).

Tax Credits

Under a carbon tax system, cost containment is more straightforward. If legislators wish to reduce compliance costs for certain industries, such as those exposed to international competition, they can simply reduce the carbon tax burden firms face. As is the case for free allocation under a cap-and-trade system, however, the effectiveness of this approach will vary by industry depending on how much of the increase in overall production costs associated with climate legislation is the result of a tax on direct emissions from the plant versus increased natural gas or electricity prices. For cement and some types of steel, where direct emissions account for a majority of the total carbon footprint, tax credits can provide considerable relief. For aluminum and chemicals, however, most of the cost increase would come in the form of higher electricity and natural gas prices, which a carbon tax break would do little to address.

Providing carbon tax credits for vulnerable industries comes with an environmental cost. Free allocation of emissions allowances under a cap-and-trade system may not protect against a decline in output but do maintain incentives for emissions reductions as firms are free to sell allowances they do not need on the market. Reducing the cost of polluting under a carbon tax system by way of a credit, however, also removes the incentive to reduce emissions. Reducing the burden of noncarbon taxes (like corporate or payroll taxes), however, can both address competitiveness concerns and maintain incentives to reduce emissions. This is discussed at greater length in the last section below.

Offsets

Offsets allow participants in a cap-and-trade system to implement emissions abatement measures outside the cap, whether in other jurisdictions or noncovered sectors. Credits from these activities could be surrendered for compliance purposes in lieu of emissions reductions under the cap. Under a carbon tax, firms can receive a tax credit rather than an allowance for emissions reductions achieved outside the plant. Since both allow companies to seek a wider range of abatement options, many of which would be cheaper than those available in their own facilities, they will tend to reduce costs. The potential for cost reduction is greater in industries where direct emissions account for the majority of total carbon costs borne by the firm. While electric power utilities may well take advantage of offsets to reduce costs, there is no certainty about when, or to what degree, they will pass these savings on to industrial consumers.

In addition, identifying genuine offset activities is harder than it sounds. From the climate perspective, one must be sure that the activities rewarded with credits would not have occurred anyway. As long as these emissions reductions are additional, real, and enforceable, the program's cumulative emissions and environmental efficacy would remain unchanged. Without certainty on these points, the climate suffers. The most prominent offsets program, the Clean Development Mechanism established under the Kyoto Protocol, has an executive board dedicated to ensuring that offset projects would not have occurred under a business-as-usual scenario. The difficulty in doing so has led to significant bottlenecks in the system and vocal discontent among both project developers (who feel that the system is too strict) and environmental groups (who consider it too lax).

Nevertheless, if done correctly, offsets can offer other advantages, including spreading cleaner technologies and encouraging other jurisdictions to explore low-cost abatement opportunities. Offsets in some form will very likely play a role in any future cap-and-trade system.[5]

A key question for the paper and pulp industry is how the forestry sector is treated as a potential source of offsets. Many US pulp mills could be considered nearly carbon-neutral if given a credit for the CO_2 absorbed growing the trees they use for both feedstock and fuel (assuming that the harvested areas are replanted and not turned into a parking lot).

Provided that the criteria used to evaluate the emissions reduction gained through offsets is sound, offsets can both provide some degree of industry protection and reduce overall economic costs while maintaining the environmental integrity of the policy.

Exemptions

A more aggressive option for containing costs for carbon-intensive manufacturing industries is to exclude them altogether from the list of regulated entities. At less than 6 percent of total US emissions, carving out this sector of the economy may seem like an acceptable sacrifice if it alleviates enough concern about industrial competitiveness to win support for broader climate legislation. Four principal concerns surround this approach.

First, carving out carbon-intensive manufacturing industries would create an incentive for all manufacturing firms, regardless of their actual exposure, to seek inclusion. While the definition of carbon-intensive industries that we adopt in this study incorporates the most vulnerable, several other industries are not far behind the ones included here (table 1.1), and it could be difficult to draw a firm line.

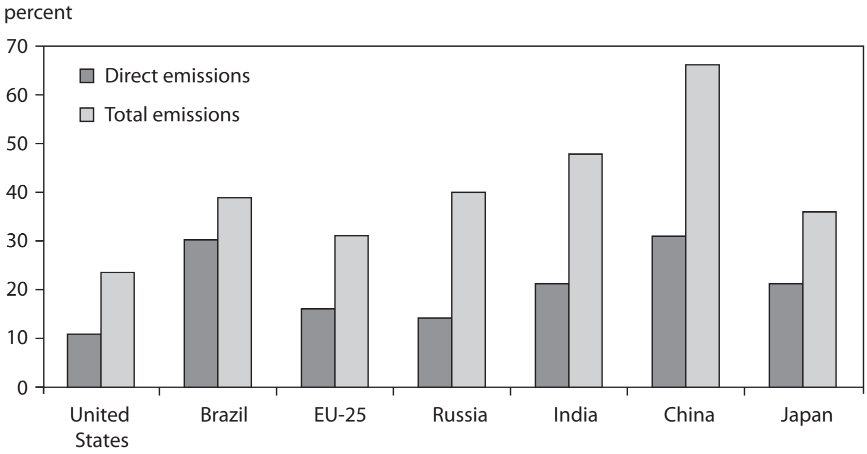
Second, carveouts for direct emissions from carbon-intensive industries do not address potential increases in the price of purchased electricity or natural gas resulting from compliance costs and fuel switching by entities, such as electric power utilities, not included in the carveout.

Third, carveouts increase compliance costs for the economy as a whole by removing some low-cost abatement options from the system.

Finally, carveouts in US policy create incentives for major trading partners to follow suit. While only 11 percent of the US total (table 1.2), direct emissions from manufacturing account for 31 percent of all emissions in

5. The Regional Greenhouse Gas Initiative (RGGI) among a group of northeastern states applies this mechanism, by allowing access to offsets from outside the RGGI states, to credits from the Kyoto Protocol mechanisms (Clean Development Mechanism and Joint Implementation) and even allowances from the EU ETS after certain price levels are reached. Furthermore, several federal proposals include provisions to allow the use of domestic and international offsets to meet upto 35 percent of compliance requirements.

Figure 2.1 Manufacturing share of total CO_2 emissions, 2005



Source: IEA (2007c).

China (figure 2.1). If indirect emissions are included, manufacturing accounts for two-thirds of the CO_2 China emits. Therefore, if carveouts are selected as a policy option, then an alternative regime, such as an international sectoral agreement, should cover industries excluded from a domestic cap-and-trade or carbon tax system, rather than exempting them altogether.

Containing Noncarbon Costs

Thus far, all the cost containment mechanisms discussed seek to reduce the direct costs of climate policy on regulated entities. Measures that increase flexibility in how individual firms comply with climate legislation, like banking and borrowing and the use of offsets, can reduce costs while maintaining the environmental integrity of the policy. Yet such measures may fail to provide enough relief to sensitive industries to alleviate competitiveness concerns. Stronger measures, like tax credits and exemptions, provide substantial relief but may shift the burden to other parts of the economy or reduce the environmental effectiveness of the program as a whole. That has led many legislators to favor free allocation of emissions allowances under a cap-and-trade system as a means of reducing compliance costs. Since it does not affect the overall emissions cap, free allocation does not reduce the environmental efficacy of the program. Free allocations compensate investors by forgoing government revenue that would have been generated if those allowances were auctioned. As firms receiving free allocation are still able to sell allowances through a domestic carbon market, the economic efficiency of a cap-and-trade system is, in theory, maintained.

While free allocation of emissions allowances compensates investors in carbon-intensive industries, it may prove ineffective in guarding against reductions in output and employment (as discussed earlier). Under a cap-and-trade system, emissions allowances will all have the same value, whether allocated for free or purchased on the market. Theoretically, profit-maximizing firms will price their goods based on this market-based allowance price, regardless of whether they received the allowances for free initially, and thus be vulnerable to a decline in market share if they face international competition (Carbon Trust 2007). Efforts to guard against this by linking allocation to output and employment levels are difficult to define and enforce and can raise the overall economic cost of the cap by keeping inefficient capital stock in operation. In addition, free allocation may not address higher electricity and natural gas costs that might arise from climate legislation. The effectiveness of free allocation in preventing industry migration and emissions leakage must be carefully investigated because its costs, in terms of forgone fiscal revenue, are quite large. In leading proposals, free allocation of allowances, particularly to the power generation industry, would be worth between $50 billion and $100 billion per year at a carbon price of $20 per ton of CO_2.

Another, and possibly more effective, way to guard against declines in output and employment is to reduce noncarbon-related costs for vulnerable industries as part of overall climate policy. Such an approach was adopted as part of the United Kingdom's climate change levy, where the economic impact of the tax is offset by a reduction in the amount employers are required to pay to the National Insurance system.[6] Under a carbon tax or cap-and-trade system in the United States, a carbon price of $20 per ton of CO_2 would create $6.5 billion per year in additional costs for the five carbon-intensive industries included in this book, though some of that cost would certainly be mitigated through efficiency improvements or passed on to downstream consumers. In comparison, health insurance alone costs the same five industries roughly $10 billion per year, while retirement expenses account for another $5 billion.[7] And these labor-related costs have increased by more than 50 percent over the past decade, creating a disincentive for firms to add employees, even in the absence of climate policy.

6. Details on the UK climate change levy are available at the website of HM Revenue & Customs at http://customs.hmrc.gov.uk.

7. Department of Labor, Bureau of Labor Statistics, National Compensation Survey and Current Employment Statistics, 2008, Washington, available at www.bls.gov. Per hour healthcare and retirement costs are based on manufacturing sectorwide averages.

Under a carbon tax system, the government could use some of the revenue generated to offset healthcare or retirement costs for carbon-intensive manufacturers. This would soften climate policy's impact on vulnerable firms without removing the incentive to reduce emissions (as occurs with carbon tax credits).

Under a cap-and-trade system, using part of the allowance auction revenue to do the same would address employment concerns more specifically than would free allocation, as companies would have an incentive to maintain or expand their workforce rather than an incentive to trade market share for profit. And compared with placing employment requirements on firms that receive free allocation of allowances that are difficult both to define and enforce, reducing labor-related costs with auction revenue may be a more economically efficient and environmentally productive way to protect vulnerable parts of the US workforce.

3

Trade Measures

The second class of measures to level the playing field for domestic carbon-intensive industries and guard against emissions leakage is based not on reducing the cost of compliance for participating companies but on applying a similar cost indirectly to international competitors. The idea of using trade measures to address competitiveness issues in climate policy was first floated in the European Union, with France and the European Parliament advocating a tax on imports from the United States as a response to American abstention from serious climate policy. Others, particularly the United Kingdom and the European Commission, have been considerably more cautious. The United States, for obvious reasons, has deeply opposed such measures. Interestingly, now that US climate policy is a serious prospect, US legislators have emerged as more enthusiastic advocates of such measures. But while the Europeans had the United States in mind when they were first contemplating such proposals, the focus in Washington is clearly on China.

Trade measures come in slightly different flavors, depending in part on whether domestic climate policy centers on a carbon tax or a cap-and-trade system (box 1.1 in chapter 1), but all seek to achieve the same result: to put domestic producers on a level international playing field and to encourage foreign countries to take steps to reduce emissions. In this chapter we evaluate the effectiveness of trade measures as a whole in achieving both outcomes. Our discussion is organized as follows:

- *designing a trade measure*: an overview of factors that shape the design of a trade measure, including the nature of domestic climate policy, considerations of World Trade Organization (WTO) legality, and the mechanics of enforcement;

- *scenarios for implementation*: under what circumstances might trade measures be imposed and what type of response such imposition (as well as mere enactment) is likely to elicit from major trading partners;
- *effect on US producers*: an assessment of what trade measures mean for the carbon-intensive industries included in this study, based on an analysis of trends in global supply and demand, international trade flows, and comparative carbon intensity across countries; and
- *implications for international engagement*: the ability of trade measures (whether threatened or imposed) to leverage other countries to reduce emissions and their potential impact on multilateral climate negotiations.

Designing a Trade Measure

The most important variable in the design of a trade measure is the nature of the domestic climate legislation of which it will be a part. Under a carbon tax system, trade measures most likely come in the form of a *border tax adjustment*—a levy on imported goods proportionate to their "embedded carbon" (the CO_2 emitted during the good's production). The equivalent under a cap-and-trade system is a requirement that importers *acquire emissions allowances* corresponding to the embedded carbon in their goods. Two other approaches are available under either a cap-and-trade or carbon tax system but have garnered less attention. The first is a requirement that all imports meet a *standard for carbon intensity* equivalent to that applied to domestic producers. The other is the application of *countervailing duties* based on "embedded carbon" and imposed at the border on products from energy-intensive industries originating in countries that have implicitly "subsidized" these industries by failing to regulate greenhouse gas emissions.

As of the start of 2008, the most prominent climate bills under debate in the US Congress call for creating a domestic cap-and-trade system and have thus adopted a variant of the second trade-related option mentioned above—i.e., emissions allowances. Legislation from Senators Joe Lieberman and John Warner, as well as Senators Jeff Bingaman and Arlen Specter, incorporate a proposal first introduced by American Electric Power (AEP) and the International Brotherhood of Electrical Workers (IBEW) in early 2007 that would require importers of carbon-intensive manufactured goods from nations without effective and comparable greenhouse gas reduction efforts to purchase emissions allowances equal to the allowances required from their US competitors.[1] And in Europe, early draft propos-

1. See America's Climate Security Act of 2007 (S 2191) and Low Carbon Economy Act of 2007 (S 1766), available at http://thomas.loc.gov.

als for the third phase of the EU Emissions Trading Scheme (which is a cap-and-trade system) also included some form of emissions allowance requirement for importers of carbon-intensive goods, though the most recent version omits such provisions, in part due to objections from the US administration.[2]

In this chapter our discussion of trade measures in general is often couched in terms of emissions allowance requirements. Where differences between this and other forms of trade measures arise, they are explored.

Making Trade Measures WTO Compliant

The international trade regime is not in its most robust state at present. The WTO's Doha Round of multilateral trade negotiations has stalled, and proponents are struggling to coax it back to life. While US policymakers are clearly concerned about the impact of climate legislation on global trade liberalization more broadly, they are navigating uncharted waters. There has been a great deal of discussion about whether trade measures being discussed would pass WTO muster. Joost Pauwelyn at Duke University has conducted a preliminary assessment of the WTO legality of climate-oriented trade measures in general (Pauwelyn 2007). An analysis of specific US legislative proposals is forthcoming from Gary Hufbauer and Jisun Kim of the Peterson Institute for International Economics. We defer to the WTO scholars to make such assessments. For the purpose of this book, we are primarily interested in how concern about WTO legality is shaping the trade measures under consideration and what this means for the competitiveness of US industry and the environmental integrity of the policy as a whole.

Generally, under WTO law a proponent of a challenged trade measure is required to demonstrate compliance with nondiscrimination standards, which limit the use of measures that discriminate in favor of domestic products or in favor of one country's imports over another's. They are also often required to show that the measure has been closely tailored to achieve a legitimate policy objective (such as protecting the environment) in a least trade restrictive manner. Protecting domestic producers from foreign competition is not recognized as a legitimate policy objective under WTO law, so US policymakers will need to credibly articulate how a trade measure has been designed to achieve greenhouse gas reductions.

