Financial Risk Management in the Anthropocene Age

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Abstract

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We examine the financial risk management of the climate crisis from three perspectives. First, we assess the serious risks from climate change. The ecological and financial consequences of climate change depend on the future path of emissions, as well as the specific circumstances of specific countries and populations. Second, we assess the previous success of market solutions through pricing sulfur and carbon dioxide emissions. Finally, we demonstrate the critical role of the insurance industry in creating incentives to reduce emissions and to invest in adapting to the climate changes that are already inevitable.

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Introduction

According to the 2018 Intergovernmental Panel on Climate Change (IPCC) report, if global warming continues to increase at the current rate (the so-called business-as-usual scenario) global temperatures are likely to reach 1.5 °C between 2030 and 2052. Limiting global warming to 1.5 °C is affordable and feasible but requires immediate action. Climate-related risks for natural and human systems depend on the magnitude and rate of warming, geographic location, levels of development and vulnerability, and on the choices and implementation of adaptation and mitigation options. Climate-related risks to health, livelihoods, food security, water supply, human security, and economic growth are projected to increase with global warming of 1.5 °C and increase further with 2 °C. Estimates of the global emissions outcome of current nationally stated mitigation ambitions as submitted under the Paris Agreement will result in global warming of about 3 °C by 2100, with warming continuing afterward.

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The climate risks that we set out below are very serious. The worst-case scenario is catastrophic. Additionally, climate risks create challenges and opportunities for the financial industry, particularly insurance. In this chapter we first set out the risks posed by climate change, and then we seek some possible solutions to reduce emissions (often referred to as climate change mitigation) and to adapt to climate change. We show that financial markets can be harnessed to reduce emissions through market mechanisms. In particular, markets can put a price on risk. That allows insurance/reinsurance companies to step in with appropriate solutions and create incentives for emissions reductions and climate change adaption. Emissions reductions will reduce the risk of catastrophic climate change. However, some climate change is already inevitable. Therefore, adaptation is essential.

The Risks from Climate Change

The destabilizing effects of the climate crisis will have both ecological and financial consequences. We examine some worst-case scenarios for the twenty-first century, in order to highlight the importance of managing the risk of catastrophic economic, ecological, and security consequences arising from the worsening climate crisis.

Scientists cannot predict the future climate with precision. The conservative estimates of the IPCC mentioned above are not the only estimates available. For example, one estimate of the range of probabilities points to a global increase of the average temperature of between 2.6 °C (4.7 °F) and 4.8 °C (8.6 °F) between 2000 and 2100 (i.e., in addition to the warming that already occurred up to 2000) (Collins et al. 2013). This does not mean that the extra 1.1, compared to earlier IPCC estimates, will be in the last 50 years until 2100. Rather, it means that the pace and magnitude of climate change are not capable of precise calculations. The range of probabilities depends on the model used, the amount of emissions, and whether a particular amount of climate change leads to events that accelerate climate change further. Land will warm faster than oceans, and the Arctic will warm faster than the tropics (Collins et al. 2013). Climate change could cause abrupt changes, including to the Atlantic meridional overturning circulation (AMOC), the Arctic sea ice, the Greenland ice sheet, the Amazon forest, and the monsoonal circulations, as it has in the past in periods of much slower climate change (Collins et al. 2013). According to a United Nations report released on September 22, 2019, climate impacts are hitting harder and sooner than climate assessments indicated even a decade ago, and interacting tipping points could lead to a cascading effect where the Earth’s temperature heats up by a catastrophic 4 °C–5 °C[2] (Kabat et al. 2019).
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The melting of the Greenland and Antarctic ice sheets may accelerate into a sudden loss of large amounts of ice, leading to dramatic changes in sea levels and ocean circulation (Bamber et al. 2019; Holland et al. 2019). Indeed, a catastrophic sea level increase is already unstoppable (Englander 2019). In the past, 400 parts per million (ppm) concentration of carbon dioxide (CO2) in the atmosphere coincided with a sea level rise of 16 meters (Dumitru et al. 2019). We have already passed the 410 ppm mark. By 2050, low-lying megacities and small island nations will face extreme sea level events annually; by 2100 extreme sea level events will occur at least annually at most locations under all scenarios (IPCC 2019b).
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The melting of the Arctic permafrost could rapidly release methane, which would create a feedback loop of increased warming that releases further methane emissions (IPCC 2019b). When seawater will have absorbed so much CO2, becoming saturated and unable to absorb any more, the rate of greenhouse warming will increase dramatically ~~(NCAR, 2019)~~. To meet the goal of the Paris Climate Agreement, to limit global warming “to well below 2 °C above pre-industrial levels and to pursue efforts to limit the temperature increase to 1.5 °C above pre-industrial levels,” global emissions must peak by 2020 (Revill et al. 2017).
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Climate change may also have political and social unrest issues. Drought may have contributed to the war in Syria, which produced a flood of migrants that set the stage for Brexit and other destabilizing political movements in the European Union (EU) (Kelley et al. 2015; Selby et al. 2017; De Châtel 2014). Similarly, climate change may have played a role in the flows of migrants from Central America, through Mexico, to the United States, by making subsistence farming less viable. This event led to other political and economic repercussions as the Trump administration threatened Mexico with trade sanctions for failure to stem the flow of migrants (Grant 2019; CRP, 2019; Kuil et al. 2016).

Science can attribute extreme weather events to climate change, such as the record-breaking heat waves in Europe in June, July, and August of 2019 (Vautard et al. 2019). Vulnerability to climate change varies between countries and between populations within countries, due to factors such as geography, income inequality, capacity to adapt to climate risks, and political systems. For example, the major emerging markets of Brazil, Russia, India, and China (BRIC) face different levels of climate risk locally and create different magnitudes of climate risk globally, as does the United States. Climate change is likely to increase economic inequality between and within these and other countries (Diffenbaugh and Burke 2019).

A recent study has estimated the economic cost of climate change by country, measured as the social cost of carbon per ton of CO2 (tCO2). India's is the highest (US$86 per tCO2), followed by the United States (US$48 per tCO2), Saudi Arabia (US$47 per tCO2), Brazil (US$24 per tCO2), China (US$24 per tCO2), and the United Arab Emirates (US$24 per tCO2). Northern Europe, Canada, and the Former Soviet Union are expected to have a net benefit because their current temperatures are below the economic optimum (Ricke et al. 2018). Another study predicts that the negative impact of climate change on economic growth, measured as the percent loss in gross domestic product (GDP) per capita by 2100 with no climate change mitigation, will be worse for the countries with the greatest temperature increases, which includes Russia (12.46%), India (13.39%), and the United States (14.32%) (Kahn et al. 2019).

China is the largest emitter of greenhouse gases (GHGs) but is making significant progress addressing mitigation. China's total emissions from fossil fuel and industrial processes are projected to peak 5–10 years ahead of its 2030 target in the Paris Agreement, with carbon emissions peaking for most cities at a per capita GDP (in 2011 purchasing power parity) of US$19,000–22,000 (Wang et al. 2019). Locally, air pollution has serious implications for public health in China. Globally, its emissions add to climate risk for all countries.

India's large population of subsistence farmers is vulnerable to floods, droughts, and famines, while India's cities are vulnerable to heat waves and floods. Indeed, climate change has shifted agriculture and subsistence strategies in the Indian subcontinent before, to adopt more drought-tolerant crops, and served as a catalyst for the de-urbanization of the Harappan civilization (Sarkar et al. 2016; Kathayat et al. 2017). While richer countries can adapt to their cities' heat waves (Vautard et al. 2019), India is unlikely to fall into this category. Indian cities will struggle to handle heat waves which can lead to the death of many of its citizens. Even if wealth increases, India has severe economic inequalities, which means that there will still be large numbers of vulnerable people who are unable to adapt through accommodations such as air-conditioning. In urban areas, it is the poorest and most vulnerable who are more likely to perish from a heat wave. While the links between climate change, migration, and conflict are complex, the effects of climate change on subsistence farmers could produce waves of climate migrants from India that would dwarf the flows seen thus far from Syria and Latin America, since their crops would fail and they would be forced off their land (Brzoska and Fröhlich 2016; Reuveny 2007). Thus, the consequences will be felt beyond India.

In Russia, forest fires in boreal forests are likely to increase dramatically, with far-reaching ecological and socioeconomic consequences (Kelly et al. 2013; WMO, 2019; RFERL 2019; NASA, 2019a). Increased air pollution, combined with rising alcoholism and suicide rates, could reduce life expectancy in Russia's population (Burke et al. 2018; Razvodovsky 2015). The boreal forest fires also increase global climate risk by destroying an important carbon sink and increasing Russia's emissions.

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Brazil's status as an agricultural powerhouse will decline as the effects of climate change increase; the destruction of the Amazon is likely to accelerate that process (USAID 2018; Economist 2019; NASA 2019a). There is a risk that the ongoing destruction of the Amazon will pass a point of no return, in which the transition from rainforest to dry tropical forest or savannah becomes unstoppable. This threshold could be as low as 20% of the Amazon. Already, 17% has been destroyed (Temple 2019). Thus, as is the case with Russia, the destruction of the Amazon increases economic risk to Brazil and global climate risk, by destroying an important carbon sink and increasing emissions.

Science can observe the effects of catastrophic climate events, such as droughts and floods. Climate change threatens the four pillars of food security: availability (yield and production), access (prices and ability to obtain food), utilization (nutrition and cooking), and stability (disruptions to availability) (IPCC 2019). Human innovations can move the dial, for example, with crops genetically modified to withstand drought or with improved irrigation systems, both of which are relevant to crop insurance. If technology develops effective approaches to mitigation and adaptation, we might experience less than the worst-case scenario. Insurance policies implement incentives to create and adopt these technologies, as we discuss below.

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We are facing an existential threat to civilization and our survival as a species (Spratt and Dunlop 2019). Climate change is difficult to address as every country has its own vulnerabilities and inequalities. Political responses to climate change, such as catastrophic crop failures and the related issue of mass migration of refugees, will have to take multiple insurance issues into account. Crop insurance can help farmers manage the risk of crop failures, but food shortages have consequences on human health, which has implications for health insurance. The mass migration of refugees also has serious implications for health insurance, particularly in countries with already overburdened public health insurance schemes. The effects of the climate crisis will only accelerate from this point on, increasing such politically destabilizing consequences, such as opposition to trade and migration.

As a result of the ever-shifting range of possible climate change scenarios, the time frame for climate change predictions is not precise. Science can show us how to mitigate climate change, how to adapt to climate change, and what the factors are that make one country, or one population, more vulnerable than another. However, the degree of climate change and the speed with which it takes place will depend on political will and technological developments, as well as the unforeseeable magnitude of shifts in the climate system. A climate-induced financial crisis would further complicate efforts to address the climate crisis (Rudebusch 2019; Andreas et al. 2019).

