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III. Carbon Markets Are Not Enough

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- Setting a price for carbon emissions is only the beginning of climate policy – not the end.
- While carbon prices will change energy costs, energy consumption and carbon emissions, relying on this mechanism alone would be both ineffective and inequitable. For example, in residential and transportation end-use, higher fuel prices would lead to a less equal distribution of resources – not a reduction in carbon emissions.
- Other policies are needed to offset the equity impacts of higher fuel costs and to launch the development of new, low-carbon energy technologies of the future.
- Because technology choice is path-dependent, with strong learning-curve effects, public sector initiatives, such as investment in promising new energy technologies, are essential to ensure that the global economy follows a climate-friendly path.
- As with many of the new energy technologies that will be needed around the world, decades of public investment may be required before developing-country technologies are successful in the marketplace.

The good news is that all major voices in the climate policy debate are now taking the problem seriously. Scepticism about the science is no longer an option: the world's scientists have never been so unanimous, and so ominous, in their projections of future perils. The bad news is that too many participants in the debate consider a climate policy as consisting primarily of manipulating markets and prices. If the only tool available were market liberalization, then the solution to every problem would seem to be a matter of getting the prices right. But setting a price for carbon emissions is only the beginning of climate policy – not the end. To address the threat of climate change, it is not only necessary to charge a price for carbon emissions; governments have to do much more, through actions to support innovation and diffusion of new, low-carbon technologies.

A. The state of the debate

For market-oriented institutions, the path is clear. The IMF simply assumes that climate policy consists of adjusting the price of carbon, when it states: "An effective mitigation policy must be based on setting a price path for the greenhouse gas (GHG) emissions that drive climate change" (IMF, 2008, 4: 2). Although it gives an occasional nod to the importance of developments such as hybrid vehicles, energy efficiency and new infrastructure spending, the IMF's approach to climate policy focuses almost entirely on market instruments. Moreover, it apparently does not consider the problem as being so serious. In the IMF's view, the world can afford to move at a comfortably slow pace: "Carbon-pricing policies … must establish a time horizon for steadily rising carbon prices that people and businesses consider believable. Increases in world carbon prices need not be large – say a $0.01 initial increase in the price of a gallon of gasoline that rises by $0.02 every three years" (IMF, 2008, 4: 42).

However, changes in carbon prices of this magnitude have been dwarfed by recent swings in the price of oil. While it may be possible to achieve climate stabilization at a moderate total cost, considerable ingenuity and new policy directions will be required; by themselves, price changes of a few cents per gallon of gasoline are not enough to achieve anything of importance.

Other voices in the international debate have recognized the greater urgency of the problem, and have been willing to consider a broader range of policy instruments. In its *Human Development Report,* the

United Nations Development Programme (UNDP, 2007: 21) states: "Carbon markets are a necessary condition for the transition to a low-carbon economy. They are not a sufficient condition. Governments have a critical role to play in setting regulatory standards and in supporting low-carbon research, development and deployment." The Report calls for carbon markets to be accompanied by government incentives for renewable energy production, tightened standards for vehicle fuel efficiency, expanded research on carbon capture and storage technology, and increased technology transfer to developing countries.

One of the most detailed recent proposals is Nicholas Stern's "global deal on climate change" (Stern, 2008). Stern argues that climate stabilization requires cutting global emissions to half of their 1990 level by 2050, with continuing declines thereafter. Stern calls for binding national reduction targets to be adopted soon by developed countries and by the fastest growing middle-income countries, and by all other countries by 2020. He envisions a carbon market in the form of a global cap-and-trade system that would allow developing countries to sell emission rights, combined with arrangements for technology transfer and large-scale government support for the development of new technologies. He states: "The world should aim for a liquid international carbon market in order to allow for the most effective, efficient and equitable emissions reductions. In addition, non-price interventions are required to expand the global market for low-carbon technologies, support common standards and promote cost-effective reduced deforestation" (Stern, 2008: 3).

In short, all major proposals for climate policy include a substantial role for carbon markets and prices, either in the form of taxes or cap-and-trade systems. While some give greater emphasis to the manipulation of prices and financing in carbon markets, others see carbon markets as only one part of a complex ensemble of policies.

B. What would carbon prices accomplish?

Carbon prices will change energy costs, energy consumption and carbon emissions. They will also change the distribution of income available for non-energy purchases. If carbon prices were increased by a tax or trading system, what would be the extent of the (intended) effect on emissions and the (unintended) effect on income distribution?