2. European Parliament, Draft Proposal for a Directive of the European Parliament and of the Council Amending Directive 2003/87/Ec So as to Improve and Extend the EU Greenhouse Gas Emission Allowance Trading System, 2007; Gerard Wynn, "Carbon Revenues Can Aid Climate Fight—Barroso," Reuters News, January 21, 2008; Stokes (2008).

Defining Scope of Coverage

It is widely assumed that for any trade measure to survive a challenge at the WTO, foreign and domestic producers must be treated equivalently in imposing carbon costs. As such, only foreign products similar to those manufactured by covered entities under US legislation can have a price assigned to their "embedded" carbon emissions.

Imported goods covered by a trade measure would then, in theory, mirror those directly affected by domestic legislation. The Lieberman-Warner bill, the most developed piece of cap-and-trade legislation, specifically names iron, steel, aluminum, cement, glass, and paper as covered products. It also leaves open the option for the administration to include "any other manufactured product that is sold in bulk for purposes of further manufacture," the production of which results in a significant amount of direct or indirect greenhouse gas emissions.[3]

We would certainly expect the carbon-intensive chemicals included in our analysis to make the final list of covered products. But, as in the case of deciding who gets allowances, offsets, or carveouts when implementing domestic cost containment measures, we would also expect to see less carbon-intensive manufacturers seek similar protection from imports. The Lieberman-Warner bill defines covered industrial entities as "any facility within the industrial sector that emits more than 10,000 carbon dioxide equivalents of greenhouse gas in any year." There are plenty of manufacturers who would fall into this category but for whom carbon costs would not have a significant impact on product prices.

Determining Carbon Intensity

Once the set of products subject to trade measures is defined, the challenge becomes determining the amount of carbon used to produce them across both companies and countries. The final carbon footprint of a good depends on the production process employed, the energy efficiency of the capital stock, the fuel source, and the type of feedstock (box 3.1). How these differences are treated in comparing the "likeness" between and among domestic and foreign products is a key variable in whether a trade measure passes the WTO's nondiscrimination disciplines (Pauwelyn 2007).

Most domestic cap-and-trade, as well as carbon tax, proposals impose a price on carbon emissions upstream at the point of fuel combustion. These costs are then passed along the production chain to downstream consumers. Under such a system, manufacturers have an incentive to reduce exposure to carbon costs through changes in the technology and produc-

3. America's Climate Security Act of 2007, available at http://thomas.loc.gov.

Box 3.1 Measuring carbon at the border

Determining the "embedded carbon" in a specific good, or the amount of CO_2 emitted during its production, is complicated. Variations in the type of energy used and the efficiency with which it is consumed can create dramatically different carbon footprints for goods that appear identical at the border. The following are some key factors that determine the carbon intensity of the five categories of goods included in this study.

Process

The production process is the principal determinant of the carbon intensity of many products. In steel, for example, the two main production processes create similar products but with very different carbon footprints. Integrated mills use coal-fired blast furnaces to melt iron ore into pig iron, which is then turned into liquid steel in a coal-fired basic oxygen furnace. Mini mills melt recycled steel scrap, rather than melting virgin iron ore, into liquid steel in an electric arc furnace. By avoiding the use of blast and basic oxygen furnaces, mini mills emit less than one-third as much CO_2 in the production of a ton of steel, even if the electricity consumed in the process is generated from coal. In paper production, process choice also significantly affects the embedded carbon in the final product. Mechanical pulping requires large quantities of purchased electricity while chemical pulping relies on energy self-generated from biomass.

Feedstock

The selection of feedstock also affects embedded carbon in significant ways. Whether a chemical product is made from oil, natural gas, or coal is the largest determinant of its carbon intensity. Ethylene produced from natural gas emits less than half as much CO_2 as ethylene produced from naphtha (a petroleum product). Ammonia (used in fertilizer) produced from gasified coal is more than three times as carbon-intensive as that produced from natural gas. In cement production, the mix between clinker (the most energy-intensive component) and other feedstocks can change the carbon intensity of production by more that 20 percent, regardless of fuel source or technical efficiency. Similarly, in steel and aluminum, the quality of iron ore or bauxite used has a direct (though smaller) impact on the carbon footprint of the final product.

Energy source

The type of energy used to convert feedstock into final product, and thus its carbon intensity, varies considerably in some industries, given local energy resource

(box continues next page)

Box 3.1 Measuring carbon at the border *(continued)*

availability and type of production process employed. This is particularly true for industries using large quantities of electricity. In aluminum production, where nearly all energy is consumed in the form of electricity, the type of fuel used in power generation determines most of the carbon intensity of a ton of product. Electricity generated from coal emits two to three times more CO_2 than that generated from natural gas, let alone carbon-free options like nuclear power or renewables. Yet given the dynamic mix of generation sources included in an average power grid, it is difficult to pinpoint which power source was used to produce a given shipment of aluminum.

Technical efficiency

Even with identical production processes, feedstock, and energy sources, the carbon intensity of the final product still varies plant by plant due to differences in the energy efficiency of the capital stock. The difference in CO_2 emissions, for example, from an ethylene cracker built in the 1970s and from one built today can be greater than 30 percent based on variations in technical efficiency alone. Steel mills, paper mills, and cement kilns also vary considerably in efficiency depending on the type of technology used.

Given these differences, it is next to impossible to accurately assess the amount of carbon embedded in a product without specific plant-level information on production process, technical efficiency, feedstock, and energy source. The carbon footprint of identical shipments of steel, aluminum, chemicals, paper, or cement, even from the same country, will vary by producer.

tion processes they use and fuels they consume. Costs they are unable to mitigate are passed on to their customers, who may then seek out cheaper, lower-carbon substitutes. From an environmental standpoint, the policy is intended to have exactly this effect. By assigning a cost to carbon emissions at the top of the production chain, the policy relies on the market to find the lowest-cost abatement options. And if all primary emissions sources are included in the regime, the price of the final product accurately reflects the amount of embedded carbon.

Trade measures, on the other hand, take the opposite approach. Costs are applied directly to downstream products for carbon emissions from all upstream processes. But given the number of variables in terms of production methods, capital stock, and energy sources, it is nearly impossible to accurately assess embedded emissions of goods at the border on a case-by-case basis without the assistance of fairly rigorous emissions monitoring and reporting in the country of origin.

As a result, most proposals simply determine the average carbon footprint of a category of goods produced in an individual country, based on available data, and use that to determine the compliance obligation for all imports from that country. While more technically feasible, this approach is inequitable in its treatment and questionable in its environmental impact.

As stated earlier, there can be considerable difference in the amount of carbon emitted by different producers of the same product (box 3.1). While domestic producers with a smaller carbon footprint would face lower compliance costs under a cap-and-trade system, the courtesy would not be extended to foreign producers. For example, under proposed legislation, all Chinese steel mills, no matter how efficient, would face the same compliance cost at the border. Trading partners would likely challenge this approach on grounds that it fails the WTO's nondiscrimination tests.

If the trade measure fails to incentivize a change in climate policy abroad, this nationwide calculus could also undermine one of the stated goals of the trade measure: encouraging emissions reductions in other countries. Foreign companies would have no incentive to reduce the carbon footprint of their products because individual action would do nothing to change the way their goods were treated at the border. And in China, where exporters of carbon-intensive goods like steel and aluminum are among the most efficient in the country, nationwide industrial emissions could actually worsen as the best in class strive for average and the worst in class stay right where they are. If the trade measure affects trade but is not well tailored to achieve the intended policy objective of preventing emissions leakage and leveraging greenhouse gas reductions in the exporting country, the measure could fail to pass WTO muster.

A more equitable and environmentally productive approach would be to make assessments at a firm rather than national level. While doing this at the border would be nearly impossible, the United States could establish a two-track system where trusted importers were allowed to appeal a nationwide carbon-intensity determination through an individual company declaration. For example, Baosteel, the largest and most energy-efficient Chinese steel producer, could voluntarily enroll in a "green importer" program with US Customs. Customs officials would conduct an initial carbon audit of Baosteel's plants (at the Chinese company's expense) and then allow Baosteel to declare the carbon content of its exports to the United States, rather than be subject to China's nationwide carbon-intensity assessment. Periodic audits could be conducted to ensure accuracy in reporting as needed.

Assessing emissions allowance requirements or border taxes at the firm level is a more effective use of the leverage access to US markets provide. While Chinese steel sales to the United States are insignificant in terms of China's overall economic health (discussed later), they are very important for the financial health of the exporting firm. And though Baosteel has limited ability to influence nationwide climate policy, it has unlimited ability to improve its own carbon footprint, if given the economic incentive to do so. Focusing trade measures at the firm level uses market incentives rather than economic threats and thus stands a better chance of succeeding. Requiring foreign producers to track their own emissions has the added benefit of building the type of monitoring capacity required for more sophisticated climate policy. It also improves the measure's chances of surviving a WTO challenge by avoiding arbitrary distinctions based on the product's country of origin.

Two-track systems have a precedent in international trade, such as the Kimberley Process Certification Scheme in the diamond industry. It should be noted, however, that the scheme was negotiated multilaterally, is backed by both the UN General Assembly and the UN Security Council, and that, following additional multilateral negotiations, the WTO has waived the application of its rules to trade measures taken to implement the scheme. It is unclear whether inadequate climate regulation will generate the same level of international outrage and international consensus as has the use of diamonds to finance terrorism and guerilla war.

Assigning a Price

Once the carbon intensity of a product is established, the way compliance costs are assigned depends on the domestic regulatory framework in place. The Lieberman-Warner bill, a cap-and-trade approach, requires importers of covered goods to purchase emissions allowances from a special pool to cover the embedded carbon in the shipments entering the United States. These "international reserve allowances" are separate from the domestic allowance pool. A number of factors determine whether this system would impose the same costs on foreign producers as faced by those within the United States.

First, in order to pass the WTO's nondiscrimination test, the price of international reserve allowances cannot be allowed to exceed the price of domestic allowances. There is not, however, a corresponding limit on how expensive domestic allowances are relative to allowances for imported goods. Under the Lieberman-Warner bill, this is left to administration discretion.

Second, if free allowances are given to domestic producers, then it is assumed the same treatment would need to be extended to foreign producers. The Lieberman-Warner bill only requires importers to purchase allowances at the same percentage of emissions as the average for domestic producers. This disadvantages new domestic firms, who were not grandfathered into the allocation scheme.

Finally, in leading cap-and-trade proposals, there are conditions as to when, and to what degree, foreign companies are required to purchase allowances. The terms under which trade measures are enacted are discussed below.

As stated earlier, under a carbon tax system, the trade measure would likely take the form of a border tax adjustment (BTA). Assigning a BTA is, in principle, much simpler that creating an international allowance pool. The tax applied to imports mirrors the tax applied to domestic producers. While determining the carbon intensity of foreign production is just as difficult under a carbon tax regime, assigning a cost for those carbon emissions on a nondiscriminatory basis is far easier.

Carbon-intensity standards do not assign a price for the embedded emissions but rather establish a criterion for determining whether imports are allowed into the country. Carbon-intensity standards are generally discussed in the context of a domestic system where certain industries are exempt from the primary climate regime, whether cap and trade or carbon tax. Under such scenarios, exempt industries would be required to limit the amount of carbon emitted in the production of a particular good, based either on a domestic industry standard or an international sectoral agreement. Imports from countries or producers that did not meet the domestic, or international, carbon intensity standard could then be penalized or banned at the US border. In fact, the US steel industry has been a strong advocate of such an approach as an alternative to the AEP/IBEW proposal discussed at the start of this chapter (Obey 2007).

Proponents of applying a financial penalty at the border against energy-intensive products from uncapped countries could also seek to rationalize these measures as countervailing duties—charges levied to counteract the competitive advantage conferred on a product through government support. Nobel Prize–winning economist Joseph Stiglitz (2006) has proposed that "the countries of Europe and elsewhere could impose countervailing duties to make up for the subsidies that American producers, using energy intensive technologies, implicitly receive when they degrade the global environment without paying the costs."

While it may be conceptually sound to treat a government's failure to internalize the costs of a widely decried externality as a subsidy, the legal and political implications for international trade could be profound. If each country were able to unilaterally characterize the gaps in other countries' regulatory systems as actionable subsidies, the imposition of countervailing duties could snowball. Governments rarely fully implement even multilaterally recognized standards, such as labor and human rights standards. For these reasons, current WTO definitions of prohibited and actionable subsidies are quite narrow and would not likely be interpreted to include a government's failure to cap greenhouse gas emissions (Pauwelyn 2007, 16). The WTO is, however, negotiating specific rules on disciplining fisheries subsidies to reduce worldwide overfishing. This may provide some useful precedents for tying evolving climate change standards to emerging trade rules.

Scenarios for Implementation

In the leading legislative proposals under consideration, trade measures would not be an immediate feature of US policy. Rather, the law would provide for a review process, which could in time lead to the imposition of trade measures if the administration judges these necessary. This is, perhaps, out of recognition that the optimal outcome, both from climate and competitiveness standpoints, is to have major trading partners impose similar costs on their industry at home rather than the United States doing so at the border. It is also likely seen as a strategy for compelling similar action in other countries lest their exports be put at a disadvantage in the US market.

In both the Lieberman-Warner bill and its predecessor from Senators Bingaman and Specter, the administration is instructed to immediately engage in international negotiations to seek binding greenhouse gas reduction commitments from all major emitting nations. No later than the beginning of 2019, the administration shall evaluate whether major US trading partners have indeed taken "comparable action." If not, imports from those countries will be subject to compliance costs starting in 2020.

Under such a framework, the question of what constitutes "comparable action" will likely be the key to not only when trade measures are invoked but also how effective the system as a whole is in addressing the competitiveness concerns of domestic carbon-intensive industry.

Question of Comparability

International comparisons are fraught with challenges. For instance, it is not even obvious what it is that should be compared. The domestic mitigation efforts of a country, the results of those efforts, the efforts at helping other countries, and the results achieved overseas all seem to be relevant criteria when making cross-country comparisons (Philibert 2005) (box 3.2). Likewise, some policy actions (e.g., carbon tax) will result in immediate effects, whereas others (e.g., R&D) are expected to bear fruit over decades. Further complicating matters is that not all countries are expected to undertake the same level of efforts (or achieve the same results).

In particular, there is broad international consensus that poorer countries with less financial, technological, and administrative capacities are not expected to make the same amount of effort as countries that have contributed to the buildup of greenhouse gases in the atmosphere and have the financial and technological means to rein in emissions. The United States has long supported the view that national responses should be "differentiated" according to national circumstances faced by different countries and that some countries should be expected to contribute more than

Box 3.2 Defining "comparable"

Quantitative indicators do not clearly measure the level of effort on climate policy that a country actually undertakes. To gauge actual efforts, it is necessary to assess the actual policies and measures adopted. In making these assessments, the following factors, when taken together, provide a basis for comparison:

- **Form of action:** This may include the following:
  - fiscal measures: taxes (including exemptions and credits) and fees;
  - market and regulatory measures: cap and trade, mandates (products and processes), standards, sectoral regulatory reforms (e.g., electricity), and product labeling; and
  - industry agreements: corporate challenges and public-private partnerships.
- **Stringency/magnitude of action:** What level of effort is required under the particular measure? For example, level of emissions target, size of tax or subsidy, and stringency of technology or performance standard.
- **Legal character:** Are the policies and measures mandatory? If so, what are the accountability provisions with respect to reporting and review of compliance?
- **Scope of action:** What sectors, processes, or fuels are covered? For example, energy production, buildings, industry subsectors, transportation, waste, forestry, and agriculture. What share of a country's emissions do the policies and measures cover? Scope of action can also be international, in that they are aimed at assisting other countries, in particular developing countries (e.g., through aid and export credits).
- **Status:** Is the measure planned or already enacted?

