Part II

Cross-Cutting Approaches to Reducing Emissions

Chapter 2
Carbon Pricing

by Shi-Ling Hsu

Summary

Carbon pricing is commonly meant to refer to two main types of climate policy instruments: carbon taxation and cap-and-trade programs. Although a number of economic and technological uncertainties render it difficult to estimate the amount of emissions reductions that can be achieved by a carbon pricing scheme, a carbon pricing scheme must be a foundational part of any effective climate policy. This chapter therefore discusses the legal issues that arise in connection with carbon pricing schemes. Because of its ubiquity and breadth, and because of its capacity to effect fairly large economic changes, a carbon pricing law should enjoy broad political support and, in most democratic countries, explicit legislative authorization. Further, the additional implementation issues involved with establishing a cap-and-trade program require some additional legal planning. For example, many cap-and-trade programs provide for the issuance of offsets, permits created above and beyond the initially established "cap," by the approval of some project deemed to have somehow reduced emissions. While useful, offsets have proven to be problematic, sometimes rewarding clever emissions accounting rather than actual reductions. Carbon taxation, however, usually involves fewer moving administrative parts, and thus fewer legal issues. As between the two, carbon taxation is less administratively complicated, and the better starting point for climate policy. The chapter describes one carbon tax option to serve as a policy foundation upon which other policies could be added, such as traditional emissions regulations under the Clean Air Act, if needed. The chapter also looks at the legal issues surrounding how a carbon tax would be designed and implemented.

I. Introduction

Carbon pricing is commonly meant to refer to two main types of climate policy instruments: carbon taxation and cap-and-trade programs. The price is levied on a unit of emissions of carbon dioxide (CO_2), or some other greenhouse gas, measured in terms of its global warming potential, in carbon dioxide equivalents (CO_2-eq). A carbon tax refers to some unitary tax on emissions at a fixed price. In a cap-and-trade program, a fixed total allowable quantity of emissions is allocated through the issuance of tradable emissions permits. In either case, a price on the emissions of greenhouse gases is imposed at some point of production or consumption, and meant to create an incentive to adopt methods of production, distribution, or consumption that result in an overall net reduction of greenhouse gas emissions. Carbon pricing (which will generally be used here to include pricing of other greenhouse gas pollutants) is a highly flexible policy tool, appropriate for deployment as a central instrument or as part of a portfolio of instruments to reduce emissions. Several country-specific deep decarbonization pathways include a specific carbon pricing component as one of several means of reducing greenhouse gas emissions.

A precise contribution to emissions reductions by carbon pricing is difficult to project. A vast and long-standing economic literature has generated a range of energy own-price elasticities,[1] so that the narrow question of emissions reduction from a business-as-usual *baseline* is relatively easy to answer, even for different countries and economies. But baselines change, and it is difficult to answer the more complex question of how much emissions will actually decline as a result of carbon pricing. At least five uncertain-

1. Price elasticity is a conventional way of expressing price sensitivity; goods and services with lower price elasticities are considered less elastic (or less sensitive to a price change), while those with higher price elasticities are considered more elastic (or more sensitive to a price change).

ties make such projections difficult: (1) the economic literature on income elasticities of energy is less robust, so it is difficult to project how much economic growth will lead to higher energy use; (2) it is not known how much the U.S. economy will grow; (3) it is unknown how quickly lower carbon or non-carbon technologies will develop and come down in price; (4) it is unknown how quickly lower carbon or non-carbon technologies will actually deploy as substitutes for fossil fuel-based energy technologies; and (5) it is unknown how much "leakage" of carbon or other greenhouse gas emissions—the relocation of emitting activity to other locations without carbon pricing—will occur. The Deep Decarbonization Pathways Project (DDPP) technical report for the United States seems to reflect this enormous uncertainty, as the error bars surrounding some of the cost estimates are larger than the estimates themselves.[2]

The DDPP reports for the United States are directed at determining technical and policy pathways to an 80% reduction in greenhouse gas emissions by 2050.[3] While estimating the emissions reductions from carbon pricing is difficult, carbon pricing is an absolutely essential foundation for a suite of policies to achieve deep decarbonization. Carbon pricing is the most effective way to create a broad price incentive, and is thus critical to achieving deep decarbonization. As the DDPP synthesis report notes, "decarbonization relies on the right choices by millions of decentralized actors,"[4] so breadth of coverage is critical. Given the ubiquity of energy needs, and the dominance of fossil fuel-centered technologies, it is clear that a pricing mechanism is needed to incentivize behavior of the vast majority and variety of people, firms, and institutions throughout the world. It would be impossible to reach all of the nooks and crannies of broadly diversified economies without a policy that applies to every individual, firm, organization, and jurisdiction. It is true that an optimal climate policy would not rely solely upon carbon pricing as a stand-alone policy; complementary policies are likely needed to reduce emissions in situations where pricing is insufficient. For example, methane leakage is a technological problem that may be better addressed by standards, as a complementary policy to carbon pricing. But no suite of policies, no matter how comprehensive, can achieve deep decarbonization without carbon pricing serving as a base policy, a foundation upon which other policies can be erected.

Given the breadth of impact of carbon pricing, legislative authorization is likely to be required, or some other form of legitimacy bestowed upon an executive action. In the United States, carbon pricing still faced intense political opposition as of the writing of this volume. It has remained an open question as to whether and to what extent the existing Clean Air Act provides the executive branch with the authority to pursue carbon pricing without further congressional authorization.

Carbon pricing as a policy tool also raises a number of legal issues pertaining to its implementation. For example, some carbon pricing programs contain provisions to protect domestic industries from extrajurisdictional competition. Without such provisions, a carbon price would impose a cost on domestic industries not suffered by extrajurisdictional competitors. Provisions to equalize the burden, however, may run afoul of international trade law, or federalism concerns.

Implicit in most discussions of carbon pricing is the notion that it would arise by singular, national, top-down lawmaking. But because large, national efforts continue to face political opposition, an alternative pathway might be for carbon pricing to be led by atomistic, subnational, ground-up lawmaking. Smaller, more politically homogenous jurisdictions, such as California and the northeastern states, have found it more politically palatable to enact carbon pricing, and to join with others in forming subnational plans. It is also possible for a carbon pricing plan to grow by accumulating new members over time. Such interjurisdictional cooperative arrangements, whether formed at the outset or knitted together from different extant programs, raise interesting legal issues, pertaining to the nature of inter-sovereign contracting, and the harmonization of existing legal provisions.

Such a ground-up process would parallel international processes for climate treaty making. Internationally, the structure of the Paris Agreement on climate change[5] sug-

2. James H. Williams et al., Pathways to Deep Decarbonization in the United States, U.S. 2050 Report, Volume 1: Technical Report 24 (Deep Decarbonization Pathways Project & Energy and Environmental Economics, Inc., 2015), *available at* http://usddpp.org/downloads/2014-technical-report.pdf].

3. *Id*. at xii. The other report is James H. Williams et al., Pathways to Deep Decarbonization in the United States, U.S. 2050 Report, Volume 2: Policy Implications of Deep Decarbonization in the United States (Deep Decarbonization Pathways Project & Energy and Environmental Economics, Inc., 2015), *available at* http://usddpp.org/downloads/2015-report-on-policy-implications.pdf.

4. Deep Decarbonization Pathways Project, Pathways to Deep Decarbonization 2015 Report 40 (Sustainable Development Solutions Network & Institute for Sustainable Development and International Relations 2015), *available at* http://deepdecarbonization.org/wp-content/uploads/2016/03/DDPP_2015_REPORT.pdf.

5. Conference of the Parties, Adoption of the Paris Agreement, U.N. Doc. FCCC/CP/2015/L.9/Rev/1 (Dec. 12, 2015).

gests that global consensus is going to have to be achieved with different countries on different timetables, and that any kind of global scheme for carbon pricing will necessarily have to be consolidated from different programs from different legal systems and different cultures. This dynamic process raises its own legal issues inherent to the joining together of rules and regulations from disparate programs. The limited experience thus far suggests that these decentralized efforts are legally complicated, but serve as an important pathway for achieving a carbon pricing scheme.

Section II of this chapter explains carbon pricing, including where and how it has already been imposed, and what emissions reductions have been achieved. Section III then discusses legal issues related to carbon pricing for both cap-and-trade and taxation systems. A suggested carbon tax is described in Section IV, which discusses the level of taxation, the point of taxation, and the use of carbon tax proceeds. Section V concludes.

II. Carbon Pricing

This section sets out an introduction to the concept of carbon pricing, as well as a review of the two main carbon pricing instruments: cap-and-trade programs and carbon taxation. The literature on emissions reductions from carbon pricing is somewhat complicated, and is synthesized in this section to provide some background on the likely effect of carbon pricing.

"Carbon pricing" is the term that is used to describe a variety of legal mechanisms that increase, by some regularized amount, the marginal costs of emitting CO_2 (or, more broadly, greenhouse gases). By "regularized amount" I mean an added cost that is either established through a transparent legal process (such as a tax) or through a robust and dependable market mechanism (such as an emissions permit trading system). And by "marginal costs" I mean that added costs would scale linearly with emissions, and not be a flat cost over a range of output, like a capital investment. The two main carbon pricing instruments are a carbon tax—a fixed-price tax on each unit of greenhouse gas emitted—and a cap-and-trade program, in which a total quantity of emissions is allocated through the issuance of tradable emissions permits. The added cost on emissions of a carbon tax is the tax itself, while the added cost of being subject to a cap-and-trade program is the cost of securing the required permits through market transactions. Within these general parameters, an enormous number of variations are possible: carbon tax proceeds can be allocated in any number of ways, and allocation of permits in a cap-and-trade program can be accomplished in any number of ways.

If working as intended, carbon pricing could supplant some of the legal mechanisms that work through administrative and enforcement agencies and other traditional legal channels. Carbon pricing can reduce regulatory compliance costs and provide flexibility and predictability for regulated parties. From the environmental perspective, the hope would be that added flexibility and predictability would induce more innovations and emissions-reducing investments. If working as intended, then, carbon pricing would simultaneously achieve both emissions reductions and cost savings, satisfying both regulated parties and environmental advocates. Instrument design is highly important to the achievement of both of these objectives.