Increased energy costs to consumers fall disproportionately on low-income groups, since the poor spend a higher proportion of their income on energy. As incomes rise, total spending on energy usually rises, but more slowly; thus the fraction of income spent on energy decreases.[60] As a result, policies that raise the price of fossil fuels either reduce the use of those fuels (thereby reducing GHG emissions), or increase the economic burden on low-income consumers – or both. Thus, there is a trade-off between the effects of fuel prices on the environment and on the distribution of income. The relative importance of the two effects depends on the price elasticity of demand for energy.[61] A larger elasticity means that a price increase has a greater effect on emissions and a lower effect on income distribution; a smaller elasticity means that the same price increase does less to reduce emissions but more to increase inequality.[62] Since price elasticities are small for energy in general, and extraordinarily small for petroleum products in the short run, price incentives are a blunt and painful instrument for achieving lower emissions.

Consider the effects of a 20 per cent increase in the price of energy. At an elasticity of -1, the 20 per cent increase in price causes a 20 per cent drop in demand. Consumers purchase 80 per cent as much energy as before at 120 per cent of the former price per unit, so that the total cost to consumers amounts to 96 per cent of the former total. At this elasticity, most of the effect is seen in the change in the quantity of energy used (and therefore emissions), while total consumer spending is little affected. In contrast, at an elasticity of -0.05, a 20 per cent price increase causes only a 1 per cent change in quantity. Consumers buy 99 per cent as much energy as before at 120 per cent of the former price per unit for a total expenditure of 119 per cent of the earlier cost. At this elasticity, there is almost no effect on the quantity of energy used, or on emissions, but a large effect on the total cost to consumers. Therefore, judged as a strategy to reduce energy consumption and emissions with minimal burdens on consumers, energy price increases seem quite effective at an elasticity of -1, but decidedly inferior at an elasticity of -0.05. Intermediate values naturally have results falling between these two extremes.

What elasticity values are applicable in reality? The largest elasticities are found in industry. Studies of 15 countries by three research groups found the price elasticity for industrial energy demand to be between -0.77 and -0.88. Estimated elasticities for Brazil and

India were not significantly different from those for developed countries (Roy et al., 2006). Industrial energy use, in other words, provides fertile ground for the application of price incentives for emission reductions. Indeed, industry lowered its energy use much farther and faster than any other sector in response to the oil price shocks of the 1970s.

Household demand for electricity, on the other hand, is much less elastic than industrial energy use. Recent estimates for the United States found a short-run price elasticity of -0.20, and a long-run price elasticity of -0.32, broadly consistent with earlier research (Bernstein and Griffin, 2006).[63] This finding of a small elasticity for electricity does not appear to be unique to the United States; for instance, the estimated long-run elasticity for Taiwan Province of China was estimated to be -0.16 (Holtedahl and Joutz, 2004).

In both industrial energy use and electricity generation, there are alternative fuels that yield the same result with differing carbon emissions. An increased carbon price would cause a noticeable reduction in industrial energy demand (but less so in household electricity demand), and also a shift towards the use of lower carbon fuels, such as replacing coal with natural gas.

The picture is different in the transportation sector – the principal market for oil – where there is essentially no widely available alternative to the use of petroleum fuels. On a global basis, the available supply of biofuels is too small to make a noticeable dent in the demand for petroleum. In the wake of the oil crises of the 1970s, most countries and industries cut back on oil use wherever possible. Oil-fired electricity generation, for example, has become much less common, except among members of the Organization of the Petroleum Exporting Countries (OPEC). Today the largest proportion of crude oil is used for transportation, and a portion of the remainder is dedicated to non-fuel uses, such as petrochemicals for which there are no close substitutes. The connection between petroleum and transportation is projected to grow even tighter: an estimated two-thirds of the growth in oil demand through 2030 will be for transportation.[64] Thus the oil/transport market is almost disconnected from the market for other fuels and end uses.

The lack of alternatives to oil means that in the short run, price elasticity is close to zero for many consumers. Households in automobile-dependent environments – including the great majority in the United States, a large proportion in many OECD countries, and increasing numbers in fast-growing, middle-income countries – have little control over the amount of driving required to go to work, school, stores and other essential services. Thus, in the short run, purchases of gasoline will be quite insensitive to price, and higher prices will simply be a burden on consumers. However, in the long run, as old cars require to be replaced, high oil prices will stimulate purchases of smaller, more fuel-efficient vehicles, as was the case in 2007-2008. Over time this will affect oil consumption, as the fleet of cars on the road slowly becomes more fuel-efficient, implying that the price elasticity is greater in the long run than in the short run.