The above classification provides a starting point for making meaningful comparisons. Once policies and measures are classified, additional considerations include:

- Given that countries are not all capable of performing, or expected to perform, equally, how much effort should a given country reasonably be expected to undertake?
- Across what time frames should efforts be evaluated? Should policies that result in certain and immediate emissions reductions be weighted more heavily than policies that may result in longer-term reductions?
- How should stringencies be compared across different forms of policy actions (e.g., technology standard versus an emissions cap)?

others. This principle is embodied in the 1992 Climate Convention,[4] which the United States has ratified. While the unanimous passage of the Byrd-Hagel resolution indicates that the US Senate is not inclined to give developing countries a free pass, both the Lieberman-Warner and Bingaman-Specter proposals take economic development status into consideration when evaluating the "comparability" of action by other countries.

In addition, many developing countries have already adopted a raft of policies and measures that can easily be compared with those in the United States. These include ambitious targets for renewable energy, reductions in energy intensity, efficiency standards for vehicles, and reforestation. Implementation of many of these policies and targets will be a challenge, and in many cases, it may not be possible to make a robust assessment of their success within the short time frames demanded by prospective US policy.

"Comparable" but Not Sufficient

Advocates of incorporating trade measures into climate policy hope providing a future US administration with the ability to threaten punitive tariffs at the border will both win industry support for overall legislation and provide incentives to other countries to take similar action. In the best case scenario, trade measures are a stick that stays firmly planted in the administration's back pocket, never actually needing to be invoked. Unfortunately, the history of US trade policy suggests that what is initially intended as a negotiating tool often becomes an embedded part of public policy (box 3.3).

In recent hearings on the Lieberman-Warner bill, both organized labor and the American Iron and Steel Industry expressed serious reservations with the 2020 start date for the trade measures included in the legislation.[5] Regardless of when the review is conducted, it is highly likely that carbon-intensive industries in the United States seeking protection from imports will take issue with the administration's determination of what constitutes "comparable action" by other countries on climate change. The European Union by any definition would pass a nationwide "comparable action" test, as it has a considerably more ambitious climate policy than the United States. However, aluminum producers in the European Union are not directly covered by climate targets (although they do face higher power prices from generators that are covered).

4. Article 3, United Nations Framework Convention on Climate Change (UNFCCC), 1992, available at http://unfccc.int.

5. Andrew G. Sharkey III, American Iron and Steel Institute, statement before the Environment and Public Works Committee, US Senate, November 13, 2007; Robert C. Baugh, executive director AFL-CIO Industrial Union Council and chair, AFL-CIO Energy Task Force, testimony before the Environment and Public Works Committee, US Senate, November 13, 2007.

Box 3.3 US antidumping law: A questionable precedent

Gary Clyde Hufbauer and Jisun Kim

The first US antidumping law, the Antidumping Act of 1916, drew its inspiration from the landmark Sherman Antitrust Act of 1890 and the Clayton Act of 1914. The 1916 Antidumping Act required "predatory intent" and invoked both criminal penalties and treble civil damages. However, the 1916 act was little used because of its high standards of proof and for practical purposes was superseded by the Antidumping Act of 1921, now regarded as the mother of antidumping legislation worldwide. The 1921 law is important for three reasons: (1) An administrative agency, the US Department of Treasury, replaced the US courts as the chief decision maker; (2) relief no longer required a demonstration of predatory intent; and (3) the remedy became antidumping duties rather than criminal liability or civil damages.

At the international level, the General Agreement on Tariffs and Trade (GATT) of 1947 established minimum standards for assessing antidumping duties on imported merchandise. Article VI of the GATT requires national authorities to make two separate determinations: (1) that subject imports are sold at "less than fair value" (LTFV); and (2) that the imports cause "material injury" to the competing domestic industry. Originally a finding of LTFV meant that export sales were priced below home market sales. However, the US Trade Act of 1974 expanded the LTFV definition to include sales below the average cost of production. Since then, so-called cost cases have become the main basis of antidumping determinations.

The US Trade Agreements Act of 1979, which implemented the Tokyo Round Agreement in 1979, shifted administrative responsibility for LTFV determinations from a "less friendly" Treasury Department to a "more friendly" Commerce Department. Much earlier, in 1954, the authority for making injury determinations was shifted from Treasury to the US Tariff Commission (now the US International Trade Commission).

Importantly, following the 1979 Trade Agreements Act, antidumping cases were no longer a matter of administrative determination; instead, they became private rights of action. Subsequent legislative and regulatory changes have made antidumping procedures ever more friendly to private petitioners. For example, highly artificial accounting procedures influence "cost" calculations.

As a consequence of all these changes, international economic policy considerations now play almost no role in deciding the outcome of antidumping cases. Antidumping actions have become the most widely used trade remedy tool for industry-specific grievances. This development raises serious concerns about the abusive use of antidumping petitions and their negative impact on global commerce. Many economists, including Michael Finger (1998) and Bruce Blonigen and Thomas Prusa (2001), point out that, under current US antidumping laws, imports are often deemed "unfair" and subject to antidumping duties even when foreign companies are behaving no differently than domestic firms.

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Going forward, China could choose to implement policies that reduce greenhouse gas emissions while imposing *no* additional costs on carbon-intensive manufacturing whatsoever. Under such a scenario, it is quite plausible that industry and labor groups would seek additional legislation from Congress, making the review process a "private right of action," as happened with the antidumping regime.

Be Careful What You Wish For . . .

Including the threat of trade measures in US climate legislation would open the door for other countries to do the same. And their timing and criteria for "comparable action" would be entirely out of Washington's hands. For all the talk of leadership on climate change, the truth is that at the moment, the United States is playing catch up. Some major trading partners, in particular the European Union, have imposed carbon emissions costs on their industry, which will likely remain higher than those in the United States for some time. The European Parliament and the French government have been among the most prominent European voices calling for trade measures against US producers on these grounds. Others have argued that the actual competitiveness impacts at stake are not worth a trade battle with the United States, and to date this argument has carried the debate. However, trade measures are getting a fresh hearing as Europe plans for phase III of the EU Emissions Trading Scheme. While the current draft of phase III stops short of including such measures, European Commission President Jose Manuel Barroso has warned that they might be in store if the United States and large developing countries do not accept commitments under the next round.[6]

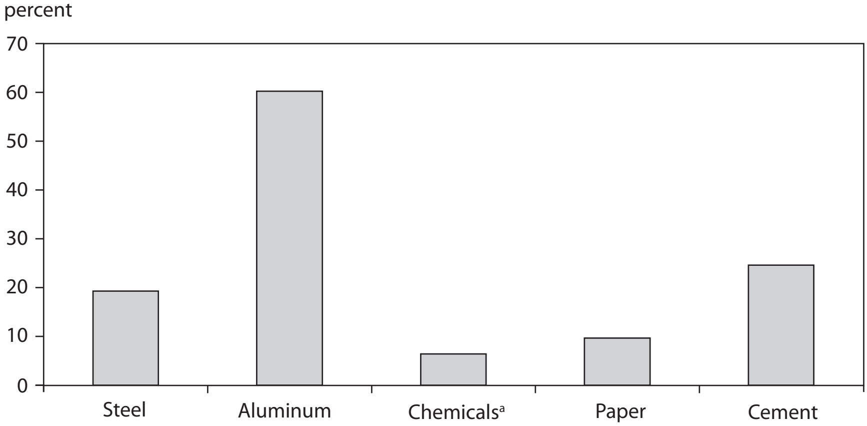
Ironically, Europe may ultimately balk at targeting these trade measures at the United States, anxious as they are to help encourage US climate action. However, this is not true of all countries. Middle Eastern producers of some energy-intensive goods are both highly skeptical of climate policy and less emissions-intensive than their US competitors. While US trade measures are intended to impose a penalty on more carbon-intensive producers, some would also give countries with lighter carbon footprints a competitive advantage over US producers. In the following section, we look at what trade measures, imposed either by the United States or other countries, would mean for individual US industries.

Effects on US Producers

The imposition of the type of trade measures outlined above would impact different carbon-intensive industries in different ways, depending on

6. Roger Harrabin, "Barroso Trade Threat on Climate," BBC News, January 22, 2008.

Figure 3.1 Net imports as share of US demand, 2005



a. Refers to the 11 basic chemical categories included in the study.

Sources: United Nations Comtrade database, 2007; International Iron and Steel Institute, *Steel Statistical Yearbook*, 2006; US Department of the Interior/US Geological Survey, *2005 Minerals Yearbook;* UN Food and Agriculture Organization, FAOSTAT database, 2007; Nakamura (2006); authors' estimates based on industry reports.

the degree to which they compete with imports, the origin of those imports, and the comparative carbon intensity of foreign producers.[7]

Prevalence and Origin of Imports

The United States runs a trade deficit in all five carbon-intensive industries included in this study, despite running a trade surplus in certain product lines. Aluminum is, by far, the most exposed to trade, with net imports accounting for 60 percent of US consumption (figure 3.1). But even in cement, long considered the classic "nontradable," foreign producers meet nearly 25 percent of domestic demand. Domestic producers have the largest market share in paper and energy-intensive chemicals, with net imports accounting for 10 and 6 percent, respectively.

The origin of imports also differs greatly between industries. Table 3.1 lists the top ten sources of imports for each product category. The majority of US imports of steel, aluminum, and paper come from other

7. A note on the data used in this chapter: Because 2005 was the most recent year for which comprehensive global trade data were available at the time this book was written, data from 2005 was also used for supply, demand, and carbon intensity in the interest of consistency. It is important to note that in fast-growing economies like China, the average carbon intensity of production has likely improved considerably since 2005, thanks to large additions of capital stock.

Table 3.1 US imports by origin, 2005

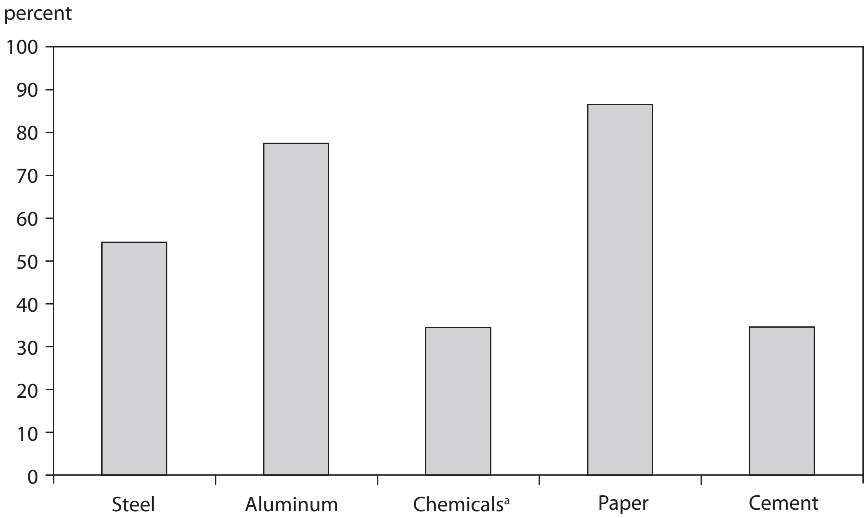
	Steel		Aluminum		Chemicals		Paper		Cement	
Rank	**Source**	**Share** (percent)	**Source**	**Share** (percent)	**Source**	**Share** (percent)	**Source**	**Share** (percent)	**Source**	**Share** (percent)
1	Canada	18.56	Canada	51.02	Trinidad and Tobago	41.58	Canada	66.89	Canada	16.06
2	European Union	17.25	Russia	17.08	Canada	19.30	European Union	16.82	China	14.04
3	Mexico	13.08	European Union	6.24	Ukraine	7.34	China	3.53	European Union	13.87
4	Brazil	8.24	OPEC	5.10	OPEC	6.60	South Korea	2.24	OPEC	9.97
5	China	7.11	Brazil	3.79	European Union	4.49	Mexico	2.20	Thailand	8.60
6	South Korea	5.67	China	3.07	South Korea	4.36	Brazil	1.84	Greece	8.28
7	Russia	5.12	South Africa	2.50	Brazil	3.79	Chile	1.50	South Korea	7.94
8	Turkey	4.16	Tajikistan	2.43	Russia	3.19	Japan	0.96	Mexico	6.49
9	Japan	4.12	Argentina	1.54	Equatorial Guinea	2.76	Norway	0.85	Colombia	5.49
10	India	2.70	Australia	1.27	Chile	1.52	OPEC	0.71	Peru	3.11
From UNFCCC Annex I industrialized countries		54.42		77.57		34.46		86.66		34.61

OPEC = Organization of Petroleum Exporting Countries
UNFCCC = UN Framework Convention on Climate Change

Note: Standard International Trade Classification Codes of included products (version 2): Steel (672, 673, 674, 675, 676, 677, 678, 679), Chemicals (51111, 51112, 51113, 51122, 51123, 51124, 51211, 52218, 52323, 52213, 52251), Cement (6612), Aluminum (6841, 6842), and Paper (641, 642).

Source: United Nations Comtrade database, 2007.

Figure 3.2 Share of US imports from Annex I countries, 2005



a. Refers to the 11 basic chemical categories included in the study.

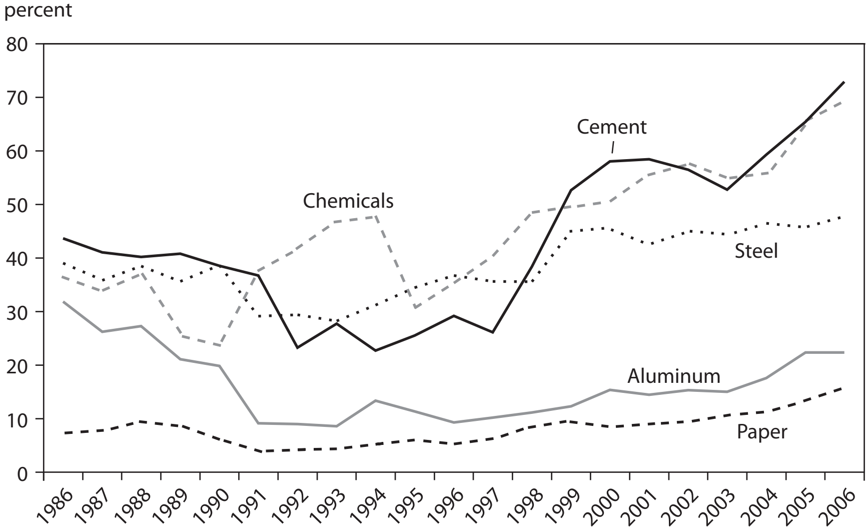
Note: Annex I countries are the industrialized countries listed in Annex I of the UN Framework Convention on Climate Change.

