ECONOMIC THEORY AND CLIMATE CHANGE POLICY

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What is the appropriate role for economics in the development of climate change policy? Ideally, when formulating public policy, decision-makers should rely on expertise from a variety of disciplines, economics among them. The natural sciences can uncover connections between anthropogenic greenhouse gas emissions and natural phenomena. Engineering can identify options and innovations that are now or could become technologically feasible. Economics can assess possible consequences of policy actions for the production, consumption, and incomes of groups of people, regions, and countries.

Yet economics is often looked upon as the ultimate arbiter of policy choices, because it seems to offer something the other sciences do not: a theoretical framework capable of valuing the consequences of different policy choices with a single metric. Models based on this framework seek to assess the cost of policy actions to society at large (where the definition of "cost" goes well beyond the expenditures directly required for compliance with the policy). Some analyses make a further attempt to evaluate the benefits of policy actions, extending the metric of monetary valuation to natural phenomena. As a consequence, economics has come to assume a pivotal role in policy making. We believe that this practice is not legitimate, and that most economic policy assessment models, in their current forms, are biased against non-marginal policy changes such as those required to meaningfully address the challenges of climate change.

The theoretical framework which provides the basis for these models is general equilibrium theory.* Economic theorists have long known that it is severely flawed. The computer-based policy evaluation models it has engendered, computable general equilibrium (CGE) models, compound the weaknesses of the theory by adding arbitrary simplifying assumptions.

Recognition of these shortcomings has recently stimulated the exploration of exciting new approaches, based on innovations both in theory and in computer modeling. These approaches do not yet offer an unambiguous, axiomatized view of the world, such as conventional economic theory provides. They may never do so, given their explicit recognition of the complexity,

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* To be sure, there are and have been other theoretical frameworks and approaches to economics. However, neoclassical general equilibrium economics – the theory we are critiquing here – has become the dominant mode of analysis in the last two decades and exerts a pervasive influence on policy debates.

nonlinearities and path dependence inherent in social phenomena. Nevertheless, because they do recognize a wider range of important features of reality, the newer models offer novel insights with interesting implications for policymaking.

Equilibrium and Optimality

Conventional economics does offer a set of concepts and techniques that are of great value in clarifying and evaluating policy options. Yet these strengths are often offset by rigid adherence to traditional models and theories. General equilibrium theory and CGE models are a case in point. The appeal of the theory is great; it unifies blocks of economic analysis into a coherent picture of the whole economy as a web of interdependent activities. The models can trace the transmission of economic effects through different sectors in the economy.

But CGE models in their current form, reflecting elements of general equilibrium theory, carry a problematic message: that competitive markets lead to a unique, optimal resource allocation. If there are a few market "distortions," such as unpriced environmental values, selective government policy can set or correct the relevant prices and thus allow the (environmentally corrected) market to operate "efficiently." Any policy intervention that makes the economy deviate from this optimum is said to impose an undesirable "welfare cost."

Part of this message is valuable; prices are a powerful mechanism to coordinate economic activity. Hence, environmental taxes are often an effective policy instrument, as they provide incentives that can be felt throughout the economy. But part of the message is misleading. The social cost of a policy measure cannot usefully be evaluated in terms of how much it makes the economy deviate from a purportedly optimal state of affairs; nor can environmental taxes be declared a policy tool superior to all others, because they bring about this optimality. Indeed, the concept of optimality employed in the theory is tenuous at best.

There is an extensive literature in economics criticizing both the internal logic and fundamental assumptions of general equilibrium theory. Even if all the theory's assumptions are granted, it suffers from internal logical and mathematical problems: the equilibrium point of a general equilibrium model is not necessarily unique, nor is it always stable under small perturbations.[1] More immediately relevant for policy purposes is the lack of realism in the underlying assumptions. Here again there is a vast literature spanning several decades of discussion; we present two examples that are relevant to climate policy. Both pertain to the question of whether or not the market brings about optimality – first, in the application of existing technologies, and second, in the development of new technologies.

