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DEALING WITH A NON-ERGODIC WORLD: INSTITUTIONAL ECONOMICS, PROPERTY RIGHTS, AND THE GLOBAL ENVIRONMENT

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I. INTRODUCTION

This is the kind of conference I like to attend. I hope that out of it will come some real additions to our understanding of a set of very complex issues. I understand that my job is to set the scene. So, what I am going to try to do is to provide a framework for our thinking and to raise a lot of serious questions, which I will not answer. But you will. I am going to begin not by being negative but by raising some thorny issues that we have to confront in the subject matter that we are concerned with here—the creation of institutions for protecting the global environmental commons.

II. A NON-ERGODIC WORLD

I am going to begin by asking, “What are the limits to our understanding of the world around us?” I think without being very self-conscious about that question, we do what so many economists

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often do—put their feet in their mouths. Let me begin by asserting that the world we live in is not an ergodic world; it is a non-ergodic world. I like the term “ergodic.” Paul Samuelson has used the term frequently when trying to show that the field of economics is scientific. In fact, Samuelson’s assertion was that if the world is not ergodic, economics is not a science. There *are* some aspects of economics that may be ergodic, but most of the issues that are important for us are non-ergodic.

If I say the world is ergodic, I mean that it has a stable underlying structure, such that we can develop theory that can be applied time after time, consistently.¹ It is very important to understand that the world with which we are concerned is continually changing, is continually novel. That does not mean that there are not ergodic aspects of the world. But we cannot develop theory that can be used over and over again and over time. For an enormous number of issues that are important to us, the world is one of novelty and change; it does not repeat itself. There may be lessons in history,² but we have to be careful about them. We have to be careful about the lessons that history may teach, if we are going to try to unravel the problems that concern us here. If indeed these issues with which we are concerned, such as global warming and the global commons, belong in a world of continuous change, a non-ergodic world, then we face a set of problems that become very complex. So, let me move from a non-ergodic world to dealing with uncertainty.

III. UNCERTAINTY, PLAYING GOD, AND THE GLOBAL ECONOMY

Economists, from Kenneth Arrow to Robert Lucas, have asserted that one cannot theorize in the face of pure uncertainty. By “uncertainty,” I mean the same thing that Frank Knight specified. For Knight, *uncertainty* means that no probability distribution of outcomes exists. This is in contrast to *risky* activities in which there is a probability distribution of outcomes. So, if one is confronted with risk, presumably one could insure against it and develop theory or models that would deal with such risk. However, if there is uncertainty, one can do no such thing. This means that, under uncertainty, one not only does not have a probability distribution of

1. I might add the development of such notions has gotten two recent Nobel Prize winners, Myron Scholes and Robert Merton, in big trouble.

2. Indeed, since I have good friends in this room who are historians, I want to assert that there *are* some lessons from history.

outcomes, but (using a Keynesian definition)³ one may not even know what the possible outcomes are, much less have a probability distribution of them.

I want to assert that almost all of the issues that we are concerned with in this room are uncertainty issues. Some result straightforwardly from simply not having enough knowledge. Faced with that kind of uncertainty, we can acquire more knowledge and therefore convert uncertainty into risk, which is what human beings have done for a long period of time. Other uncertainty issues, however, arise from the non-ergodic aspects of the systems with which we are concerned. That is, the systems in which we are interested reside in a world of continuous change, in many dimensions—not only in terms of physical change but also change in the social structure and behavior of human beings. Furthermore, to make our lives even more difficult, all the theory that we have in economics, at least all of the theory that is well developed, is *static* theory. Whether one looks to neoclassical price theory or its derivatives, it is all a static body of theory. However, all of the important issues with which we are interested here concern a *dynamic* world, one of continuous change.

Thus, we have uncertainty in three dimensions. In one, we need to acquire more information and knowledge to be able to reduce uncertainty to risk. In the second, involving the non-ergodic aspects of systems in which we are interested, we have to grope around and have much less assurance that we are going to solve the problems with which we are concerned. In the third, we are stymied without a dynamic theory of change.