Sources: United Nations Comtrade database, 2007; International Iron and Steel Institute, *Steel Statistical Yearbook*, 2006; US Department of the Interior/US Geological Survey, *2005 Minerals Yearbook;* UN Food and Agriculture Organization, FAOSTAT database, 2007; Nakamura (2006); authors' estimates based on industry reports.

industrialized countries, those listed in Annex I of the UN Framework Convention on Climate Change (figure 3.2). With the exception of the United States, all Annex I countries have accepted mandatory emissions reduction targets as part of the Kyoto Protocol. As such, these countries would likely pass a "comparability test" exempting them from allowance requirements under US cap-and-trade legislation. Under a carbon tax regime with a border tax adjustment, some Annex I countries may seek a tax credit arguing their products are less carbon-intensive than those manufactured in the United States.

Despite the concern about carbon-intensive imports from China, they account for less than 10 percent of all but cement imports. Canada is the largest foreign source of all carbon-intensive imports except chemicals, where it ranks second only to Trinidad and Tobago. Canada accounts for more than half of US paper and aluminum imports, compared with China at 3 percent. That said, it is important to note that over the past 15 years, more US carbon-intensive imports have come from developing countries (figure 3.3). How this trend translates into competitiveness of US industry under trade measures that attach a price to embedded carbon in imports

Figure 3.3 Share of US imports from non-Annex I countries, 1986–2006



Note: Non-Annex I countries are mostly developing countries and are not listed in Annex I of the UN Framework Convention on Climate Change.

Source: United Nations Comtrade database, 2007.

depends on the carbon intensity of foreign production. As discussed later, the developing countries from which these goods are imported are, in many industries, less carbon-intensive on average than the United States.

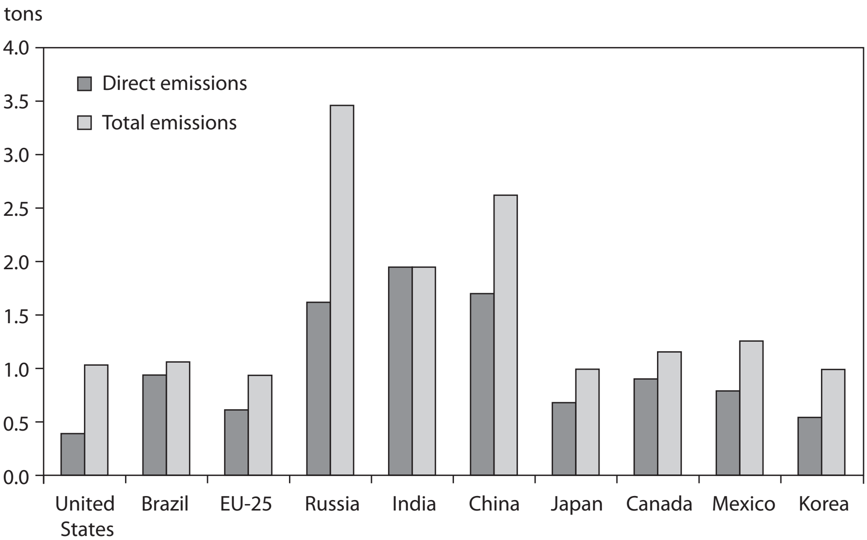
Comparative Carbon Intensity

As discussed earlier, two factors determine the carbon intensity of industrial production: the source of energy used to manufacture the good and the efficiency with which it is produced (box 3.1). These two factors can differ greatly between firms and between countries. Yet under the trade measures included in current US legislative proposals, carbon intensity would be assessed at the nationwide level. In response, this study takes the same approach. Below we provide an overview of how the United States stacks up against its international competition in each of the five industries.

Steel

On average, US steel production is among the least carbon-intensive in the world (figure 3.4). This is primarily the result of the type of production process the industry employs. Nearly half of all steel in the United

Figure 3.4 Carbon intensity of steel, 2005
(tons of CO_2 emissions per ton of steel)



Sources: International Iron and Steel Institute, *Steel Statistical Yearbook,* 2006; IEA (2007c); authors' estimates.

States is made in "mini mills," which use electricity to recycle scrap steel rather than starting from scratch by burning coal and coke to melt iron ore into iron. The electric arc furnaces employed by the mini mills emit one-fourth the amount of CO_2 per ton of steel as the blast furnaces and basic oxygen furnaces used in integrated mills if only direct emissions from the factory are counted. If one includes the CO_2 emitted to produce the electricity an electric arc furnace consumes, the embedded carbon increases (though still less than that from an integrated mill, especially if that electricity is generated from low-carbon fuel sources).

Countries like China and India, which have yet to build up their own supplies of scrap steel, rely much more on integrated mills. While US mini mills would likely see an increase in competitiveness resulting from the implementation of a trade measure in the short term, this benefit would dissipate over time as other countries installed electric arc furnaces and the price of US scrap rose in response to demand from foreign producers. Also, if the carbon content of imports is assessed nationwide rather than at the firm or process level, US integrated mills would see a decline in competitiveness vis-à-vis Canadian, Japanese, European, Mexican, and Brazilian imports, which account for over 60 percent of the current US steel imports.

Aluminum

The majority of the energy consumed in manufacturing primary aluminum is in the form of electricity. Thus, the carbon intensity of a ton of aluminum is largely determined by the source of electricity used to produce it. In the United States, roughly half of the electricity used in primarily aluminum production comes from hydropower, with the remainder coming from coal. That makes US smelters less carbon intensive than the average Asian or African smelter, despite being less energy efficient, but more carbon intensive than Canadian, European, Russian, or Middle Eastern smelters, which account for nearly 80 percent of US aluminum imports. In addition, most new aluminum smelters slated for construction in the years ahead will be sited next to cheap yet low-carbon electricity sources such as hydro and geothermal power in Iceland or stranded natural gas in Russia and the Middle East. China, with rising coal-fired electricity prices, is struggling to remain competitive with these low-cost producers, even in the absence of a regime that prices carbon.

Chemicals

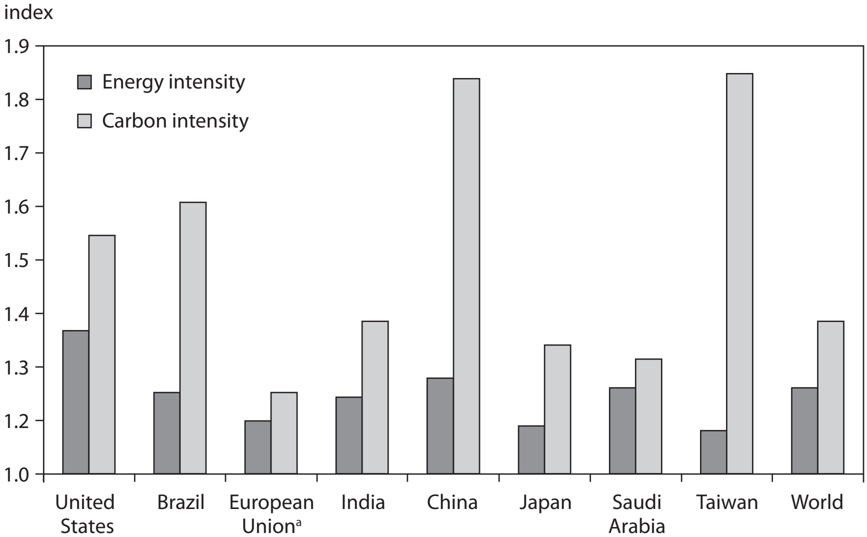
The US chemical industry, with some of the oldest capital stock in the world, is fairly energy inefficient in the production of commodity chemicals. New ethylene crackers[8] in China and the Middle East are all more energy efficient than the average facility in the United States, and older crackers in Japan and Europe have been upgraded and are now some of the most energy efficient in the world (figure 3.5).

At the same time, the US chemical industry is more dependent on natural gas for feedstock than its competitors in Asia, which rely primarily on an oil-derived feedstock called naphtha, and as a result it is less carbon intensive than China and Taiwan. For some chemical products, like ammonia (used for fertilizer) and methanol, China also uses considerable amounts of coal as a feedstock, further increasing the average carbon intensity of its chemical industry. Japan and Europe are more reliant on naphtha than the United States, but highly efficient capital stock there makes their industries less carbon intensive overall.

Yet in commodity chemicals for which energy costs matter, the United States does not compete so much with Europe and Asia as with producers in the Western Hemisphere like Canada and Trinidad and Tobago, which are even more dependent on natural gas. And as is the case with alu-

8. Cracking is the process of breaking down complex chemical compounds into simpler ones of lower boiling points by means of excess heat and distillation under pressure in order to give a greater yield of low-boiling products than could be obtained by simple distillation.

Figure 3.5 Energy and carbon intensity index for chemicals, 2005



a. Germany, Italy, the United Kingdom, France, and the Netherlands.

Note: An energy and carbon intensity index value of 1.00 equals best available technology and feedstock.

Sources: IEA (2007a); authors' estimates.

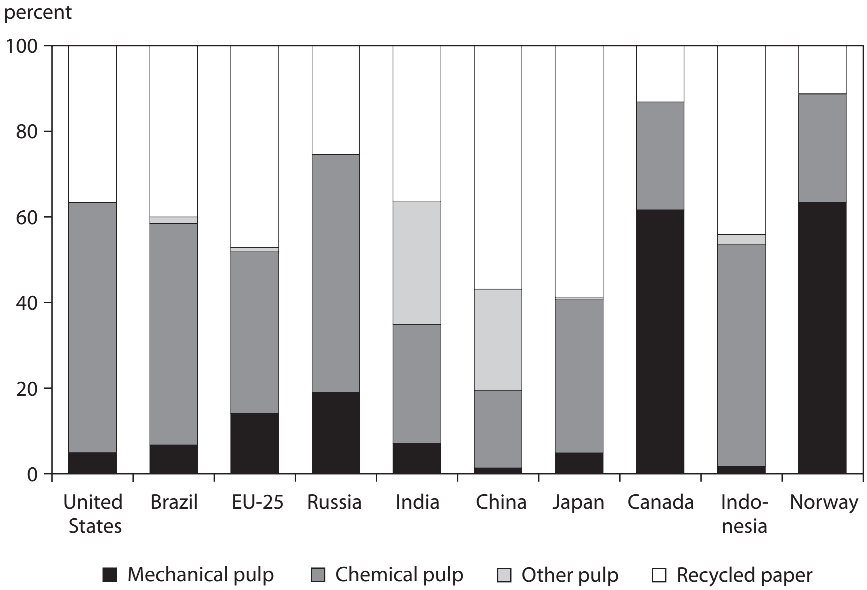
minum, much of the new capacity in commodity chemicals is being built in the Middle East to take advantage of relatively abundant natural gas.[9]

Paper

The US paper industry would perhaps stand to gain the most from a trade regime that imposed costs on the carbon content of imports. There are two basic processes for making the pulp used in paper manufacturing. Mechanical pulping uses electric-powered machines to grind wood into pulp. Chemical pulping breaks the wood down through a chemical process. Waste paper can also be turned into pulp suitable for some types of paper manufacturing. Chemical pulping is dominant in the US and Brazilian paper industries while mechanical pulping is more prevalent in

9. While historically most aluminum smelters and ethylene crackers in the Middle East have been built to utilize stranded natural gas, slow gas development has prompted some countries to look to oil as a substitute energy source and feedstock. See Neil King Jr., "Saudi Industrial Drive Strains Oil-Export Role—Kingdom's Use Jumps as Cities, Smelters Bloom in the Desert," *Wall Street Journal*, December 12, 2007.

Figure 3.6 Pulp used in paper production, 2005



Sources: UN Food and Agriculture Organization, FAOSTAT Forestry (ForesSTAT) database (accessed August 18, 2007); authors' estimates.

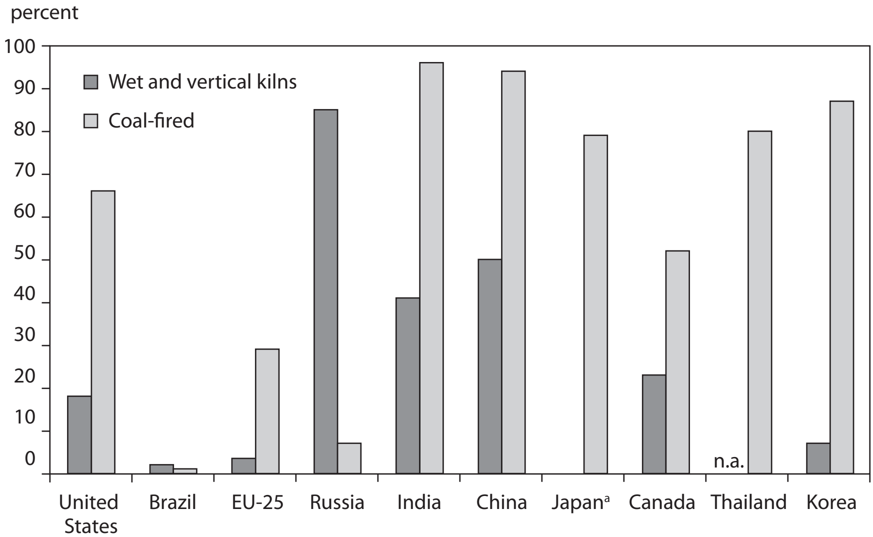
Canada and Norway. Japan and China, with thinner forestry resources, rely on recycled paper (much of it is imported from the West) for their paper production (figure 3.6).

From an energy standpoint, recycling is the most efficient way to produce paper. But from a CO_2 standpoint, chemical pulping can produce paper with a smaller carbon footprint, if one includes the CO_2 removed from the atmosphere during the life span of the trees (the kind of calculus used for biofuels). In fact, an integrated chemical pulping plant and paper mill can be configured to have zero emissions itself while also selling surplus low-carbon energy to other users (IEA 2007a). If US climate policy credited paper producers with the CO_2 absorbed when they replant trees, trade measures would likely give US mills a leg up on Asian and Canadian producers, though not those from Indonesia or Brazil.

Cement

For cement production, the most important variable in determining carbon intensity is the type of kiln used. Wet kilns are used when the feedstock has a high moisture content and are between 25 and 125 percent more energy intensive than dry kilns (IEA 2007a). In the United States, 18 percent of production is from wet kilns, more than Europe or Brazil but

Figure 3.7 Cement kiln type and fuel source, 2005



n.a. = not available

a. Dry kilns account for 100 percent of kiln type in Japan.

Source: IEA (2007a).

less than Canada and Russia (figure 3.7). In China, and to a lesser extent India, vertical kilns are still widely used, which can be slightly more efficient than wet kilns but much less efficient than dry kilns.

Coal accounts for two-thirds of the fuel used in US kilns, less than the shares in China and India but more than Canada and far more than Brazil and Europe, which use large amounts of biomass (figure 3.7). Many Latin American and European producers also reduce the carbon footprint of their cement through the use of additives. As a result the US cement industry is, on average, less carbon intensive than most Asian producers (about one-third of US cement imports), more carbon intensive than European and Latin American producers (another one-third of imports), and about the same as Canadian producers (16 percent of imports).

