

***DESIGNING ENERGY AND ENVIRONMENTAL FISCAL INSTRUMENTS
TO IMPROVE PUBLIC HEALTH***

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Abstract

Environmental pollution represents a significant cause of morbidity and premature mortality. Nearly seven million people die prematurely around the world each year as a result of air pollution, and hundreds of thousands more die due to unimproved water and sanitation (Lim et al., 2012). The monetized health and productivity damages from air pollution exceed a hundred billion dollars annually in China and the United States (Matus et al., 2012; US EPA, 2011).

In response to the significant impacts of pollution on health, governments traditionally pursued command-and-control regulations. These have delivered significant gains in environmental health, although high costs of regulatory mandates suggest the need for alternative approaches to reducing pollution. This paper focuses on taxes and subsidies as potential means for reducing the health burden from environmental pollution.

Pollution taxes change the business calculus for the sources of pollution (Aldy et al., 2010). Just as higher wages induce firms to invest in labor-saving capital, a pollution tax induces investments that lower pollution. A well-designed tax can ensure that all sources face the same marginal cost of pollution, thereby minimizing the aggregate costs for a given gain in environmental and health quality, and can maximize social welfare by ensuring that the tax equals the marginal benefits of pollution reduction. Raising revenue through a pollution tax could help offset labor and capital taxes, which are distortionary and impose welfare costs as a consequence of raising revenues through these means. Some countries environmentally-related tax revenues comprise 5-10 percent of total tax revenue (OECD, 2011). Taxing fossil fuels in the United States to account for local air pollution and climate change damages would raise revenues equal to about 1.5 percent of GDP (Jorgenson, 2012).

Subsidies in the energy sector can have a profound impact on pollution and health outcomes. Many countries in the developing world subsidize fossil fuels that results in excessive consumption and increased air pollution. Iran's 2010 subsidy reform illustrates the impact of reducing fossil fuel subsidies: fuel prices increases of an order of magnitude reduced carbon dioxide, sulfur dioxide, and nitrogen oxide emissions by 10-20 percent (IMF, 2011). Subsidies for clean energy technologies, by lowering their adoption cost, may displace dirtier sources of energy and produce public health benefits. Subsidizing specific clean energy technologies is typically more costly in aggregate than a pollution tax since it fails to fully exploit the flexibility that a tax offers. For example, a subsidy for an existing set of technologies may not reward innovation like a tax would, nor would it support technologies or process changes that are beyond the scope of the parameters of the subsidy.

The design and implementation of fiscal instruments should account for a variety of real-world considerations. Tax instruments deliver greater certainty for the returns to emission abatement investment, and could drive more abatement and innovation than command-and-control regulations or cap-and-trade programs. Such certainty is transparent, which may elicit political opposition since policy-makers typically prefer to impose opaque costs on constituents (Keohane et al., 1998). In some cases, it may be technically or administratively challenging to directly target the pollution externality. For example, India taxes coal as opposed to the more

difficult to monitor sulfur dioxide emissions from coal combustion. There are also important interaction effects among multiple policies, such as the prospect of a pollution tax to raise revenue that enables a reduction in labor and capital tax rates. This new revenue source could improve the political palatability of pollution taxes given the fiscal demands in many countries, and a prudent ramping of the policy over time may facilitate broader public support. In countries with subsidized fossil fuel prices, a pollution tax may be ineffective unless the tax can be passed through to consumers. Finally, a pollution tax or fossil fuel subsidy elimination will increase energy prices, and this could raise important distributional questions. Some policy reforms – including the British Columbia carbon tax and the 2005 fossil fuel subsidy reform in Indonesia – have included means-tested unconditional cash transfers to address regressivity concerns.

Keywords: pollution tax, carbon tax, fossil fuel subsidies, cap-and-trade

JEL Codes: H23, Q53, Q58

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I. INTRODUCTION

Environmental pollution represents a significant cause of morbidity and premature mortality. Household air pollution from the combustion of solid fuels, such as coal and biomass, ranks as the third leading risk factor in the global disease burden, resulting in some 3.5 million premature mortalities annually. Ambient particulate matter pollution, primarily from the combustion of fossil fuels in transportation, industry, and the power sectors, contributes to another 3.2 million premature mortalities globally. Unimproved water and sanitation lead to more than 300,000 premature mortalities around the world each year (Lim et al., 2012).

Waterborne diseases rank as the third leading cause of excess mortality in the developing world (Bruce et al. 2006). In developing countries, indoor air pollution causes about one-third of children's acute respiratory infections, which accounts for about 20 percent of under-age five mortality (Duflo et al., 2008). Air pollution imposes economic damages – from morbidity, mortality, and foregone labor productivity – in China on the order of more than \$120 billion per year (Matus et al., 2012). Reducing particulate matter pollution in the United States through 2020 may lower annual premature mortality by several hundred thousand (US EPA, 2011).

In response to the significant, adverse impacts of pollution on health, governments have pursued an array of public policy interventions. Conventional command-and-control regulations have delivered significant gains in environmental health, especially in developed countries, although questions of cost-effectiveness remain (US EPA 1997; Lutter and Belzer, 2000). Subsidies for investments in cleaner-burning cook stoves and for water treatment have aimed to

reduce exposure to environmental pollutants in developing countries, with mixed results (Hanna et al., 2012). Market-based approaches, such as pollution taxes and cap-and-trade programs, have increased in application to air, water, and waste pollution problems in recent years, reflecting interest in cost-effective mitigation and the potential for raising revenues (OECD, 2011). This paper focuses on fiscal instruments – taxes, subsidies, and to a limited degree, cap-and-trade programs – as potential means for reducing the health burden from environmental pollution.

Pollution taxes change the business calculus for the sources of pollution. With the emission of every unit of pollution, sources covered by such a tax must bear the social cost of pollution – for many types of emissions, this primarily reflects premature mortality risk – and this creates the incentive for them to seek out ways to reduce their adverse impact on environmental health. A well-designed tax can ensure that all sources face the same marginal cost of pollution, thereby minimizing the aggregate costs for a given gain in environmental and health quality, and can maximize social welfare by ensuring that the tax equals the marginal benefits of pollution reduction. The tax instrument provides a significant opportunity to raise revenue – some countries environmentally-related tax revenues comprise 5-10 percent of total tax revenue – that could allow for a reduction in distortionary labor and capital tax rates. While pollution taxes can deliver socially efficient environmental protection and substantial associated health benefits, administrative feasibility and political obstacles have undermined broader application to date.