The Markets for Pollution Permits

Financial and insurance markets can play critical roles in mitigating emissions and adapting to the effects of climate change. The financial industry can contribute to mitigation through cap-and-trade markets. As we shall see in this chapter, these markets reduce the growth of new emissions, by capping emissions, distributing emissions permits, and allowing polluters to trade emissions permits in a market. They also encourage better mitigation strategies for countries because they create incentives for innovations in the polluting industries that lower the costs of emissions below the cost of the emissions permits. The insurance industry can contribute to both mitigation and adaptation. Insurance and reinsurance companies naturally take a long-term view of the types of risks associated with climate change because the entire business of insurance is based on pricing risks. For example, rising seas and more intense hurricanes will bring more flooding to coastal communities. Insurance and reinsurance companies can measure those risks and price insurance policies on buildings and municipal governments accordingly. They can create incentives for their clients to mitigate and adapt to those risks. For example, they can encourage municipalities to refuse building permits on flood plains and discourage homeowners from rebuilding a home that was destroyed by floods. When a flood destroys a home, if the insurance company refuses to insure the municipality against lawsuits for having issued a building permit for a new one or refuses to insure the new home against flood risks, the owner is unlikely to invest in rebuilding the flooded home.

In this section, we first analyze how the lessons learned from sulfur dioxide (SO2) markets in the United States can be applied to CO2 markets. Then, we discuss two CO2 markets—one compulsory and one voluntary. In the following section, we discuss the role of insurance and reinsurance markets in the context of adaptation and mitigation strategies for climate change.

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Mitigation Lessons from SO2 Market

The traditional approach to reduce pollution was a “command and control” regulation, until the SO2 market came along. In the command and control method, a government determines a pollution target and decides by how much each polluting agent has to reduce pollution (EPA 2017). This is usually done by setting a uniform emissions rate for a class of emitters (such as a fixed rate for electric utility company per ton of coal used) or by mandating a specific type of pollution-control equipment (such as a scrubber, regardless of the technology being used). This “one size fits all” approach ignores the heterogeneity of types of technologies that exist in the industry. As a result, the cost of compliance varies considerably across plants of different vintages.

Why did the Environmental Protection Agency (EPA) target the electric utilities for their SO2 emissions? Electric utilities accounted for about 70% of SO2 emissions in 1990. Coal-fired electric generation units accounted for 96% of this total, and oil-fired units accounted for the remainder. The other 30% of emissions were accounted for by a wide variety of industrial/commercial/residential boilers, smelters, paper mills, and other process-oriented sources (EPA 2019).

The SO2 market, operating in the United States since 1995, became the first cap-and-trade market in the world to operate successfully. There are lessons to be learned from that for the CO2 market. Therefore, we take a closer look at the SO2 market.

In 1990, the Clean Air Act Amendments established the Title IV Acid Rain Program (ARP). The amendment (in the Title IV) of the Clean Air Act mandated requirements for the control of acid deposition—also known as acid rain. The Clean Air Act Amendments of 1990 set a goal of reducing annual SO2 emissions by 10 million tons below 1980 levels. To achieve these reductions, the law required a two-phase tightening of the restrictions placed on fossil fuel-fired power plants.

How Does One Go About Creating Such Markets?

First, to set the parameters, the legislators have to come together to pass certain laws. The political economy of such rule-making is messy (Joskow and Schmalensee 1998). Any new legislation produces winners, who benefit economically from the new laws, and losers, who suffer economically. New legislation can have differing effects as it is difficult to benefit everyone affected by the legislative change. In the case of SO2 it was no different. There were states that produced coal and were net exporters to other states. Some states produced and used coal for power generation but did not export either to other states. In addition, there were states that did neither but were affected by acid rain for being located in the neighborhood. In the United States every state is different in its production and export markets; therefore the SO2 regulations affected some positively and some negatively. As a large producer of coal, West Virginia was a clear loser because the SO2 regulations made coal a less profitable energy source for electricity generation companies to use.

We note that this problem looms larger in the case of CO2 because the inequality between states in the United States is much smaller than the inequality that exists between countries. Therefore, any practical solution to the CO2 problem must address the problem of political economy inherent in these issues. Otherwise, proposed solutions are doomed to fail as was demonstrated clearly by the failure of the Kyoto Protocol (Kutney 2014).

Second, regulators have to set up regulatory parameters based on the laws enacted. They must anticipate whether such regulations would produce perverse reactions or unintended negative consequences somewhere else. Essentially, they have to produce regulation to properly internalize the externality created by CO2 emissions that leads to market failure.

Third, once the regulation is set forth, institutions have to be built for permit exchange. There has to be constant vigilance to prevent fraudulent activities. Additional legal institutions might be necessary for such new activities to take place.

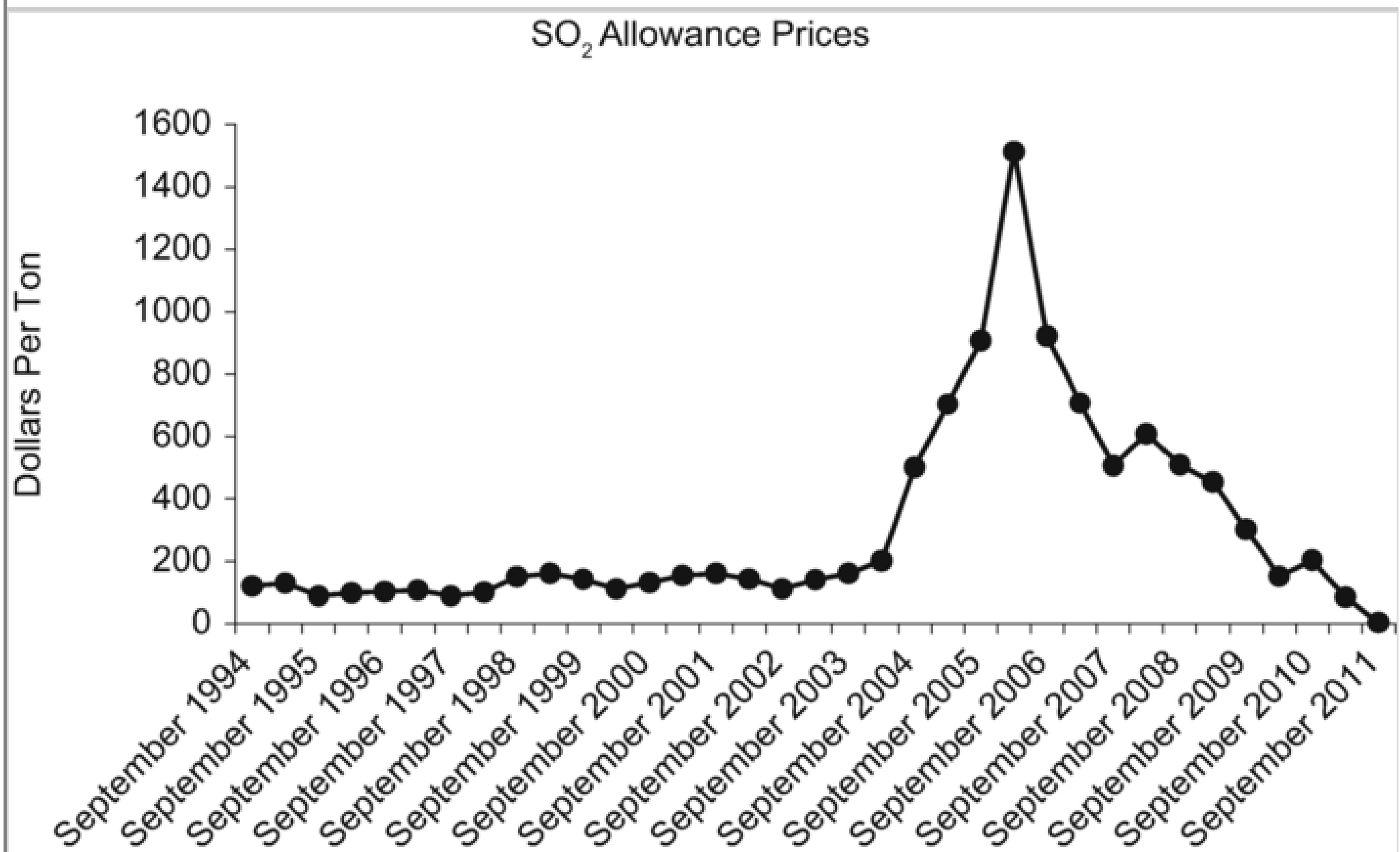
Finally, a new legion of traders has to be trained and the buyers and the sellers of the permits have to be educated. At every stage, a number of lawyers will have to be involved to make sure all the transactions are admissible.

For the SO2 market, Phase I of the process began operating in 1995. It was targeted to 263 units at 110 coal-burning electric utility plants located in 21 Eastern and Midwestern states of the United States. An additional 182 units were added to the Phase I of the program as substitution or compensating units, bringing the total of affected units to 445 in Phase I.

The idea of the market was simple. The EPA would auction permits (each representing one ton of pollution). Then, private companies would trade these permits in a specially created product at the Chicago Board of Trade. Once the permits were auctioned, they were resold in the private market. The price was determined by demand and supply, not just in the spot market, but also by the expected future value of each permit. Thus, expectation plays a vital role in the market for permits (see Fig. 12.1 for the market prices).

Fig. 12.1

Prices of the traded permits in SO2 market 1994–2012. Source: EPA (2019). Compilation by the authors. The Trump administration removed the data sources from the EPA website, so they are no longer available to the public



In the first 12–18-month period, there were a handful of traders. The price was in the US$250–300 per ton range. By the end of 1994, the price had dropped below US$150 per ton, and the volume of private trades exceeded the volume offered in the EPA auction (see Fig. 12.1). The prices had fallen to about US$100 per ton by 1998, and private trading of allowances for more than 5 million tons per year that had eclipsed the EPA auction by a factor of 15 to 1. The costs of trading allowances were 2% of the prevailing price (see Fig. 12.1).

The prices of traded permits were very close to one another. For example, the spread between average bids and lowest winning bids at EPA auctions was 1–3% (of the price) and trading in the private market appeared to be similarly concentrated around a single price. The SO2 program spurred innovation in the technology of power plants because compliance would reduce the cost of operation. All the new plants installed scrubbers to reduce SO2 emissions.