Impact on Downstream Industries

By necessity, a trade provision would have to draw a boundary around a set group of products for which a BTA or allowance requirement is applied. The law may, for example, regulate imports of steel sheet, but not the steel in an automobile or toaster oven, as the origin and carbon content of that steel would be extremely difficult to assess. Yet the American Iron and Steel Institute (AISI 2006) estimates that in 2005, the United States imported 36.9 million tons of steel in the form of final goods like automobiles and toaster ovens, more than the 30 million tons in actual steel products imported that year. A trade measure that imposed carbon costs on steel products but not the steel contained in other products would raise material costs for US auto and appliance industries without applying similar treatment to their foreign competitors. In addition, such measures create an incentive for foreign producers to move downstream and export finished goods to the United States rather than carbon-intensive intermediates. Steel-consuming industries have argued that tariffs and restraints on steel imports (for noncarbon reasons) cost the United States more in the way of economic output and employment in downstream industries than is saved in steel production (Barringer, Pierce, and McCullough 2007).

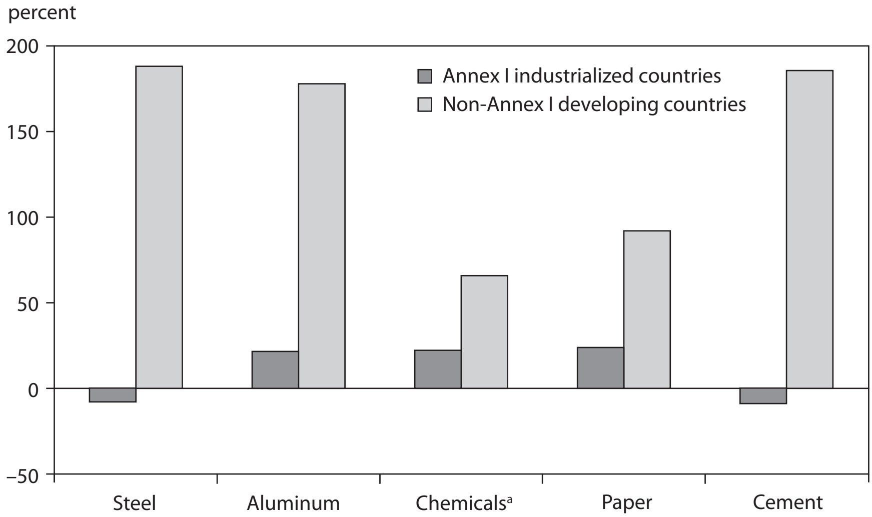
For aluminum, in which the United States runs a larger trade deficit than in steel, tariffs on imports would also impose a cost on downstream consuming industries, often the same firms that buy large quantities of steel. But downstream impacts may be most significant in the chemicals sector. Of the $209 billion in US economic output from the chemicals sector in 2005, only a fraction came from the production of carbon-intensive commodity chemicals like ethylene, chlorine, and ammonia. The bulk of the value added and the employment is in the production of downstream specialty chemicals that use basic chemicals as feedstock. Of the $1 trillion in global chemicals trade in 2005, only $38 billion could be considered carbon intensive (United Nations Comtrade database, 2007). And while the United States runs a trade deficit in carbon-intensive chemicals, it is fairly competitive in the much larger specialty chemicals market. As in steel, applying a carbon tariff on commodity chemicals but not downstream products could be both trade distorting and detrimental to the competitiveness of the sector as a whole.

The potential impact on downstream industries is least relevant in the case of cement and paper. The majority of cement is consumed by the construction industry, which is not globally traded. And as US paper production is among the least carbon-intensive in the world, paper-consuming industries likely would not see a significant increase in their paper costs vis-à-vis their overseas competitors.

Competing in Export Markets

The final consideration in quantifying the impact of a trade measure on carbon-intensive industry in the United States is whether the relevant market is at home or abroad. While the trade-related provisions included in both the Lieberman-Warner and Bingaman-Specter bills try to level the playing field for domestic producers and importers, they do nothing to address the competitiveness of US production in foreign markets. As most

Figure 3.8 Demand growth by country grouping, 1991–2005



a. Refers to the 11 basic chemical categories included in the study.

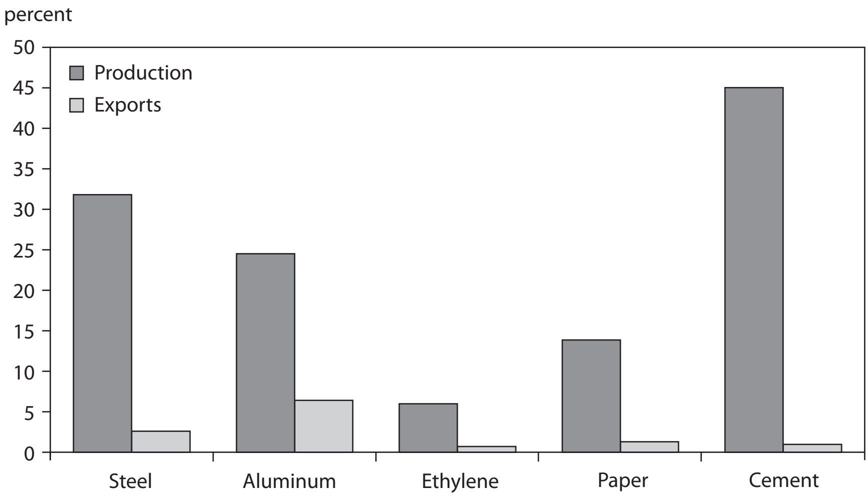
Sources: United Nations Comtrade database, 2007; International Iron and Steel Institute, *Steel Statistical Yearbook,* 2006; US Department of the Interior/US Geological Survey, *2005 Minerals Yearbook;* UN Food and Agriculture Organization, FAOSTAT database, 2007; Nakamura (2006); Rhodes (1996); authors' estimates based on industry reports.

carbon-intensive industries in the United States run a substantial trade deficit, defending the home market has been the primary consideration of policymakers to date.

Yet the developing world, not the United States, will account for most of the growth in demand for these goods in the years ahead. Demand for steel in industrialized countries has, in fact, declined over the past 15 years, while demand from the developing world has tripled (figure 3.8). Demand for aluminum, paper, and chemicals has grown in industrialized countries but has still been far outpaced by demand from emerging economies. China, which alone has accounted for three-quarters of the growth in global steel, cement, and aluminum production over the past decade, has built out capacity primarily to supply its fast-growing domestic market.

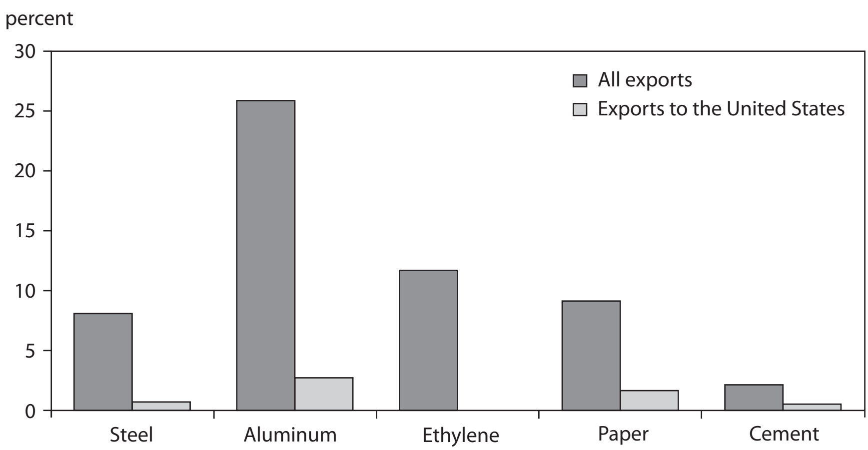
While this capacity has recently gone into surplus and is spilling into international markets, there is little doubt that China is, and will continue to be, the primary driver of global demand for these goods. For example, while overcapacity has made China the world's largest steel exporter, only 8 percent of total production was sold abroad in 2005 and less than 1 percent showed up in the United States (figures 3.9 and 3.10). Exports to the United States account for an even smaller share of Chinese cement

Figure 3.9 Chinese production and exports as shares of global supply, 2005



Sources: United Nations Comtrade database, 2007; International Iron and Steel Institute, *Steel Statistical Yearbook,* 2006; US Department of the Interior/US Geological Survey, *2005 Minerals Yearbook;* UN Food and Agriculture Organization, FAOSTAT database, 2007; Nakamura (2006); authors' estimates based on industry reports.

Figure 3.10 Chinese exports as share of domestic production, 2005



Note: Chinese ethylene exports to the United States are negligible.

Sources: United Nations Comtrade database, 2007; International Iron and Steel Institute, *Steel Statistical Yearbook,* 2006; US Department of the Interior/US Geological Survey, *2005 Minerals Yearbook;* UN Food and Agriculture Organization, FAOSTAT database, 2007; Nakamura (2006); authors' estimates based on industry reports.

and ethylene production. In addition, there is good reason to think that China may again become a net importer of energy-intensive goods in the years ahead. This raises the question of just how much leverage US trade measures, if taken unilaterally, would have on the industrial behavior of China and other developing countries.

A BTA under a carbon tax regulatory regime provides more flexibility in leveling the playing field for US exports. A carbon tax rebate for products sold to countries without "comparable" climate policy could be issued at the border, in the same way as value-added tax (VAT) rebates are given to exporters in some countries.

Implications for International Engagement

An important assumption of proponents of trade measures is that they will help drive other countries to the negotiating table and thus strengthen global climate action. Current legislative proposals would only impose penalties on carbon-intensive imports from countries that had not implemented climate policy "comparable" with that taken in the United States. The rationale is that giving countries an economic incentive to participate in international climate change mitigation efforts will make them more inclined to submit to greenhouse gas reduction targets. After all, access to international markets is likely to be a higher priority for many governments than international climate negotiations. Perhaps trade measures could raise the political focus on mitigation options for America's major trading partners. And as mentioned earlier, the United States is not alone in considering the use of trade measures for such ends. On a recent trip to Beijing, French President Nicolas Sarkozy warned that if the Chinese government did not take action on climate change, Chinese goods could face restrictions in entering the European market.[10]

Multilateral action would not only expand the coverage in terms of industrial emissions (the United States accounts for 14 percent of the global total) but also expand the degree of protection for US industry and increase the leverage on the behavior of nonparticipating countries (see box 3.4 on the disadvantages of unilateral action). Yet there is reason to be skeptical of the likelihood that the threats of trade measures alone, whether unilaterally by the United States or in concert with Europe and Japan, will force developing countries to take a different position in international negotiations.

Developing-country leaders, like politicians in many other countries, need to act tough for the domestic audience. This is particularly true in the case of China, which is also the primary focus of most trade measures

10. Tony Barber and Mure Dickie, "Sarkozy Warns China of Carbon Tariffs," *Financial Times*, November 27, 2007.

Box 3.4 Porous borders

The fungible nature of international markets for basic materials like steel, aluminum, and chemicals must be considered when contemplating unilateral use of trade measures. For example, a border tariff or emissions allowance requirement for Chinese but not Japanese steel could create incentives for producers simply to redirect trade flows rather than reduce emissions. In 2006 the United States imported 5 million and 2 million tons of steel from China and Japan, respectively. If a US trade measure made Japanese steel more competitive in the US market than Chinese steel, Japanese firms could redirect steel produced for the domestic market to the United States to take advantage of the price gap, leaving Japanese steel consumers to import more from China.

Likewise, US trade measures could encourage import substitution in countries like China, by reducing the profitability of exports vis-à-vis domestic sales. Accounting for over 30 percent of global steel demand, China is not only the world's largest steel consumer but also its second largest importer, buying 19 million tons from foreign producers in 2006. Growing at over 14 percent per year, domestic Chinese steel demand during one month will soon be greater than total steel exports to the United States during the course of a year. While trade measures enacted by the United States would likely reduce Chinese steel exports to the American market, they would not address the competitiveness of Chinese producers relative to Japanese, US, European, or Korean producers in supplying the far larger and faster-growing domestic Chinese market.

currently proposed. In judging extraterritorial "conditions" in other countries, it is helpful to consider a "reciprocity test": What would be the US reaction, for instance, to a provision adopted by the Indian Parliament or the Chinese Communist Party that conditioned Indian or Chinese actions on those of the United States? Threats of punitive trade sanctions against Beijing have failed to make headway on issues far less contentious then climate change and in which the United States had considerably more leverage (box 3.5). And as climate change is an issue that can be solved only with the involvement of the developing world, China in particular, there is considerable risk in a brinksmanship approach on the part of the United States.

That said, Beijing has demonstrated the willingness and ability to make painful adjustments to the structure of the Chinese economy in order to be part of a multilateral framework, when it perceives such membership to be in its national interest. With China surpassing the United States as the world's largest CO_2 emitter (on an annual basis), the country's leadership is under growing domestic and international pressure to take ac-

Box 3.5 The sanctions track record

The use of economic sanctions to coerce foreign countries to change policy has a mixed track record. In an assessment of 174 instances of economic sanctions worldwide, the Peterson Institute's Gary Clyde Hufbauer, Jeffrey J. Schott, Kimberly Ann Elliott, and Barbara Oegg (2007) find some degree of success in only 34 percent of the cases. Among those where trade was the only form of leverage applied, the success rate dropped to 25 percent. The success rate was higher among cases where the intended effect of the sanctions was a modest policy change and where the economic cost of the sanctions was high.

Trade measures in US legislation intended to coerce large developing countries like China into adopting "comparable" climate policy would seek to bring about a substantial change in government behavior with extremely limited economic leverage. Chinese exports to the United States of the five carbon-intensive goods included in this study amounted to only $3.5 billion in 2005, less than 0.2 percent of the country's economic output. Even exports of these goods to all countries accounts for only 1 percent of China's GDP. Given that the cost of climate policy "comparable" to that under consideration in the United States would almost certainly exceed this amount, it is unlikely that the threat of losing market access for these goods would be enough to jawbone Beijing into taking steps it otherwise would not.

Moreover, the threat of sanctions in the past on an even wider array of Chinese goods than the carbon-intensive products discussed here made little headway in changing Beijing's behavior. A number of legislative proposals and trade petitions aimed at coercing China into appreciating its currency, the renminbi, against the US dollar have thus far failed to achieve the desired result. One bill, sponsored by Senators Charles Schumer and Lindsey Graham, would have imposed a 27.5 percent tariff on all imports from China. Beijing correctly predicted that, given its economic consequences for US business and consumers, such legislation was unlikely to pass. If it did, Beijing was confident that an administration that relies on Chinese help in foreign policy issues like international terrorism, North Korea, and Iran would veto the bill. If US climate policy included the possibility of imposing trade measures on Chinese goods, Chinese leaders would likely be similarly confident that the administration would ultimately stop short of using them.

tion. But to translate that political momentum into a meaningful policy commitment, the industrialized world will be more successful engaging China and other large developing counties through inducement rather than threat. The next chapter addresses scenarios for coordinated international action, both in terms of curbing greenhouse gas emissions and addressing industrial competitiveness concerns.