A comparative international analysis estimated oil price elasticities for many countries for the period 1979–2000 (Cooper, 2003). For the United States, it found a short-run elasticity of -0.06 and a long-run elasticity of -0.46,[65] and for the G-7 group of industrialized countries, it found a short-run elasticity ranging from -0.024 to -0.071, and a long-run elasticity from -0.18 to -0.57.

Short-run price elasticities for gasoline and other transport fuels are close to zero, which is why the 2007–2008 surge in the price of oil did not cause an immediate collapse in demand. Many months later, a global economic downturn depressed incomes and fuel use. As highlighted in this Chapter, that downturn was not solely, or even primarily, caused by the high price of oil. Any feasible carbon policy would, in the near term, raise fossil fuel prices by less than the oil price increases of 2007–2008. While such a policy could cause a noticeable change in industrial energy use, it would have less effect on transportation than the recent surge in oil prices. Something more needs to be done, therefore to reduce emissions on the necessary scale and timetable.

C. Where do new technologies come from?

Price signals lead to efficient choices among existing alternatives. This is the great success of the market economy. However, while it is an important step in climate change mitigation efforts, it is not enough. New technologies are necessary to solve the climate crisis, and will not be created by high carbon prices alone. Where will the new technologies come from?

Conventional economic models have often finessed this question with the ad hoc assumption of a predictable rate of technical change, unrelated to investment choices or policy decisions. That assumption creates a bias towards passively waiting for new technologies to emerge: abatement, so the argument goes, will always be cheaper if it is done later, after better technologies have made their appearance. However, in reality, important innovations do not fall from the sky. New technologies are created by conscious effort. They typically start out expensive and become cheaper over time, a process that is often described in terms of “learning curves” or “experience curves”. As a result, early investment in start-up costs can determine which technologies will become cost-effective in the future. Technological change is path-dependent: the current set of available choices depends on past policies and actions, just as the available technological options in the future will depend on our policies and actions today.

The learning-curve phenomenon is particularly important when there is a benefit from standardization. In such cases, an early market leader can become “locked in”, whether or not it represents the ideal technology, as occurred with the Windows operating system for computers, for example.[66] The current style of industrialization has been described as “carbon lock-in”, meaning that carbon-intensive technologies gained an early lead at a time when fossil fuels were cheap and concern about global warming was not yet on the horizon (Unruh and Carrillo-Hermosilla, 2006). Today, the economic benefits of standardization and the low costs of imitating and replicating existing technologies keep the world locked into that same undesirable path.

New energy technologies often display strong learning-curve effects. Research on wind power, for example, has found reductions in unit costs as great as 20 per cent from a doubling of production (Junginger, Faaij and Turkenburg, 2005), which made it competitive in the marketplace under many conditions. This success was made possible by decades of European and United States governments’ investments in R&D. Brazilian ethanol production, another alternative energy industry launched by government policy, experienced a 29 per cent reduction in costs when production doubled (Goldemberg et al., 2004).

With technological progress at these rates, often private enterprises only find it profitable to buy a new product after others have been buying it for a number of years, thereby bringing down the price. Hence the need for public sector involvement: governments can and must choose to support the new technologies, especially when – as with climate policy – there is a clear need for change. A plausible model of energy development projects, solar photovoltaics, which are at present one of the most expensive ways to generate electricity, could become one of the cheapest options by 2100 as a result of learning-curve effects (Rao, Keppo and Riahi et al., 2006).

This is not a unique characteristic of new energy technologies; rather, it is the norm in technological change. Microelectronics, a major success story of the private sector today, was the outcome of United States Government spending during the Cold War years. According to Morton (1999), “The U.S. military initially purchased nearly the total production of transistors in the early 1950’s, using them to make the new generation of communications, radar and improved avionics systems, command and control systems, as well as for missiles and jet fighters … The U.S. government acted as the major market for integrated circuits in the early years … In 1962 … the U.S. government, with extensive research interests in space, defense, and other areas, purchased virtually 100 per cent of all integrated circuits manufactured in the United States.” As with wind power, a few decades of generous public support were sufficient to launch the microelectronics industry as a success in the marketplace. If the world had waited for automatic technical change, or relied on getting the prices right, microelectronics might never have happened.