Subsidies in the energy sector can have a profound impact on pollution and subsequent health outcomes. Many countries in the developing world subsidize fossil fuels – gasoline, diesel, kerosene, electricity, and natural gas – that results in excessive consumption of these fuels, weak incentives for adoption of low-emitting alternatives, and increased air pollution.

Phasing out these fossil fuel subsidies could deliver substantial health benefits and serve as a precursor to subsequent pollution taxes. Failing to remedy fossil fuel subsidies could limit the efficacy of pollution taxes in delivering emission abatement. Subsidies for clean energy technologies, by lowering their adoption cost, may displace dirtier sources of energy and produce some public health benefits. Subsidizing specific clean energy technologies is typically more costly in aggregate than a pollution tax since it fails to fully exploit the flexibility that a tax offers to covered firms. In many countries, the politics of clean energy subsidies are ambiguous: energy sector firms generally prefer subsidies for new investment to taxes on existing investment, but budget hawks may prefer tax revenues to a subsidy scheme's tax expenditures.

In this paper, I address energy taxes and subsidies. The vast majority of local air pollution and the carbon dioxide (CO₂) emissions that contribute to global warming occur as a by-product of fossil fuel combustion. Many developed countries have employed taxes on transportation fuels, and on other forms of energy to a lesser extent, and many developing countries have subsidized transportation fuels and electricity, with potentially significant environmental health and climate change impacts. The array of energy fiscal instruments affect today's health through local air pollution and future health outcomes through global climate change. In this assessment, I also include a discussion of cap-and-trade. Although cap-and-trade is typically considered a regulatory instrument, it has some important fiscal implications, especially in the case of auctioning emission allowances. Cap-and-trade also has a more extensive track record in practice around the world that can serve to inform consideration of emission taxes.

The next section describes the design of specific energy and environmental fiscal instruments and reviews their application around the world, including pollution and carbon taxes, subsidies for fossil fuels, subsidies for clean energy technologies, and cap-and-trade. The third

section addresses key design features and the political economy of the use of energy and environmental fiscal instruments. The final section concludes with a discussion of policy implications.

II. EXPERIENCE WITH ENERGY AND ENVIRONMENTAL FISCAL INSTRUMENTS

A. Pollution Taxes

The most straightforward fiscal instrument to reduce pollution is to tax it. Imposing a tax on the emissions of an environmental pollutant ensures that the sources of the pollution externality bear the same incentive to reduce the pollution. A well-structured tax can be set at a level equating marginal benefits to marginal costs and, hence, maximizes social welfare. In doing so, the pollution tax can generate substantial revenue to meet existing fiscal needs and/or permit a reduction in distortionary taxes, such as on capital and labor.

The base of a pollution tax could reflect monitored emissions, emission inputs, or some other related measure. For example, the U.S. government collects high-frequency data on sulfur dioxide (SO₂) emissions from power plants. Thus, a SO₂ emission tax could be implemented based on these monitored data. Alternatively, a carbon tax could be implemented based on the carbon content of fossil fuels (see below for more discussion). In general, the basis for the tax should be as closely connected with the harm caused by the pollution as is administratively feasible. In some countries, monitoring and enforcement may suggest a tax on a proxy associated with pollution. For example, India has implemented a coal tax of about \$1 per ton, with the revenues dedicated to clean energy financing. (Refer to section III for a discussion of the trade-offs between administrative feasibility and effective targeting of the externality).

A broad-based tax that covers all sources of a given type of pollution can facilitate cost-effective emission abatement and maximize the tax revenue for a given tax rate. By setting a common tax rate on all sources, firms will respond and make investments such that the cost of their last unit of abatement should be equivalent to the firm's cost of complying with the emission tax. Firms with low abatement costs would undertake more emission abatement and firms with high abatement costs would undertake less emission abatement, but they should all incur the same marginal cost of abatement. As a result, the reduction in environmental pollution is achieved cost-effectively, and no other policy can deliver the same environmental outcome at a lower cost. This approach taps into the profit motive of private firms by providing them with the flexibility to undertake any actions to lower their emissions, and hence legally reduce their tax bill. This represents a more economically appealing alternative to higher cost, command-and-control approaches that limit a firm's flexibility in complying with environmental standards.

To maximize social welfare, the emission tax rate should be set such that it equals the marginal benefits of emission reduction. This is equivalent to requiring the source of pollution to pay for the marginal environmental damage associated with that pollution. Just as a firm must bear the cost of using labor, materials, and capital in the production of its goods, it would also bear the cost of the pollution by-product from its manufacturing process. In practice, emission taxes may fall short of the full social cost, perhaps reflecting political pressure. For example, France implemented a tax on nitrogen oxide emissions (NO_x) of about \$23 per ton starting in the early 1980s while Sweden imposed a tax of about \$4,000/t NO_x .¹ This does not reflect two orders of magnitude difference in the social cost of nitrogen oxide emissions between France and Sweden, but variation in the outcome of a political process.

¹ Note that all references to tons in this paper are technically to metric tonnes.

Several European nations have employed emission taxes as a component of their policy programs aimed at reducing water pollution (OECD, 2011). The Netherlands imposed effluent charges on industrial pollution starting in the 1970s, and these charges are considered the primary driver of declines in organic and heavy metal pollution – as much as one-half in first decade of operation (Bressers, 1988). France has employed a combination of command-and-control regulations and effluent taxes. The tax rates in France are considered too low to have a meaningful impact on pollution (Barde and Smith, 1997; Glachant, 2001). Germany and Denmark have also implemented effluent charges, but with more modest environmental benefits than in the Dutch case, perhaps reflecting differences in policy design and institutional context (Andersen, 2001). In these countries, the revenues from the water effluent charges are typically earmarked for investment in wastewater treatment capacity. Thus, even if the investment does not induce a reduction in pollution at the source, it may nonetheless finance public investment in water quality and hence improve public health. An array of political and institutional factors explains the paucity of effluent charges (as well as cap-and-trade schemes) to reduce water pollution (Boyd, 2003).

In many countries that have centralized water distribution systems, the government typically sets the prices on the quantity of water used by residential, industrial, and agricultural consumers. Changes in Israeli water pricing policies, in response to water scarcity concerns, have reduced agricultural sector water consumption while water productivity in crop production has improved (OECD, 2011). In the U.S. residential sector, households respond to higher prices by economizing on their consumption as well (Olmstead et al., 2007). In combination, price-setting to affect water demand and effluent charges to affect the pollution load of discharged water can

improve local water quality, although the price and tax levels have, in practice, often been set below socially-optimal levels.