Let me take the discussion regarding uncertainty and apply it to some specifics that concern us. First, uncertainty exists with respect to the physical dimensions of the subject. As an enormous amount of controversy has shown, we simply do not know enough about the physical dimensions of global warming and other aspects of the global environment to have guarantees about what we are doing. Furthermore, if we cannot measure the physical dimensions of what we are doing, then we are in big trouble right from the start.⁴ Indeed, we *are* in trouble on that account. Not only are there difficulties in

3. Keynes' definition of uncertainty was more sweeping. For Keynes, "uncertainty" means that we simply do not know what outcomes will occur.

4. This point is crucial, because we have to be able to measure what we are doing or else we will not be able to create and maintain effective institutions for solving global environmental problems. See discussion *infra* Part IV.

measuring what is happening in the physical environment, there are even uncertainties associated with the implications and consequences of alternative models that we derive about what is happening in the atmosphere and the global environment. So, there is a big problem with respect to the physical aspects of the problems with which we are concerned, and I have nothing to contribute to that.

What I do have something to say about are the ways in which we structure human interaction to attempt to solve problems. When we try to structure this human interaction, such as make rules for playing a game, we run into a new set of issues that involve essentially altering and restructuring the way that the society, polity, and economy operate. Now, such restructuring is hard enough to do when we are concerned with a developed world, where a well-developed body of property rights and effective enforcement mechanisms exist. While these enforcement mechanisms work imperfectly (as any of us who go around concerning ourselves with these issues knows), they nevertheless *work*. But these mechanisms work on a very different level in the developed world than on the level that I have become used to in the last ten years as I have wandered around the world doing what I call “playing God,” which is advising third world countries on development problems. When you do enough advising of third world countries, you become very self-conscious about how different the property rights and enforcement mechanisms are in most third world countries when compared to countries in the developed world. In the context of the third world, the third dimension of my uncertainty is even more important and difficult: how in a *dynamic* context do we get the game changed in the direction we want?

I have been involved with Venezuela for the last five or six years. Venezuela's is a story in which everything has gone wrong almost all of the time and every effort at producing change in the system has usually produced almost exactly the reverse consequences downstream. In 1993, Jeffrey Sachs described Venezuela as finally having turned the corner, as becoming a country that would grow very well after using the ‘big bang’ and shock therapy and as having just avoided the most terrible disaster that could happen to a country. That disaster was the political disorder that would have resulted from—if it had succeeded—a coup attempt by Lieutenant Colonel Hugo Chavez. However, in December 1998, Lieutenant Colonel Hugo Chavez became President of Venezuela. I will leave to you how we got from one end of that story to the other. But, essentially,

it is an endless story of our having very poor understanding of an enormously complex process in which the uncertainty, again, is in all three dimensions. We do not know enough; we are dealing with a world of continuous change; and we do not have any dynamic theory to guide us when we attempt to get from one point to the next.

I want to add one last thorn before I turn positive. That is, one of the things we talk about (and it is a part of the title of this conference) is a “global economy.” Now, it is *not* a global economy. It is partly a global economy. It is a world in which we interact and trade with each other and in which we have movements of productive factors and of goods and services. But a true global *economy* would require a global *government*. That is, there would have to be enforcement mechanisms that could be applied internationally. When we talk about property rights and structuring markets in a given country, there must be an institutional structure that can define a set of rules of the game, can specify those rules, and can provide enforcement mechanisms. We do *not* have such an institutional structure for the global economy. What we do have are many much more imperfect devices that we use to structure the international game.⁵ We have much more imperfect abilities to structure international markets than we have to structure national markets, where there are rules of the game and enforcement mechanisms that are clear and unambiguous.

IV. TRANSACTION COSTS: MEASUREMENT AND ENFORCEMENT

Let me turn now to being positive, or at least starting to be positive. I am going to begin by talking about transaction costs, because they are, in fact, the appropriate way of getting at the issues that concern us. Now, for me, transaction costs are only two things: (1) the costs of measuring the dimensions of whatever it is that is being produced or exchanged and (2) the costs of enforcement. I will speak about each one of these in turn.

Measurement is the most crucial issue. Most of what we do in economics, such as dealing with exchange or principal/agent relationships, involves subjects that have many dimensions to them. For example, when dealing with the exchange of goods and services, the goods or services that are the subject of an exchange have dimensions to them. It was Kevin Lancaster who told us, back about

5. I want to emphasize this, because the economic crises that we are dealing with today are partly a function of our imperfect abilities to structure international markets.

thirty or forty years ago, that if what is being exchanged has many dimensions, then, to the degree that those dimensions cannot be defined yet are valuable, imperfect property rights exist. The more dimensions that exist for which there are no ways to measure them, the more imperfect the property rights. That is crucial, because indeed almost all of the issues here with which we are concerned turn on our ability to be able to measure precisely what we are talking about. So, a lot of what we need to do is to try to measure the dimensions of what we are talking about in such a way that we can define them precisely. Without that ability, there is little that we can resolve; we cannot even get to first base.