The technology also had a spillover effect. It reduced other harmful emissions such as NOx, mercury, lead, and microscopic particles because the process of SO2 reduction not only reduces SO2 but also reduces other microscopic particles (Advanced Technologies for the Control of Sulfur Dioxide Emissions from Coal-Fired Boilers 1999). Another innovation was in the mining techniques for extracting lower-sulfur coal seams. These were known methods in the coal industry, but they were not in wide use because there was no incentive for this method. Another benefit from the SO2 program was the re-examination of the old industry standards to find low-cost modifications to reduce SO2. One example of this was the blending of low-sulfur and high-sulfur coal (Chen et al. 2012). The industry standard did not allow large-scale blending for it was believed that the boilers would not function correctly. That belief turned out to be wrong. A change in the mentality of the industry and the reincorporation of large-scale blending allowed the combination of low- and high-sulfur coast blending without costly modifications to the equipment (Paul 2004).

The Acid Rain Program (ARP) also generated innovations in the management practices of the utilities (EPA 1995). It encouraged the utilities to seek to streamline the fluctuation in the input cost through activities in the futures markets for coal and oil as uncertainty in cost increases the cost of production. As a result, the power generating utility companies were able to reduce their overall cost of production.

Phase II began in 2000 with more stringent annual emissions limits imposed on large, higher emitting plants (in 1995, 263 generating units at 110 mostly coal-burning electric utility plants located in 21 Eastern and Midwestern US states were identified as “large, higher emitting plants”). It also set restrictions on smaller, cleaner plants fired by coal, oil, and gas, encompassing over 2000 power generating units in total. The program incorporated existing utility units serving generators with an output capacity of greater than 25 megawatts and all new utility units.

In Table 12.1, we reproduce the winners of the permits auctioned by the EPA in 1995. There are names that we expect for such bids, such as Duke Power and Virginia Power. They are companies that were buying permits for their own use. However, some buyers didn’t intend to purchase these permits for profit or speculation. These nonspeculative, nonprofit-maximizing buyers included several law schools and societies, as well as the Pollution Retirement Center. They were buying these permits not only for profit or speculation but to participate in the market for the explicit purpose of reducing the number of permits that the other market players could have, so that in the aggregate there would be less pollution. In the end, they were very minor players and they did not affect the market price or quantity in any significant way. Ultimately, they did not make much of a difference in the market. However, this practice highlights the possibility that in other circumstance, other entities can enter the market and change the market dynamics.

Table 12.1

Winning bidders for the 1995 SO2 permits

Bidder’s name	Quantity	Percent of total	Cost
Duke Power Company	17,750	35.1%	$2,332,500
PECO Energy Company	8000	15.8%	$1,061,000
Cantor Fitzgerald Brokerage, L.P.	8000	15.8%	$1,058,000
Virginia Power	6000	11.9%	$800,000
Canterbury Coal Company	4000	7.9%	$520,000
Detroit Edison Company	2952	5.8%	$386,712
Allowance Holdings Corporation	2160	4.3%	$280,800

Source: EPA (2019). Compilation by the authors. The Trump administration removed the data sources from the EPA website, so they are no longer available to the public

Bidder's name	Quantity	Percent of total	Cost
Hoosier Energy REC, Inc. Ratts Unit 2SG1	500	1.0%	$68,000
Marine Coal Sales Company	500	1.0%	$67,500
National Healthy Air License Exchange	135	0.3%	$18,350
Sam Peltzman Revocable Trust	50	0.1%	$7050
INHALE/Glens Falls, NY Middle School	21	<0.1%	$3171
CATEX Vitol Electric Inc.	12	<0.1%	$1584
University of Michigan Environmental Law Society	5	<0.1%	$1000
Environment Law Students Association	2	<0.1%	$410
Hamline University School of Law	2	<0.1%	$350
New England School of Law	1	<0.1%	$350
Electric Software Products David Gloski	1	0.01%	$300
Electric Software Products Alexander Long	1	0.01%	$300
Thomas M. Cooley Environment Law Society	1	<0.1%	$200
Duke University School of the Environment	1	<0.1%	$176
Michael S. Hamilton	1	<0.1%	$170
Pollution Retirement Center	1	<0.1%	$160
L.J. O'Callaghan, Sr.	1	<0.1%	$153
University of Maryland School of Law	1	<0.1%	$150
Total	50,600	100.0%	$6,676,386

Source: EPA (2019). Compilation by the authors. The Trump administration removed the data sources from the EPA website, so they are no longer available to the public

In 2003, following the success of SO2 trading, the NOx Budget Trading Program (NBP) started in nine states. The NBP was a cap-and-trade program that required emissions reductions from power plants and industrial plants in the Eastern United States during the summer months. The program was to last until 2008. Meanwhile, the Bush administration tried but failed to tighten the SO2 emissions through the Clear Skies Act. It died at the committee level in the Congress (Chen et al. 2012).

The Bush administration then came up with the Clean Air Interstate Rule (CAIR) in 2005. The purpose was to lower the SO2 emissions to a level 70% below the 2003 level (McLean 2008). CAIR tried to achieve this by reducing the cap by two-thirds in some of the states that were not part of the original ARP—it intended to include 28 Eastern states plus the District of Columbia by replacing the entire ARP with CAIR. The aim was to reduce interstate transport of pollution from upwind states to downwind states. This action had a clear impact on the SO2 price in the market. It shot up nearly threefold. However, the entire structure of the CAIR was based on the so-called good neighbor policy interpretation of the Clean Air Act Clause §110(a)(2)(D)(i)(I) (McLean 2008).

Not surprisingly, various states (principally Michigan, Minnesota, and North Carolina) were opposed to the CAIR. In July 2008, the US Court of Appeals for the District of Columbia Circuit declared that the CAIR cap-and-trade method was fundamentally flawed, concluding that the EPA focused on region-wide emission reductions and did not adequately factor in each state's significant contribution to air pollution issues. It declared that the methods for determining SO2 and NOx pollution were not objective. The court held that the EPA lacked authority to remove the Acid Rain Program allowances through CAIR (Chen et al. 2012).

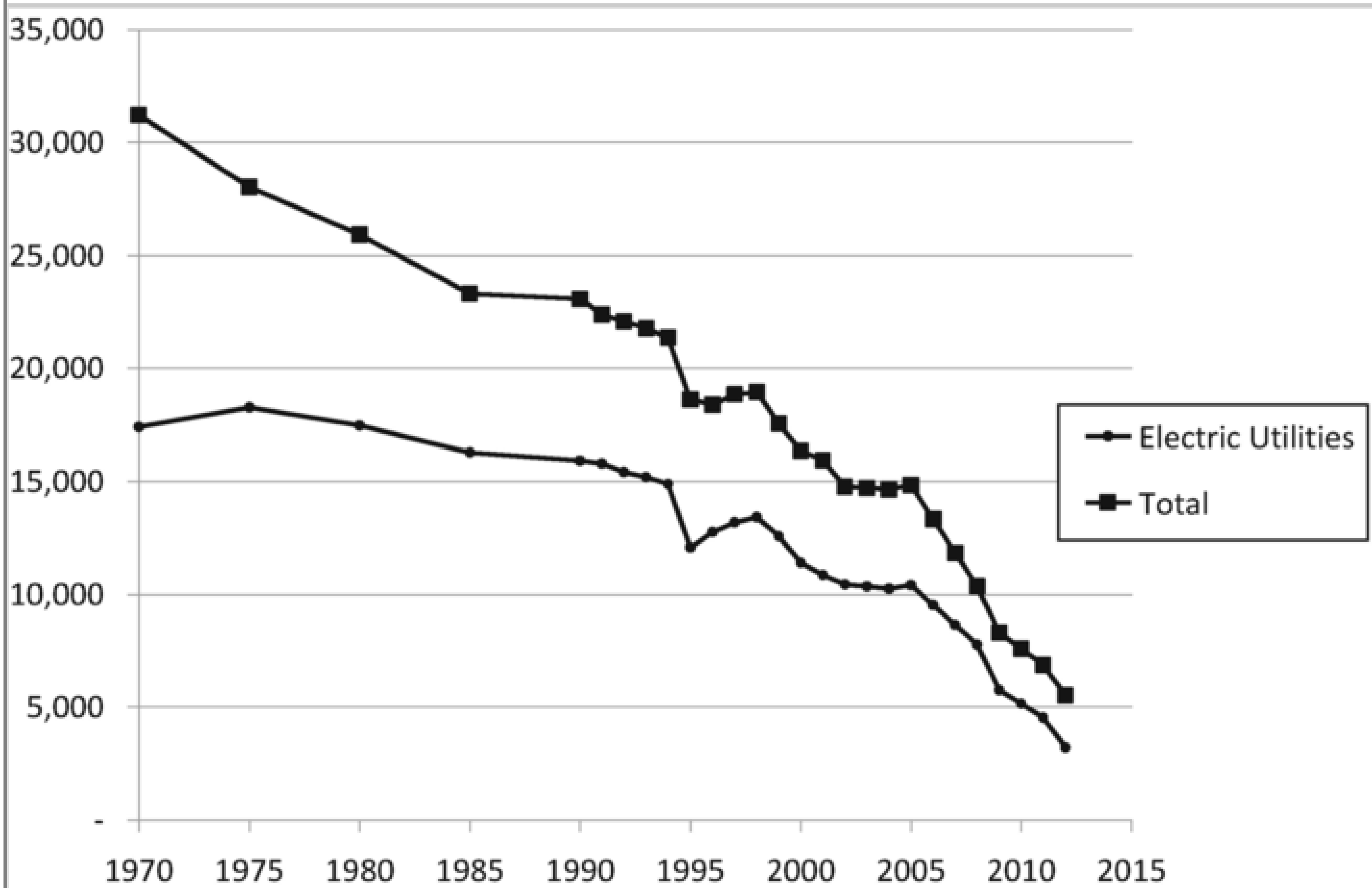
To salvage the situation, the EPA finalized the Cross-State Air Pollution Rule (CSAPR) to replace CAIR. This rule responded to the court's concerns and fulfilled the "good neighbor" provision of the Clean Air Act by addressing the problem of air pollution that is transported across state borders. The "good neighbor" provision means one state must be a "good neighbor" by not polluting a neighboring state with its emissions of SO2. The court decision of 2008 and the subsequent maneuver by the EPA to resurrect the SO2 market through other mechanisms failed. Predictably, the price of SO2 permits went down to virtually zero. The introduction of the CSAPR did not fare much better. In another lawsuit, the CSAPR was also struck down in August 2012. The courts decided that the EPA failed to show that the "downwind states" are different from "upwind states." In addition, the EPA did not give the affected states enough time to come up with their own solution (EME Homer City v. EPA 2012).