In effect, carbon pricing mechanisms devolve some emission abatement decisions to private actors, and provide emitters with some autonomy in terms of the specific methods of compliance. For example, a blunt regulatory mechanism might identify specific means of abatement, or a less blunt mechanism might specify some abatement *performance* known to be achievable with certain methods of abatement. Such legal mechanisms—referred to as traditional, or somewhat pejoratively as "command-and-control"—have evolved in terms of sophistication, but still require at some point (or at multiple points) an administrative determination as to legal compliance. From the perspective of the regulated party, this can be a significant cost, and a source of uncertainty that complicates long-term planning. By contrast, carbon pricing would elide many of these administrative determinations, leaving emitters with a considerable amount of freedom to decide how and when to reduce emissions.

If working as intended, carbon pricing would also reach more behavior than traditional methods of regulation. The point of instituting a broad price is to change the behavior of as many actors as possible, not just those with some legal relationship with a regulator such as the U.S. Environmental Protection Agency (EPA), which must necessarily be limited to some tractable number of people or firms. By reaching a broader range of actors, carbon pricing instruments create *more opportunities* for emissions reduction than more traditional regulatory mechanisms. As a practical matter, there is no way to regulate, in the traditional way of regulating, the number of decisionmakers that must be recruited to the task of reducing emissions.

In understanding carbon pricing as a climate policy instrument, it is worth keeping in mind that carbon pricing has historically been very unpopular in the United States and Canada, mostly acceptable in Europe, and moderately acceptable in some other places. The political economy of carbon policy generally is such that industries that stand to lose the most—coal-heavy utility companies, energy-intensive manufacturing companies, and oil companies—are concentrated and organized, while the beneficiaries of carbon pricing—literally, everybody else in the entire world—are dispersed and difficult to organize, making it difficult for coalitions to form. American politics has been especially brutal, as anti-tax and fossil fuel interest groups have campaigned aggressively against carbon pricing, going so far as to punish those supporting carbon pricing by financially backing their opponents.

One important factor to bear in mind, however, about carbon pricing is that it can generate revenues, which can be used to moderate some of the political opposition. Carbon taxes produce revenues, and these revenues can serve political purposes. British Columbia's carbon tax,[6] the first in North America, was packaged with reductions in personal and corporate income tax rates. A federal U.S. carbon tax of $40 per ton would generate approximately $200 billion per year in revenues,[7] which can be used to rally considerable support. A cap-and-trade program could also generate revenues if permits were auctioned, although the fluctuation in permit prices would make the amounts difficult to project. The Regional Greenhouse Gas Initiative (RGGI) has generated $2.7 billion over its history,[8] much of which has been used for energy efficiency and renewable energy programs. Cap-and-trade programs can also offer the permits themselves as political palliatives. The ultimately failed cap-and-trade legislation, the American Clean Energy and Security Act of 2009,[9] or, more commonly, "Waxman-Markey" after its chief cosponsors, allocated an enormous number of emissions permits to the electricity generation industry, which ultimately supported the legislation.

A. *Where in the World Is Carbon Priced?*

The two main forms of carbon pricing, carbon taxation and cap-and-trade programs, are simple in theory but usually convoluted in practice. As noted in Section I, many variations exist, so categorizing climate policy instruments as carbon pricing instruments is a line-drawing exercise. That said, some examples of each instrument are reviewed in this section.

1. Cap-and-Trade Programs

Roughly speaking, 17 cap-and-trade programs exist worldwide. They range in size from the European Union Emissions Trading System (EUETS), which applies to more than 11,000 emitters in 28 European Union (EU) Member States responsible for about 2 gigatons (Gt) of CO_2-eq emissions[10] (this includes the United Kingdom, which will be exiting the EU, but may remain subject to the EUETS), to the Swiss Emission Trading System, which applies to only 55 emitters responsible for only 5 megatons (Mt) of emissions.[11] China has declared plans to launch a cap-and-trade system that would cover about 4 Gt of emissions, which would be twice as large as the EUETS and greater than all existing carbon markets combined.[12]

Any discussion of cap-and-trade must begin with a discussion of the EUETS, which launched in 2005, and has served as a gigantic pilot for cap-and-trade programs, as it has experienced a number of implementation problems. For one thing, prices of emissions permits have usually been unexpectedly low[13]—at times approaching zero—so that induced emissions reductions have been modest, likely on the order of 2.5% to 5% of emissions.[14] Actual emissions in covered sectors have declined by more, but it is difficult to say exactly how much is attributable to the EUETS, because of exogenous economic factors such as the 2008-2009 global financial crisis. Low permit prices reduce incentives to innovate and to reduce emissions.

The first carbon pricing scheme in North America was the Specified Gas Emitters Regulation[15] (SGER) enacted in 2007 by the Canadian province of Alberta. The SGER is not strictly a cap-and-trade system, however, because the SGER regulation allows for more emissions if emitters manage to make their operations more efficient, lowering their emissions *intensity*—the amount of emissions per unit of productivity (such as a barrel of oil, or dollars in sales), rather than their absolute quantity of emissions. This variation of cap-and-trade has the effect of incentivizing operational efficiencies, rather than absolute emissions reductions. So despite intensity caps that tighten over time, emissions in Alberta have increased regularly

6. Carbon Tax Act, S.B.C., ch. 40 (2008) (Can.).
7. John Schwartz, *"A Conservative Climate Solution": Republican Group Calls for Carbon Tax*, N.Y. Times, Feb. 8, 2017, at A13.
8. Regional Greenhouse Gas Initiative, *Cumulative Allowances & Proceeds (by State)*, http://rggi.org/market/co2_auctions/results#state_proceeds (last visited Sept. 24, 2017).
9. American Clean Energy and Security Act of 2009, H.R. 2454, 111th Cong. (2009).
10. International Carbon Action Partnership, Emissions Trading Worldwide Status Report 2015, at 29 (2015).
11. *Id.* at 31.
12. Jeff Swartz, China's National Emissions Trading System: Implications for Carbon Markets and Trade vii (International Centre for Trade and Sustainable Development, Issue Paper No. 6, 2016), *available at* http://www.ieta.org/resources/China/Chinas_National_ETS_Implications_for_Carbon_Markets_and_Trade_ICTSD_March2016_Jeff_Swartz.pdf.
13. *See*, *e.g.*, Nicolas Koch et al., *Causes of the EU ETS Price Drop: Recession, CDM, Renewable Policies or a Bit of Everything?—New Evidence*, 73 Energy Pol'y 676 (2014).
14. Juha Siikamäki et al., Resources for the Future, The European Union Emissions Trading System 9 (2012) (citing A. Denny Ellerman & Barbara K. Buchner, *Over-allocation or Abatement? A Preliminary Analysis of the E.U. ETS Based on the 2005-06 Emissions Data*, 41 Envtl. & Resource Econ. 267 (2008), and Michael Grubb et al., Climate Policy and Industrial Competitiveness: Ten Insights From Europe on the EU Emissions Trading System (German Marshall Fund of the United States, Climate and Energy Paper Series No. 9, 2009), *available at* http://www.gmfus.org/publications/climate-policy-and-industrial-competitiveness-ten-insights-europe-eu-emissions-trading).
15. Climate Change and Emissions Management Act, S.A., ch. C-16.7, §3 (2003) (Can.); Specified Gas Emitters Regulation, Alta. Reg. 139/2007 (Can.).

from the onset of the SGER, as regulated emitters have managed to implement new operational efficiencies more quickly than the intensity cap declines.

Also particularly noteworthy is the increasing uptake of cap-and-trade programs in East Asian jurisdictions. South Korea has a cap-and-trade system, as do the Japanese cities of Tokyo and Saitama.[16] Perhaps most significantly, the announced intent of China to implement a cap-and-trade program suggests that even with a strong emphasis on economic growth, Asian jurisdictions seem prepared to embrace carbon pricing, and cap-and-trade in particular.

As noted above, the political economy of carbon pricing can be a significant obstacle to enactment. Smaller, more politically homogenous jurisdictions such as states or provinces may have advantages in being able to marshal the political support needed to implement a comprehensive carbon pricing scheme. In the United States, the RGGI is a cap-and-trade program for electricity generators in nine northeastern states.[17] The nine states effectively represent a single market for emissions permits, which electricity generators must hold in order to emit greenhouse gases. The RGGI states are reliably Democratic states, and most of them were parties to an early lawsuit forcing EPA to regulate greenhouse gas emissions. The RGGI has suffered one defection: the exit of New Jersey.[18]

A subnational program might also start with one or a smaller group of jurisdictions and grow by adding members over time. As a regional program matures, administrative snarls can be worked out. Also, over time, initially hesitant states can observe that the political prognostications of economic catastrophe are false. Moreover, for cap-and-trade programs, cost efficiencies accrue from the heterogeneity of abatement cost across facilities; the larger the number of regulated facilities, the larger the heterogeneity and the greater cost savings realized from a trading program. Thus, once a cap-and-trade program is established, regulated entities would have an interest in expansion by linking with other jurisdictions.

An example of this process might be the Western Climate Initiative (WCI),[19] which began as a coalition of western states that would join together to create a cap-and-trade program, much as the RGGI did, but not limited to electricity generators. In 2006, California passed a climate law, the Global Warming Solutions Act,[20] that seemed to serve as a template for expansion into other states. California's Global Warming Solutions Act authorized the implementation of a cap-and-trade program for greenhouse gas emissions that would reduce the state's carbon footprint to 1990 levels by 2020,[21] representing a 15% reduction from a business-as-usual scenario.[22] The cap-and-trade program applies to entities emitting more than 25,000 tons of CO_2-eq, accounting for about 85% of the state's total emissions.[23] It applies to entities that generate or deliver electricity, process industries and manufacturers, oil and gas producers, and refineries—about 450 entities in total.[24]

As the political dynamics in the other WCI member states changed and opposition swelled, all of the other states fell away, leaving California alone with a climate policy. In a rebound, however, California has been joined by the Canadian province of Quebec, which developed its own cap-and-trade program and linked it to the California program, essentially creating a multijurisdictional (and multinational) cap-and-trade program.[25] The neighboring province of Ontario, the most populous, has also announced that it will join the California-Quebec program.[26] As political fortunes change yet again, some of the original western states, or some of the RGGI states, may still join on.