D. Carbon markets and developing countries

It has become commonplace to insist on the need for a globally harmonized price of carbon. Price harmonization is thought to ensure efficiency in worldwide abatement efforts: with appropriate market institutions, investment in emissions reductions will flow to the countries where the marginal abatement costs are lowest. Fears about the effects of unharmonized carbon charges have slowed climate policy initiatives in some high-income countries, and prompted an unproductive and potentially protectionist discussion of border tariff adjustments. This notion is mistaken, both in fact and theory. Empirically, only a handful of industries are so carbon-intensive that a difference in carbon charges could lead them to move from one country to another – and large segments of these industries have already moved to middle- and low-income countries.

In theory, remarkably enough, marginal abatement costs do *not* have to be equal in every country in order to achieve economic efficiency. Theorists who conclude that equal marginal costs are needed generally rely on the unexamined assumption that world income distribution is equitable, or, equivalently, that increases in per capita consumption are equally urgent everywhere (Sheeran, 2006; Chichilnisky and Heal, 1994). In the absence of that assumption, it is more efficient to carry out abatement efforts in richer countries, even though that might entail higher costs. That is, in an inequitable world, efficiency can be improved by imposing higher carbon prices in richer countries. This is not to suggest that the problem of climate change can be solved in high-income countries alone. Rather, it means that it is equitable for richer countries to invest in more costly measures, higher up on their marginal abatement curves.

It seems unlikely, however, that the movement towards a uniform worldwide carbon price will be blocked for long. Eventually, developing countries are likely to face a global carbon price, while their local prices for labour, land and other inputs remain far below the levels of higher income countries. The dissonance between expensive carbon and cheaper local inputs will create both an obstacle and an opportunity. The obstacle is that development may be distorted in the direction of activities of little or no value, simply because they yield marketable carbon reductions. Safeguards will be needed to prevent "carbon-allowance-seeking" investments. That is, in any global carbon market it will be essential to verify that emissions are not newly created in order to profit by reducing them. Unfortunately, the temptation to seek bogus allowances is a natural consequence of a global carbon price in a low-cost local economy.

The positive side of the same effect is that much deeper reductions in carbon emissions will be economical in developing countries. In the simplest terms, the fixed price of saving a ton of carbon in those countries is "worth" more hours of labour at a lower wage rate. Thus there will be a category of carbon-saving investments and technologies that are profitable only in developing countries, where the trade-off between carbon and other inputs is more favourable to emissions reductions. With appropriate public initiatives and financing for these technologies, developing countries could "leapfrog" beyond the patterns of energy use in higher income countries, thereby establishing a new frontier for carbon reduction. The potential for leapfrogging beyond the current technology frontier has been much discussed, but is difficult to achieve. The classic example is in telephones, where developing countries have been able to skip the expensive development of universal land lines and go directly to the use of cell phones. This, however, became possible only after cell phones were invented and commercialized in developed countries (Unruh and Carillo-Hermosilla, 2006).

To realize the opportunity created by a global carbon price in low-cost economies, there will be a need for R&D in appropriate, cutting-edge technologies for carbon reduction. As with many of the new energy technologies that will be needed around the world, decades of public investment may be required before the developing-country technologies are successful in the marketplace. This is one more reason why carbon prices are necessary, but not sufficient, for an equitable solution to the climate crisis.

E. Conclusion

Setting a price for carbon emissions is a valuable beginning, but not the end, of climate policy. Much more needs to be done to complement the new markets in carbon emissions, and to ensure an effective policy response to the threat of climate change.

Reliance on carbon price increases alone would be both ineffective and inequitable. For end uses with small price elasticities, such as residential electricity and, above all, transportation, a higher fuel price leads primarily to a less equal distribution of resources – not to a reduction in carbon emissions. Other policies are needed to offset the equity impacts of higher fuel costs, and to launch the development of new, low-carbon energy technologies of the future. Because technology choice is path-dependent, with strong learning-curve effects, public sector initiatives, such as investment in promising new energy technologies, are essential to ensure that the global economy follows a climate-friendly path.

Developing countries must play a leading role in key aspects of climate policy. If international agreements move towards a globally harmonized carbon price, it will become profitable for those countries to "leapfrog" beyond the technologies which are cost-effective in higher income countries.