In spite of the litigation setbacks suffered by the EPA with respect to SO2 emissions, there is no doubt about the overall success of the program. We will discuss three dimensions of success.

First, the program managed to reduce the SO2 emissions much faster than what was originally stipulated by the EPA. This dimension is illustrated in Fig. 12.2. Overall SO2 emissions were reduced from about 23,000 tons per year in 1990 to less than 7000 tons per year in 2011. One common criticism of this reduction examines the reduction in emissions between 1970 and 1990. During that period too, there was a reduction in SO2 emissions. Therefore, it is argued that the reductions during the two decades after 1990 were going to happen with or without the ARP.

Fig. 12.2

Thousands of tons of SO2 emitted in 1970–2012. Source: EPA (2019). Compilation by the authors. The Trump administration removed the data sources from the EPA website, so they are no longer available to the public



To understand the impact of the ARP, we need to examine exactly from where such a reduction in SO2 emissions came. Recall that ARP was directed squarely at the power utilities. In Fig. 12.2 we examine two separate sources—the utilities and others. In 1990, the utilities accounted for two-thirds of all the SO2 emissions. The electric utilities were the principal source of reductions during the following two decades. The rest did not have much of a reduction. This evidence gives us a clear indication that the SO2 reduction was not simply a “natural” reduction with better technologies from all sources. The ARP was indeed the catalyst for such a change.

Second, the EPA has documented the dramatic changes in geographical distribution of sulfate deposition in the United States between 1989 and 2011. From Illinois, Indiana, Ohio, and Pennsylvania to all the way up to Maine, the sulfate deposit has been reduced at least by half in most states. In some states, the reduction has been over 70%. There is no doubt that this reduction was largely caused by the Acid Rain Program because, in the previous decade, the reduction was about 5%.

Third, as a consequence of the reduction in pollution in the Midwestern and Northeastern states of the United States, where nearly 40% of the US population lives, large benefits have been accruing due to (1) health impact, (2) improved land value for agriculture, and (3) ecological impact. The value of such benefits has been calculated by the EPA. We demonstrate the impact in Fig. 12.3.

Fig. 12.3

Monetized benefits 2000–2020. Source: Author calculation based on EPA (2009)

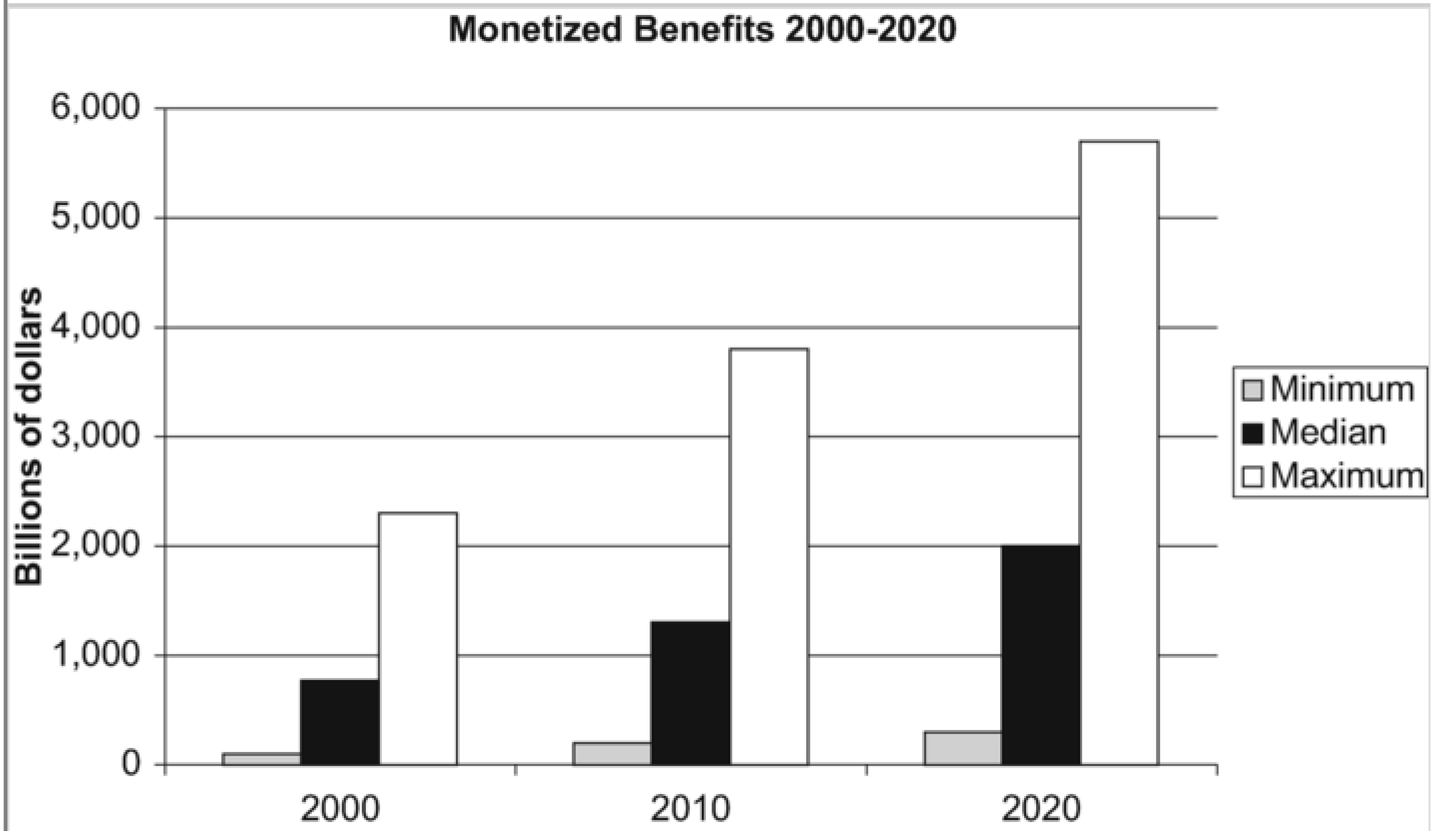


Figure 12.3 shows the monetized value of cumulative benefits coming from the SO2 reduction program. The value is measured in terms of reduction of lost lives, reduction of respiratory diseases, improved recreational facilities, and ecological improvement, among other things. Estimated median value of such gains for 2000 was US$700 billion, rising to US$1300 billion in 2010 and to US$2000 billion in 2020. The EPA also estimated the minimum and maximum gains for each of those years as we illustrate in Fig. 12.3. These are extremely large gains. To get an idea of the magnitude, the US GDP for the year 2011 was estimated at US$15,000 billion.

The SO2 experiment shows that cap-and-trade can actually work in real life. While the gains in terms of morbidity and mortality were not well understood at the time when the plan was implemented, it became clear later. These additional benefits of reduced mortality eclipsed the original benefits of reduced morbidity posited when the implementation was being debated in the US Congress.

CO2 Markets

This discussion about SO2 brings us to the question of CO2 emissions and cap-and-trade markets for CO2. The first serious stab at reducing CO2 emissions came with the Kyoto Protocol. The Kyoto Protocol set binding targets for 37 industrialized countries and the European Community for reducing GHG emissions. The goal was to reduce the GHG emissions of these countries in 2008–2012 to a level of 5% below the level of emissions of 1990. The detailed rules for the implementation of the Protocol were adopted at the 2001 Conference of Parties (COP 7) in Marrakesh and came into effect on February 16, 2005 (UNFCCC 2019). Under the United Nations Framework Convention on Climate Change (UNFCCC), the countries needed to meet the emissions standards with national measures. However, the Protocol created flexibility. It allowed each country to meet the targets with additional measures: (1) cap-and-trade, (2) Clean Development Mechanism (CDM), and (3) Joint Implementation (JI). Below we briefly discuss the CDM and the JI. The most important element of the Kyoto Protocol, the cap-and-trade markets, is discussed in greater detail at the end.

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Under the CDM, emissions-reduction projects in developing countries can earn certified emission reduction credits. Industries in the developed countries can use these saleable credits to meet a limited part of their emissions-reduction targets under the Kyoto Protocol.

One key element of the CDM is the mechanism for verifying compliance of whether the proposed reduction in emission has been achieved. Some are easy to verify. For example, one of the projects funded for the CDM was the Delhi Metro (CDM 2019). It was fairly easy to calculate the benefits of CO2 accrued due to the project. Similarly, another project funded was the 2012 extension of the Mexico City Metro. For these kinds of projects, compliance was not a problem.

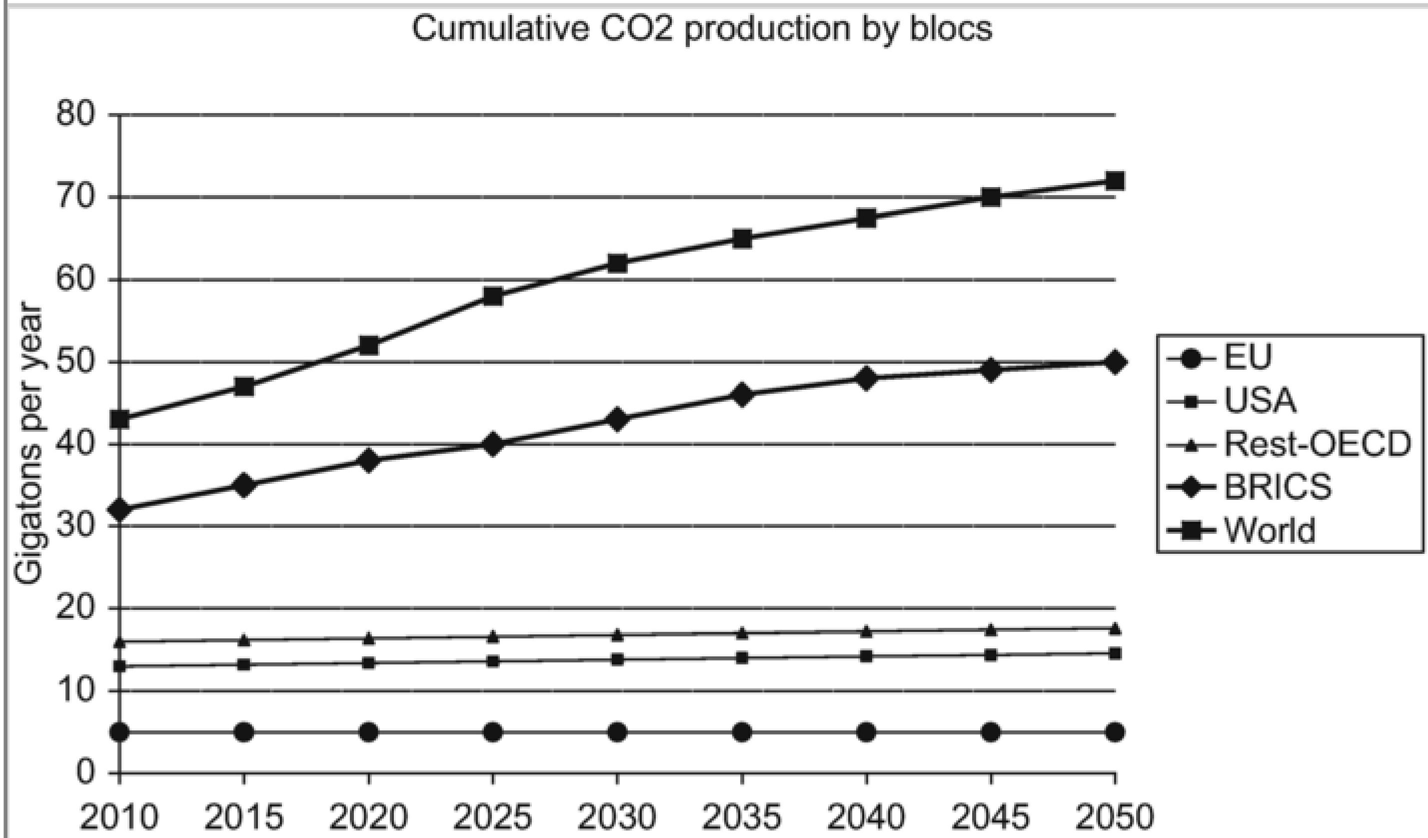
There are, however, potential problems with the CDM. It has been argued by some advocates of small-scale developments that the CDM would allow large companies in developed countries to impose projects that are not in the best interests of host countries (UNEP 2019). The CDM now requires that host countries verify that CDM projects contribute to their own sustainable development. Such certification processes are also not without problems. Since developing country government officials are often susceptible to bribes, it is possible that such processes can be corrupted easily (Olken and Pande 2012).