It is harder, but quite possible, to link existing programs rather than accumulating converts, because of the legal difficulties of amending and harmonizing existing legal provisions regarding permit allocation, monitoring and verification, and provisions defining which emitters are covered by the program. That said, it is certainly possible to do so. California and Quebec succeeded despite having to navigate differences in language, legal systems (Quebec being a civil law jurisdiction), and the constitutional makeup of two different countries. Now that WCI seems again to be gaining momentum, the additions of Ontario and Quebec might enhance the prospects of further enlargement. The larger a cap-and-trade program is, the larger is the body of regulated facilities with which mutually beneficial trades might be made.

16. International Carbon Action Partnership, Emissions Trading Worldwide Status Report 2015, at 48-63 (2015).
17. Regional Greenhouse Gas Initiative, *Program Overview*, https://www.rggi.org/design/overview (last visited Nov. 17, 2017).
18. Mireya Navarro, *Christie Pulls New Jersey From 10-State Climate Initiative*, N.Y. Times, May 26, 2011, at http://www.nytimes.com/2011/05/27/nyregion/christie-pulls-nj-from-greenhouse-gas-coalition.html.
19. Western Climate Initiative, *Program Design*, http://www.westernclimateinitiative.org/designing-the-program (last visited Nov. 17, 2017).
20. California Global Warming Solutions Act of 2006, ch. 488, 2006 Cal. Stat. 3419 (codified as Cal. Health & Safety Code §§38500-38599 (West 2008)).
21. *Id.*
22. California Air Resources Board, *Assembly Bill 32 Overview*, https://www.arb.ca.gov/cc/ab32/ab32.htm (last reviewed Aug. 5, 2014).
23. Guri Bang et al., *California's Cap-and-trade System: Diffusion and Lessons*, 17 Global Envtl. Pol. 12, 17 (2017).
24. *Id.*
25. *Id.* at 27.
26. *Ontario Confirms It Will Join Quebec, California in Carbon Market*, Reuters, Apr. 13, 2015, http://www.reuters.com/article/us-climatechange-canada-idUSKBN0N41X220150413.

2. Carbon Taxation

At the time of writing this volume, some form of a carbon tax existed in 15 countries.[27] Norway, Sweden, Denmark, and Finland all enacted national carbon taxes between 1990 and 1992, and were the first countries in the world to do so.[28] The implementation of carbon taxes in the Scandinavian countries has been complicated by their membership in the EU or the European Economic Area (EEA), which carry with it various policy restrictions. For example, EU rules for pricing or taxing retail electricity so as to avoid discriminating against providers from other Member States make it difficult to tax electricity from a coal-burning plant in another EU country.[29] Finland's carbon tax, therefore, exempts fuels used for electricity generation so as to avoid a conflict with EU restrictions,[30] instead taxing electricity consumption, which does not differentiate between fossil and non-fossil sources.[31] For the same reason, Sweden's carbon tax, the world's highest at about USD120 per ton of CO_2,[32] also exempts fossil fuels for electricity, although most of Sweden's electricity is generated by nuclear or hydroelectric power.[33] In addition, membership in the EU or the EEA exposes domestic industries to competition from throughout Europe, so that a carbon tax, on top of the need to buy allowances under the EUETS, faces political objections from trade-exposed industries. Almost all European countries are in fact covered by the EUETS, so that those taxing carbon-exempt industries are required to participate in the EUETS.[34]

A second wave of carbon tax laws began in 2008, with Switzerland[35] and the Canadian province of British Columbia[36] enacting carbon taxes in 2008, Ireland[37] and Iceland[38] in 2010, Mexico[39] and Japan[40] in 2012, and France[41] and Chile[42] in 2014. These taxes range in cost from about USD2 per ton of CO_{2}-eq to USD68.[43]

Almost all of these carbon taxes contain exclusions, exemptions, and other provisions that distort economic decisions, and make it difficult to estimate their impacts on greenhouse gas emissions. Costa Rica charges a tax of 3.5% of the market value of fossil fuels, an ad valorem tax that fails to distinguish between coal, natural gas, and petroleum.[44] However, Costa Rica is so rich in hydropower and geothermal energy that its carbon footprint is extremely low anyway: a mere 12 Mt of CO_2-eq in 2012,[45] about the same as Papua New Guinea,[46] a country with less than a third of Costa Rica's gross domestic product (GDP).[47] Chile's carbon tax is limited to thermal power plants.[48] Mexico taxes fossil fuels on the basis of carbon content *exceeding that of natural gas*. Natural gas is thus untaxed, but petroleum and coal are taxed as a carbon penalty for the excess emissions over that which would occur if natural gas had been used. However, this does not create any incentives for renewable sources of energy. An even bigger failing is that the tax is capped at 3% of the sales price of the fuel, virtually negating any price penalty

27. World Bank, Putting a Price on Carbon With a Tax (2014).
28. *Id.*
29. Philipp Genschel & Markus Jachtenfuchs, *How the European Union Constrains the State: Multilevel Governance of Taxation*, 50 Eur. J. Pol. Res. 293 (2011).
30. Act on Excise Duty on Electricity and Certain Fuels of December 30, 1996, 1260/96 (Fin.), www.finlex.fi/fi/laki/alkup/1996/19961260. *See* Organisation for Economic Co-operation and Development, Inventory of Estimated Budgetary Support and Tax Expenditures for Fossil Fuels 2013, at 153-64 (2013), http://www.oecd-ilibrary.org/environment/inventory-of-estimated-budgetary-support-and-tax-expenditures-for-fossil-fuels-2013_9789264187610-en. *See also* Stefan Speck et al., Nordic Council of Ministers, The Use of Economic Instruments in Nordic and Baltic Environmental Policy 2001-2005, at 99-113 (2006), *available at* http://norden.diva-portal.org/smash/get/diva2:701846/FULLTEXT01.pdf.
31. Sarianne Tikkanen, *Remarks on Few Signs of Environmental Tax Reform in Finland*, *in* 3 Critical Issues in Environmental Taxation 330 (Alberto Cavaliere et al. eds., Richmond Law and Tax 2006).
32. As of March 12, 2015, the Swedish krona traded for USD0.116. With a carbon tax of 110 öre per kilogram of CO_2 (*see* Svensko Energi, *Mål och Styrmedel*, http://www.svenskenergi.se/Elfakta/Miljo-och-klimat/Mal-och-styrmedel/ (last visited Sept. 24, 2017), this translates into a carbon tax of USD116 per ton of CO_2.
33. Act on the Taxation of Energy, S.F.S., 1994:1776 (Swed.), http://www.riksdagen.se/sv/Dokument-Lagar/Lagar/Svenskforfattningssamling/Lag-19941776-om-skatt-pa-en_sfs-1994-1776/. *See also* International Energy Agency, Energy Policies of IEA Countries: Sweden 2013 Review (2013), *available at* http://www.iea.org/textbase/nppdf/free/2013/sweden2013_excerpt.pdf.
34. World Bank, *supra* note 27. Switzerland is an exception, but it has its own trading system.
35. Federal Act on the Reduction of CO_2 Emissions of December 23, 2011 (CO_2 Act), 641.71 (Switz.), http://www.admin.ch/opc/en/classified-compilation/20091310/index.html.
36. Carbon Tax Act, S.B.C., ch. 40 (2008) (Can.).
37. Finance Act 2010, No. 5, chs. 1-3 (2010) (Ir.), http://www.irishstatutebook.ie/pdf/2010/en.act.2010.0005.pdf.
38. Environmental and Natural Resources Tax Act, No. 129 (2009) (Ice.), http://www.althingi.is/altext/stjt/2009.129.html.
39. "Ley del Impuesto Especial Sobre Producción y Servicios," D.O., 11 de diciembre de 2013, second section 1-10 (Mex.), www.sat.gob.mx/comext/esquema_integral/Documents/LIEPS.doc.
40. Tax Reform Act, Special Provisions for Carbon Dioxide Tax of Global Warming Measures, Law No. 16 of 2012 (Japan), http://climatepolicydatabase.org/index.php?title=Act_Partially_Amending_the_Law_on_Special_Tax_Measures_(Tax_Reform_Act_2012)_(Law_No._16_of_2012)_Japan_2012.
41. Law No. 2013-1279 of December 29, 2013, J.O., Dec. 30, 2013 (Fr.), http://www.legifrance.gouv.fr/affichTexte.do?cidTexte=JORFTEXT000028400921.
42. Law No. 20780 of September 29, 2014, D.O., I-39 (Chile); Kate Galbraith, *Climate Change Concerns Push Chile to Forefront of Carbon Tax Movement*, N.Y. Times, Oct. 29, 2014, https://www.nytimes.com/2014/10/30/business/international/climate-change-concerns-push-chile-to-forefront-of-carbon-tax-movement.html.
43. World Bank, Putting a Price on Carbon With a Tax (2014). The lowest tax is that of Japan's, and the highest is that of Switzerland's.
44. Law of Tax Simplification and Efficiency, No. 8114, L.G., No. 131 (2001) (Costa Rica), https://ministeriopublico.poder-judicial.go.cr/normativa/nacional/03-delitos%20economicos/13.pdf.
45. World Resources Institute, *CAIT Climate Data Explorer*, http://www.wri.org/resources/data-visualizations/cait-climate-data-explorer (last visited Sept. 24, 2017).
46. *Id.*
47. The World Bank, *World Bank Open Data*, https://data.worldbank.org/ (last visited Sept. 24, 2017) (Costa Rica, 2015 GDP USD51.1 billion, Papua New Guinea, 2014 GDP USD16.9 billion).
48. Law No. 20780 of September 29, 2014, D.O., I-39 (Chile); Galbraith, *supra* note 42.

paid for burning coal. All of these idiosyncratic ways of taxing carbon make it very difficult to estimate the effects of these policies, or even the effective carbon price.

The Canadian province of British Columbia has a carbon tax that is widely praised as being simple and effective, and devoid of the exclusions and exemptions that complicate other carbon taxes. The tax, which started out in 2008 at CAD10 per ton of CO_2-eq emissions, and ramped up to its current rate of CAD30 per ton,[49] applies to 20 classes of fossil fuels and other specified combustibles,[50] but excludes fuels exported from British Columbia and fuels for interjurisdictional marine use and aviation.[51] The tax was meant to be "revenue neutral," and so was packaged with reductions in the marginal income tax rates of the lowest two tax brackets, as well as reductions in the corporate income tax rate.[52] The tax also included provisions for additional "adjustment measures"[53] to ensure that the province took in less money in carbon tax revenues than it spent under the law.