An emission tax can raise revenue to finance reductions in taxes that discourage the supply of labor and capital. Lowering payroll, income, or capital gains tax rates could offset some of the costs of environmental policy. Such a “tax swap” would increase the tax rate on “bads,” such as pollution, and reduce the tax rate on “goods,” such as labor and capital. Environmentally-related tax revenue represents about 5 to 10 percent of total tax revenue for several developed countries, including Australia, Denmark, Finland, Italy, the Netherlands, Norway, Sweden, Switzerland, and the United Kingdom (OECD, 2011). In the United States, imposing pollution taxes on fossil fuels to reflect their social costs associated with local air pollution and climate change would raise a significant amount of revenue. The pollution tax on coal would be more than 200 percent of its current price, while the pollution tax on oil and natural gas would be about 10 percent (Jorgenson, 2012). This illustrates the very significant adverse impacts of coal, primarily through premature mortality, that are not reflected in the current prices for the commodity. Implementing such tax rates would result in emission sources facing marginal costs equal to the marginal benefits of pollution abatement and raise tax revenues equal to about 1.5 percent of GDP (based on an analysis calibrated to 2011 data; Jorgenson, 2012).

Despite the appealing attributes of emission taxes, most environmental policies employ command-and-control regulatory standards to reduce pollution. While these regulatory mandates have delivered significant environmental health gains in developed countries over the past several decades, diminishing returns in developed countries and weak monitoring and

enforcement in many developing countries suggest an opening for more extensive use of tax instruments to deliver improved environmental health.

B. Carbon Taxes

A carbon tax represents the simplest approach to ensure that sources of CO₂ emissions bear the full cost of those emissions (Metcalf, 2007). Most carbon tax proposals call for the government to set a tax in terms of dollars per ton of CO₂ on the carbon content of the three fossil fuels (coal, petroleum, and natural gas) as they enter the economy (Aldy, Ley, and Parry 2008). Such an upstream approach can effectively minimize the number of firms covered necessary to tax the entire CO₂ emissions base. It is an appropriate means of targeting CO₂ emissions given the properties of fossil fuels. Monitoring the physical quantities of these fuels yields a precise estimate of the emissions that would occur during their combustion, unless carbon capture and storage technology becomes commercially viable.

To be cost-effective, such a tax would cover all sources, and to be efficient, the carbon price would be set equal to the marginal benefits of emission reduction, represented by estimates of the social cost of carbon (Interagency Working Group on Social Cost of Carbon, 2010). A carbon tax would be administratively straightforward to implement in most industrialized countries, since the tax could piggy-back on existing methods for fuel-supply monitoring and reporting to the tax authority. For example, in the United States, refineries and importers of refined petroleum product pay a per barrel tax to finance the Oil Spill Liability Trust Fund and coal mines pay a per ton tax to finance the Black Lung Disability Trust Fund (Aldy, 2013b). Some developing countries, with effective tax systems, could also implement carbon taxes in a similar manner.

Raising energy prices – through carbon taxation and/or removing fossil fuel subsidies – drive changes in the investment and use of emission-intensive technologies, as reflected in real-world experience with energy prices. In the United States, high gasoline prices in 2008 reduced vehicle miles traveled by the existing light-duty vehicle fleet and resulted in a shift in the composition of new cars and trucks sold toward more fuel-efficient vehicles (Ramey and Vine, 2010). The dramatic decline in U.S. natural gas prices (and decline in the relative gas-coal price) in recent years caused utilities to dispatch more electricity from gas plants that resulted in lower carbon dioxide emissions and the lowest share of U.S. power generation by coal in some four decades (US EIA, 2009). In Guatemala, higher crude oil prices reduced liquefied petroleum gas (LPG) consumption as households substituted to biomass for cooking. The higher consumption of biomass increased the rate of respiratory illnesses among children (Venkataramani and Fried, 2011). High energy prices induce more innovation – measured by frequency and importance of patents – and increase the commercial availability of more energy-efficient products (Newell, Jaffe, and Stavins, 1999; Popp, 2002).

In the 1990s, Denmark, Finland, Norway, and Sweden imposed carbon taxes as part of their programs to limit their greenhouse gas emissions.² In contrast to the standard policy prescription to impose a uniform carbon tax on the entire emission base, these countries have set tax rates that vary by fuel and industry. In Norway, the carbon tax on gasoline is about 70 percent higher than the carbon tax on diesel (Government of Norway, 2009) and, in Denmark and Sweden, energy-intensive manufacturing is effectively exempt from the carbon tax (Government of Denmark, 2009; Daugbjerg and Pedersen, 2004). For those sources facing a carbon tax in northern Europe, the tax rate varied by an order of magnitude in recent years, ranging between US\$17 – US\$135 per ton CO₂ (Aldy and Stavins, 2012a).

² Refer to Aldy and Stavins (2012a) for further discussion of these programs.

The carbon tax policies represented an element of fiscal reform. For example, in 1991, Sweden implemented a carbon tax of about \$33/tCO₂ as a part of a fiscal reform that lowered high income tax rates (Speck, 2008). In 1997, Finland imposed a general tax on energy coupled with a surtax based on the carbon content of the energy.

In 2008, the Canadian province of British Columbia (BC) implemented a carbon tax consistent with many principles of a good tax design discussed above. The carbon tax covers all sources in the economy through an upstream point of compliance (Duff, 2008). The tax started at C\$10 per ton of CO₂ emissions in 2008 and increased by C\$5 per year for four years, finally reaching C\$30/ton in 2012. The provincial government returns 100% of the tax revenue through tax cuts to businesses and individuals, and a Low Income Climate Action Tax Credit for low-income individuals.

An initial assessment of the BC carbon tax suggests that it has reduced consumption of petroleum products and lowered CO₂ emissions without undermining economic activity in the province. A simple differences-in-differences analysis of outcomes for BC relative to other Canadian provinces between the pre-2008 period and the first four years of the carbon tax in BC indicates that per capita consumption of refined petroleum products is about 5.6 percent lower, per capita greenhouse gas emissions are about 5.3 percent lower, and provincial GDP is about 1/10 of 1 percent higher in BC after the implementation of the tax (Elgie, 2012).

C. Fossil Fuel Subsidies

Many countries, especially in the developing world, subsidize the consumption of fossil fuels that result in excessive fuel consumption, local air pollution, and CO₂ emissions. About 61 percent of the world's population lives in countries that price refined petroleum products below

market prices and 60 percent live in countries with subsidized electricity prices (IEA, 2012; UN, 2012).