Joint Implementation (the third measure) means one country in Annex I can implement a project in another country in Annex I to reduce CO2 emissions to earn credits for reducing emissions. The aim of JI is to encourage clean energy technology use in the so-called transition economies—the countries of the former "Eastern Bloc" (countries such as the Russian Federation and Ukraine that lack modern technology for power generation and other areas).

The logic behind the Kyoto Protocol can be illustrated by the following (see Fig. 12.4). In 2010, total emissions in the world were about 43 gigatons of CO2. By 2050, they are slated to grow to over 70 gigatons per year if nothing is done. The emissions would not change much in the European Union over the next 40 years. They would go up marginally in the United States and the rest of the Organisation for Economic Co-operation and Development. However, the main growth of the emissions would come from Brazil, Russia, India, China, and South Africa and from the rest of the world if nothing is done. Therefore, to make any headway into a possible future reduction, two things have to happen. First, there has to be an absolute reduction in emissions in the developed world, which accounts for nearly 40% of the emissions today but contains less than 20% of the world's population (see Fig. 12.4). Second, the developing countries need to have the technology of the developed world today in order to reduce their emissions.

Fig. 12.4

CO2 emissions up to 2050 by blocks of countries. Source: Author calculations based on various IPCC reports



AQ11

Compulsory and Voluntary Markets for CO2

In this section, we discuss two separate markets: one compulsory (European Union Emissions Trading System [EU ETS]) and one voluntary (Chicago Carbon Exchange [CCX]).

Compulsory Market: EU ETS

As a direct result of signing the Kyoto Protocol, the European Union set up the EU ETS emissions trading system for 11,300 energy-intensive installations across the 27 Member States. In the Kyoto Protocol, the EU set its emissions-reduction target to 8% by 2012 compared with the level observed in 1990. This goal was modified into emissions-reduction objectives at the Member State level following the so-called Burden Sharing Agreements. In 2003, Directive 2003/87/EC established a scheme for greenhouse gas emission allowance trading within the community and amending Council Directive 96/61/EC, creating the EU ETS. It explicitly recognized the following six gases as greenhouse gases: carbon dioxide, methane (CH4), nitrous oxide (N2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF6). The scheme covered about half of all GHGs at the EU level.

There were four phases of the market envisioned in the plan (EU ETS 2019).

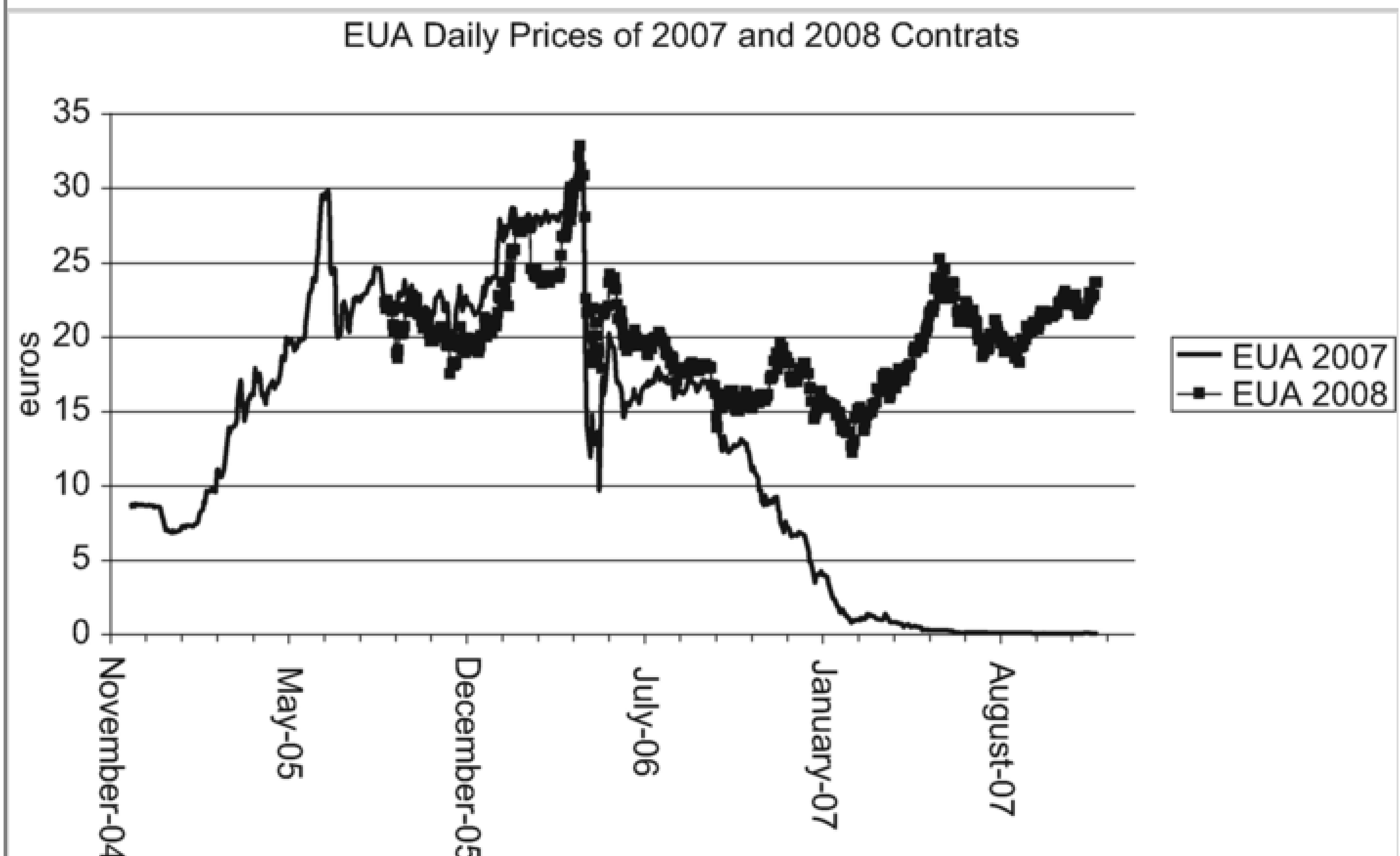
Phase I went from 2005 to 2007—the so-called warm-up period prior to the introduction of the Kyoto Protocol. Phase II went from 2008 to 2012. It is concomitant to the Kyoto Protocol. Phase III went into effect from 2013 to 2020. Phase III corresponds to the objectives of the EU “Energy-Climate Package” introduced in January 2008 to reduce emissions by 20% by 2020 along with increasing energy efficiency by 20% and increasing the share of renewable resources in the energy mix to 20%. This plan became known as the “20-20-20 target.” Phase IV envisions full implementation of the Paris Agreement target by 2030.

The allowance for one contract exchanged on the EU ETS corresponds to one ton of CO2 released into the atmosphere. It is called a European Union Allowance (EUA). For the Phase I, 2.2 billion allowances per year were distributed (2005–2007). During the Phase II (2008–2012), 2.08 billion allowances per year were distributed.

Figure 12.5 displays the movement of daily EUA prices between 2005 and 2008 for the contracts expiring in 2007 and 2008. The first notable feature of the prices is that they were volatile. It covered an enormous range over a relatively short period of time.