B. Emissions Reductions From Carbon Pricing

As noted above, projecting absolute levels of emissions with precision is extremely difficult with current economic and data tools. What economic models have done reliably for decades is measure and project emissions reductions from some baseline scenario. That is, economic models answer the narrow question of the effect that one independent variable—say the price of gasoline—has on a dependent variable, such as gasoline consumption. Especially for a commodity such as energy, in which many other factors affect consumption, models cannot definitively predict that a certain price increase will lead to a particular decrease in consumption. Economic models can only project, within a range of certainty, what consumption would be *assuming that everything else stays the same*.

Different models assume different carbon prices and make different assumptions about all of the other economic factors that matter, like economic growth, technological progress, and substitution of natural gas and renewable energy. The U.S. Energy Information Administration (EIA), in its Annual Energy Outlook 2014 report, modeled a carbon price of $25 per metric ton, increasing 5% per year.[54] In the electricity sector, the EIA model found that such a carbon price would generate very small changes in retail electricity prices and demand, but a dramatic shift in fuel choice from coal to natural gas and renewable sources. Electricity generated using coal would plummet by 85% from the reference (or business-as-usual) case by 2030, and virtually disappear by 2040, while natural gas generation would increase by 27% by 2030 before falling back to reference case levels by 2040. Renewable energy generation would increase by 56% by 2030.[55] Resulting emissions from the electricity sector would decline an estimated 63% from the reference case by 2030.[56]

A carbon price would also reduce emissions from transportation. The EIA estimated that under the scenario it modeled, gasoline prices would increase by 12% by 2030, and that both gasoline usage and emissions would decrease by 4%,[57] a price elasticity of 0.33. This is *lower* than prevailing price elasticity estimates in the economic literature, which range from 0.6 to 0.8 in the long run.[58] Moreover, EIA assumes virtually no technological progress; electric vehicles, ride-sharing, and no landscape changes (changes in urban density and land use by such activities as infrastructure development) from carbon pricing. Although estimating adjustments in transportation in response to carbon pricing is more challenging than in the electricity sector, the EIA projections seem to underestimate the effect that a carbon price would have on transportation emissions.

Taking the electricity and transportation sectors together, the EIA projects that a $25 per metric ton carbon price will lead to a decline in emissions of 28% across the entire economy from 2012 to 2030.[59] The vast majority of this reduction is driven by the whopping 80% reduction from the electricity sector, and extremely small reductions in other sectors. This is in line with other models, which have assumed carbon tax rates of between $15 and $25 per ton that increase by 4% per year, and project emissions reductions, relative to a baseline case, of 11% to 31%.[60] EIA's estimate of 28% is thus in line with those estimates. As is the case with the EIA model, these models make the

49. Carbon Tax Act, S.B.C., sched. 1 (2008) (Can.).
50. *Id.* sched. 2.
51. *Id.* §10.
52. Kathryn Harrison, The Political Economy of British Columbia's Carbon Tax 3 (Organisation for Economic Co-operation and Development, OECD Environment Working Papers No. 63, 2013), *available at* http://www.oecd-ilibrary.org/environment-and-sustainable-development/the-political-economy-of-british-columbia-s-carbon-tax_5k3z04gkkhkg-en.
53. Carbon Tax Act, S.B.C., §2 (2008) (Can.).
54. EIA, Annual Energy Outlook 2014: With Projections to 2040 MT-34 (2014) (DOE/EIA-0383(2014)), *available at* https://www.eia.gov/outlooks/aeo/pdf/0383(2014).pdf.
55. *Id.* at D-12 tbl. D5.
56. *Id.*
57. *Id.* at E-9.
58. Noah Kaufman et al., World Resources Institute, Putting a Price on Carbon: Reducing Emissions 20 (2016).
59. EIA, *supra* note 54, at MT-34.
60. Warwick McKibbin et al., Brookings Institution, The Potential Role of a Carbon Tax in U.S. Fiscal Reform (2012), https://www.brookings.edu/research/the-potential-role-of-a-carbon-tax-in-u-s-fiscal-reform/; Sebastian Rausch & John M. Reilly, MIT Joint Program on the Science and Policy of Global Change, Report No. 228, Carbon Tax Revenue and the Budget Deficit: A Win-win-win Solution? (2012), *available at* https://globalchange.mit.edu/publication/15718; Sebastian Rausch et al., *Distributional Implications of Alternative U.S. Greenhouse Gas Control Measures*, 10 B.E. J. Econ. Analysis & Pol'y art. 1 (2010); Robert Shapiro et al., The U.S. Climate Task Force, Addressing Climate Change Without Impairing the U.S. Economy: The Economics and Environmental Science of Combining a Carbon-based Tax and Tax Relief (2008).

same conservative assumptions as the EIA model, and also potentially underestimate the emissions induced by a carbon price.[61]

A World Resources Institute report, *Putting a Price on Carbon: Reducing Emissions*,[62] raises some questions about these projections. The report noted that the EIA projections made the following assumptions, which it argued were unduly pessimistic: (1) residential and commercial consumers would not make any adjustments in behavior, equipment, or structures, in response to higher electricity prices; (2) manufacturers would change production to adjust to higher electricity costs, but not for other inputs, such as materials, chemicals, and equipment; (3) both producers and consumers of transportation fuels would make very little adjustment to higher fuel prices; and (4) very little technological change would occur from higher fossil fuel prices, meaning that the costs of renewable energy remain roughly the same, and that no significant improvements in transmission technology or methods (such as smart grids) occur.[63]

Are these conservative assumptions, adopted by most studies, warranted? As a matter of economic practice, they may be more justifiable than other assumptions that may be more realistic, but less grounded in empirical support. Natural experiments such as British Columbia's carbon tax at least suggest that adaptive behavior can produce more emissions reductions than well-trod economic models might estimate. Emissions in British Columbia have been estimated to have fallen 5% to 15% from a baseline level, which is very significant because British Columbia is a province with almost no fossil fuel-generated electricity, more than 90% of it being generated by hydropower.[64] The emissions reductions were thus accomplished with little help from the low-hanging fruit of emissions reductions from electricity generation.

It is worth reiterating two points. First, estimates of emissions reductions are not the same thing as estimates of the levels of emissions, because it is unknown how much economic growth will occur, and how much of that will translate into greater energy usage. The EIA has made some reasonable assumptions about those parameters, but economic growth has always been unpredictable, so that part of the model must be deemed to be educated guesswork. The 2008-2009 global financial crisis was mostly unexpected (at least to policymakers) and largely accounted for a stunning 6.1% decrease in CO_2 emissions in the United States from 2008 to 2009.[65] Also, how economic growth (or contraction) translates into energy usage is uncertain. Sweden, which has had a carbon tax in place since 1990, seems to have decoupled economic growth from energy usage.[66] That is not necessarily the case with other countries, and underscores the difficulty of taking that next step of estimating emissions per se.

The second point to reiterate is that technological progress is also very hard to model, which is no doubt one reason why the EIA made such conservative assumptions. Ample evidence exists of long-run adjustments to high energy prices, including startling progress in renewable energy production prices and some other potentially "disruptive" technologies, such as home energy storage technologies that could achieve very significant emissions reductions from that achieved under the traditional hub-and-spokes model of electricity supply. While it would be speculative to try to estimate the technological component of emissions reduction from carbon pricing, it does seem reasonable to surmise that it would be greater than that reflected in historical long-run electricity price elasticities, much of which was derived from energy supply and usage before the era of deregulation.

Carbon pricing might also make a greater contribution to decarbonization if a carbon pricing program generated revenues, and the revenues were used to support other decarbonization strategies. For example, carbon tax revenues could be reinvested into development of renewable energy technologies. As a general matter, federally funded research and development is woefully undersupplied. Out of the total $133 billion in federally funded research (out of a total federal budget of $3.7 trillion) in 2015,[67] less than $2 billion was awarded to energy-related research and development. Economists estimate that an additional $10 to $15 billion per year is needed to fully fund currently identified energy-related research needs.[68] If revenues were made available, and succeeded in producing low-carbon or non-carbon energy technologies, then carbon pricing could make a larger contribution to decarbonization.

Projections out to 2050 are more adventurous than the current model projections out to 2030, but by the assumptions made by most current economic models, additional policies would *appear* to be needed to complement and buttress carbon pricing to achieve an 80% reduction by

61. EIA, *supra* note 54, at D-12.
62. Kaufman et al., *supra* note 58.
63. *Id.* at 3.
64. Brian Murray & Nicholas Rivers, *British Columbia's Revenue-neutral Carbon Tax: A Review of the Latest "Grand Experiment" in Environmental Policy*, 86 Energy Pol'y 674 (2015).
65. EPA, Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2014 ES-5 fig. ES-2 (2016).
66. Nate Aden, *The Roads to Decoupling: 21 Countries Are Reducing Carbon Emissions While Growing GDP*, World Resources Inst., Apr. 5, 2016, http://www.wri.org/blog/2016/04/roads-decoupling-21-countries-are-reducing-carbon-emissions-while-growing-gdp.
67. Congressional Budget Office, The Federal Budget in 2015: An Infographic (2016), https://www.cbo.gov/publication/51110.
68. Richard G. Newell, *The Energy Innovation System: A Historical Perspective*, *in* Accelerating Energy Innovation: Insights From Multiple Sectors (Rebecca M. Henderson & Richard G. Newell eds., University of Chicago Press 2011).

2050. It is difficult to anticipate what those policies would be. Just in the past handful of years, surprising technologies and ideas have emerged from seemingly nowhere, and pose a plausible likelihood of upending existing systems and imposing striking and disruptive changes that could slash emissions by orders of magnitude. Few imagined, as recently as five years ago, that electric vehicles and home battery storage units, paired with photovoltaic solar panels, could dramatically reduce the need for a hub-and-spokes regulated electric utility altogether. Many obstacles stand in the way of such an achievement—still considered speculative—but the dramatic nature of such an idea and its emergence is a humbling reminder of what is still unknown about technological progress. (The use of law for technological innovation is discussed in Chapter 4.)