Hidden Costs or Bounded Rationality?

In general equilibrium theory, and in typical CGE models, the rational, well-informed maximizing behavior of producers and consumers ensures that every profitable opportunity is exploited by someone. As the saying goes, there are no twenty-dollar bills lying on the sidewalk, since someone would have picked them up. However, studies of energy efficiency and conservation routinely find substantial opportunities for profitable investment that have not yet been adopted. According to bottom-up energy models, many of which explicitly represent individual technologies of energy supply and use, the sidewalks are littered with zero or negative-cost efficiency options just waiting to be picked up.

To fit this empirical evidence into their models, economic analysts often claim that there are "hidden costs" to the apparently profitable energy efficiency opportunities. This claim has at times proved useful in clarifying the obstacles to increased efficiency; in practice, some energy-saving options have certainly turned out to be more difficult to implement than is suggested by engineering studies alone. However, the opposite is also true: conservation initiatives frequently do succeed in saving both energy and money.[2] Many innovations adopted in the course of the oil crises of the 1970s remained profitable even after oil prices had returned to their previous levels.[3] Often, in order to refute findings such as these, the "hidden costs" of conservation must be assumed to be implausibly large.

Taken to its logical extreme, the claim of "hidden costs" reduces to a tautology which allows economists to maintain the assumption that economic agents are always "rational", and hence (given a few more assumptions), that competitive market equilibria are always optimal. The implication for policy is clear: perturbing an optimal state of affairs is costly; policies that induce conservation above the optimal (i.e., prevailing) level impose an undesirable cost on the economy.

But people do not exhibit perfect, boundless rationality, in their economic decisions or in other roles. Sciences other than economics, using different models of human decision making, would have little difficulty in explaining the absence of optimization. Economists, too, have at times provided interesting alternative models of behavior. Herbert Simon's analysis of "bounded rationality" is a well-known, classic account of the inability of firms and individuals to engage in global optimization over the entire set of opportunities they face.[4] More recent work on principal-agent problems and the barriers to information flows within firms makes the same point in more sophisticated models; some of these newer approaches are directly motivated by the results of bottom-up energy research.[5] It is time to incorporate these insights into models for policy evaluation.

Increasing Returns and Technological Change

Above, we argued that the assumption of "rationality" has immediate policy relevance: It determines how much room for improvement we believe there is in the short-run choice of a technology mix. A different kind of assumption determines what we conclude about the opportunities for technological change. Clearly, the speed and direction of technological change will be decisive for the success of climate change policy.

Here, too, the simplest formulation of economic theory has misleading policy implications. The problem is that the theory depends on an assumption that is of critical importance for the modeling of technology: namely, that there are no cases of increasing returns to scale in production.** This assumption is needed to prove that every optimal resource allocation can be reached by market mechanisms, a conclusion that is frequently cited in support of market-based policies. It is also used to argue that there is a unique, optimal path for the unfolding of technological change, and that the market will find that path – provided prices are "corrected" for externalities through the use of taxes and subsidies.[6] In this setting, the market allocates the resources that generate technological progress in a manner that will achieve the highest possible pay-off.

But contrary to such theories, the existence and importance of increasing returns appear to be beyond dispute. There are three related but distinguishable grounds for increasing returns. First, the minimum efficient scale of operations is quite large in some industries, so there are increasing returns until a firm reaches the efficient size; railroads are a good example. Second, many production processes exhibit the phenomenon of "learning by doing": as an industry gains increasing experience in production, the unit costs for producing more in the future become steadily lower. This is a principal reason for the ever-lower prices for computers and other new high-technology products. Third, for some technologies there are benefits to making the same choice as others around you, giving rise to systemwide economies of scale, or "network externalities." The choice of computer operating systems (e.g., Windows vs. Macintosh) is a recent example.