4

Coordinated International Action

In the long run, only a comprehensive, harmonized international climate policy can reconcile competing concerns of climate change and international competitiveness. A global carbon tax or cap-and-trade regime covering all major economies could fit the bill, and many approaches have been proposed that carefully devise such far-reaching regimes. Sadly, these options are likely to remain distant hopes for some time to come. One reason is the continued (and not entirely unjustified) insistence of some developing countries that they want to see some serious action from the big, rich polluters before they take their own sweeping national measures. Another is the sheer technical and institutional capacity needed to implement a cap-and-trade system, which remains years away in most major emerging economies.

It does not follow, however, that emerging economies are ready to do nothing. On the contrary, China, for instance, is already taking serious steps and will likely do more. The question for policymakers around the world is how, in the face of an eclectic mix of policies and commitments from a range of countries, to evaluate each other's efforts, to prevent carbon emissions leakage, and to deal with political concerns about affected industry sectors.

The trade measures discussed in the previous chapter are intended to level the carbon playing field by indirectly imposing a cost on foreign producers, by way of an emissions allowance requirement or other costs imposed at the border, equal to that domestic producers face as a result of US federal climate policy. Including such provisions in climate legislation (1) could prevent the displacement of energy-intensive production to uncapped countries; (2) incentivize other countries to adopt emissions reduction standards comparable to the United States; and (3) provide enough assurance to US carbon-intensive industries to win passage of domestic legislation. While the logistics of implementing these provisions are challenging, and their effectiveness in delivering these benefits mixed, they at least offer concrete tools to address competitiveness concerns. Proponents of trade measures themselves argue such measures are second-best approaches. The ideal outcome (from both climate and competitiveness standpoints) is to have major trading partners impose similar costs on their industry directly, rather than having US Customs do so at the border.

First, US trade measures alone would cover only a fraction of global trade in carbon-intensive goods (table 4.1). Of the 1,113 million tons of steel produced in 2005, less than 9 percent involved the United States. While the American market is slightly more important for aluminum, paper, and cement, US imports still account for less than one-fifth of global trade. Acting alone, the United States could see trade measures undercut, as dirtier producers would simply redirect their exports from the United States to countries without carbon tariffs, allowing those countries to export more low-carbon products to the United States (box 3.3).

Second, even if all developed countries adopted trade measures for carbon-intensive goods, the overall impact on industrial CO_2 emissions would be limited. Only one-third of the steel produced worldwide is traded, less than China's consumption of domestically produced steel alone. For cement, only 7 percent of global production crosses international borders. A regime that covered all internationally traded carbon-intensive goods would address only 29 percent of global emissions from those industries.

Finally, as discussed in the previous chapter, imposing carbon costs at the border would have mixed results for the competitiveness of US firms:

- Major trading partners could take action that would be "comparable" from a climate standpoint but impose no additional costs on industry.
- Most imports of goods covered by trade measures come from countries that are less carbon-intensive than goods produced in the United States.
- Trade measures covering just carbon-intensive intermediate goods could harm the competitiveness of downstream consuming industries.
- While most proposed measures would defend the domestic market from lower-cost imports, foreign markets will see the most growth in demand in the years ahead.

Persuading major trading partners to impose similar costs on their carbon-intensive industry as those imposed in the United States would address these concerns. Ideally, various national programs would trend

Table 4.1 US role in global production, trade, and carbon emissions, 2005 (millions of metric tons)

	Global production		Global trade		US production		US imports		US share of global CO_2 (percent)	
Industry	**Volume**	**CO_2**	**Volume**	**CO_2**	**Volume**	**CO_2**	**Volume**	**CO_2**	**Production**	**Imports**
Steel	1,113.45	1,971.65	360.93	639.12	93.22	96.21	29.88	52.91	4.88	2.68
Aluminum	31.90	543.48	32.79	558.65	2.48	74.78	5.23	89.09	13.76	16.39
Chemicals	553.80	1,529.97	72.16	148.78	105.90	376.73	15.95	32.88	24.62	2.15
Paper	354.09	485.14	144.94	198.58	81.44	159.38	21.54	29.51	32.85	6.08
Cement	2,130.00	1,063.72	150.74	75.28	100.90	96.65	33.65	16.80	9.09	1.58
Total	4,183.24	5,593.96	761.56	1,620.40	383.93	803.76	106.25	221.19	14.37	3.95

Note: CO_2 includes both direct and indirect emissions.

Sources: IEA (2007c); United Nations Comtrade database, 2007; International Iron and Steel Institute, *Steel Statistical Yearbook,* 2006; US Department of the Interior/US Geological Survey, *2005 Minerals Yearbook;* UN Food and Agriculture Organization, FAOSTAT database, 2007; and authors' estimates.

toward harmonization, allowing efficiencies to be realized and guaranteeing greater environmental integrity. While many assume that convincing developing countries, China in particular, to agree to voluntarily impose costs on its carbon-intensive industry would be impossible, there may be more scope for such collaboration than first meets the eye. And even in the face of developing-nation hesitation to impose such costs, the United States can play a pivotal role in developing a harmonized carbon market by helping these nations transition to new technologies and increase their administrative and regulatory capacity.

Prospects for International Engagement: The Case of China

There is an increasing understanding in China of the grave risks from climate change. As a country with large vulnerable coastal populations and often-stretched water resources, these risks are very real. Furthermore, there is perhaps a fuller understanding of the science at the highest political levels in China than is the case in the United States. The recent National Climate Change Programme laid considerable emphasis on the seriousness of the climate challenge for China.[1]

While Beijing has, to date, resisted binding emissions reduction commitments in the international arena, it has begun implementing measures at home that reduce the competitiveness of carbon-intensive Chinese industry. The prevailing wisdom a decade ago among government officials was that any economic activity that could be done in China should be done in China. In order to boost local economic growth, provincial officials sought to attract big-ticket investments like steel mills, aluminum smelters, and chemical industry parks by offering free land, low taxes, and cheap energy (Rosen and Houser 2007). These local incentives, aided by a financial system biased toward lending to heavy industrial state-owned enterprises, dramatically expanded energy-intensive industry starting in 2002, as Chinese producers sought to meet surging Chinese demand for goods like steel, aluminum, chemicals, and cement.

By 2006, energy demand had grown more in just four years than it had during the previous 25 years, with heavy industry largely to blame. Manufacturing accounts for 60 percent of all energy consumed in China, two-thirds of which is attributable to the five carbon-intensive industries included in this study. The steel sector alone consumes more energy and emits more CO_2 than all Chinese households; chemical production uses more energy than all the personal cars clogging the country's new roads;

1. China's National Climate Change Programme, prepared under the auspices of the National Development and Reform Commission, People's Republic of China, June 2007, available at http://en.ndrc.gov.cn (accessed February 15, 2008).

and aluminum smelters surpass the entire commercial sector in terms of electricity consumed. So while the United States' climate problem comes from its consumers (75 percent of all US emissions are from transport, commercial and residential), China's comes from its producers.

In addition to creating energy security and environmental challenges at home, this surge in heavy industry has created tensions in China's economic relationship with its major trading partners. In 2002 China was the world's largest steel importer, with a $10 billion steel trade deficit. By the end of 2006, China had become the world's largest steel exporter and was running a $10 billion trade surplus. The change in the trade balance of steel and other energy-intensive goods was responsible for 30 percent of the growth in China's global trade surplus during that period.[2]

Policymakers at the national level have begun taking steps to curb the growth in energy-intensive industry. As China needs to create tens of millions of new jobs each year to absorb migrant workers from rural areas, as well as those laid off from mothballed state-owned enterprises, diverting the country's economic resources into heavy industry makes little macroeconomic sense.[3] Total employment in China in the five carbon-intensive industries included in this study is less than 14 million people and has remained roughly unchanged since 2000 despite the sharp growth in industrial output.[4] This number is less than that for service-sector employment in Guangdong province alone. In addition, with dense population and overwhelming reliance on coal, heavy industry takes a significant toll on public health. China's State Environmental Protection Agency estimates that sulfur pollution alone costs the country $60 billion per year in economic losses, nearly equal to the economic value created by the entire steel industry.[5] Officials in Beijing have attempted to curb the growth in carbon-intensive sectors by raising the price of energy, limiting the availability of bank lending, and withholding project approval.[6] They have also repealed tax rebates exporters of energy-intensive goods used to receive for goods sold abroad and in doing so have voluntarily imposed an additional cost on domestic steel, aluminum, chemical, and cement pro-

2. Data obtained from the China General Customs Administration via the CEIC China premium database, ISI Emerging Markets.

3. Tom Miller, "Booming Economy Creates 12m Urban Jobs," *South China Morning Post*, March 13, 2007.

4. Data obtained from the National Bureau of Statistics via the CEIC China premium database, ISI Emerging Markets.

5. "500b-Yuan Loss from Sulfur Cloud," *South China Morning Post*, August 4, 2006; National Bureau of Statistics via the CEIC China premium database, ISI Emerging Markets.

6. Juan Chen, "China Regulators to Share Data to Curb Loans to Polluters," Dow Jones International News, July 19, 2007; Howard W. French and Li Zhen, "Beijing Seeks Energy Cuts; Localities Find Loopholes," *New York Times,* November 24, 2007.

ducers equal in price to a $50 per ton carbon tax for certain products (Eichelberger, Kelly, and Lim 2007).

It is still too early to see just how much impact these measures will have in helping China curtail its growing energy demand and CO_2 emissions. But these measures demonstrate that the often-discussed trade-off between environmental protection and economic growth for China is largely a false choice. While Beijing may bristle at the prospect of economywide emissions caps, the leadership could be engaged in ways complementary to its existing economic objectives but that also mitigate some of the competitiveness concerns held by US industry.

Models for Cooperation on Industrial Emissions

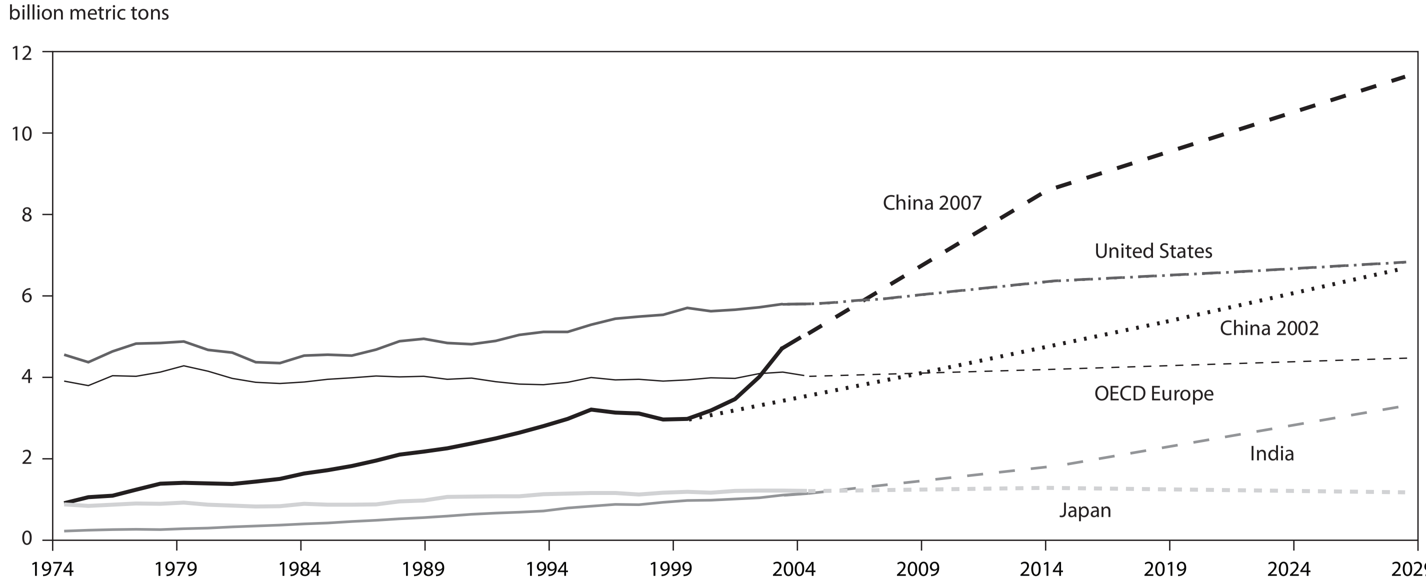
The defined economywide limits on greenhouse gas emissions that the industrialized world agreed to under the Kyoto Protocol, while providing the most environmental certainty, are not the only available strategies for emissions abatement. In fact, for developing countries, whose economic structure and growth are still very much in flux, absolute limits may not be appropriate, as they require establishing a credible baseline for future emissions.

In China, for example, the rapidly changing structure of the economy has made establishing such a baseline quite difficult. The International Energy Agency (IEA), in its *2002 World Energy Outlook*, predicted annual Chinese CO_2 emissions would reach 6.7 billion metric tons in 2030. Only five years later, the IEA revised that figure upwards by 70 percent, a margin of error greater than total European emissions today (figure 4.1). During the intervening period, China had not changed the types of energy on which it relied nor the efficiency with which it was consumed. Rather, the structure of the Chinese economy had changed dramatically as heavy industry outpaced light industry and services. Similarly, if a baseline for future Chinese emissions was established based on today's projections, it could end up being 70 percent higher than reality if a structural adjustment of the same order of magnitude took place in the other direction and China's heavy industry migrated to other parts of the world.

In addition, Beijing correctly points out that per capita emissions in China are one-fifth the level in the United States (figure 4.2) and that holding the United States and China to the same economywide caps would be inequitable for Chinese citizens. The leadership may, however, be more receptive to proposals that would specifically target carbon-intensive Chinese industry rather than relatively low-carbon Chinese consumers (Lewis 2007).

The notion of international agreements covering emissions from certain key industrial sectors has gained traction in recent years for one reason: They address industrial competitiveness concerns in the developed coun-

Figure 4.1 Annual CO_2 emissions, historic and projected, 1974–2029

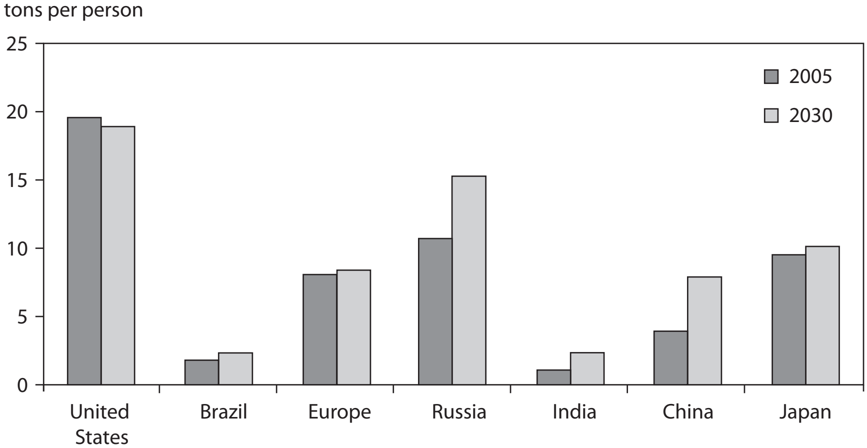


OECD = Organization for Economic Cooperation and Development.