The unpredictability of technological progress renders somewhat futile an exercise in choosing from among different paths. Carbon pricing is crucial not because it would inform such an exercise, but because it is a foundational policy upon which other policies could be added with a minimum of complication. In fact, a crucial advantage of carbon pricing is that it would *avoid* having to make technological choices, and allow markets to play that role. Market failures would still persist, and hence additional policies might address them, even if they implicitly make some technological choices. Energy research and development, for example, generates knowledge in excess of its costs, and a souped-up federal research program may be called for. But as a foundational policy, carbon pricing is the most essential way to stimulate technological development to reduce emissions.

III. Legal Issues

This section sets out some of the legal issues that arise in the context of carbon pricing policies. Carbon pricing generally raises some legal issues pertaining to implementation and compatibility with other laws. Also, cap-and-trade programs and carbon taxation raise some issues specific to respective instrument designs, which are discussed in this section.

A. Executive Action Issues

For the most part, and in most democratic countries, carbon pricing requires explicit legislative authorization. The goal of carbon pricing is to impose a ubiquitous price signal to change the behavior of as many actors as possible so as to reduce emissions. Moreover, price signals need to be large enough to actually induce significant changes in behavior. As such, a robust carbon pricing scheme will cause fairly large shifts in fossil-intensive industries, and economic dislocation is inevitable. The fact that a large populace with a diverse economy would derive an overall net benefit is not likely to be of much consolation to negatively affected industries, regions, and communities. Given the extent of change caused by carbon pricing, it is the sort of policy that would require broader legitimacy and broader legal authorization, at least in democratic jurisdictions. In countries with parliamentary democracies, where executive action may be tantamount to legislative action, carbon pricing schemes have still mostly been undertaken with some political caution, as governing parties have been wary of the power of populist political opposition.

During the years of the Obama Administration, U.S. climate policy took on the form of executive rather than legislative action. The Clean Power Plan[69] aimed to reduce emissions from electricity generation by regulation under the Clean Air Act,[70] which does not explicitly contemplate carbon pricing. That is not to say that carbon pricing is *impossible* under the Clean Air Act, but the avenues for achieving it on a federal level are of uncertain legality. The potential problem with the Clean Power Plan was that while its core mandate—a state-by-state performance standard for all electricity generators—was well within the spirit of past Clean Air Act regulations, the means by which states could achieve them were not necessarily so. Substantial emissions reductions potential comes from energy efficiency measures that reduce the demand for electricity. But whether such measures could be mandated indirectly through a state-by-state performance standard is an open legal question.

Another possibility for executive action without congressional authorization derives from §115 of the Clean Air Act, which authorizes EPA to require states to develop a plan to reduce emissions of "international" air pollutants.[71] The language of §115 is broad enough to entertain realistic notions of federal carbon pricing as a tool in EPA's toolkit, as there is no textual restriction on what states can or must do to address international air pollution, or what EPA can require them to do. Reasonable minds may differ on whether this is a viable legal basis to support carbon pricing, but this clause at least provides a potential vehicle for carbon pricing through executive action.

B. Carbon Taxation Issues

Carbon taxes are the simpler of the two carbon pricing options, and typically build upon existing revenue collection infrastructures. As such, carbon tax programs rarely

69. Carbon Pollution Emission Guidelines for Existing Stationary Sources: Electric Utility Generating Units, 80 Fed. Reg. 64,662 (Oct. 23, 2015) [hereinafter Final Rule] (to be codified at 40 C.F.R. pt. 60).
70. 42 U.S.C. §§7401-7671q.
71. *See* Michael Burger et al., *Legal Pathways to Reducing Greenhouse Gas Emissions Under Section 115 of the Clean Air Act*, 28 Geo. Envtl. L. Rev. 359 (2016).

suffer the kinds of unexpected implementation problems after enactment that have afflicted cap-and-trade programs. For example, the British Columbia carbon tax was simple and inexpensive to implement and carry out, as every fossil fuel extracted or imported in the province already generated a paper trail easily accessible to regulators. Even for a province half again larger than Texas, with a sixth of its population, the cost of carbon tax revenue collection and administration has been modest: an estimated CAD1.4 to CAD1.8 million annually,[72] mostly for the hiring of 18 staff associated with the program.[73]

That said, carbon tax programs sometimes contain provisions to make them more politically palatable, and these can pose legal or economic issues. One unfortunate aspect of the British Columbia carbon tax was its overzealous (in retrospect) commitment to keep its carbon tax from generating net revenues. To guarantee that it did not increase the size of the government budget, the British Columbia Carbon Tax Act required the provincial finance minister to *personally* guarantee, under a penalty of a salary reduction, that the province did not collect more carbon tax revenues than it paid out.[74] The Act provided that the minister could undertake "adjustment measures" and "revenue measures" to ensure not just revenue neutrality, but revenue negativity.[75] These measures have been carbon tax exemptions for vulnerable industries, and sometimes just outright grants of money only tangentially related to greenhouse gas emissions. As a result, the carbon tax has been a continuous drag on provincial revenues, and for projects of dubious public benefit.

C. *Cap-and-trade Issues*

Establishing carbon pricing programs would require some thought in the design stage to address issues that affect either the effectiveness of the program or, ex ante, its political salability. Cap-and-trade programs, in particular, having more moving parts than a carbon tax, require careful planning to avoid some of the problems that have plagued cap-and-trade schemes in the past. As noted above, the EUETS has been plagued by low permit prices that have undermined the incentives to lower emissions. In part, low prices have been caused by mistakes in allocating emissions allowances, leading to oversupplies.[76] Also, policies meant as complementary climate policies, such as end-use energy efficiency measures, reduce electricity demand and concomitantly emissions allowances prices.[77]

The EUETS has established a "Market Stability Reserve," a reserve pool of permits that could either be released in times of tight supply and high permit prices, or used to buy permits and prop up prices in times of excess supply.[78] The idea would be to smooth out price fluctuations so as to ensure a stable price, reducing uncertainty for businesses and investors making long-term decisions based on permit prices. These price stabilization fixes, however, attempt to mimic the price stability of a carbon tax, and raise the question of whether a carbon tax would be simpler.

Some cap-and-trade programs provide for the issuance of *offsets*, which are permits created above and beyond the initially established "cap," by the approval of some project deemed to have somehow reduced emissions not covered by the EUETS, or otherwise unrealized. Offsets can be useful, incentivizing projects such as landfill gas capture, nitrous oxide-reducing agricultural practices, or tree planting as a carbon sequestration mechanism. These are projects that are difficult to incentivize with a carbon price alone. Those seeking offset credits for these kinds of projects are required to demonstrate that the project leads to a net reduction in greenhouse gases, which are essentially permits that are artificially created to incentivize emissions reductions outside of the scope of regulation.

Unfortunately, but fortunately for such project developers, convincing an approval board to grant offset credits for projects has been easy. Too easy. A persistent problem raised by offsets is whether in fact they result in a net reduction in greenhouse gas emissions or atmospheric concentrations, or whether the claimed reductions were cleverly manufactured to hoodwink regulators into granting a valuable asset. In a now widely told tale of rent-seeking,[79] an enormous number of offsets were granted under the Kyoto Protocol for the construction of plants in China producing a refrigerant that also generates a powerful greenhouse gas, hydrofluorocarbon (HFC), as a byproduct. Offsets were issued for the capture of HFC, which was not required under international law. However, it became readily apparent that the plants were constructed not for the purpose of producing the refrigerant, which had trivial value, but for the offsets, which had enormous value. An estimated 83 million credits per year were issued, worth

72. E-mail Communication From Anne Foy, B.C. Ministry of Finance, to Danny Richter, Legislative Director, Citizens Climate Lobby (July 15, 2013) (Re: Request on the Administrative Cost of the British Columbia Carbon Tax) (on file with author).
73. E-mail Communication From Hugh Hughson, Manager, Fuel & Carbon Tax, B.C. Ministry of Finance, to Hilary Kennedy, Senior Economic Advisor, Climate Action Secretariat, B.C. Ministry of Environment (July 11, 2013) (Re: Request on the Administrative Cost of the British Columbia Carbon Tax) (on file with author).
74. Carbon Tax Act, S.B.C., ch. 40, §5 (2008) (Can.).
75. *Id.* §2(1).
76. *Supra* note 14.
77. Johannes Thema et al., *The Impact of Electricity Demand Reduction Policies on the EU-ETS: Modelling Electricity and Carbon Prices and the Effect on Industrial Competitiveness*, 60 Energy Pol'y 656, 657 (2013).
78. European Commission, Climate Action, The EU Emissions Trading System, Market Stability Reserve (2017) https://ec.europa.eu/clima/policies/ets/reform_en.
79. Michael Wara, *Measuring the Clean Development Mechanism's Performance and Potential*, 55 UCLA L. Rev. 1759 (2008).

more than USD1 billion, far in excess of the value of the refrigerant, for *the construction of plants that had no other purpose than the generation of those credits*. The enrichment of clever project developers was not the most unfortunate aspect of this story. The most unfortunate aspect of this story is that those credits were used by entities covered by the EUETS to substitute for actual emissions reductions. In effect, the issuance of bogus offsets effectively increased the EUETS cap by 83 Mt of CO_2-eq per year.

D. Trade Protection Issues

Carbon pricing can place domestic industries at a competitive disadvantage vis-à-vis extrajurisdictional competitors that do not have to suffer the burden of a carbon tax.[80] To equalize the burden, carbon pricing programs can require of importers the payment of a "border tax adjustment," a duty levied by a country adopting some carbon pricing scheme, on a country that does not have a carbon pricing scheme, so that imported goods face the equivalent of the carbon tax paid by a domestic manufacturer.[81] For a cap-and-trade program, a border tax adjustment may take the form of requiring importers to hold the equivalent number of emissions permits that a domestic manufacturer would need to produce the same product. These measures are controversial because they could be used to discriminate against importers, a practice that is prohibited under international trade law. A vast literature exists on the legality, under international trade law, of border tax adjustments[82] and will not be revisited here. (See Chapter 8 (International Trade)). Suffice it to say, however, any carbon pricing scheme that attempts to protect domestic industries by means of a trade mechanism faces some legal uncertainty.