Fig. 12.5

EUA 2007 and EUA 2008 prices in the EU ETA market. Source: EU ETS (2019) data extracted and graphed by the authors

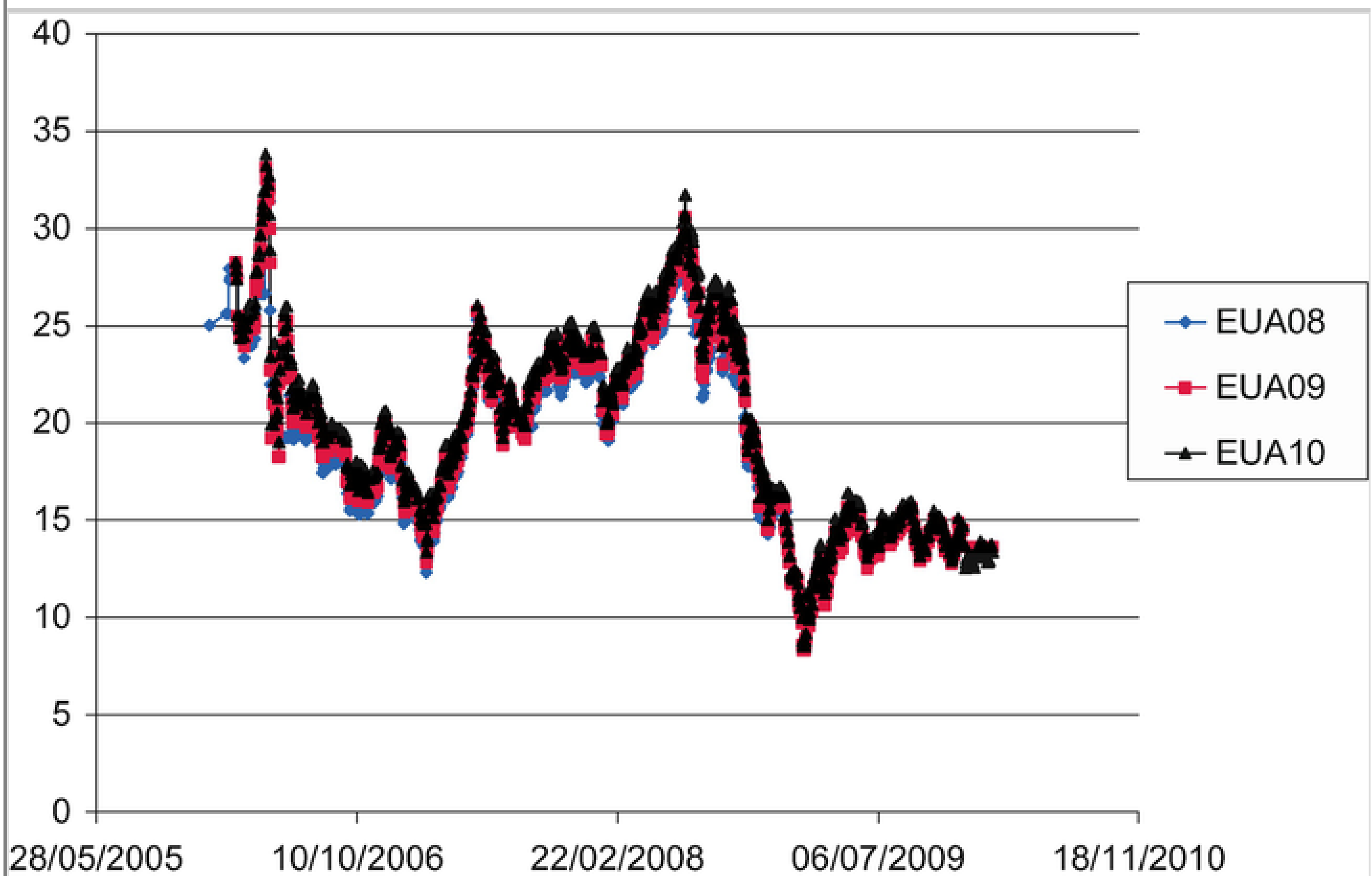


The second feature is that the EUA 2007 and EUA 2008 prices moved in tandem and close to each other over a year before the dramatic fall of the EUA 2007 price. Since EUA 2007 contracts did not have much value after 2007, it was expected that the prices would diverge at the end. But when they were both valuable, both the prices were close. In economic terms, these products were close substitutes for a while and therefore had very similar prices. This phenomenon is called the “law of one price” in economics. It is often used as an acid test for understanding the pricing of a product. As we will see below, the price in other parts of the world for one ton of carbon has not been the same. This illustrates that the price is critically dependent not just on the current laws governing the market but also on future expectations about the legal status of the market. For example, we saw how the successful challenge of CAIR in the courts caused the collapse of the SO2 market in the United States (Chen et al. 2012).

Each year, the EU ETS issued more permits with expiry dates and then they were traded in the markets. In Fig. 12.6, we examine the co-movement of three such contracts over time: EUA 2008, EUA 2009, and EUA 2010. Once again, the prices show closeness which demonstrates that they were being treated very similarly in the marketplace.

Fig. 12.6

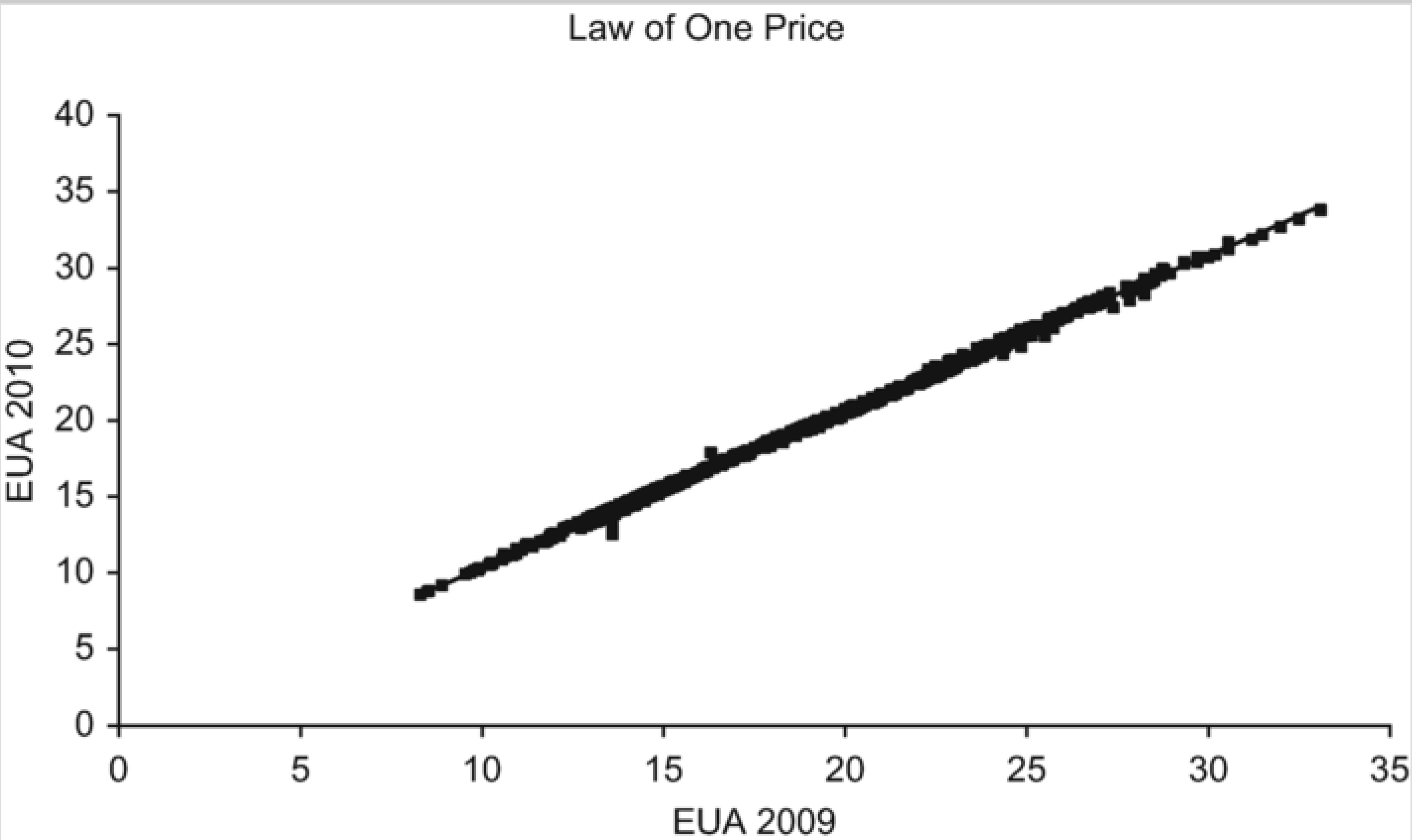
Co-movement prices of different contracts in the EU ETA market. Source: EU ETS (2019) data extracted and graphed by the authors



In addition, we performed correlation analysis between the EUA 2009 and EUA 2010 prices. It shows that the correlation between the prices is 0.9988, which can also be seen when we plot these two prices together in Fig. 12.7.

Fig. 12.7

Law of one price in EU ETA. Source: EU ETS (2019) data extracted and graphed by the authors



The EU ETS market was a compulsory market—the companies in the EU were forced to participate. In this regard, it stands in contrast to the voluntary market that we talk about in the next section.

Voluntary Market: Chicago Carbon Exchange

In addition, in the United States, another experiment was conducted by a voluntary market called the Chicago Carbon Exchange. This was the brainchild of Robert Sandor (Sandor 2012). He took his cue from an observation of the economist Ronald Coase, who noticed that while economists have argued that economic agents would not pay for public goods with positive externalities (such as the maintenance of a lighthouse), the Trinity House, a private consortium, had been building lighthouses in England for five centuries and making profits (Sandor 2012).

While this was a voluntary market, over time it managed to capture 17% of the value of the companies listed in the Dow Jones Index (Sandor 2012). It represented 25% of the power industry, and during the peak year, it managed to reduce more CO2 than France did (which operated under the compulsory market of the EU ETS). The CCX not only managed to do business in the US market, but it also helped to generate CO2 reductions in far-flung places like Kerala, India, by getting payment for producing biogas (Kurian 2008).