Notes: The International Energy Agency (IEA), in its 2002 *World Energy Outlook*, predicted annual Chinese CO_2 emissions would reach 6.7 billion metric tons in 2030. Just five years later, the IEA (2007b) revised that figure upwards by 70 percent.

Sources: Historic data (before 2007) are from IEA (2007c); projections (after 2007) are from IEA (2007b).

Figure 4.2 Per capita CO_2 emissions, current and projected



Sources: Economist Intelligence Unit Country Data, Bureau Van Dijk Electronic Publishing, 2007; IEA (2007b). Brazil 2030 forecast is from International Energy Agency, *World Energy Outlook 2006*.

tries while being more palatable for developing countries (Bodansky 2007). Sectoral agreements are less economically efficient than economy-wide programs in achieving emissions reductions (Bradley et al. 2007), but if economywide commitments are a nonstarter for developing countries, then sectoral agreements can serve as useful alternatives. And given the outsized role of industry in the carbon footprint of China and other large emerging economies, sectoral agreements could be structured to cover the majority of both current and projected emissions from the developing world through 2030 (IEA 2007b). This is not to say that other sectors would be wholly neglected—after all, new energy technologies, efficient appliances, and vehicle innovations will all emerge from global markets, in which the developing world will surely be a major player. But by focusing developing-country commitments on producers rather than consumers, an agreement may generate real support, as well as help China in particular meet other domestic policy goals (box 4.1).

Sectoral agreements could involve different forms of substantive commitments, could be legally binding or nonbinding, and have varying degrees of environmental stringency. In particular, sectoral agreements can take three forms: emissions targets, technology standards, and policy harmonization.

Emissions Targets and Trading

Emissions targets could set explicit limits on the amount of emissions from particular sectors. Such targets are usually proposed in connection

Box 4.1 Lessons from WTO accession

As negotiations kick off for a successor agreement to the Kyoto Protocol, a key question is the type of commitment that can be expected from China under a post-Kyoto international climate framework. Given the well-publicized challenges in reconciling the national leadership's policy with the disparate incentives facing local officials, the question has centered as much around what type of policies Beijing will be *able to enforce* as around the type of commitments they will be willing to make. While it is true that enforcement at a local level continues to be difficult on many issues, it is wrong to assume that Beijing has lost its ability to make the provinces listen. The careers of local officials are in the hands of national policymakers, who rank performance using metrics set in Beijing. While investment-led economic growth has been the principal criterion for promotion in recent years, the energy and environmental consequences of this development model has prompted the leadership to start changing the formula. Policies aimed at "rebalancing growth" in a more sustainable direction are rising in importance and gaining teeth.

In years past, Beijing has looked to international agreements as useful tools in aiding economic reform at home, particularly when such reforms were resisted at a local level. China's accession to the World Trade Organization (WTO) is a perfect example. In the 1990s, progressive policymakers saw the carrot of WTO membership as a way to help incentivize and win support for economic reforms they had already been pushing. Under the leadership of Premier Zhu Rongji, the national government forced fairly painful economic adjustment on the provinces, in part to ensure that China met the requirements for WTO accession.

The contrast in the success of WTO accession in changing policy in China and the failure of trade sanctions, or the threat thereof, to do the same is the difference between inducement and coercion. Membership in a multilateral organization like the WTO, in addition to serving the country's long-term economic interests, was a point of national pride for Chinese leadership. The international prestige it offered helped reformers build consensus for the difficult structural adjustments required for accession. Similarly, eliciting Beijing's involvement in an international climate framework that helps progressive policymakers meet economic objectives at home (like disciplining heavy industry) will be most successful if presented as an opportunity for China to demonstrate leadership on a key global issue. Threatening the use of sanctions in order to coerce China's involvement may well make it harder for those in Beijing already inclined to take a more active role in an international climate agreement to build support for such action at home.

with emissions trading, which has the potential to promote greenhouse gas emissions abatement where it is least costly. At least three forms of emissions targets would be attractive for sectoral action.

A fixed limit on emissions within a particular sector—i.e., a sectorwide emissions cap—would be similar in form to targets adopted in the Kyoto

Protocol, although the scope of the target would be confined here to one or more individual sectors. An agreement might involve absolute reductions or limitations on future growth in a particular sector, perhaps with targets differentiated by country. The challenge with such an approach is that it does not fully account for the volatile nature of industrial production. As stated earlier, an investment-led surge of heavy industry in China was responsible for the upside surprise in CO_2 emissions between 2002 and 2007. The end of the current investment wave could lead to a contraction in industrial CO_2 emissions, without any improvement in efficiency, but those emissions would only pop up in other parts of the world as urbanization takes off there. For internationally traded sectors, defined limits would create a quota system similar to the Multi-Fiber Arrangement, which would reduce the economic efficiency of industrial production.

The second approach to sectoral targets involves capping the quantity of emissions per unit of economic output. These intensity targets, particularly at the sectoral level, can avoid some of the economic uncertainty associated with fixed targets yet do so at the cost of certainty regarding environmental outcomes; emissions reductions are ultimately determined by the actual output of a sector rather than by setting a specific level of allowed emissions (Herzog, Baumert, and Pershing 2006). Exchange rate effects and differences in product type can make intensity targets measured in terms of emissions per unit of economic value difficult to define.

The third type of target uses the physical unit of production, rather than the economic value, as the denominator in calculating carbon intensity. For example, the carbon intensity of a ton of steel would be measured as embedded emissions divided by weight. Most trade measures would use this approach in assessing embedded carbon at the border. While there is still uncertainty in terms of environmental outcomes, harmonization across countries with such a target is easier than with an economic value intensity target. The International Iron and Steel Institute (IISI 2007) issued a policy paper in support of such treatment for the steel industry at the climate negotiations in Bali, Indonesia. Both the American Iron and Steel Institute and the China Iron and Steel Association have expressed support for such an approach.[7]

Under all three types of targets, emissions credits could be traded across borders to improve the economic efficiency of the system as a whole. From a competitiveness standpoint, however, the key would be to ensure that the targets were binding. "No-lose" targets with emissions trading, where developing countries are not bound to meet a target but allowed to sell credits if it is exceeded, would be less successful in preventing emissions leakage. If possible, the targets should also cover the sector's indirect emis-

7. AISI (2007); Peter Marsh, "China Trade Body Backs Check on Steel Emissions," *Financial Times*, October 10, 2007.

sions, such as electricity generation or coke manufacturing, to as great an extent as possible.

Standards

Standards are a second kind of substantive commitment that could characterize a sectoral agreement. Standards tend to focus on technologies, processes, or products, rather than the resulting emissions. *Technology standards* might mandate the use of a specific technology or process. With many technology-specific policy options, technology lock-in is a risk, and agreements must be carefully designed to avoid such outcomes. Of added concern is the relatively poor track record of government policies in picking optimal technologies.

Alternatively, *performance standards* can be technology neutral. Such a standard might require a certain level of energy efficiency in appliances or motor vehicles. A performance standard could be applied at the level of a technology (e.g., refrigerators) or in some cases at the broader sectoral level (e.g., all electric power production). Performance standards can also overlap conceptually with harmonized emissions rates—or benchmarks—discussed earlier, which can be viewed as an *emissions performance* standard.

Some critics of the Kyoto Protocol maintain that a standard-setting approach, unlike the protocol, has a self-enforcing quality that would promote compliance and global participation (Barrett 2001, 2002; Benedick 2001). This dynamic is achieved through "network externalities." For instance, if the United States and the European Union enacted automobile performance standards (for domestic production and sale), other countries would find it in their economic interests to also adopt those standards. Otherwise, cross-border trade and investment would be impeded. The catalytic converter is one example of a common technology standard that has achieved widespread global adoption, even though its purpose is to address a local environment problem (Barrett 2001).

For carbon-intensive products like steel and cement, the application of product standards is slightly different. Unlike automobiles or refrigerators, emissions from steel occur during the *production* of the good, rather than its *operation*. As such, incentives are only created for foreign producers to reduce process emissions if those emissions are somehow measured and charged at the border. Agreements on standards are easier in industries with more homogeneous production processes.

Policy Harmonization/Coordination

Substantive commitments within sectoral agreements could also take other forms, such as agreements pertaining to taxation, subsidies, or treatment of waste. While such unilateral reforms might be justified, it is also the case that "[i]nternationally coordinated action can facilitate the process of removing environmentally damaging subsidies" (Pershing and MacKenzie 2004). For instance, common subsidy reforms could help level the playing field to promote renewable energy technologies (Pershing and MacKenzie 2004). Other kinds of policy harmonization and coordination might include product recycling requirements (e.g., for aluminum) or government procurements requirements (e.g., for low-emission vehicles). Cooperative efforts on research and development of specific technologies—such as carbon capture and storage or nuclear power—might also be considered "sectoral."

For carbon-intensive industries, policy coordination could come in the form of an agreed carbon tax for internationally traded goods, similar to agreements on border tariff levels as part of the World Trade Organization. But in the case of carbon, it would be a negotiated minimum price rather than a maximum tariff. While an economywide carbon tax might be a nonstarter for developing countries, there is more potential for agreement on taxes for specific internationally traded industries. As mentioned earlier, China recently imposed the equivalent of a $50 per ton carbon tax on steel exports to achieve energy and environmental outcomes and did so voluntarily and unilaterally.

In many sectors, the groundwork has already been laid for constructive international engagement. Efforts to benchmark energy use and share technological best practices exist in the steel, aluminum, and cement industries (Bradley et al. 2007). The Asia-Pacific Partnership on Clean Development and Climate aims to do the same by bringing together the United States, China, India, Australia, South Korea, Canada, and Japan in a public-private partnership.[8] And even within China, the government has launched a "Top 1000" program, which issues energy-efficiency targets to the 1,008 most energy-intensive companies in the country and benchmarks their performance (Price and Xuejun 2007). These programs could serve as the basis for developing-world commitments, provided that the United States first demonstrates a commitment to addressing its consumer-led emissions as well.

Sectoral agreements can, and should, complement rather than replace other types of climate commitments. Global sectoral agreements for key traded industries should not be seen as an alternative to economywide targets for developed countries, as has often been the case in the United States. Likewise, taking part in a sectoral agreement does not mean developing countries cannot adopt other climate policies, from vehicle efficiency standards to renewable energy targets.

8. For more information on this partnership, see www.asiapacificpartnership.org.

Need for US Leadership

It is difficult to ignore the fact that the United States has remained distant from international climate policy negotiations in recent years. And since an inclusive international agreement is the best-case scenario for ensuring that climate policy does not adversely affect US competitiveness, this abstinence has not served US interests well. To have any chance of influencing China on climate change and prevent a significant loss of the "consumer surplus" that results from free trade the United States must first demonstrate a much stronger commitment to addressing its own emissions, both historic and projected. Developing countries argue that until the United States leads, they can hardly be expected to follow and that ultimately, the developed world will need to help them bear the costs of adjustment. Population, average wealth, and historical emissions buttress this argument. This is compounded by the raft of policies and measures that China is already undertaking, which, as noted earlier, arguably leave the United States with some catching up to do.

Many current bills in the US Congress note the absence of the United States from negotiations of late and the desirability of reengagement internationally. However, in a number of bills, international negotiation is explicitly linked to a review process to assess the *adequacy* of other countries' commitments. This review in turn can trigger a reduction in US action or the enactment of other trade measures discussed previously. While this trigger mechanism is intended to placate enough of the competitiveness concerns of carbon-intensive industry to win support for US federal climate policy overall, in terms of a negotiating strategy, it could risk poisoning the well for more constructive engagement with major trading partners. This is particularly troubling if the trade measures, once invoked, would not provide the desired protection for US industry.

Scope for International Agreement

The good news is that the scope for positive engagement is large and growing. To relatively little fanfare, the UN process transformed itself profoundly at the end of 2007, with a new agreement in Bali on a two-year negotiating agenda. Under the Kyoto Protocol's first commitment period, there was an iron-clad divide between developed and developing countries: The former took on emissions caps at a national level; the latter only a generalized commitment to integrate climate into their development plans. The Bali Action Plan, agreed to in December 2007 at the Thirteenth Conference of the Parties to the United Nations Framework Convention on Climate Change (UNFCCC), dramatically reduces that gap. The plan calls for enhanced action on climate change, including space for developing countries to articulate specific commitments under the post-2012 agreement. Both developed and developing countries would commit to undertaking "nationally appropriate mitigation actions . . . in a measurable, reportable and verifiable manner" (UNFCCC 2007b). This language is clearly a key step toward a global regime in which all countries participate. The most important remaining distinction is that developing countries can expect "technology transfer and financial support" to help them implement their commitments. Exactly what this means in practice will need to be defined during the coming two-year negotiations.

A second important innovation in the Bali Action Plan is that "cooperative sectoral approaches and sector-specific actions" are also part of the negotiating agenda. In addition, technology provisions are littered throughout the text, as well as framed as an explicit commitment to "enhanced action on technology development and transfer" (UNFCCC 2007b). These sectoral and technology measures will need to be defined in the coming two years, but in principle there is a lot of scope here for real engagement to both bring about genuine emissions reductions and create a level playing field for carbon-intensive industries.

The price for this greater diversity of commitment types will be eternal, or at least enhanced, vigilance. US policymakers or their agencies will find themselves having to judge whether the measures of other countries are appropriate relative to those of the United States; whether they are likely to be implemented; and whether, assuming they are implemented, additional protection is needed to prevent carbon leakage.

The international trading system will likely play a key role in addressing these issues on a multilateral basis going forward. The importance of global trade in delivering low-carbon technology at affordable prices was highlighted at Bali by a joint US-EU proposal to eliminate tariff and nontariff barriers to environmental goods and services. The World Bank (2008) estimates that global trade in climate-friendly technology, currently about $70 billion per year, will need to expand substantially for the world to achieve cost-effective reduction in emissions.

5

Conclusion

The adoption of federal climate legislation in the United States would be one of the most significant economic and environmental policy developments on record. While considerable work remains to be done to quantify the impact of climate policy on various sectors of the economy, carbon-intensive manufacturing would face meaningful increases in production costs under most proposals being discussed. The effect of such a cost increase on the international competitiveness of these industries has become a key concern for policymakers, not just in the United States but also in most countries. While these concerns are best addressed through a harmonized international climate policy, the differences between countries in the level of economic development, political conditions, obligations stemming from historic emissions, and responsibilities arising from future emissions mean harmonization is still a long way off. The question then, in the design of domestic US climate policy today, is how to level the playing field for carbon-intensive industries during a period of uncertainty about policy movement internationally.

Broadly defined, options for addressing competitiveness and emissions leakage in US climate policy fall into three categories: (1) reducing the cost of compliance for domestic producers, (2) imposing similar costs on foreign producers indirectly through an adjustment at the border, and (3) encouraging other countries to impose similar costs on their industries directly. Each of these approaches can be found in the leading legislative proposals being considered in the US Congress at present. Based on analysis of energy requirements, the international trade flows, and trends in supply and demand of key carbon-intensive industries, we arrive at the following conclusions for each approach.