IV. A Carbon Tax Option

Both carbon taxation and cap-and-trade can serve as a carbon pricing policy, but as between the two, cap-and-trade programs generally raise more administrative issues than carbon taxes. For example, which entities should be required to hold permits to emit? For emitters, what threshold of emissions must be crossed before permitting requirements apply? Can permits be banked for future use, and can they be borrowed from the future? How are permits to be allocated as an initial matter? As for carbon taxes, at least in their pure form, fewer moving parts means fewer legal issues, and fewer implementation snags. It is also easier to design a carbon tax to avoid jurisdictional complications. Most countries and their subnational state or provincial units have some inherent power to tax, so that a carbon tax raises no questions of conflicts with other jurisdictions.

In general, while both carbon taxation and cap-and-trade programs can be effective carbon pricing schemes, it is more complicated to design a suite of policies with cap-and-trade as its policy center than a carbon tax. With cap-and-trade systems, care must be taken before implementing any complementary policies, lest they affect the market price of traded emissions permits, as they have for the EUETS. With cap-and-trade, some market monitoring is necessary to ensure the integrity of traded permits. If offsets are to be a part of a cap-and-trade program, great care must be taken to ensure that credits are only granted for bona fide emissions reductions projects that truly remove greenhouse gases, and not just create emissions for the sake of removing them at a profit. While all of these implementation issues are solvable, when added together they point to carbon taxation as the less complicated of the two options.

This section thus takes a carbon tax as the simplest starting point for climate policy, and lays out the outlines of a carbon tax option. This is *not* to say that cap-and-trade is untenable as a carbon pricing policy. Much of the following discussion could apply to cap-and-trade programs as well, but some qualifications would be needed to lay out cap-and-trade as a foundational climate policy option. For example, a discussion of carbon tax revenues could apply equally to the revenues from a cap-and-trade system, if only the allowances under the latter were *auctioned*, rather than allocated for free to emitters. Cap-and-trade auction revenues would be less predictable than carbon tax revenues, but emissions reductions could be more predictable.

The carbon tax option described in this section forms a policy foundation upon which other policies *could* be added, such as traditional emissions regulations under

80. *See* M. Scott Taylor, *Unbundling the Pollution Haven Hypothesis*, 4 B.E. J. Econ. Analysis & Pol'y art. 8 (2005) (The notion that emissions-intensive industries will move to less stringently regulated countries as a result of environmental policy is known as the "pollution haven hypothesis," and has been tested using theoretical and empirical models. A related concern is emissions leakage: if pollution-intensive activities simply shift from one jurisdiction to another as a result of a carbon price, then (for a global pollutant like CO_2) there may be no net environmental improvement as a result of the policy).

81. *See, e.g.*, American Clean Energy and Security Act of 2009, H.R. 2454, 111th Cong. (2009) (died, passed House) (the proposed U.S. climate bill included provisions supporting the eventual implementation of border tax adjustments).

82. *See generally* Gary C. Hufbauer et al., Global Warming and the World Trading System 66-70 (2009); Trade and Climate Change: Issues in Perspective (Aaron Cosbey ed., 2008); Ben Lockwood & John Whalley, *Carbon-motivated Border Tax Adjustments: Old Wine in Green Bottles?*, 33 World Econ. 810, 811 (2010); Christine Kaufmann & Rolf H. Weber, *Carbon-related Border Tax Adjustment: Mitigating Climate Change or Restricting International Trade?*, 10 World Trade Rev. 497, 498 (2011); Yazid Dissou & Terry Eyland, *Carbon Control Policies, Competitiveness, and Border Tax Adjustments*, 33 Energy Econ. 556, 556-57 (2011); Peter Holmes et al., *Border Carbon Adjustments and the Potential for Protectionism*, 11 Climate Pol'y 883, 884 (2011); Carolyn Fischer & Alan K. Fox, *The Role of Trade and Competitiveness Measures in U.S. Climate Policy*, 101 Am. Econ. Rev.: Papers & Proc. 258, 259, 261 (2011); John Whalley, *What Role for Trade in a Post-2012 Global Climate Policy Regime*, 34 World Econ. 1844, 1850-51 (2011).

the Clean Air Act, if needed. This could be of particular importance if additional policies are needed to carry out some complementary strategies to reduce emissions. For example, a technological standard applying to oil and gas facilities could easily be added onto a carbon tax, but not a cap-and-trade program that covered oil and gas facilities.

Designing and implementing a carbon tax would require resolution of several fundamental issues: (1) the level of taxation, along with any changes over time; (2) the point of taxation; and (3) the use of carbon tax proceeds.

A. Level of Taxation

Environmental taxation as a concept is nearly a century old. Its intellectual heritage is traceable back to economist A.C. Pigou, who argued that because pollution is an "external" harm—meaning that polluters do not fully suffer the costs of pollution—it should be taxed to discourage its production.[83] While pollution is a negative side effect of generally positive industrial activity, polluters who do not fully suffer the costs of their pollution will pollute *more* than is economically efficient for society as a whole. A *Pigouvian* tax is a tax on a unit of pollution that is set at the amount of social harm caused by that unit of pollution.[84]

The Pigouvian ideal of taxation at the level of marginal social harm remains a useful reference point. But in jurisdictions with carbon taxes, economic theory readily gives way to practical considerations. Carbon taxation could be a revenue-raising mechanism, in which case the tax level might be set at a level sufficient to raise a certain amount for government coffers. Carbon taxation might also be set with interjurisdictional competitiveness in mind, so that industries subject to the tax would not suffer too much loss of business vis-à-vis emitters in jurisdictions where carbon is not taxed or regulated. Finally, carbon taxation might be set so as to achieve a particular level of emissions reduction, bearing in mind the uncertainties involved with economic projections (as discussed above).

Given the high levels of uncertainty about the marginal social harms from greenhouse gas emissions, setting a level of carbon taxation is thus not so much the application of economic theory to practice, but an exercise in finding some reasonable level, given political constraints. It is certainly more important that some carbon tax be imposed, even at a low level, than to get the level exactly right at the Pigouvian ideal. The U.S. government, through an interagency working group convened by the Council of Economic Advisers and the Office of Management and Budget, has estimated the current "social cost of carbon"—the marginal cost of a ton of CO_2 emissions—at $42.[85] To underscore the range of uncertainty, the updated 2015 analysis—which raised the analogous 2010 estimate from $26 per ton—used three different discount rates to calculate a range of social cost of carbon estimates from $11 to $56 per ton.[86] While the social cost of carbon is not intended to inform a federal carbon tax, but rather to aid federal agencies in performing cost-benefit analyses, the sophisticated analysis embedded in the project would seem to provide some reasonable anchor for a carbon tax level.

The higher of two carbon taxes assumed by EIA in its analysis, discussed above[87]—$25 per metric ton—is a reasonable starting point. Such a level would place it on a par with British Columbia's carbon tax. Such a level would place the United States in the middle of a global range of carbon prices, much lower than those in Scandinavian countries, but much higher than in less prosperous countries such as Mexico and Costa Rica.

A carbon tax should increase over time. Economists engaged in climate policy have provided a theoretical framework for increasing a carbon tax over time. With highly uncertain estimates of damages caused by climate change, economists have more or less taken a guess as to the functional form for economic damages, and inserted what seem like reasonable parameters. The prevalent notion that a carbon tax should increase over time is driven by two stylized economic facts: (1) the discount rate—the rate at which future costs and benefits should be discounted in aggregating the many effects of climate change; and (2) the increasing damage over time of climate change. While economists have debated the functional form and parameter values, all agree that in the absence of sufficient climate policy, the damages from climate change increase over time.[88] Again, with Pigouvian taxation as a guide, economists widely agree that a carbon tax should increase over time.

But here again, policy and political realities trump economic arguments. Increments in carbon taxation level are driven more by what is considered feasible or politically expedient. The British Columbia carbon tax began at the level of CAD10 per ton, and increased by CAD5 per ton per year until it reached its current level of CAD30 per ton. The ramp-up period was designed to provide notice for emitters in British Columbia, and the $30 level just a reasonable-sounding endpoint, given the other extant and proposed carbon prices throughout the world. Certainly, if

83. Alfred C. Pigou, The Economics of Welfare 131-35 (1928).
84. William J. Baumol & Wallace E. Oates, The Theory of Environmental Policy 21-23 (2d ed. 1988).
85. Interagency Working Group on Social Cost of Carbon, Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12866, at 3 (2015), https://obamawhitehouse.archives.gov/sites/default/files/omb/inforeg/scc-tsd-final-july-2015.pdf.
86. *Id.*
87. EIA, *supra* note 54, at MT-34.
88. Nicholas Stern, The Economics of Climate Change: the Stern Review 303 (2007).

economic reason were to prevail, the province would have continued increasing its carbon price. But competitiveness and political concerns have quelled efforts to further increase the British Columbia carbon tax.

In order to ensure that the carbon tax level increases over time to reflect rising damages from climate change, a carbon tax level must increase in *real* terms, not just nominal terms. EIA's estimates assumed carbon taxes increased at the rate of 5% per year *in excess of inflation*, so as to maintain a steadily increasing economic incentive no matter what the inflation rate happens to be.[89] A carbon tax should be similarly indexed to increase in real terms, not just nominal terms. The federal Highway Trust Fund, which was not indexed at all, is so grossly underfunded so to render U.S. federal infrastructure dangerously inadequate.[90]

B. *Point of Taxation*

Economic theory posits that the point of taxation is irrelevant. A tax imposed upstream, at a fuel production point, would be partially passed down to consumers. But a fuel producer is limited in its ability to pass costs onto consumers, because at a certain point, consumers would adjust their behavior and reduce consumption. Fuel producers would thus balance lost revenues against lost demand, and absorb some of the tax burden. A tax imposed downstream, on consumers, would also induce changes in behavior and reduction in demand. Anticipating this, producers would lower wholesale prices so as to absorb some of the tax burden. In such a manner, a downstream tax is passed "upwards" to producers. In both cases, the key is that adjustment occurs at the point at which it is least costly, and the tax burden borne by those least able to adjust.