In a model of the economy, any form of increasing returns allows positive feedback: an increase in production lowers unit costs or (for systemwide economies of scale) increases demand, and thus makes it more likely that even more will be produced in the future. This can lead to technological "lock-in": if the benefits of using a technology (such as a computer operating system) increase when more people use it, or the unit costs of production decline fast enough as output grows, then at a certain level of production society can become locked into its initial choice – even if it is intrinsically inferior to the alternatives. As a result, final outcomes are path-dependent; a small initial head start for one firm or technology over another can determine which of several alternatives becomes dominant. Brian Arthur has formalized these notions with a variety of innovative mathematical models.[7]

This analysis has profound implications for energy, and hence for climate change policy. The various forms of increasing returns can all be seen in energy use. As the example of railroads illustrates, the minimum efficient scale for energy-efficient transportation and land use planning may be substantial. Learning by doing, implying rapidly declining unit costs as production increases, is a much-discussed characteristic of solar power, wind energy, and other renewable technologies. For technologically complex options, such as use of alternatively powered vehicles, systemwide economies of scale (based on, e.g. availability of fuel, spare parts, and repair expertise) will be critical.

** A production process has "increasing returns to scale" if an increase in all inputs by the same factor would lead to a more than proportional increase in output. Equivalently, an expansion in output would increase the input requirements less than proportionally and hence lower unit costs.

The possibility of lock-in to inferior technologies has vital implications for the current debates on climate change policy. The strategy of waiting and investing in carbon emission abatement technologies later, when abatement costs will presumably be lower,[8] is imaginable in a conventional model without increasing returns or lock-in effects. In reality, however, by waiting we risk becoming locked into inferior, energy-inefficient and emission-intensive technologies. By acting now, we can create opportunities for locking into a preferred technological path toward energy efficiency and emission abatement.

Public policies could provide initial stimuli for the development of desirable new technologies, though identifying deserving candidates is by no means easy. The important implication of increasing returns and path dependence is that there is no magic formula for choosing the right policy. Price signals and market-based policies are of undoubted importance, but there is no reason to believe that reliance on these measures alone is inherently superior to a development strategy that employs a range of policies designed to complement each other. Performance standards, infrastructure investments, and public support for basic science and RD&D might well prove equally, or more, effective in leading us along the preferred technological path.

Acting in the Face of Uncertainty

New work in economic theory has begun to incorporate the possibility of increasing returns, although often only in a limited form. Paul Romer's "endogenous growth" model is a well-known example, yet it still assumes the existence of a single optimal growth path.[9] Paul Krugman has done interesting work on increasing returns, trade, and the location of production.[10] Even newer approaches are beginning to explicitly model the emergence of macro-phenomena from interaction among agents with less than perfect rationality. Yet these insights have not yet found their way into policy models, and much more needs to be done in this area.

An economic model that is to be useful for analyzing climate change policy must make increasing returns central to its treatment of technology. A model that truly embraced the implications of positive feedback mechanisms would look very different from existing ones. Such a model would not offer a unique, optimal outcome which selective, price-based policies would bring about. Rather, it could provide a range of alternative outcomes, given differing initial conditions, possibly with differing distributions of advantages and disadvantage among economic agents. While some outcomes would be clearly more attractive or compelling than others, there would be no single metric for evaluation of the alternatives. Institutional constraints and opportunities would be an integral part of such an analysis, affecting both the model's results and their social evaluation.

This perspective does not reject the importance of economic analysis. But it does call on economists to understand (and even model) the inherent uncertainty of future outcomes, a task that requires a reconceptualization of the role and the possible accomplishments of economics. Most fundamentally, it is necessary to wake up from the dream of optimality. The model of a unique, optimal allocation of resources fails both in the short run as a description of reality, and in the long run as a description of society's goals.

Path dependence and increasing returns imply that society can choose, intentionally or accidentally, which technological path to pursue; we have argued here that the market cannot meaningfully make that choice for us. However, once that choice has been made, economics – hopefully in the new, improved version that we look forward to – can tell us a great deal about how to implement it.

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