Removing fossil fuel subsidies can deliver incentives for efficiency and fuel switching comparable to imposing a carbon tax or SO₂ tax. The economic and fiscal benefits of fossil fuel subsidy reform could be significant. In 2008, fossil fuel consumption subsidies exceeded \$500 billion globally, and could exceed \$660 billion by 2020 without policy reforms (IEA, 2011). In at least ten countries, fossil fuel subsidies exceeded 5 percent of GDP, and constituted substantial fractions of government budgets (IEA, 2010). For example, Egypt, Indonesia, and Yemen have had fossil fuel subsidies equal to at least 20 percent of their national government budgets in recent years (OECD et al., 2010; IMF, 2010; Fattouh and El-Katiri, 2012).

Eliminating fossil fuel subsidies could reduce global oil consumption by about 4.7 million barrels per day by 2020, representing a decline of about 5 percent of current consumption. The International Energy Agency (2010) estimates that eliminating all fossil fuel subsidies would reduce global CO₂ emissions by about two gigatons per year by 2020. In general, the climate and health benefits of eliminating fossil fuel subsidies arise from an incentive to conserve or switch to less-polluting sources. For example, the significant ramping up of refined petroleum product prices in Iran starting in December 2010 – in some cases increasing prices by more than an order of magnitude – is estimated to have reduced nitrogen oxide (NO_x) and sulfur dioxide (SO₂) emissions by 10–20 percent in the first year of the subsidy reform (IMF, 2011). Exceptions to this include subsidies for LPG for poor and rural households in developing countries. Removing these subsidies may result in households burning more biomass for cooking, which can cause more adverse respiratory impacts than these fuels. In addition, the

climate benefits of reducing LPG subsidies could be significantly offset by land clearing for and combustion of biomass fuels.

Some governments claim that fossil fuel subsidies serve as a way to benefit poor households, especially in those countries that lack the institutional capacity to implement an effective means-tested cash transfer program. In practice, a significant fraction of subsidies benefit the wealthy. For example, the wealthiest income quintile enjoys 44 percent of petroleum subsidies in Africa and 38 percent of petroleum subsidies in Latin America, while the lowest income quintile receives only 8 and 6 percent, respectively, of the subsidy value in these regions (Coady et al., 2010). In addition, subsidized fuels, especially those targeting low-income households, may be diverted illegally to non-subsidized markets, thereby benefitting those operating in the black market, not low-income households. For example, 40 percent of subsidized kerosene in India has been diverted to non-subsidized markets (Shenoy, 2010).

Some energy subsidies are explicitly design to target low-income households and these programs deliver public health benefits. For example, the U.S. Low Income Home Energy Assistance Program (LIHEAP) provides mean-tested financial support to households for heating in the winter and cooling in the summer. For low-income households, there is a “heat or eat” trade-off, in which fuel expenditure shocks result in lower expenditures and consumption of food (Bhattacharya et al., 2003; Beatty et al., forthcoming). LIHEAP subsidy receipt is associated with less evidence of undernutrition and lower probabilities of emergency room visits among low-income children (Frank et al., 2006). The vast majority of energy subsidies globally, however, are not targeted to low-income households.

D. Clean Energy Subsidies

Many governments have subsidized clean energy investments in an effort to lower conventional air pollution and CO₂ emissions. For example, the clean energy package of the 2009 American Recovery and Reinvestment Act focused on investments in clean energy that targeted various externalities, particularly CO₂ emissions (Aldy, 2013a). Although subsidies for low-emitting technologies are not as efficient as taxing the emitting sources themselves (Metcalf, 2009), the primary policy tools of an economic stimulus are tax expenditures and government outlays, not new taxes.

The Recovery Act provided more than \$90 billion to support clean energy activities including more than \$25 billion for renewable power and nearly \$20 billion for energy efficiency investments (CEA, 2010). Transportation activities, including high-speed rail, mass transit, and advanced vehicles, fuels, and battery technologies received about \$24 billion. The Act appropriated more than \$10 billion for grid modernization, including smart grid deployment and financing for transmission capacity for two Federal power marketing administrations. To promote the deployment of new technologies, the clean energy package employed a variety of policy instruments including deployment grants, tax credits, subsidized bonds, and R&D outlays. Globally, governments spent more than \$400 billion on clean energy subsidies as a part of their stimulus packages in 2008-2009 (Robins et al., 2009).

The significant ramping up of subsidies had a material impact on energy sector investment. In energy efficiency, the Department of Energy weatherized nearly 300,000 homes in 2010 (triple the annual average over 2003-2007), and approximately 600,000 homes with Recovery Act funding. The Recovery Act promoted renewable power through tax credits, grants, loan guarantees, and accelerated depreciation. By the end of 2010, U.S. wind generating capacity had increased about 60% over two years, reflecting triple the investment that the U.S. Energy

Information Administration forecast under its business-as-usual (i.e., no stimulus) scenario. Wind power generation increased from 55 billion kilowatt hours in 2008 to 95 billion kilowatt hours in 2010 and was forecast to exceed 115 billion kilowatt hours in 2011 (US EIA, 2011). These wind subsidies may have reduced U.S. power sector CO₂ emissions as much as 43 million tons in 2010 (Aldy, 2013a).

In recent years, Germany has delivered substantial subsidies for solar power through feed-in tariffs (FITs): fixed rates for power above expected electricity prices for conventional power sources. Over 2008-2010, Germany's expenditures for solar FITs exceeded €10 billion with guaranteed rates as high as 46¢/kWh. During these three years, installed solar capacity more than quadrupled in Germany. Although these resource expenditures delivered a significant increase in solar capacity, these subsidies were not cost-effective. The effective cost per ton of CO₂ abated through the solar FIT was more than €500/tCO₂, an order of magnitude greater than the estimated cost of emission abatement under the EU Emission Trading Scheme (Marcantonini and Ellerman, 2013). Likewise, the generous suite of Recovery Act subsidies for wind (e.g., tax credit, loan guarantees, and accelerated depreciation) and state programs supporting wind power investment (e.g., renewable portfolio standards) resulted in a cost per ton of CO₂ avoided at least four times the social cost of carbon (Aldy, 2013a).