From a tax collection perspective, minimizing the number of taxed parties minimizes leakage and therefore maximizes revenues, so that levying the tax upstream—at a point of extraction or processing—would appear to be optimal. A downstream tax would also be more visible, so that it would feed the economically faulty but politically opportunistic argument that a carbon tax is "hurting consumers." Carbon taxes hurt both consumers and producers no matter where they are imposed, but the political optics of upstream versus downstream are dramatically different. Given the political optics and the administrative issues with carbon taxation, the most sensible point at which to levy a tax is upstream, at the point of fuel extraction or processing, or at a point of import. At that level, the number of taxed entities is on the order of several thousand,[91] and is manageable in terms of tax administration and enforcement.

C. *Revenue Options*

A discussion of revenue options is important for a full accounting of carbon pricing. A carbon tax creates compliance costs for producers and consumers shifting to less greenhouse gas-intensive behavior, but generates benefits in the form of reducing emissions. Critically, a carbon tax also offers the benefits of revenues (also for cap-and-trade, but only if allowances are auctioned), which could be used to fund any number of things. A $40 per ton carbon tax would generate approximately $200 billion per year in revenues,[92] so this is a very substantial item on the benefit side of the cost-benefits ledger.

Carbon taxation thus carries with it very large fiscal implications. A carbon tax of any significant level, whether at the state or federal level, is necessarily fiscal policy. Decisions on the uses of carbon tax revenues are thus not purely economic in nature. If they were, then there would be no reason to stray from the standard public finance prescription of simply absorbing carbon tax revenues into the general treasury and appropriating them where most needed.[93] Rather, enacting a carbon tax, along with its revenue implications, is a discrete action with specific political and legal choices.

Carbon tax revenues might serve a variety of uses. They might be spent on environmental or climate-related projects. Carbon tax revenues might also be returned to taxpayers, commonly referred to as "revenue recycling." Finally, carbon tax revenues might simply be treated as any other source of government revenue. In purely economic terms, there is no reason *not* to treat carbon tax revenues like any other source of revenue. But the political reality is that, in order for a carbon tax to be enacted, it must be accompanied by some other policy that satisfies a political objective. Carbon tax revenues provide a vehicle for satisfying those objectives.

Generally and broadly speaking, three objectives might be advanced by carbon tax revenues: (1) economic efficiency; (2) wealth redistribution; and (3) environmental objectives. As it happens, most credible economic analysis suggests there is relatively little overlap among the three. That is, a revenue use that redistributes wealth appears, with current economic modeling techniques,

89. EIA, *supra,* note 54.
90. Tax Policy Center Briefing Book: Key Elements of the U.S. Tax System, *What is the Highway Trust Fund, and how is it financed?,* http://www.taxpolicycenter.org/briefing-book/what-highway-trust-fund-and-how-it-financed (last visited Nov. 17, 2017).
91. Gilbert Metcalf & David Weisbach, *The Design of a Carbon Tax*, 33 Harv. Envtl. L. Rev. 499 (2012).
92. Schwartz, *supra* note 7.
93. *See* Craig Brett & Michael Keen, *Political Uncertainty and the Earmarking of Environmental Taxes*, 75 J. Pub. Econ. 315, 316 (2000).

to be relatively inefficient in terms of levels of economic activity.[94]

This section of the chapter reports analysis that comes with several very important caveats. One caveat is that current economic modeling techniques do not necessarily capture all of the important economic and social effects that might affect economic activity, inequality, or even environmental impacts. As such, some of the results should be taken with a grain of salt, as some of the unmeasured effects may have large (but unmeasurable) economic effects. Another caveat is that efficiency is gauged by "economic activity," which is in turn gauged by GDP, which economists widely admit is a very crude index.[95] "Economic activity" is manifestly not the same thing as economic efficiency. Many economic transactions create costs that exceed the benefits of economic activity, but GDP fails to assign the proper negative weight to harmful externalities of economic activities.[96] Not only that, GDP may actually assign a positive economic value to public health harms, in that medical treatment necessitated by pollution could count as positive economic activity.[97] So statements about economic efficiency contained in this part of the chapter should be read with an awareness of a number of biases.

With those caveats in mind, it is still useful to review the impacts of carbon tax revenue uses that would advance the three objectives outlined above. A variety of policies might serve any one objective; it is still possible to make some general observations, cautiously informed by economic analysis, about the likely impacts of these policies.

1. Economic Efficiency

Carbon taxation has sporadically entered budget discussions as a way to reduce other taxes that may be distortionary and therefore suppress economic activity. The United States has the highest statutory corporate income tax rates among the 34 Organisation for Economic Co-operation and Development (OECD) countries,[98] so reduction in marginal federal corporate income tax rates has often been mentioned as a part of a bargain among fiscal conservatives and climate advocates. While U.S. corporations also enjoy an intractably large and bewildering array of tax benefits, effective corporate income tax rates are still high in comparison with other OECD countries.[99] In recent years, a number of U.S.-incorporated firms have actually changed their taxpaying status by engaging in a merger with a foreign corporation, and reincorporating in another country, thereby avoiding high U.S. rates.[100] Corporate income taxes are also believed to displace investment, which contributes to economic activity and therefore growth.[101]

Roughly the same may be said of using carbon tax proceeds to reduce capital gains taxes, which implicate corporations as well as wealthy individuals. Reducing both of these taxes would benefit wealthy individuals and corporations in this country, but would, under current modeling techniques, create the smallest decline in economic activity, and, in some cases, generate a slight increase.[102] If one were to use GDP as the metric for economic efficiency, a carbon tax that is paired with reductions in corporate income tax or capital gains tax rates are, in a sense, almost costless.

In purely economic terms, there is no logical reason to treat carbon tax revenues any differently from any other source of revenue for the government. It could well be that the most efficient use would be to lower corporate income tax rates, but there is no logical reason for any carbon tax proposal to constrain the options available to a welfare-maximizing government. The problem is, of course, that few people believe that governments maximize welfare, nor are many willing to accept the choices made in trying to maximize welfare. A proposal that carbon tax proceeds be absorbed into the U.S. Treasury would face strong political challenges.

2. Wealth Redistribution

"Recycling" carbon tax revenues in ways that seem to increase GDP have the unfortunate side effect of exacerbating wealth and income inequalities.[103] Without any rev-

94. Jared Carbone et al., Resources for the Future, Deficit Reduction and Carbon Taxes: Budgetary, Economic, and Distributional Impacts 8 (2013), *available at* http://www.rff.org/files/sharepoint/WorkImages/Download/RFF-Rpt-Carbone.etal.CarbonTaxes.pdf.
95. *See, e.g.*, Daniel Kahneman et al., *Back to Bentham? Explorations of Experienced Utility*, 112 Q.J. Econ. 375, 375 (1997); Andrew J. Oswald, *Happiness and Economic Performance*, 107 Econ. J. 1815, 1815 (1977) ("Economic performance is not intrinsically interesting. No-one is concerned in a genuine sense about the level of gross national product last year or about next year's exchange rate. . . . The relevance of economic performance is . . . not the consumption of beefburgers, nor the accumulation of television sets, nor the vanquishing of some high level of interest rates, but rather the enrichment of mankind's feeling of well-being. Economic things matter only in so far as they make people happier.").
96. *See, e.g.*, Joseph E. Stiglitz et al., Mis-measuring Our Lives: Why GDP Doesn't Add Up 23 (2010).
97. Edward D. Kleinbard, We Are Better Than This: How Government Should Spend Our Money 18 (2014).
98. OECD Tax Database, *Table II.1. Statutory Corporate Income Tax Rate*, http://stats.oecd.org/index.aspx?DataSetCode=TABLE_II1 (last visited Sept. 24, 2017).
99. Kevin A. Hassett & Aparna Mathur, *Report Card on Effective Corporate Tax Rates: United States Gets an F*, 1 Am. Enterprise Inst. Tax Pol'y Outlook 3-5, (2011), *available at* https://www.aei.org/wp-content/uploads/2011/10/TPO-2011-01-g.pdf.
100. *See, e.g.*, David Jolly, *Ireland, Home to U.S. "Inversions," Sees Huge Growth in G.D.P.*, N.Y. Times, July 12, 2016, https://www.nytimes.com/2016/07/13/business/dealbook/ireland-us-tax-inversion.html.
101. *See* Steven Fazzari et al., *Investment, Financing Decisions, and Tax Policy*, 78 Am. Econ. Rev.: Papers & Proc. 200, 204 (1988).
102. *See, e.g.*, Carbone et al., *supra* note 94, at 4.
103. David Domeij & Jonathan Heathcote, *On the Distributional Effects of Reducing Capital Taxes*, 45 Int'l Econ. Rev. 523, 538-39 (2004).

enue recycling at all (such as assuming a riotous bonfire of carbon tax proceeds), a carbon tax is widely believed to be regressive.[104] While rich households consume more energy (which in most parts of the United States is highly fossil fuel-generated) and generally have a larger carbon footprint than poor households, energy makes up a larger fraction of a less flexible household budget for poorer households.[105] A naked carbon tax by itself imposes more pain on poorer households than rich. If carbon tax revenues are collected and actually accounted for, but distributed to wealthier households, the regressiveness of such a carbon tax would be exacerbated. Using carbon tax proceeds to provide tax relief to predominantly wealthy households would likely have this additionally regressive effect.

While some revenue recycling schemes exacerbate regressiveness, some schemes not only offset, but *reverse*, the regressiveness of a carbon tax. While carbon tax revenues could be used to reduce distortionary but progressive taxes, they could also be used to reduce regressive taxes. Payroll taxes such as Social Security disproportionately affect lower income earners, so reducing them would be substituting one regressive tax for a different, perhaps more regressive tax. More generally, carbon tax proceeds could serve wealth redistribution objectives by reducing income taxes, provided that the income tax relief is targeted towards poorer households. The British Columbia carbon tax reduced the personal income tax rates for the two lowest of the five personal income tax brackets, with the goal of ensuring that no taxpayer earning more than about CAD80,000 would receive a personal income tax reduction.[106]

Another proposal is to collect carbon taxes using a sovereign trust instrument that is dedicated to rebating the proceeds to every U.S. household in a flat lump sum. While every household would receive the same amount of money, the marginal effects on wealth of the rebate would be much greater for poor households than rich. Because rich households consume far more carbon-intensive energy than poor ones, the rebate would generally overcompensate poor households for their increased energy costs, while undercompensating rich ones. The net effect of such a dedicated trust proposal would be to effect a modest wealth redistribution from rich to poor. For a $30 per ton carbon tax, the mean rebate would amount to about $1,500.[107] It is important to note that considerably less than 100% of carbon tax revenues is needed to make poorer households whole.[108] Thus, it is possible for the proceeds to be split up among different uses to address different objectives.

