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Mechanism Design: How to Implement Social Goals

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el 5 de Octubre de 2009
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Sumario

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MECHANISM DESIGN: HOW TO IMPLEMENT SOCIAL GOALS†

The theory of mechanism design can be thought of as the "engineering" side of economic theory. Much theoretical work, of course, focuses on *existing* economic institutions. The theorist wants to explain or forecast the economic or social outcomes that these institutions generate. But in mechanism design theory the direction of inquiry is reversed. We begin by identifying our desired outcome or *social goal*. We then ask whether or not an appropriate institution (mechanism) could be designed to attain that goal. If the answer is yes, then we want to know what form that mechanism might take.

In this paper, I offer a brief introduction to the part of mechanism design called *implementation theory*, which, given a social goal, characterizes when we can design a mechanism whose *predicted* outcomes (i.e., the set of equilibrium outcomes) coincide with the *desirable* outcomes, according to that goal. I try to keep technicalities to a minimum, and usually confine them to footnotes.

I. Outcomes, Goals, and Mechanisms

What we mean by an "outcome" will naturally depend on the context. Thus, for a government charged with delivering public goods, an outcome will consist of the quantities provided of such goods as intercity highways, national defense and security, environmental protection, and public education, together with the arrangements by which they are financed. For an electorate seeking to fill a political office, an outcome is simply the choice of a candidate for that office. For an auctioneer selling a collection of assets, an outcome corresponds to an allocation of these assets across potential buyers, together with the payments that these buyers make. Finally, in the case of a home buyer and a builder contemplating the construction of a new house, an outcome is a specification of the house's characteristics and the builder's remuneration.

† This article is a revised version of the lecture Eric S. Maskin delivered in Stockholm, Sweden, on December 8, 2007, when he received the Bank of Sweden Prize in Economic Sciences in Memory of Alfred Nobel. The article

Similarly, the standards by which we judge the "desirability" or "optimality" of an outcome will also depend on the setting. In evaluating public good choices, the criterion of "net social surplus" maximization is often invoked: does the public good decision maximize gross social benefit minus the cost of providing the goods? As for electing politicians, the property that a candidate would beat each competitor in head-to-head competition (i.e., would emerge a *Condorcet winner*) is sometimes viewed as a natural desideratum (see Partha Dasgupta and Eric Maskin, forthcoming). In the auctioning of assets, there are two different criteria by which an outcome is typically judged: (a) whether the assets are put into the hands of bidders who value them the most (i.e., whether the allocation is *efficient*); and, alternatively, (b) whether the seller raises the greatest possible revenue from sales (i.e., whether *revenue maximization* is achieved). Finally, for the home buyer and builder, an outcome will ordinarily be considered "optimal" if it exhausts the potential gains from exchange between the parties, i.e., the house specification and remuneration are together Pareto optimal and individually rational.

A *mechanism* is an institution, procedure, or game for determining outcomes. Not surpris- ingly, who gets to choose the mechanism—i.e., who is the mechanism designer—will, once again, depend on the setting. In the case of public goods, we normally think of the government providing the goods as also choosing the method by which the levels of provision and financing are determined. Similarly, when it comes to sales of assets—where an *auction* is the typical mechanism—the asset seller often gets to call the shots about the rules, i.e., he is the one who chooses the auction format.

In the case of national political elections, by contrast, a mechanism is an *electoral procedure*, e.g., plurality rule, run-off voting, or the like. Moreover, the procedure is ordinarily prescribed long in advance, indeed sometimes by the country's constitution. Thus, here we should think of the framers of the constitution as the mechanism designers.

Finally, in the house-building example, a mechanism is a contract between the home buyer and builder and lays out the rights and responsibilities of each. Since these parties are presumably the ones who negotiate this contract, they themselves are the mechanism designers in this last setting. Now, in the public framework, if the government knows at the outset which choice of public goods is optimal, then there is a simple—indeed, trivial—mechanism for achieving the opti- mum: the government has only to pass a law mandating this outcome. Similarly, if the auctioneer has prior knowledge of which bidders value the assets most, he can simply award them directly to those bidders (with or without payment).

The basic difficulty—which gives the subject of mechanism design its theoretical interest—is that the government or auctioneer will typically *not* have this information. After all, the net surplus-maximizing choice of public goods depends on citizens' *preferences* for such goods, and there is no particular reason why the government should know these preferences. Likewise, we wouldn't normally expect an auctioneer to know how much different potential buyers value the assets being sold.