E. Cap-and-Trade

While cap-and-trade is typically considered a regulatory instrument, I have included it in this discussion because it can have important fiscal properties and deliver comparable incentives to reduce pollution as an emission tax. A cap-and-trade system effectively rations the right to emit in a cost-effective manner. It constrains the aggregate emissions of regulated sources by

creating a limited number of tradable emission allowances – in sum equal to the overall cap – and requiring those sources to surrender allowances to cover their emissions (Stavins, 2007). The value a firm places on an allowance reflects the cost of the emission reductions that can be avoided by surrendering an allowance. Trading creates the incentives for allowances to be put to their highest-valued use, i.e., covering those emissions that are the most costly to reduce while firms undertake the least costly reductions (Montgomery, 1972; Hahn and Stavins, 2011). As firms buy and sell a fixed quantity of allowances, a price on emissions emerges, which is effectively the dual of an emission tax that prices emissions and yields a quantity of emissions as firms respond to the tax’s mitigation incentives. Uncertainty in emission abatement costs leads to uncertainty regarding the emissions price under a cap-and-trade system and uncertainty regarding emissions quantity under a tax.

In designing a cap-and-trade system, policymakers must determine the size of the emission cap (i.e., how many allowances to issue), and the scope of the cap’s coverage (i.e., the types of emissions and sources covered by the cap). Policymakers must also determine whether to freely distribute or sell (auction) allowances. Free allocation of allowances to firms could reflect some historical record (“grandfathering”), such as past emissions or sales. Such grandfathering involves a transfer of wealth, equal to the value of the allowances, to existing firms, whereas, with an auction, this same wealth is transferred to the government. As with receipts under an emission tax, auction revenues could be used to reduce distortionary taxes or finance other programs.

In the United States, allowance trading systems have been deployed to phase out lead from gasoline in the 1980s and to lower SO₂ emissions contributing to acid rain starting in the 1990s (Schmalensee and Stavins, 2012). The SO₂ cap-and-trade program lowered emissions in

the power sector to half of their 1980 levels at much lower costs (and allowance prices) than anticipated at the time that the program was passed into law. More importantly, it became clear with epidemiological research that the SO₂ reductions delivered dramatic public health benefits, with annual economic benefits from mortality risk reduction on the order of \$50 - \$100 billion (Schmalensee and Stavins, 2012).

By far the world's largest cap-and-trade program is the European Union Emission Trading Scheme (EU ETS). Beginning in 2005, the EU ETS covers about 11,500 facilities, representing approximately half of EU CO₂ emissions, including oil refineries, combustion installations over 20 MWh, coke ovens, cement factories, ferrous metal production, glass and ceramics production, and pulp and paper production. The EU ETS has expanded to include several non-EU European countries: Croatia, Iceland, Norway, and Liechtenstein. The European Union plans to extend the EU ETS through Phase III, 2013-2020, with a cap becoming increasingly more stringent (at least 20% below 1990 emissions), and a larger share of the allowances subject to auctioning. The EU appears to have lowered greenhouse gas emissions consistent with its Kyoto Protocol target of 8 percent below 1990 levels over the 2008-2012 period (net of some offsets through the Clean Development Mechanism, a project-based approach to lowering emissions in developing countries under the Kyoto Protocol), although further analysis is necessary to determine the role that the ETS played, relative to renewable and efficiency mandates, and the decline in economic activity.

In January 2008, New Zealand launched its Emissions Trading Scheme (NZ ETS) and Australia brought its hybrid tax/cap-and-trade program online in 2012. China has plans to initiate

seven city/provincial level cap-and-trade pilot programs over the next few years and South Korea also plans a cap-and-trade program to address greenhouse gas emissions.³

In the United States, ten northeast and mid-Atlantic states launched the Regional Greenhouse Gas Initiative (RGGI) in 2008, a power sector CO₂ cap-and-trade program. RGGI auctions off all of the emission allowances and most states use the revenues to subsidize clean energy investment. The cap-and-trade program has delivered little environmental benefit because the emissions caps were set at levels that have not been binding since policymakers did not anticipate the 2008-2009 recession or the dramatic decline in natural gas prices. Through June 2013, RGGI has held twenty auctions, and allowances have sold for about \$2-\$3/t CO₂ (reflecting the auction price floor of about \$2/t CO₂ and the prospect of banking allowances for future years when emission caps may be binding). As a result, the program has raised about \$1.3 billion over 2008-2013 for use primarily in state energy programs, and some limited use as general revenues in these states. In 2012, California implemented a cap-and-trade program covering about 85 percent of the state's greenhouse gas emissions. The program established a downward trajectory for emissions through caps intended to lower emissions to 1990 levels by 2020 (Burtraw et al., 2012).

III. INSTRUMENT CHOICE AND DESIGN

A. Prices versus Quantities versus Command-and-Control Regulation

Dating back to the dawn of the modern environmental movement in the 1970s, the conventional approaches to environmental policy have employed uniform standards to protect environmental quality. These so-called command-and-control regulatory standards typically

³ For further details on these cap-and-trade programs, refer to *The World's Carbon Markets: A Case Study Guide to Emissions Trading*, produced by Environmental Defense Fund and the International Emissions Trading Association, available at: <http://www.edf.org/climate/worlds-carbon-markets> (last accessed June 26, 2013).

require specific equipment or procedures (technology standards) or specify allowable levels of emissions (performance standards). In principle and in some practice, uniform technology and performance standards have been effective in achieving some environmental objectives.

Such approaches, however, result in higher costs than necessary to reduce pollution. In addition to failing on static cost-effectiveness grounds, conventional standards do not provide dynamic incentives for the development, adoption and diffusion of environmentally and economically superior emission mitigation technologies. Firms face little incentive to develop or adopt cleaner technology once they have demonstrated compliance with a regulation. The prospect that the government may impose tighter standards in the future if firms voluntarily adopt superior technology today may further inhibit innovation. Since command-and-control regulation impose greater costs than emission taxes or cap-and-trade, it may be difficult to secure political support for a given environmental goal and thus result in weaker standards and lower environmental benefits.⁴

In contrast, emission taxes and cap-and-trade can deliver cost-effective and economically efficient pollution mitigation. As noted above, by explicitly pricing the pollution externality, these types of instruments provide incentives to the private sector to seek out and exploit the lowest cost ways of reducing emissions. By minimizing the costs of pollution abatement, they can facilitate the setting of more ambitious pollution reduction goals, in terms of both the political process and benefit-cost analysis. The setting of tax levels or emission caps such that marginal costs equal the marginal benefits of pollution abatement can maximize social welfare. In theory, and assuming certainty in costs and benefits, an emission tax and a cap-and-trade program can be designed to deliver equivalent, welfare-maximizing outcomes.