It is also possible to think of wealth distribution in more political terms. Since certain regions of the country would be disproportionately harmed by climate policy, such as coal-producing regions, carbon tax proceeds could also be used to compensate these regions or groups for a loss of business. A common suggestion has thus been that a comprehensive climate policy should include a component that would reduce the economic dislocation that would be caused by a large shift in energy resources, if not out of a sense of obligation, then at least out of a strategic desire to improve the political acceptability of climate policy.[109] Taking into account the needs of individuals and households in these vulnerable groups and communities is, from this perspective, just considering another aspect of regressiveness.

How money could be used effectively to compensate for the loss of an entire industry is unclear. Retraining individual workers would seem to go the farthest in terms of addressing concerns with economic dislocation.[110] This undertaking is not beyond imagination. The U.S. Bureau of Labor Statistics reports that roughly 70,000 workers are employed by the coal industry,[111] making a transition of that scope worthy of considerable thought and planning. Retraining programs would need to be part of a larger, more comprehensive program. There is no point in retraining individuals for nonexistent jobs. A more comprehensive and thoughtful effort would redevelop the economy of entire regions. There is some economic risk in such a plan: as opposed to programs that return money directly to households, these types of programs are social spending programs fraught with potential for waste. (This issue is discussed in greater detail in Chapter 24 (Phasing Out Fossil Fuels in the Electricity Sector).)

Economic models generally produce results suggesting that redistributing wealth may ease inequalities, but at a cost to economic activity.[112] This is the prevailing economic wisdom because these models assume that if a dollar is allocated to a poor household, it is a dollar that could have been allocated to capital investments that might produce economic growth. A dollar in the hands of a poor

104. *See, e.g.*, Shi-Ling Hsu, The Case for a Carbon Tax: Getting Past Our Hang-ups to Effective Climate Policy 124-38 (2011).
105. *Id.* at 124-138.
106. Shi-Ling Hsu & Tony Crossman, *British Columbia Climate Change Law and Policy*, *in* The Law of Climate Change in Canada 5-1 (Dennis Mahony ed., Canada Law Book 2d ed. 2013).
107. Roberton C. Williams III et al., *The Initial Incidence of a Carbon Tax Across Income Groups*, 68 Nat'l Tax J. 207-13 (2015).
108. Danny Cullenward et al., *Dynamically Estimating the Distributional Impacts of U.S. Climate Policy With NEMS: A Case Study of the Climate Protection Act of 2013*, 55 Energy Econ. 303, 305 (2013).
109. Adele C. Morris, Brookings Institution, Build a Better Future for Coal Workers and Their Communities (2016), *available at* https://www.brookings.edu/wp-content/uploads/2016/04/build-a-better-future-for-coal-workers-and-their-communities-morris-updated-071216.pdf.
110. *Id.*
111. U.S. Bureau of Labor Statistics, *Occupational Employment Statistics, May 2016 National Industry-specific Occupational Employment and Wage Estimates, NAICS 212100—Coal Mining* ("All Occupations," 69,460), https://www.bls.gov/oes/current/naics4_212100.htm#00-0000 (last modified Mar. 31, 2017).
112. *See, e.g.*, Carbone et al., *supra* note 94, at 4.

individual is more likely to be spent, generating economic activity, and models take this into account. But by and large, model parameters produce results that suggest that money in the hands of wealthy producers generates more economic activity than it would if it were placed in the hands of poor consumers.[113]

There is reason to believe, however, that this prevailing economic wisdom may not capture every important aspect of the current world economy. It has been commonly observed that, subsequent to the 2008-2009 global financial crisis, firms have used money to hoard cash, eschewing capital investments, and therefore not stimulating economic activity.[114] If, taking into account historical investment trends, that is true, and if there is a systemic economic reason for a lack of spending, then there is no reason to be placing money in the hands of producers, since they are not spending it anyway. It is hard to say, given current economic modeling techniques, whether the stimulative effects of investment tax relief or consumer spending is greater. But in considering the tradeoff between wealth redistribution and GDP, it may be worth keeping in mind that the tradeoff may not be quite as stark as current economic models suggest.

3. Climate Policy Spending

In addition to imposing a marginal cost on emissions, a carbon tax could also be used to augment greenhouse gas reduction measures by using the proceeds to subsidize low-carbon or non-carbon energy generation. Carbon tax proceeds might subsidize capital investments for such technologies. As part of economic stimulus to address the 2008-2009 global financial crisis, the American Recovery and Reinvestment Act put into place subsidies for renewable energy sources, which have contributed to an upsurge in wind and solar energy deployment.[115]

However, economists who favor carbon taxation do not generally favor the "belt and suspenders" approach of also using the proceeds to subsidize renewable energy.[116] The more elegant economic prescription is to levy the right level of carbon tax, rather than use two instruments—the tax and the subsidy—to accomplish the same purposes. The one exception would be to fund some research and development for renewable energy technologies. Some economists recognize that incumbent fossil fuel industries, having evolved for more than a century, enjoy huge advantages in terms of scale economies and research and development infrastructure, and have an enormous head start over alternative, low- or non-carbon technologies.[117] Under those circumstances, some "catch-up" funding to build up research and deployment capacity for renewable energy technologies may be economically efficient after all.

4. Revenue Options Generally

Revenue recycling options present intriguing possibilities for overcoming some of the political opposition to carbon taxation. However, the actual implementation of such a proposal is more complicated than assumed by economic models projecting the likely effects. For example, some models assume, for the sake of clarifying the tradeoffs inherent in a carbon-tax-for-income-tax swap, that the *exact* amount of carbon tax revenues can be returned in the form of income tax relief. In other words, perfect revenue neutrality is *assumed*, rather than built into the design of hypothesized policy. In reality, of course, tax revenues are uncertain. Personal income tax collections, in particular, depend on a variety of factors, such as compliance rates (which themselves are a function of the resources afforded the Internal Revenue Service to monitor compliance), economic conditions, income distributions, and international tax dynamics. Revenue neutrality is thus a concept that should not be taken too literally.

It is also entirely possible that carbon tax revenue uses could be put to multiple uses, not just one of the above. In that way, some of the tensions between, say, wealth distribution and economic efficiency (at least as modeling efforts seem to suggest) might be greatly reduced by dedicating some of the proceeds to mitigating the costs to poor households and some to stimulating economic activity. The British Columbia carbon tax reduced the lowest two marginal personal income tax brackets, while also reducing provincial corporate income tax rates.

Given the possibility of serving multiple masters, a carbon tax proposal seems most usefully designed to achieve some combination of all three objectives. Further subsidizing renewable energy deployment may be duplicative, but using a small amount of carbon tax revenues to provide a boost to underfunded research and development efforts for low- or non-carbon technologies could be economically worthwhile. As between addressing economic efficiency and wealth redistribution, gaps in economic knowledge militate in favor of recycling revenues by dedicating more of it to poorer households. Using carbon tax proceeds to avoid regressive effects is a more certain proposition than using them to boost economic activity. While it is certain that carbon taxation is regressive, and that returning some

113. Carbone et al., *supra* note 94, at 4.
114. *See, e.g.*, Adam Davidson, *Why Are Corporations Hoarding Trillions?* N.Y. Times, Jan. 24, 2016, at MM22.
115. Shi-Ling Hsu, *Capital Rigidities, Latent Externalities*, 51 Hous. L. Rev. 719, 750 (2014).
116. Donald B. Marron & Adele C. Morris, Tax Policy Center, How to Use Carbon Tax Revenues (2016), *available at* https://www.brookings.edu/wp-content/uploads/2016/07/howtousecarbontaxrevenuemarronmorris.pdf.
117. Daron Acemoglu et al., *Transition to Clean Technology*, 124 J. Pol. Econ. 52 (2016).

amount of proceeds to poorer households can avoid that regressive effect, it is far less certain that income tax relief targeted towards potential producers would have a positive economic effect.

D. The Effect of a Carbon Tax Option

The best guess for the effect of the $25 per ton carbon tax hypothesized by the EIA is that it would produce an emissions decrease larger than that forecast by EIA: a 36% decrease in emissions from a baseline case by 2040, representing a 32% decline from emissions that occurred in 2012. The error bars are very large. There is still good reason to believe that models forecasting emissions reductions are too conservative, and fail to capture unpredictable events, like disruptive technological change in energy or climate technologies. Because of the reluctance of economic modelers to wander too far from forecasts based on measurable historical data, it is more likely that emissions reductions estimates are more modest than will actually be the case. How much so is impossible to say.

V. Conclusion

Carbon pricing must clearly be a centerpiece of any portfolio of policies to achieve deep decarbonization. The breadth of behavior and infrastructure that must be changed, and the ubiquity of decisions made by literally billions of actors, require that some incentive in the form of a price be imposed across an entire economy. It is true that a portfolio of policies is needed, as carbon pricing alone would still leave many areas of emissions unregulated, potentially undoing some emissions reductions. But as a foundational policy that leaves open the possibility of other regulations, carbon pricing is a necessary first step. As between the two carbon pricing instruments, carbon taxes are superior to cap-and-trade programs in building upon, and not conflicting with, other policies.

While carbon pricing is essential to deep decarbonization, its exact contribution to any particular strategy is at this point very difficult to accurately project. Economic models of various carbon prices suggest that more policies will be needed to achieve an 80% reduction in emissions by 2050, but even this tentative conclusion is clouded by numerous uncertainties. The absolute level of emissions decades in the future depends upon too many variables, of which a carbon price is one—the most important one, to be sure—but only one factor. Economic growth, technological progress, and a variety of economic and geopolitical factors may drive emissions, even in the presence of a strong carbon price.

Because carbon pricing creates very broad economic effects, legitimacy for a carbon pricing law is essential. Several pathways to carbon pricing exist that build in the requisite political and legal legitimacy. Climate change is broadly recognized as an existential threat to humankind and for millions of other forms of life, but as recent history demonstrates, that is no guarantee of agreement on climate policy. Carbon pricing is the most effective, but ironically the most contentious, of climate policies, and requires the highest level of political and legal legitimacy.