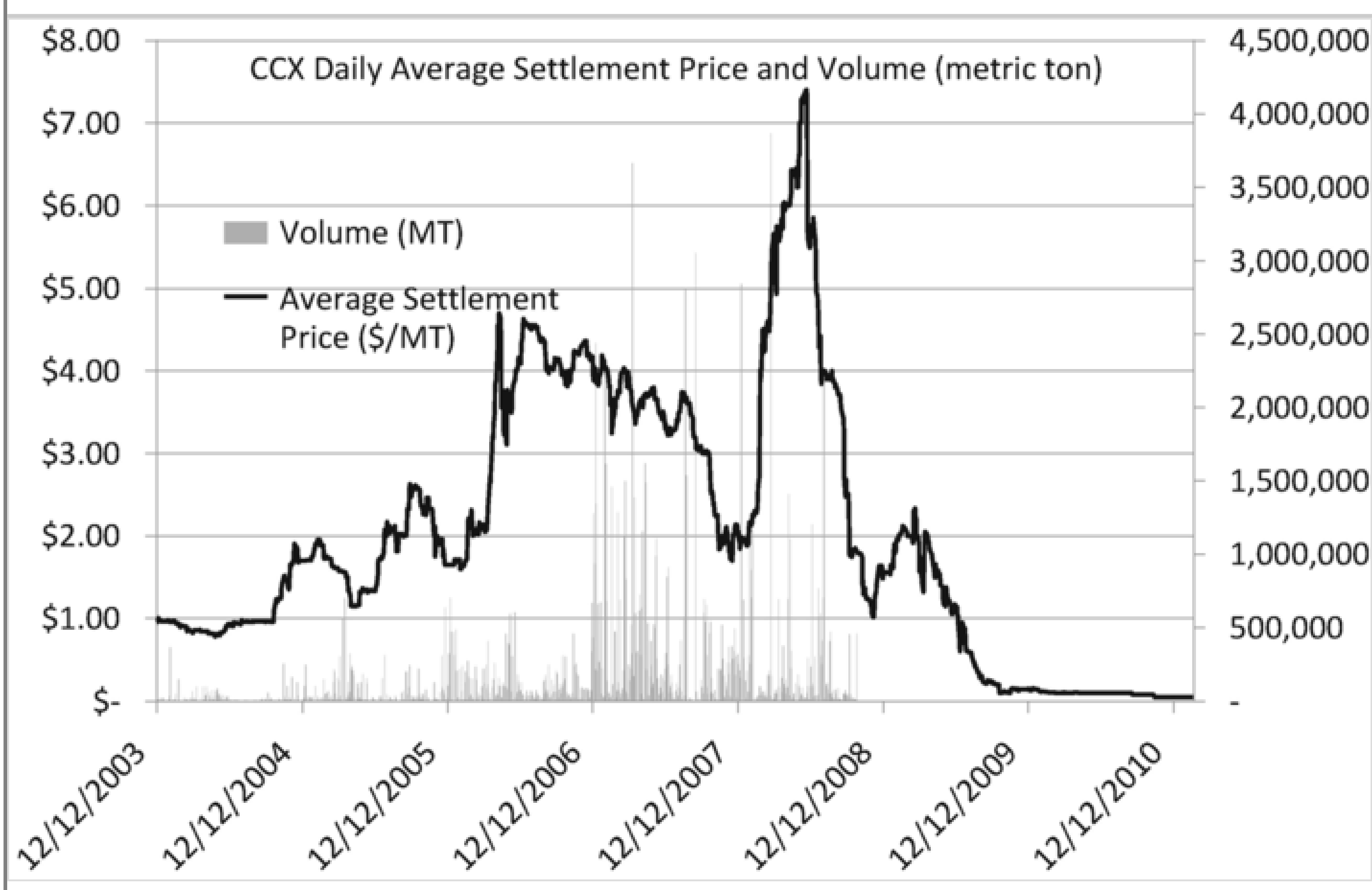
In a number of villages in Andhra Pradesh and Kerala, the CCX helped develop collection of waste from cows. The cow waste was used to capture methane, which was to be used for cooking (Sandor 2012). Families received a financial incentive of about US$2 per month for collecting cow waste. As a result, the amount of GHG reduced more than offset the "cost" of carbon captured by other means, as wood burning became unnecessary. It also generated a bonus. In those villages, small school-age girls were used to fetching wood and sticks to burn for cooking. Their time was freed up, allowing them to attend school. Moreover, the use of methane burning stoves reduced the air pollution inside the huts, improving the health of those villagers (Sandor 2012).

Sandor (2012) sets out the requisites for a successful launch of financial products. First, the financial products have to be traded in a well-defined exchange. Second, the trades have to be completely transparent to all the market participants. Third, they have to be regulated. Here, he noted that it does not have to be regulated by the government. The exchange can be self-regulated (such as the lighthouses in England where a charity organization called the Trinity House runs all the lighthouses with a Royal Charter from 1514). Finally, there should be a central clearing system in the market to minimize counterparty risk. He notes that these conditions are sufficient for a market to work, but all conditions are not necessary. Products such as interest-rate and foreign-exchange swaps are not centrally cleared, but they work well. He also insists that there has to be a standard product for the market to work well. Without a well-defined product, the market would collapse. There is also a need for evidence of ownership of the product. If property rights are not well established, the market will not work.

Sandor explains why a volunteer market like the CCX would work. There is not a single reason why all the parties came to trade. Some companies traded because they had business to conduct in the EU. That was the case with the Ford Motor Company. Baxter Laboratories traded in the market because they wanted to create goodwill. They wanted to be part of the green market. As Sandor (2012, p. 379) notes: “Baxter Laboratories was a leader in the health-care industry. Although the company’s emissions were negligible, its commitment to sustainability and the public relations benefits from joining the exchange were obvious.” Other companies came in because they anticipated that sooner or later the market would be implemented across the entire nation, therefore they wanted to have a practice run. In Fig. 12.8, we display the entire experiment between 2003 and 2011 with volumes that were traded in the CCX, along with the prices at which they were traded.

Fig. 12.8

Chicago Climate Exchange market price and volume. Source: Data supplied personally by Richard Sandor and on file with the authors



The Regional Greenhouse Gas Initiative (RGGI) is another mandatory program to reduce greenhouse gas emissions in the United States. The RGGI is a cooperative effort among nine Eastern states of the United States: Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New York, Rhode Island, and Vermont. Together, these states have capped and reduced CO_2 emissions from the power sector by about 50% between 2005 and 2018. Originally, New Jersey was also part of the RGGI. In 2012, New Jersey pulled out of the program after the governor argued that it was not an effective way of capping emissions.

In our discussion above, we observe that the price of carbon differs in different countries. The law of one price does not seem to hold, and there is a clear reason for it. The future viability of carbon markets is not clear in many places. There are potentially fatal lawsuits challenging the legality of making the trade mandatory that could invalidate the operations in some markets (such as California).

Progress in multilateral treaty negotiations is also doubtful, with only EU countries agreeing to extend their participation in the Kyoto Protocol and the announced withdrawal of the United States from the Paris Agreement. While the 2018 Conference of Parties (COP 24) led to an agreement on implementing the Paris Agreement (the Katowice Climate Package of December 15, 2018), there will be no new targets until the COP in 2020. All of this legal uncertainty makes the same ton of CO_2 emissions different in various jurisdictions. On one hand, the price in the voluntary Chicago market never went above US$10 per ton. On the other hand, in the EUA markets, the prices were well above that for a period of time. This explains why prices are not (yet) equalized across countries and regions.

China has become the largest producer of CO_2 in the world by producing double the amount of the second biggest producer, the United States (UCS 2018). Pollution in China has become a big problem, killing more than a million persons a year and with an estimated cost of US$38 billion a year (Gu et al. 2018).

Not surprisingly, China has proposed pilot programs of cap-and-trade in five provinces and two cities for 2013: Beijing, Shanghai, Tianjin, Chongqing, Shenzhen, Guangdong, and Hubei. Some of them are cities with large industries and others are states with large industrial hubs. The markets are expected to begin trading in 2020 (Hua 2019).

Ironically, the cap-and-trade model seems especially well suited to address the problem of climate change, in that emitted GHGs are evenly distributed throughout the world's atmosphere. Emissions reductions anywhere make identical contributions to help alleviate the problem, and there are no pollutant concentration hot spots. The number and variety of GHG emissions sources increase the practical difficulty of developing a comprehensive and effective command-and-control approach. Additionally, it magnifies the cost savings that could be achieved by enlisting the market to find the least costly abatement options.

As we saw earlier in our discussion of the SO_2 market, the "one size fits all" approach of mandatory pollution controls ignores the heterogeneity of types of technologies that exist in a particular industry, such as electricity generation plants. As a result, the cost of compliance would vary considerably across plants of different vintages, depending on their technological starting point, making this type of environmental regulation less cost-efficient than cap-and-trade. This is because a cap-and-trade program imposes an overall pollution limit for the emissions, distributes permits up to that limit, and then allows the plants to buy and sell pollution permits. Plants that can reduce emissions more cheaply than the cost of permits do so and sell their permits to plants for which reductions are more costly than the cost of buying pollution permits. In this way, emissions reductions occur first where they are least costly to achieve. Over time, the cap-and-trade program reduces the overall pollution limit for the emissions for the industry as a whole.

It is difficult to achieve an international agreement to limit GHG emissions, however, for precisely the same reasons, many countries, hosting many emissions sources, must agree to take action. Given the complexities of either developing a domestic US cap-and-trade system for GHGs or obtaining congressional approval for an international system in which the United States participates, it is likely that at least as much bipartisan (between the Democrats and the Republicans parties) collaboration would be required as was evident in the process to enact the Clean Air Act Amendments that established the Acid Rain Program. Instead, we have much less. This is because of the concerns regarding the effects of mandatory GHG emissions reductions on the competitiveness and profitability of the affected industries.

If one country requires its industry to reduce emissions, this implies higher compliance costs for that industry. If other countries do not require emissions reductions, their industry will not face the same additional costs. This would give the nonregulated country's industry a competitive advantage over the regulated country's industry. Domestically, the regulated industry resists regulation that would increase its production costs and impair profits. The regulated industry also resists regulation that would increase its production costs, impair profits, and shift production to competitors in other countries that face less regulatory costs. In international negotiations, countries seek advantages for their own industries by arguing that they should face less strict requirements, for example, because they are *developing* countries or because *developed* countries have more historical responsibility for climate change than more recently industrialized countries. The result of domestic industry lobbying politicians thus plays out in domestic negotiations over the appropriate emissions regulation and in international negotiations over which countries industry will bear the greatest cost of emissions reductions.

The stakes for a broad-based GHG policy—economic, political, and environmental—are much higher than they were for SO2 policy in 1990 because the effects are global. While the debate over federal policy to address climate change in the United States is currently in hiatus, due to the Trump administration's refusal to address climate change, the lessons of the SO2 allowance-trading program will prove useful and relevant to future deliberations about climate change policy when the time arrives for serious reflection. As the effects of climate change multiply, governments will come under increasing pressure to act, for example, by creating CO2 cap-and-trade programs that are capable of repeating the local success of the US SO2 cap-and-trade program on a global level for CO2. Since the effects of CO2 and climate change are global, regardless of the source of the emissions, the largest CO2 emitters must create cap-and-trade programs both domestically and internationally if the planet is to have any hope of containing the serious risks that climate change poses to human, animal and plant life, and health around the globe.

If the fragmented CO2 markets of China, Australia, the EU, RGGI, and California band together, they can produce a vast market for CO2. In that market, they would compete for clean energy technology and buy up permits to drive up the demand for clean air technology. The experience with the SO2 market in the United States suggests that such an approach would be an effective means to achieve emissions reductions and clean energy technology dissemination and adoption. It would be even more effective with more players. Indeed, if the countries that account for the majority of GHG emissions could negotiate such an agreement, it would represent a big step forward.

Adaptation, Mitigation, and Insurance

In our discussions so far, we have had very little to say about adaptation strategies. For the governments of many countries, so far, adaptation strategies are nonexistent (Mertz et al. 2009). This state of affairs is not just for the developing countries. For example, in the "Status of State Climate Adaptation Plans" in the United States, most of the states have no plans at all (GlobalChange.gov 2019). This is the status in a *developed* country. Not surprisingly, in the developing countries, adaptation is not even on the radar of the policymakers.