⁴ Command-and-control regulation may be appropriate for those special cases in which emission monitoring and enforcement are technically challenging and particularly costly. This serves as one explanation for light-duty vehicle tailpipe emission standards.

While emission taxes and cap-and-trade are generally preferred on efficiency and cost-effectiveness grounds to command-and-control, the comparison between tax and cap-and-trade instruments is more ambiguous. On efficiency grounds, an emission tax would be preferred to an otherwise equivalent cap-and-trade program if the former enabled a reduction in distortionary tax rates while the latter gave away emission allowances for free. On political grounds, however, the free allocation of allowances may be necessary to secure sufficient support for the pollution reduction policy (Aldy and Pizer, 2009).

The uncertainties characterizing the costs of reducing pollution impact the tax versus cap-and-trade calculus. Price-based approaches like an emission tax provide certainty over marginal costs of compliance but result in uncertain environmental outcomes. Quantity-based approaches like cap-and-trade provide certainty over the environmental outcomes but result in uncertain marginal abatement costs. Given the uncertainties in reducing emissions, a tax is generally preferred if a small change in emission abatement would result in a greater change in costs than in benefits. If small change in abatement delivers a greater change in benefits than costs, then a quantity instrument would be preferred under abatement cost uncertainty (Weitzman, 1974). In the context of mitigating greenhouse gas emissions, the estimated benefit and cost functions typically employed to evaluate climate change policies provide evidence that a price-based approach, such as a carbon tax, would deliver greater social welfare than cap-and-trade (Aldy et al., 2010).

Complicating this analysis, and suggesting further evidence that a tax instrument is preferable to cap-and-trade, is the impact that uncertainty has on investment (Dixit and Pindyck, 1994). Firms may delay making decisions about investments that are irreversible in nature (e.g., like most pollution-control equipment) if there is uncertainty about the returns to the investment

and some prospect of learning that reduces this uncertainty over time. Under an emission tax, a firm knows with certainty the abatement cost for a unit of emissions. Under cap-and-trade, a firm cannot know with certainty the price of emission allowances in advance of the implementation of the program. Thus, it could be in the firm's interest to postpone an investment decision until it has better information about the price of allowances, such as after the program has begun and trading has commenced. If there are future events that could impact the price of allowances, and hence the returns to abatement decisions, this could also inhibit investment well beyond the start-up of a cap-and-trade regime. As a result, the lower investment could yield higher costs and potentially less innovation than what an otherwise equivalent emission tax would deliver.

B. Efficacy of Targeting the Externality

An effective tax or subsidy should target the externality as closely as possible to minimize the policy's welfare losses. Administrative and/or political feasibility may limit how well a given instrument targets the externality. Consider a few examples.

Parry and Small (2005) note that some externalities associated with driving light-duty vehicles are a function of fuel consumption (e.g., CO₂ emissions), while others are a function of vehicle miles traveled (e.g., accidents, local air pollution). As a result, a simple tax instrument that addresses just one of these margins, such as a gasoline tax, will not ensure that drivers bear the accurate social cost of driving. In their analyses of the externalities from driving in the United States, Parry and Small found that the optimal vehicle miles traveled tax yields about four times greater welfare gain than the optimal gasoline tax. A combination gasoline and vehicle miles traveled tax could yield greater social welfare than one instrument in isolation.

Heterogeneity in the damages from consuming energy may also undermine the efficiency of a fiscal instrument. For example, all wind power farms in the United States can claim a 2¢/kWh production tax credit, even though a given wind farm in the Pacific Northwest may displace hydropower on the grid, yielding no CO₂ or local air pollutant benefits, while a wind farm in the Midwest may displace coal- or gas-fired power generation with associated CO₂ emission mitigation and, in the case of coal, considerable local air pollution mitigation benefits.

Related to this spatial heterogeneity point, Muller and Mendelsohn (2009) find dramatic differences across the country in the social damages – primarily premature mortality – from a ton of SO₂ emissions (as well as a ton of NO_x emissions). Some emission sources are upwind of large, dense population centers that could bear significant adverse health impacts from emissions, while others are in sparsely populated areas. As a result, they estimate that the US SO₂ cap-and-trade program, which treats a ton of SO₂ as the same regardless of location, foregoes at least half of the potential social welfare benefits of pursuing trading in lieu of command-and-control regulation by failing to permit trading as a function of the health damages associated with emissions at any pair of sources considering an allowance trade. Such a scheme of trading ratios, however, could significantly reduce trading volume – given its complexity and effective rendering of a commodity into a specialized, transaction-specific product – and may elicit political objections by identifying quite explicitly winners and losers. In addition, the complexities and nonlinearities of atmospheric chemistry – such as the fact that NO_x emissions from some sources upwind of a few large, eastern urban areas *decrease* premature mortality (Fraas and Lutter, 2012) – may suggest that a simpler, administratively feasible approach may be preferable even if, in theory, it is sub-optimal in terms of social welfare.

Heterogeneity also impacts the effectiveness of a gasoline tax. Knittel and Sandler (2013) show that a uniform gasoline tax intended to fully internalize the costs of local air pollutants on average only reduces about 25 percent of the deadweight loss that occurs when these pollutants are untaxed. This reflects the fact that some cars, especially older cars, are significantly dirtier than others. In their evaluation of more than seven million California vehicles, they find that a car 10-15 years old has, on average, three times more hydrocarbon, ten times more carbon monoxide, and about two times more NO_x emissions per mile than a car four to nine years old. Thus, a well-targeted tax instrument should attempt to address the vintage or, more specifically, the pollution profile of the automobile. This may also be administratively challenging and may elicit some political challenges because of its potentially regressive nature.

C. Institutional Capacity and Administrative Feasibility

The choice of fiscal instrument may depend in part on a given government's institutional capacity. For example, in some developing countries, finance ministries have implemented tax systems that could permit relatively straightforward implementation of an emission tax. In contrast, few developing countries have strong, effective environmental ministries and the requisite legal system to implement a cap-and-trade program.

The challenge and cost of measuring emissions may make weaken the case for an emission tax. In such a scenario, subsidies for easily observable activity (e.g., building a wind farm) may be the only feasible option. Alternatively, a tax on a proxy – such as coal instead of SO₂ emissions at a power plant – may be available to policymakers, although it may not represent an efficacious targeting of the externality.