This leads to the costs of enforcement. Without being able to measure accurately whatever it is you are trying to enforce, there cannot be effective enforcement, even as a possibility. I teach a course in law and economics at Washington University with a law professor. One of the things that I have learned over the dozen or so years that I have been teaching with him is how much of legal jargon is so imprecise that it encourages litigation. Litigation is encouraged because so much of legal jargon does not specify *precisely* what the parties are trying to enforce with a contract. Consequently, because of this imprecision in specifying the subject matter of contracts, there can be many different measures of what constitutes performance or non-performance. Because we do not have precise measures of what we are talking about, we substitute slippery terms and slippery words for them. Thus, measurement is really the beginning and end of much of the enterprise on which we want to spend our time and of the issues we are trying to resolve. Obviously, without the ability to precisely measure what we are talking about, enforcement is handicapped from the start.

But, while effective enforcement requires precise measurement, enforcement is much more than that. Enforcement means that somehow there is a way to make a grievance stand up. There are three levels of enforcement: first-party enforcement, second-party enforcement, and third-party enforcement. First-party enforcement means there is self-enforcement. The values and norms that exist in society may get people to live up to contracts and standards, which is obviously a big part of what makes transaction costs low enough to have exchange in many contexts in the world. Second-party enforcement is by retaliation. That is, when there are two parties and one can retaliate against the other, there is a mechanism for enforcement. Regardless of how imperfect it is, second-party

enforcement still works. Third-party enforcement is much more complex, and it is the one on which we spend the most time. Not only is third-party enforcement the informal kind of enforcement we talk about so much in game theory, where reputation mechanisms and things like that work, but it is coercive enforcement by a third party, the state. This coercive third-party enforcement by the state has been a necessary and essential part of the rise of the Western world. There has to be a third-party enforcement vehicle when a market gets big enough that the Adam Smithian proportions of worldwide production and exchange are reached. Thus, the notion of enforcement is crucial.

Let me add one more point about enforcement, which is obvious to economists. That is, one does not want enforcement to be perfect, because the marginal gains and costs are asymmetric with respect to the way they evolve.⁶ Typically, one wants enough enforcement to solve the problems at issue or at least to realize and deal with the problems, but that always means that enforcement is imperfect. Since enforcement is imperfect, one would allow a certain amount of leeway or behavior on the part of the other party and take that into account when thinking about what is going to happen—how the parties will behave and the consequences. That point is important when dealing with mechanisms for controlling environmental problems, our main concern here.

Two things determine transaction costs, or the costs of measurement and enforcement. One is, of course, the technology available. I do not have anything specific to add regarding this point, although the interplay between technology and institutions is a complex one that we will have to come back to again and again. The other determinant of transaction costs is the institutional structure present. Institutions define the structure of human interaction. By “institutions,” I mean three things: (1) the formal rules of the game that are defined in legal terms, (2) the informal norms of behavior that supplement and compliment and modify institutions, and (3) the effectiveness of enforcement mechanisms. It is the mixture of the three that determines the effectiveness of institutions in influencing transaction costs. And the effect of institutions on transaction costs is obviously important.

6. That is, the marginal benefits of complete enforcement will be lower than the marginal costs of perfect enforcement.

V. RATIONALITY AND INSTITUTIONS

I want to make a brief digression into cognitive science. Currently, in my own research but particularly in a lot of the current work on the interplay between cognitive science and the social sciences, there is increasing awareness that the ability of human beings to make effective decisions and choices is influenced by institutions. Human decision-making is a combination of intended *rational choices*, supplemented by *effective institutions* that constrain the environment and the uncertainties of the environment, and *artifactual structure*. What I have called “artifactual structure” is the set of institutions, tools, and techniques that humans create when dealing with the world around them. It is the combination of mental models that humans possess and the artifactual structure that humans create which determine how well humans do, or the effectiveness of human decisions. I want to emphasize this, because it focuses us on the limitations of what we mean by “rationality,” which is currently undergoing a lot of critical examination.