Cost Containment Mechanisms

Reducing emissions at the lowest possible cost to the economy as a whole is an overarching priority in climate policy design. As such, a market-based regulatory system like a carbon tax or a cap-and-trade system will likely be at the core of any US climate policy. The most economically efficient system from a *nationwide* standpoint, however, could reduce the international competitiveness of key carbon-intensive industries, and thus output and employment, if major trading partners do not follow suit. Several options are available to lower the compliance costs for these industries, though doing so may weaken the policy's environmental effectiveness. In considering the use of cost containment mechanisms to level the playing field for US industry, policymakers should consider a number of factors.

Effectiveness Varies Greatly Across Industries and Firms. The ability of cost containment mechanisms to reduce compliance costs for carbon-intensive manufacturing depends on the type of energy consumed and whether associated CO_2 is emitted directly by the manufacturing facility or indirectly in the generation of electricity. Significant differences in both exist across industries and firms.

Measures that Increase Flexibility Are Broadly Helpful. Granting firms the option to "bank and borrow" emissions allowances and use offsets reduces compliance costs for all carbon-intensive industries, though to varying degrees. If properly enforced, such measures help level the playing field without compromising the environmental integrity of the system as a whole.

Allocation of Allowances May Do Little to Guard Against Declines in Output and Employment Levels in Vulnerable Industries. Providing emissions allowances free to carbon-intensive industries under a cap-and-trade system has been discussed as a way to prevent firms from closing shop in the face of international competition that does not face similar carbon costs. While such measures would help compensate investors, they may not protect output or employment levels if firms opt for profit over market share by pricing products based on the cost of purchased allowances rather than those received for free. Allocating free allowances to nontraded sectors, like electric power, does little to help the competitiveness of carbon-intensive US manufacturing.

Price Caps Are a Blunt Tool for Dealing with Industry Competitiveness. The uncertainty in the price of carbon under a cap-and-trade system has led some policymakers to support the inclusion of a defined limit on the cost of emissions allowances. While price caps would limit costs for carbon-intensive industries, they would weaken incentives to reduce emissions for other sectors of the economy as well and thus undermine the policy's environmental objectives.

A Carbon Tax Offers a More Targeted Approach, but with Environmental Costs. If price certainty is a priority, policymakers should consider making a carbon tax part of the domestic regime. As opposed to a cap-and-trade system with a price cap, a carbon tax offers greater flexibility in targeting relief specifically to industries competing internationally. Such relief comes at an environmental cost, however, as carbon tax credits remove incentives to reduce emissions.

Reducing Noncarbon Costs Guards Against Job Loss while Meeting Environmental Goals. As opposed to free allocation of emissions, which may protect profits more than employment levels, and carbon tax credits, which increase emissions, using allowance auction or carbon tax revenue to reduce labor-related costs for carbon-intensive manufacturing creates incentives for firms to both maintain employment levels and reduce emissions. The cost of such relief is a fraction of the amount of forgone revenue that would result from the free allocation of emissions allowances considered under most proposals. And while free allocation is often justified on competitiveness grounds, reducing noncarbon costs for affected industries may be more effective in maintaining output levels.

Trade Measures

After the United States withdrew from the Kyoto Protocol, some in Europe considered addressing what they considered to be an unfair trade advantage for American industry exempt from carbon costs by imposing tariffs on US goods at the border. Now that the United States is returning to the fold, policymakers in Washington are considering similar steps aimed primarily at developing-world producers. Trade measures, whether under a cap-and-trade or a carbon tax system, seek to impose indirectly at the border the same costs borne by domestic firms on foreign producers. The mechanics of implementing such measures, the range of products that would be covered, and their impact on US industry and the international trading system are a key focus of this report.

Assessing Carbon at the Border Is Complicated. To subject foreign producers to the same costs faced by US firms under a cap-and-trade or carbon tax regime through trade measures requires an accurate assessment of the amount of CO_2 emitted during the production of a specific good.

For most carbon-intensive intermediate products like steel, aluminum, chemicals, and cement, this is a daunting task, given the enormous variety of production processes employed and fuels used. The amount of carbon "embedded" in a ton of steel varies greatly both by country and by individual firm. For final goods like electronics, appliances, and vehicles, accurately assessing embedded carbon at the border is next to impossible.

A Level Playing Field Does Not Benefit All US Industry. In an effort to treat domestic and imported goods equitably in terms of embedded carbon (required to withstand a WTO challenge), trade measures would provide protection for some US producers but not for others. In terms of average carbon intensity, the US steel, paper, and chemical industries score better than cement and aluminum, though important differences exist between individual firms in all industries. And while US policymakers may have more carbon-intensive China and India in mind when considering the use of trade measures, most imports of the goods in question come from countries with less carbon-intensive production than the United States. In addition, if the United States imposes trade measures alone, China (for instance) could redirect its products to Japan, freeing up carbon-light Japanese production for export to the United States.

Focusing on Carbon-Intensive Imports Misses Important Industries Downstream. Given the challenges in assessing embedded carbon in fairly standardized intermediate products like steel, aluminum, and basic chemicals, it would be nearly impossible to do the same for the millions of downstream products that rely on these goods for final assembly. Yet using trade measures for imported steel but not for imported automobiles, for example, would increase the steel acquisition costs for the US auto industry vis-à-vis foreign competition, putting it at a competitive disadvantage.

Trade Measures Provide Little Leverage Internationally. Many policymakers see the threat of trade measures as a way both to win domestic support for US climate legislation and to encourage other countries to take similar steps to reduce emissions. Yet the risk of losing access to the US market for carbon-intensive goods alone provides little leverage in inducing a change in policy in most countries. While China accounts for 32 percent of global steel production (figure 3.9), only 8 percent of the 353 million tons produced in 2005 was exported (figure 3.10). Less than 1 percent was sold to the United States (figure 3.10). The US market accounts for 3 percent of Chinese aluminum production, 2 percent of paper production, and less than 1 percent of both basic chemicals and cement. Most of the demand for carbon-intensive products comes from developing countries, China in particular. The United States accounts for only 10 percent of global demand in the five carbon-intensive industries, the imported share of which accounts for less than 3 percent.

Border Calculations May Fail to Create Firm-Level Incentives. Under most proposals, the carbon embedded in imported goods would be assessed using a national average for the country of origin. As exporting firms from countries such as China are often the best in class, such calculations create little incentive for exporters to get cleaner. That said, trade measures could, if assessed at the firm level, create positive incentives for foreign companies to reduce carbon emissions individually even if they do not provide enough leverage to convince their governments to do so through policy. This would, however, require the voluntary participation of the exporting company or its home government in tracking and monitoring emissions. Fortunately, the prospects for eliciting such international participation are more promising than many believe.

Coordinated International Action

Given the challenges in using unilateral trade measures to address competitiveness concerns, working with major trading partners to impose costs directly on their industries at home, rather than indirectly at the border, is a more promising way to level the playing field both for producers of carbon-intensive goods and the industries that consume them. In addition, a trade approach alone would fail to address the majority of industrial emissions. US imports of carbon-intensive goods account for less than 4 percent of emissions from those industries worldwide (table 4.1). Even if other countries acted alongside the United States, only 18 percent of the steel, aluminum, cement, paper, and basic chemicals produced worldwide is internationally traded. While developing countries produce a growing majority of carbon-intensive goods, the vast bulk is consumed domestically, feeding the rapid urbanization taking place. Getting at that production requires international engagement.

International Engagement Offers More Than One Way to Address Competitiveness Concerns. The need to raise living standards through economic growth likely means that absolute caps on emissions during the next round of climate negotiations will be unacceptable to most in the developing world, including India and China. Indeed, many policymakers are attracted to trade measures partly because they provide a concrete alternative should international climate negotiations fail to alleviate competitiveness concerns. Many commitments short of absolute caps, however, could be even more effective in leveling the carbon playing field for US industry. An agreement to discipline industrial emissions from key sectors, whether through emissions-intensity targets, product standards, or a direct tax, would do far more than would trade measures alone, both for the competitiveness of US industry and overall reduction of emissions.

Engagement with the Developing World Has More Potential than Most Observers Think. The reluctance of developing countries to adopt absolute caps on emissions does not signal unwillingness to discipline industrial emissions. China, the source of much of the concern in the US climate policy debate, is working aggressively to curb the growth and improve the efficiency of its carbon-intensive industries out of local environmental and energy security concerns. Actions taken already include changes in tax policy equal to the imposition of a $50 per ton carbon tariff applied to exports of Chinese steel. During the last round of climate negotiations in Bali, industry-level agreements garnered support from developed and developing countries alike. There is considerable room to work together with large emerging economies like China and India to level the carbon playing field.

Looking Forward

The rules and institutions of the international trading system may well have a role to play in leveling the carbon playing field in the years ahead. If approached multilaterally and in conjunction with a broader international climate framework, trade policy could create additional incentives to reduce greenhouse gas emissions. To be successful, a trade regime that included climate considerations would require the willing participation of both developed and developing countries. Such multilateral involvement would promote an accurate assessment of embedded carbon both by product and by producer, so that low-carbon goods and production processes were adequately rewarded. Absent broad multilateral action, the use of trade measures to address competitiveness concerns and emissions leakage will have only limited success and could put considerable strain on the international trading system we rely on to boost economic growth in developing countries and deliver the technology required to make that growth green.

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Glossary

Annex I countries. The industrialized and transition countries listed in Annex I to the United Nations Framework Convention on Climate Change. These countries include Australia, Austria, Belarus, Belgium, Bulgaria, Canada, Croatia, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Latvia, Lithuania, Luxembourg, Netherlands, New Zealand, Norway, Poland, Portugal, Romania, Russia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey, Ukraine, United Kingdom, and the United States.

banking and borrowing of allowances. The ability of regulated entities to either save allowances for future compliance periods (banking) or reduce compliance obligations in the current period in return for more stringent caps in future periods (borrowing). Banking and borrowing are typically seen as effective tools to minimize allowance price volatility between multiple compliance periods.

cap-and-trade system. A regulatory mechanism used to limit the emissions of a specific pollutant. In the case of climate change, a regulating entity sets a target level for greenhouse gas emissions (cap) and allows firms to buy and sell (trade) permits under this cap. Compared with traditional command-and-control methods of regulating pollutants, a cap-and-trade system uses market forces to achieve the most economically efficient emissions mitigation.

carbon intensity. The ratio of CO_2 emissions to activity or output. At the national level, this indicator is shown as CO_2 emissions per unit GDP.

carbon tax. A tax on the carbon content of the fossil fuels—coal, petroleum products, and natural gas—used for electricity generation, transportation, residential and commercial space heating, industrial processes, and other activities. Carbon taxes attempt to reduce greenhouse gas emissions by internalizing the negative externality associated with such emissions.

cost containment. A term used to express a desire to minimize and level the costs of greenhouse gas emissions mitigation policies. Common policy design elements that typically fall into this category include banking and borrowing of allowances, price caps on allowances, and alternative compliance mechanisms such as the use of offsets.

direct emissions. Greenhouse gas emissions from sources directly owned or controlled by an entity. They mainly arise from production of energy; manufacturing processes themselves; transportation of materials, products, waste, and employees; use of mobile combustion sources, such as trucks and cars but not those owned and operated by another entity; and fugitive emissions, which are intentional or unintentional greenhouse gas releases (such as methane emissions from coal mines).

embedded carbon. Carbon emissions associated with the production of a product through the entirety of its supply chain. Such calculations typically include both the direct and indirect emissions associated with manufacture in order to know the full emissions impact of the product.

emissions abatement. A reduction in the amount or intensity of emissions.

emissions allowance. A permit to emit a specific quantity of a specified pollutant. In the context of climate change policy, each allowance is typically a permit to emit one ton of CO_2 equivalent.

emissions leakage. Any emissions abatement that occurs in one location but is offset by associated emissions growth in another.

emissions trajectory. The path of emissions levels over time. Plotted on a graph, the increase or decrease of emissions over time is generally referred to as the emissions trajectory, and different trajectories are often used to assess the impact of different scientific, policy, economic, or technology scenarios.

energy intensity. The ratio of energy consumption (use) to activity or output. At the national level, this indicator is shown as primary energy consumption per unit GDP.

European Union Emissions Trading Scheme (EU ETS). The European Union launched a cap-and-trade system known as the EU Greenhouse Gas Emissions Trading Scheme (EU ETS) in 2005. It is aimed at reducing CO_2 emissions by capping the level of emissions allowed and distributing tradable allowances to industrial emitters. It is the first of its kind and is the world's largest multicountry, multisector greenhouse gas emissions trading scheme. ETS covers over 11,500 energy-intensive installations across the European Union, which represent close to half of Europe's emissions of CO_2. These installations include combustion plants, oil refineries, coke ovens, iron and steel plants, and factories making cement, glass, lime, brick, ceramics, pulp, and paper. For more information, see http://ec.europa.eu/environment/climat/emission.htm (accessed March 5, 2008).

fuel switching. The substitution of one kind of fuel for another. In this context, generally switching from coal, a high-carbon fuel, to natural gas or another lower-carbon fuel for power generation.

greenhouse gas. Any gas that absorbs and re-emits infrared radiation into the atmosphere. The main greenhouse gases include water vapor, carbon dioxide, methane, and nitrous oxide.

historic emissions. Cumulative sum of an entity's (e.g., a country's) emissions over time, beginning with oldest available data.

indirect emissions. Greenhouse gas emissions from the activities of an entity that occur at sources owned or controlled by another entity. These emissions are mainly associated with waste disposed off-site, as well as the generation of imported/purchased electricity (not generated on site), heat, steam, and gas, and the production and distribution of petroleum products.

Kyoto Protocol. An international agreement adopted by Parties to the United Nations Framework Convention on Climate Change in Kyoto, Japan, in December 1997. The protocol entered into force in 2005. See http://unfccc.int.

non-Annex I countries. The countries that are not listed in Annex I of the United Nations Framework Convention on Climate Change (*see* Annex I countries). This group consists primarily of developing countries. For a listing of members, see http://unfccc.int.

offsets. Sponsored emissions reductions elsewhere in lieu of reducing one's own emissions. These can be purchased voluntarily, as part of an effort to become "carbon neutral," from offset providers, for example, project developers for afforestation or renewable energy programs. Offsets can also be a cost containment mechanism within a mandatory cap, where regulated entities receive credit for implementing mitigation activities outside the scope of the regulation, whether in other jurisdictions or non-covered sectors.

price caps. Provision designed to limit the cost of compliance with a cap-and-trade system. When the price of allowances reaches a certain level, the government can reduce the cost to regulated entities by increasing the supply of allowances above the cap or by allowing entities to pay a fee in lieu of acquiring allowances.

total emissions. At the firm/industry/entity level, CO_2 emissions can be measured in terms of direct and indirect emissions (*see specific entries*), which give the total emissions for that particular firm/industry/entity. But at the national/country level, emissions are always measured as overall total emissions. Direct and indirect emissions have no bearing when talking of a country's total emissions because all sources are included.

United Nations Framework Convention on Climate Change (UNFCCC). A treaty signed at the 1992 Earth Summit in Rio de Janeiro that nearly all countries of the world have joined. See http://unfccc.int.

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