As a general principle, an administratively simple (and feasible) fiscal instrument should be preferred over a more complex option. An administratively simple and transparent tax is more likely to be understood by covered sources, and thus they may respond in socially desirable ways. A simpler tax instrument also facilitates explanations of rules as well as enforcement actions by the tax authority. Likewise, simpler subsidy regime designs remove ambiguity that might otherwise inhibit socially-desirable investment.

D. Interactions among Multiple Policy Instruments

1. Tax versus Cap-and-Trade in Presence of Other Instruments

Although public policies are frequently proposed and analyzed in isolation, they in fact interact with one another in a number of very important ways, which can affect the policy's environmental effectiveness and costs. Emission mitigation policies of all kinds raise production costs and act as implicit taxes and interact with pre-existing taxes in ways that drive up the costs of the policies. This is the so-called tax-interaction effect (Goulder, 1995). Those policy instruments that produce revenues for government, including carbon taxes and cap-and-trade with auctioned allowances, can dedicate part or all of their revenue to cutting existing, distortionary taxes, thereby offsetting some or – in principle – all of the tax-interaction effect. These interactions can have profound effects on the costs of a climate policy (Goulder and Parry, 2008).

In addition, cap-and-trade systems introduce another set of issues due to their interaction with other policies. In general, once a cap-and-trade program is in place, any attempt to elicit greater reductions from some specific source or sector under the cap will essentially be undone by some other covered source or sector under the cap, because of allowed trading. Thus,

subsidizing clean energy investments in a sector covered by cap-and-trade yields zero incremental health benefits. Likewise, a performance standard coupled with cap-and-trade also reduces cost-effectiveness, increases costs, and delivers no additional health benefits when compared to cap-and-trade in isolation.

This is a significant issue for cap-and-trade systems, renewable electricity standards, clean energy standards, and motor-vehicle fuel efficiency standards. These problematic interactions can occur when one policy instrument is nested within another, as with sub-national policies and national policies and when two policy instruments co-exist within the same political jurisdiction (Goulder and Stavins, 2011; McGuinness and Ellerman, 2008; Fischer and Preonas, 2010; Levinson, 2010; OECD 2010). The social costs of such perverse interactions are likely to be lower with an emission tax than cap-and-trade, since multiple policies could yield a lower emission level than the tax in isolation, but at the expense of cost-effectiveness.

2. Fossil Fuel Subsidies and Emission Taxes

The extensive role of the state in setting prices for transportation fuels, electricity, and other fossil fuels may undermine the effectiveness of an emission tax in some countries. An efficacious emission tax operates on several margins: inducing the emission source to make investments to lower the emission intensity of production and raising the cost of the emission-intensive good, thereby inducing less consumption of the polluting good. If the retail price of an emission-intensive good, such as electricity, is fixed by the government, then power plants may not be able to pass through the emission tax to consumers. As a result, the environmental and public health benefit of the emission tax will have been muted in part by the government's system of fossil fuel subsidies. Thus, governments seriously considering emission taxes should

account for how these instruments will interact with existing energy price-setting regimes and determine how the taxes can be passed through to consumers.

E. Political Economy Considerations

1. Distributional Considerations

Any public policy will inevitably have significant distributional consequences, even if it does no more than reinforce the status quo. Taxing emissions, especially CO₂ but also any pollutant associated with fossil fuel combustion, will increase energy prices, particularly increasing the cost of energy derived from coal combustion and, to a lesser extent, petroleum and natural gas combustion. Firms providing pollution control equipment and low-emitting technologies would likely benefit from emission taxes. Reducing pollution through tax instruments would likely disproportionately benefit young children, the elderly, and those in poor health. The economic incidence of such energy price increases – in terms of costs and benefits – may vary across sectors of the economy, across regions of the nation, across income groups, and even across countries, and are likely to have significant political impacts on the feasibility of policy instruments.

2. Instrument Transparency

Given the political economy implications of the costs of environmental policy and the political stigma of taxes (in at least some countries), policymakers have strong incentives to select instruments that minimize the perceived costs of policies (Keohane et al., 1998). Of course, unambitious policies can accomplish this goal, but more importantly cost-effective instruments may also deliver on this political objective. Public officials may find policy

instruments that hide or partially obscure their costs appealing. This explains, in part, the long-term support for conventional command-and-control instruments, such as performance and technology standards to address environmental health risks.

3. Ramping Up Policy Stringency

In an array of policy contexts, stakeholder and public support have been gained through the gradual ramping-up in policy stringency. British Columbia implemented a carbon tax in 2008 at C\$10/tCO₂ and increased the tax C\$5/tCO₂ annually until reaching C\$30/tCO₂ in 2012. The U.S. EPA phased in the SO₂ cap-and-trade program over two time periods. The first phase started in 1995 and covered the largest power plants and the second phase began five years later when the program expanded to cover the balance of the facilities. The EU launched the Emission Trading Scheme with a pilot phase in 2005 that imposed a relatively lax CO₂ emission caps. The pilot phase provided time for covered facilities and regulators to gain experience with the trading regime before moving into the more stringent second phase in 2008.

4. Need for Revenues

Given the current poor fiscal outlook in many developed countries, a new revenue stream through an emission tax may become politically palatable even if a tax typically would not be in isolation (Aldy, 2013b). Likewise, developing country governments may find fossil fuel subsidy reform appealing in light of the kinds of pressures such subsidies impose on other spending needs. Conversely, subsidies for clean energy technologies may face tough political headwinds given the various demands for spending and deficit reduction in many countries. It appears quite unlikely that clean energy subsidies in developed countries could return to their levels of 2009.

5. Salient Revenue Recycling

Skeptics of a tax swap – taxing emissions and using the revenues to lower labor and/or capital taxes – claim that governments may impose an emission tax and use the revenues to enlarge the public sector. To address this concern and to build support for a new CO₂ mitigation program, the province of British Columbia distributed C\$100 checks to every resident in the month before implementing the tax. These initial checks represented a down payment on the revenue expected to be raised by the tax in the first year.

In a similar context, several countries have implemented fossil fuel subsidy reforms coupled with cash transfers. In 2002, the Government of Indonesia made an ill-fated attempt to increase petroleum product prices as street protests led the government to back off from increasing prices. In 2005, the government successfully doubled gasoline and diesel prices and tripled kerosene prices (eliminating much of the effective subsidy at the time). In conjunction with the energy price reforms, the Government of Indonesia implemented a means-tested cash transfer program. The typical monthly transfer of \$10 per household for some 19 million households likely reduced the incentive for some Indonesians to protest the price hikes (Mourougane, 2010). In December 2010, the Government of Iran increased gasoline, diesel, and kerosene prices by at least a factor of ten. At the same time, the government transferred about \$30 billion to approximately 80 percent of the population through specially created bank accounts (IMF, 2011).