We are beginning to get an understanding of what we mean by rationality, and perhaps the best understanding of it has been in a recent article that John Ferejohn and Debra Satz wrote in the *Journal of Philosophy*.⁷ They point out that rationality, in the sense that economists talk about it, works best when the choices of the players are most limited. Let me say that again, because it is terribly important. Rationality works best, that is, we generally get the kind of results that we want, in a world where the choices are very limited. Now, the reason for that is very simple. When you structure the environment by rules, laws, and tools and techniques, the players are constrained in certain directions. It is the constraints on the actors that help the decision-maker. The more unconstrained the environment, through lack of an effective artifactual structure, the more difficult it is for people to make choices or to implement their choices in effective ways.

These days we are doing a lot of intriguing research on this topic in economics and in other social sciences. If I had time, I would talk more about it, because it has been my pet subject recently. But, today, I want to simply leave you with my impressions about when I go to third world countries where I am concerned with attempting to implement policy changes to get better performance. It is a *fact* that the choices made in those contexts, where there is not an effective

7. Debra Satz & John Ferejohn, *Rational Choice and Social Theory*, 91 J. PHIL. 71 (1994).

artifactual structure, lead to poor decisions. Now, of all the things that are important for us to take into account when analyzing global problems, that fact is a crucial one. The article by Satz and Ferejohn is a landmark in the interplay between the social sciences and cognitive science and in attempting to direct us toward a more complete understanding of human decision-making.⁸

VI. MOVING FROM PERSONAL TO IMPERSONAL MARKETS

Obviously, the ideal institutions for the problems with which we are concerned are self-enforcing. In fact, if we could always have all our institutions be self-enforcing, then it would be easy to deal with almost all of the problems that concern us here. But most institutions are not self-enforcing, which requires us to confront a major hurdle that those who are concerned with property rights and their evolution have had to face. That is, when shifting from a world of personal exchange to a world of impersonal exchange, to use a game theory analogy, one moves from a world in which it pays the players to cooperate to a world in which it pays the players to defect. In the world of *personal* exchange, it pays for parties to an exchange to cooperate, because the parties have personal knowledge of the other players and there is the possibility for repeat dealings between the parties. But in a world of *impersonal* exchange, it pays for the parties to defect, *ceteris paribus*. With impersonal exchange, the world is one in which there is not an iterated game. That is, parties either have an end game, or they only play once. One does not know anything about the other players, and indeed there are a large number of players. In that sort of world, the game must be structured so as to alter the payoffs so it pays to cooperate.

Now, a lot of interesting work done in economic history in the last twenty-five years has attempted to see the way the Western World has evolved. Structures to devise institutions that alter the payoffs so as to allow for long-distance trade, for the development of impersonal markets, have been a big step in allowing us to come to grips with a lot of problems. Some environmental problems can be partially solved in a setting of personal exchange. However, other environmental problems involve large, impersonal markets; thus, we are going to have to devise institutions *de novo* that attempt to confront and deal with worlds of impersonal exchange.

8. There is more recent work in cognitive science by, among others, my colleague at Washington University, Andy Clark, who has just written a book called *Being There*, and Ed Hutchins in a study entitled *Cognition in the Wild*.

For the world of semi-impersonal exchange, Elinor Ostrom has probably done more than anybody else in her work examining common pool problems and ways in which we can effectively structure problems involving common property. Ostrom's work in the field, as well as the theoretical work that she has done, has made her a pioneer. In her book, *Governing the Commons*, she has a list of commandments for solving common pool problems.⁹ These commandments are very sensible. When I have been concerned with specific problems at relatively local levels and have tried to devise institutional structures that work, Ostrom's advice and sage thoughts have been extremely valuable.

