

MARKET MECHANISMS & GREEN TECHNOLOGY

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Brussels Economic Forum May 25, 2010

Questions

- 1. Can green technologies play a key role in reaching high and sustainable growth in Europe?
 - GREEN TECHNOLOGY PLAYED A RELATIVELY SMALL ROLE IN PAST POLLUTION ABATEMENT (e.g., SO₂ in USA). HOWEVER, IT IS ESSENTIAL FOR DEALING WITH CLIMATE CHANGE.
 - IT WILL CONTRIBUTE TO EU GROWTH IN THE MEDIUM & LONG RUN, BUT NOT IN THE VERY SHORT RUN.
- 2. What are the economic implications of tackling global warming through market mechanisms?
 - EMISSION TRADING IS A NECESSARY BUT NOT A SUFFICIENT CONDITION FOR DEALING WITH CLIMATE CHANGE.

GHGs are a much broader problem

- Even if one could control emissions effectively through emission trading by electric utilities, for GHGs this would *not* take care of the problem.
- This is because power plants account for a far smaller share of GHG emissions than they did for SO₂ emissions.
 - Power plants account for 33% of US GHG emissions. In California, they account for 22% of GHG emissions (half of this is from out of state generation).
 - By contrast they account for 65% of SO₂ emissions
 - Transportation accounts for 27% of emissions nationally, and 40% in California

Strategies used to reduce SO₂

- Existing power plants
 - Modify combustion by switching from high- to low-sulfur coal.
 - Install scrubber to remove emissions post-combustion
 - Change dispatch order to favor lower-emission plants
- New power plants
 - Fired by natural gas rather than coal

- Strategies used all relied on known, mature technologies.
- Strategies *not* used:
 - Conservation, demand management
 - Switch to renewables
 - New combustion technologies
- Technological innovation played essentially no role

But, CO₂ is different than SO₂

- For CO₂ there is no good analog for the strategies used to reduce SO₂:
- Fuel switching is not such a major option
 - There is no low-CO₂ coal
 - Co-firing with biomass can be done, but on a far more limited scale than low-sulfur coal.
- There is no post-combustion scrubber
 - Carbon capture and sequestration can't be retrofitted to an existing power plant; it requires a brand new plant.

- The approach used with SO₂ was to reduce emissions by modifying the functioning of the existing coal-fired fleet of power plants.
- Existing capital stock was left intact.
- This won't work for CO₂ because the existing power plants & industrial boilers can't do much to reduce their emissions.
- The only significant way to reduce CO₂ emissions from existing coal-fired plants is to use them less.
- With CO₂ from coal-fired generation, the key opportunity to reduce emissions lies with *new* plants and how they are designed:
 - Higher thermal efficiency through technologies such as supercritical combustion or IGCC
 - Designed so they can accommodate CCS

What is needed with GHGs

- Conservation, increased energy efficiency
 - Behavioral change
 - Technological innovation
- Deployment of new technologies to decarbonize the economy:
 - Renewables to generate electricity
 - New fuel technologies such as biofuels, hydrogen
- Accelerated turnover of capital stock, replacing it with greener technologies.

The policy tools

1. Carbon tax or emission market to generate a price signal.
2. Performance-based regulatory standards.
3. Technology promotion programs

There has been a tendency among economists to assert that only (1) is needed. I believe that a portfolio of instruments will be needed, with (2) and (3) playing a more important role than (1).

Conventional economic models

- Take demand and supply curves as given. Allow for some rate of exogenous technological change. At best allow for some price-induced endogenous technological change.
- Do not allow for changes in behavior. Assume that regulated behavioral change must lower welfare.
- Ignore importance of salience in mediating responses to price signals.
- Do not allow for regulation-induced technological change.
- Are equilibrium models. Do not address speed or costs of adjustment. Do not recognize differing speeds of adjustments among different actors. Do not track turnover of capital stock.
- Ignore heterogeneity within sectors. Ignore potential change in composition of firms within sector.
- Assume a fixed economic structure – fixed number of firms, fixed number/types of actors. Ignore opportunities for introducing intermediaries who can change market outcome (e.g., energy efficiency aggregators).

The limits to price signals

- Economics focuses on price signals as motivators of behavior.
- A signal needs to be perceived and salient to have an effect.
- The empirical experience with SO₂, lead and NO_x is that emission price signal played little role in emission reduction. The individual caps on firms may have been more influential (Hanemann 2009, 2010).
- Non-price attributes can have a larger influence on behavior than prices.
- So can changing the consideration set.

Conceptualizing technological change

- Schumpeter's three stages
 - Invention [The first development of a scientifically or technically new product or process, which may involve both basic and applied research.]
 - Innovation [Accomplished when the new product or process is commercialized, i.e., made available on the market.]
 - Diffusion [The product or process comes to be widely used through adoption by many firms or individuals.]
- SO₂ emission control involved diffusion.
- For climate change, the key is invention and innovation – development & commercialization of technologies that do not exist yet or, at best, are still highly experimental (e.g., CCS).

Invention/innovation coordination problem

- Economists focus mainly on knowledge externality as the market failure hampering invention/innovation.
- This overlooks the coordination problem in going from a raw idea to full-scale production and commercialization.
 - Actions by multiple agents have to occur in synchrony and in the right sequence over time
 - Uncertainty is an inherent barrier to coordinated decision-making
 - Policy goal is to promote coordination

Importance of complementary inputs

- Economists have overlooked the significance of complementary inputs as drivers of change.
- For containerized shipping, the complementary inputs included having a new type of crane, standardized containers, and docks with parking space for trucks.
- Having the right business model is a key complementary input to innovation
 - For energy conservation, it is financial intermediation by Energy Service Companies.
 - For CCS, it may be necessary for the coal companies to provide CCS services.

Conclusion

- Conventional economic models focus typically on adjustments within a given structure.
- Climate change is more about changing the model structure. The goal is to shift/bend demand and supply curves so that the emissions market clears at a lower equilibrium price than otherwise.
- Innovation is crucially a coordination problem. Part of the coordination is getting the needed complementary inputs in place.
- There is a key role here for government as well as the market.