In summary, there is very little that is being done either at the level of international institutions or at the state and local government levels. This is one area where private insurance and reinsurance companies can make a substantial contribution by teaming up with governments by developing risk mitigation and adaptation activities or offering products (such as Cat Re bonds). Most individuals and companies avoid risks. Insurance companies, however, create business by accepting risks.

The US$5 trillion insurance industry is at the vanguard of climate change ~~(Sigma 2019)~~. Many risks that insurance and reinsurance companies cover are related to weather. Flood insurance, hurricane insurance, windstorm damage insurance, and crop insurance (along with more recent synthetic insurance policies with features of put options) are staples of the insurance and the reinsurance business. At least half of the world's population lives in regions highly exposed to natural disasters, but only a small fraction of them are insured. Insured losses alone from weather-related disasters have jumped from US$5 billion per year in the period between 1970 and 1989 to US$27 billion annually over the last three decades (Sigma 2019). Events such as Hurricane Katrina pushed the annual cost of catastrophes to over US$100 billion in 2005. While the actual losses from Katrina were over US$113 billion, less than half of it was insured. In 2017, losses from Harvey rivaled that of Katrina (Sigma 2019).

In theory, any risk whose probability distribution and loss magnitude can be quantified can be priced and insured. Therefore, it is possible to insure against natural catastrophic losses. Such risks are changing over time and the volatility of such risks is rising, which makes forecasting future losses a challenge. Many such risks are insured on a year-by-year basis. But if the underlying variability of such risks changes, that is, events that were once in 100 years become once in 30, it may take the insurers a long time to find that out. When they do find out, it may make them insolvent.

Consider crop and flood insurance products. They are related to the amount and the variability of rainfall. Over time, rainfall in a given area is changing. It is not a simple matter of more or less rain; the entire distribution of rainfall is moving in unexpected ways.

Most of these extreme events are not insured by ordinary insurance companies but by reinsurance companies because reinsurance companies are mainly in the large risk/low probability markets. Naturally, large global reinsurance companies like Munich Re and Swiss Re have taken great interest in this field (Sigma 2019). They take the IPCC reports very seriously. The companies provide a market test: they have a financial stake in climate change in the long run. Thus, they take climate change more seriously than politicians, many of whom, by the nature of their business, have very short-term interests.

Specific actions have been suggested by many governments. For example, the October 2010 report on climate change from the White House suggests that the government needs to "facilitate the incorporation of climate change into insurance mechanisms." Particularly, insurance markets may have insufficient capital to cover increasing catastrophic losses, especially if rates cannot track climate risks. It also encourages public-private partnerships to produce an open-source risk assessment model. However, in the Fourth National Climate Assessment for 2018, the report notes that coastal property owners depend on private or public insurance policies to recover losses from the coastal effects of climate change, but there are few private flood insurance policies. Mortgage holders within a federally designated Special Flood Hazard Area are required to purchase flood insurance, which almost always comes from the National Flood Insurance Program, generating losses and creating substantial financial risk for the US federal government and taxpayers (U.S. Global Change Research Program 2019).

For the developing countries, the stakes are higher. For some countries, like the small island nations around the globe (the Maldives, Micronesia, and Polynesian island countries among the most affected ones), rising sea water levels will critically affect their survival as low-lying countries will have higher likelihood of floods. But island countries will not be the only ones affected, other countries will face challenges as well. For example, many large cities in Latin America where there is urban poverty and precarious living conditions have grown without any plan. As we saw in the first section, climate change will cause rising sea levels, more violent storms, flooding, and extreme temperatures. There will be problems of water supply, food scarcity, and threats to health and sanitation.

The lack of maturity of capital markets brings additional challenges for the developing countries. Routine synthetic financial products (such as rainfall insurance) are simply not available in most developing countries. This is where international multilateral organizations such as the World Bank, International Monetary Fund, Inter-American Development Bank, and Asian Development Bank can play an important role in providing private–public partnerships in the form of microinsurance and other innovative products that are normally not available in such markets.

There are many ways that insurance companies can help to address climate change.

First, insurance companies can help with the understanding of the climate change problem. Insurers are beginning to share their expertise in data collection, catastrophe modeling, and risk analysis to track trends in weather-related data. These activities can be used to address problems posed by climate change. Insurers are building forward-looking risk models that take climate change into account. For example, the movement of the rainfall index over the past century can be used to create a rainfall index for the future. For planning and for insurance, such modeling will not generate unexpected losses in the long run. Such modeling is essential for the survival of the insurance industry itself. If a 100-year flood becomes a 10-year flood, insurance companies will have insufficient capital to confront such risks in the long run.

Second, insurance can promote loss prevention through risk mitigation. Managing risks and controlling losses is central to any insurance business. The insurance industry has been setting up fire departments and advocating building codes for natural and man-made hazards for a long time. For example, after the Great Fire of London in 1666, Nicholas Barbon started an insurance company to offer protection against fire (Sheldon 2019). He did two other innovative things: (1) he started differential rates for different building material used—2% of the rent if the houses were made of bricks and 5% of the rent if they were made of wood—and (2) he also hired the watermen from the river Thames to work as part-time firefighters.

The first of these acts encouraged the building of brick houses in London. The second act created an eventual fire department for the city. More recently, insurance companies have been giving rebates for households with fire insurance if they do not use halogen lamps. For insurance companies, it reduces the fire hazards and for households it reduces the use of electricity, thereby reducing GHG emissions. This is a simple example of how spillover effect from fire hazard to lower GHG gas emission is facilitated by insurance companies.

Third, insurance companies can encourage risk reducing behavior. Insurance contracts can design policy exclusions to instill behaviors that reduce greenhouse gas emissions and seek the appropriate efforts to prepare for the impacts. For example, the so-called pay-as-you-drive insurance products are offered by insurers that recognize the link between accident risk and the distance driven. In this case, the insurance company can do this cost effectively with today’s technology. It can use the car’s GPS to monitor activities with very little cost. It encourages people to drive less. This, in turn, co-benefits the environment.

Fourth, insurance companies are promoting innovative products. Insurance companies are offering special rates for “green buildings” and products that cover risks associated with energy efficiency or renewable energy projects (III 2019). This encourages the construction of more efficient buildings in the future as well as retrofitting old buildings to become more energy efficient.

Fifth, insurance companies are offering climate protection improvements. Insurance companies that also have banking operations are engaged in financing projects that (1) improve resilience to the impacts of climate change and (2) contribute to reducing emissions. Several companies are providing preferential mortgage rates for energy efficient appliances and home upgrades. Some companies are offering “Clean Car Credit” financing for low-emissions vehicles (Mills 2009).

Sixth, the so-called carbon risk disclosure requirement is being encouraged by insurance companies that insure business entities. The carbon risk disclosure requires a company to disclose information related to risk factors and calls for management discussion and analysis (Mills 2009). This issue got a boost with the 2009 position paper of the Securities and Exchange Commission, which states that businesses “should consider the impact of existing climate change legislation and regulation, international accords or treaties on climate change, indirect consequences of regulation or business trends, for example new risks for the company created by legal, technical, political and scientific developments, and the physical impacts of climate change” (SEC 2010).

Canada has had similar requirements since 2008. In addition, in the near future, Canada will make such disclosures obligatory rather than voluntary (Council of Canadian Academies 2019).

Conclusion

Global warming poses risk management challenges for the financial sector in two principal ways: (1) extreme weather events (such as floods, droughts, hurricanes, blizzards, and wildfires) and (2) health (such as diseases, pandemics, and food shortages). These two categories are not mutually exclusive. For example, extreme weather events can cause food shortages and spread diseases. However, reducing emissions reduces air pollution, which in turn reduces associated health risks. Climate change also presents opportunities for the financial sector.

The experience with SO2 markets demonstrates the potential benefits of a similar mitigation strategy for CO2 markets. The Acid Rain Program reduced SO2 emissions from about 23,000 tons per year in 1990 to less than 7000 tons per year in 2011. This demonstrates that a cap-and-trade program for CO2 emissions could be effective in rapidly reducing emissions. While we cannot say that the success of the SO2 markets would be duplicated in the CO2 markets, it does indicate just how effective such an emissions-reduction approach can be.

The lessons of the SO2 markets go beyond mere reductions in emissions. In the Midwestern and Northeastern states of the United States, where nearly 40% of the US population lives, the reduction in SO2 pollution has had big benefits due to (1) health impact, (2) improved land value for agriculture, and (3) ecological impact. The EPA calculated the monetized value of these benefits, including the reduction of lost lives, reduction of respiratory diseases, improved recreational facilities, and ecological improvement. The estimated median value of such gains for 2000 was US$700 billion, rising to US$1300 billion in 2010, and to US$2000 billion in 2020. These are extremely large gains. To get an idea of the magnitude, the US GDP for the year 2011 was estimated at US$15,000 billion (see Fig. 12.3). The SO2 experiment shows that cap-and-trade can also produce gains in terms of morbidity and mortality (Laden et al. 2006). These lessons have important implications for selling CO2 reductions to politicians and voters based on the immediately foreseeable benefits to public health and economic gains, in addition to longer-term environmental benefits and risk reductions.

AQ12

There is a strong connection between the role of cap-and-trade markets and insurance markets. First, the emissions reductions that cap-and-trade markets achieve will benefit the insurance industry by reducing economic risks from damage to infrastructure and the economies that depend on that infrastructure, health risks from air pollution and the spread of disease, and risks of catastrophic financial losses from extreme weather events such as hurricanes, floods, and droughts. Second, the incentives that the insurance industry creates to reduce emissions can act in a synergistic way with the incentives created by cap-and-trade markets. The effectiveness of cap-and-trade markets increases with insurance incentives to reduce emissions, and the insurance markets reap risk reduction benefits from incentives in the cap-and-trade markets to reduce emissions. Finally, the reductions in economic, health, and catastrophic risks also reduce the financial risks from the investment portfolios of insurance companies. The success of cap-and-trade markets is thus closely tied to the success of insurance markets.

Financial and insurance markets can play a critical role in reducing emissions and promoting adaptation. The principal contribution the financial industry can have to mitigation is through cap-and-trade markets. These markets can reduce the growth of new emissions, encourage better mitigation strategies, and bring innovations to the targeted industries that are not related to the emissions themselves. The insurance industry can contribute to both mitigation and adaptation. Insurance and reinsurance companies take a long-term view of the types of risks associated with climate change, can measure those risks, and can create incentives for their clients to mitigate and adapt to those risks.

The financial industry has a critical role to play in addressing climate change. Limiting climate change is also critical to the future of the financial industry–in particular, for insurance business which is a lifeline for reducing business risks.

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AQ13

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