VII. CONCLUSION: CREATING INSTITUTIONS FOR A NON-ERGODIC WORLD

Let me conclude by speaking in general terms about some issues that I hope will be useful. In particular, when analyzing problems concerning the global environment, one begins by addressing the

9. The commandments, which she calls "design principles," are the following:

1. Clearly define boundaries
Individuals or households who have rights to withdraw resource units from the common pool resource (CPR) must be clearly defined, as must the boundaries of the CPR itself.
 2. Congruence between appropriation and provision rules and local conditions
Appropriation rules restricting time, place, technology, and/or quantity of resource units are related to local conditions and to the provision rules requiring labor, material, and/or money.
 3. Collective-choice arrangements
Most individuals affected by the operational rules can participate in modifying the operational rules.
 4. Monitoring
Monitors, who actively audit CPR conditions and appropriator behavior, are accountable to the appropriators or are the appropriators.
 5. Graduated sanctions
Appropriators who violate operational rules are likely to be assessed graduated sanctions (depending on the seriousness and context of the offense) by other appropriators, by officials accountable to these appropriators, or by both.
 6. Conflict-resolution mechanisms
Appropriators and their officials have rapid access to low-cost local arenas to resolve conflicts among appropriators or between appropriators and officials.
 7. Minimal recognition of rights to organize
The rights of appropriators to devise their own institutions are not challenged by external governmental authorities.
- For CPRs that are parts of larger systems:
8. Nested enterprises
Appropriation, provision, monitoring, enforcement, conflict resolution, and governance activities are organized in multiple layers of nested enterprise.

ELINOR OSTROM, *GOVERNING THE COMMONS* 90 (1990).

issue of devising institutions in a non-ergodic world. Now, I am briefly going to speak about goods and services markets and not about the global environment. First, one of the things that we have been learning and that I have been aware of as an advisor to the World Bank on a number of studies of markets is that there is no such thing as *laissez faire* in this world. Markets do not work well if they are not structured. There is no such thing as an effective, unstructured market. Every market not only requires that we broadly devise a set of rules of the game that apply generally but also that we try to specify the market structure so that people compete via price and quality. We need people to compete via price and quality rather than by killing each other or engaging in other behavior characteristic of Russia today. Thus, we have to structure every market. Whether it is the market for agricultural products or the market for telecommunications or the market for whatever, each one of them has to be structured so that the players compete via price and quality or the particular social dimensions by which we want them to compete. By now, this should be apparent to people, because of all the things that we are only beginning to learn about the current financial crises in Asia and around the world. That is, capital markets, especially, must be structured to get the players to compete in certain dimensions and not in other dimensions.

Now, the first issue is that markets must be structured, but the second one is equally crucial. The second issue is that what works today is not going to work tomorrow. There is no structure that is going to work for all time and for all places. A simple example involves the work done for the World Bank regarding telecommunications. The telecommunications industry in the past was a natural monopoly. However, today it is a competitive industry. Furthermore, the kind of structure that one would devise for a natural monopoly is *not* the same as one would devise for a competitive industry. In a competitive industry, it is not just technological dimensions that keep changing; so do the relative bargaining power of the other players in the world and the nature of the markets themselves. There are many changes occurring; thus, searching for a single, stable definition and structure for a market is just not the way we should think about devising institutions.

Now, one of the goals that is immediately relevant to our concerns here—devising institutions to protect global resources and reduce the probability of global warming—is simply to be able to devise ways to structure environmental markets so that they work

today. But one of the things with which we must be concerned is structuring environmental markets so that they are flexible enough to change. Then, when the context, the technology, or the physical dimensions of environmental problems evolve over time, these markets will have the flexibility and resilience to continue to work *tomorrow*.

I am going to end with that thought regarding designing institutions in light of future change, because the one thing that we know least about is *adaptive efficiency*. I use the term “adaptive efficiency” to describe how economies and societies work effectively, not at a moment in time, but through time. We do not yet know how to structure markets and institutions so that they are adaptively efficient. But we do know that the United States has been an adaptively efficient economy. The United States economy has been growing for more than two hundred years, and that is a remarkable achievement. It is remarkable in many dimensions, politically as well as economically. How we did this, however, is currently elusive. It would be nice to have a model, but we do not have one.

The political and economic system of the United States did not often evolve deliberately. Much of the time we were fumbling in the dark. But we have evolved a set of informal norms of behavior that make it possible for the game that we play to evolve in time. Our institutions have been flexible, here and there. So, the United States has continued to have economic growth, despite the enormous amount of stresses, strains, and tensions that have evolved in our economy over time. Thus, adaptive efficiency is certainly a required characteristic of any institutions that we devise with regard to the global environment. We must think in terms of creating not only a structure that will improve the environment today but a structure with built-in flexibility so that it can adjust to the tensions, strains, and unanticipated circumstances of tomorrow.