While these lump-sum transfers make the recycling of revenues more salient to the public, and the policy reforms potentially more politically appealing, they also run the risk of foregoing even greater economic benefits through the reduction of pre-existing distortionary

taxes. An array of model simulations show that lump-sum recycling of a carbon tax foregoes significant economic benefits associated with reducing distortionary tax rates (Goulder et al., 1997). The British Columbia experience is instructive in this case: a single lump-sum payment to households opened the program, and then the government recycled revenues thereafter by cutting personal and business income tax rates.

V. CONCLUSIONS

With pollution serving as one of the highest-ranked risk factors contributing to premature mortality around the world, expanding the use of tax and subsidy instruments to reduce pollution could deliver significant public health benefits. Well-designed and effectively implemented versions of a pollution tax, carbon tax, fossil fuel subsidy reform, clean energy subsidies, and cap-and-trade could each produce important health benefits, especially in developing countries with nascent efforts to mitigate environmental health risks (Table 1).

[Table 1]

Fossil fuel subsidy reform could represent a meaningful first step in many countries that currently price fuels and power well below what would otherwise be the prevailing market price. In some countries, such reforms would increase fossil fuel prices much more than a carbon tax and provide revenues that could finance means-tested cash transfers, increased health spending, or other socially beneficial programs. Such reforms are also administratively much simpler than designing other fiscal instruments, since it involves the modification of existing government interventions in energy markets.

The technical and administrative capacity to monitor pollution would affect the applicability of a pollution tax and cap-and-trade in many countries. Thus, initial efforts to implement a pollution tax (or cap-and-trade) may focus on the easy-to-monitor large point sources, such as power plants and factories. These challenges may also suggest focusing on taxing proxies – e.g., a tax on inefficient or pollution-intensive vehicles instead of on tailpipe emissions – that have lower administrative barriers. In contrast, it may be relatively straightforward to administer a carbon tax in many countries given the opportunity to build the tax onto either (a) existing energy excise tax regimes, or (b) existing government price-setting schemes for fuels and power. Since finance ministries and tax regimes are typically stronger and better developed, respectively, than environmental ministries and regulatory frameworks in many developing countries, it may be challenging to implement a successful cap-and-trade program to reduce pollution.

Each of these policy instruments has been employed in practice, indicating that the political barriers are not insurmountable. Nonetheless, political obstacles can explain why governments have not implemented these instruments more broadly. For the instruments that will raise energy and product prices (pollution and carbon taxes and fossil fuel subsidy reform), political feasibility will likely depend on efforts to demonstrate the return of revenues to the economy through means-tested cash transfers and/or reductions in other tax rates. In addition, the tax instruments will need to demonstrate environmental and health returns or risk facing opposition from advocates for more conventional command-and-control regulation. Support for a carbon tax in developing countries may also depend on progress in international negotiations, since few countries will take on meaningful emission reduction policies without some assurance

that their economic peers are doing the same. Clean energy subsidies face lower political hurdles, but require funding if they are to meaningfully scale up.

The details in the design and implementation of these instruments are important, and poorly designed policies risk unintended consequences. A low tax would generate modest revenues and little to no environmental and health benefits, which could weaken long-term support for the instrument. Industry carve-outs from a pollution tax or a carbon tax could likewise undermine its environmental objective. Given the adverse health impacts of residential biomass combustion, a fossil fuel subsidy reform that does not address cook stoves in low-income areas may risk increasing poor health outcomes. In particular, it may be sensible to support broader use of LPG as a substitute for biomass and kerosene. The challenge lies in effective targeting of subsidies so that it yields meaningful incremental investment in cleaner energy technologies. In the context of cap-and-trade, free allowance allocations that may be necessary to ensure its political acceptance could reduce government revenues and make it more difficult to tighten the cap in the future in order to deliver greater environmental and health benefits.

The promise of such instruments suggests that further research on the environmental and health efficacy, economic and fiscal impacts, and political economy of these tax and subsidy instruments in practice could inform policy-makers as they consider policies to address the environmental health impacts of energy use and economic activity more broadly. Implementing these instruments would serve as substantial complements to governments' efforts to improve public health.

ACKNOWLEDGMENTS

This research was funded by the Center for Disease Dynamics, Economics, and Policy for the Lancet Commission on Investing in Health. Helpful comments on an earlier draft were provided by Ramanan Laxminarayan and participants at the 2013 Workshop on Health and Welfare Implications of Taxation and Subsidy Policies to Alter Non-Communicable Disease Risks sponsored by the Commission in Investing in Health, the Harvard Global Health Institute, and the Disease Control Priorities Project.

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Table 1
Issues for Consideration on the Expanded Use of Fiscal Instruments to Improve Health Outcomes

Instrument	Potential Magnitude of Health Benefits	Applicability in Developing Countries	Political Feasibility	Unintended Consequences
Pollution Tax	Significant if designed to broadly cover pollution sources and set near socially optimal level	Large power plants, factories, and easy to monitor sources could be covered by a pollution tax	Demonstrating environmental efficacy and revenue recycling important to political acceptability	If tax set too low, may not change firms' behavior and thus deliver little health benefits
Carbon Tax	Significant climate benefits and local air pollution co-benefits	Could build on existing excise taxes on fuels and fuel price-setting scheme	Progress in international talks, revenue recycling necessary for support	Industry carve-outs undermine emission reductions, benefits
Fossil Fuel Subsidy Reform	Significant climate benefits and local air pollution co-benefits	Governments in many developing countries have explicit fuel and power price-setting policies that would only need to be modified for subsidy reform	Successful implementation may require effective communication strategy and means-tested unconditional cash transfers	Reducing LPG subsidies could increase biomass combustion in low-income homes, increasing public health risks
Clean Energy Subsidies	Significant if targeting most important health risks in the use of energy (eg, cookstoves)	Funding source (government, international financial institutions, foundations) a key question	Conditional on funding, clean energy subsidies likely more appealing than alternatives	May be challenging to target subsidies to drive incremental investment and to benefit those in need
Cap-and-Trade	Significant if cap set near socially optimal level and implemented effectively	Countries with little regulatory experience and weak environmental ministries may lack capacity to implement	Covered firms may demand free allowances, which undermines opportunity for revenue recycling	May forego significant revenues if political feasibility requires free allowance allocation