Because mechanism designers do not generally know which outcomes are optimal in advance, they have to proceed more indirectly than simply prescribing outcomes by fiat; in particular, the mechanisms designed must generate the information needed as they are executed. The problem is exacerbated by the fact that the individuals who *do* have this critical information—the citizens in the public good case or the buyers in the asset-selling example—have their own objectives and so may not have the incentive to behave in a way that reveals what they know. Thus, the mecha- nisms must be *incentive compatible*. Much of the work in mechanism design, including my own, has been directed at answering three basic questions:

(A) When is it possible to design incentive-compatible mechanisms for attaining social goals?

(B) What form might these mechanisms take when they exist?

and

(C) When is finding such mechanisms ruled out theoretically?

That it is ever possible to design such mechanisms may, at first, seem surprising. How, after all, can a mechanism designer attain an optimal outcome without knowing exactly what he is aiming for? Thus, it may be helpful to consider a simple concrete example.

II. An Example

Consider a society consisting of two consumers of energy, Alice and Bob. An energy authority is charged with choosing the type of energy to be used by Alice and Bob. The options—from which the authority must make a single selection—are gas, oil, nuclear power, and coal.

Let us suppose that there are two possible states of the world. In state 1, the consumers place relatively little weight on the future, i.e., they have comparatively high temporal discount rates.

In state 2, by contrast, they attach a great deal of importance to the future, meaning that their rates of discount are correspondingly low.

Alice, we will imagine, cares primarily about convenience when it comes to energy. This means that, in state 1, she will rank gas over oil, oil over coal, and coal over nuclear power, because as we move down her ranking, the energy source becomes either messier or more cum- bersome to use. In state 2, by contrast, her ranking is

nuclear

gas

coal

oil

because she anticipates that technical advances will eventually make gas, coal, and especially nuclear power much easier to use—and, in this state, she lays particular stress on *future* benefits.

Bob is interested particularly in *safety*. This implies that in state 1, when he puts greatest weight on the present, he favors nuclear power over oil, oil over coal, and coal over gas. But if state 2 obtains—so that the future is comparatively important—his ranking is oil

gas

coal

nuclear

which reflects the fact that, in the long run, the problem of disposing of nuclear waste can be expected to loom large, but that oil and gas safety are likely to improve somewhat.

To summarize, the consumers' rankings in the two states are given in Table 1.

Assume that the energy authority is interested in selecting an energy source that both consum- ers are reasonably happy with. If we interpret "reasonably happy" as getting one's first or second choice, then oil is the optimal choice in state, whereas gas is the best outcome in state 2. In the language of implementation theory, we say that the authority's *social choice rule* prescribes oil in state and gas in state 2. Thus, if *f* is the social choice rule, it is given by Table 2.[1]

Table 1

State 1		State 2	
Alice	Bob	Alice	Bob
gas	nuclear	nuclear	oil
oil	oil	gas	gas
coal	coal	coal	coal
nuclear	gas	oil	nuclear

Table 2

f (state 1) = oil	f (state 2) = gas

1. In a more general setting, where Θ is the set of possible states of the world and *A* is the set of possible outcomes, a social choice rule *f* is a correspondence (a set-valued function) $f : \Theta gg A$, where, for any $\theta, f(\theta)$ is interpreted as the set of optimal outcomes in state θ (we are allowing for the possibility that more than one outcome might be considered optimal in a given state).

Suppose, however, that the authority does not know the state (although Alice and Bob do).

This means that it does not know which alternative the social choice rule prescribes, i.e., whether oil or gas is the optimum.

Probably the most straightforward mechanism would be for the authority to ask each consumer to announce the state, whereupon it would choose oil if both consumers said "state 1," choose gas if both said "state 2," and flip a coin between them if it got a mixed response. But, notice that in this mechanism Alice has the incentive to say "state 2" regardless of the actual state and regardless of what Bob says, because she prefers gas to oil in both states. Indeed, by saying "state 2" rather than "state 1," she raises the probability of her preferred outcome from 0 to 0.5 if Bob says "state 1," and from 0.5 to if Bob says "state 2." Hence, we would expect Alice to report "state 2" in both states. Similarly, Bob would always report "state 1," because he prefers oil to gas in either state. Taken together, Alice's and Bob's behavior implies that, in each state, the outcome is a 50–50 randomization between oil and gas. That is, there is only a 50 percent chance that the outcome is optimal, and so this mechanism is demonstrably too naïve.

Let us suppose, therefore, that the authority has the consumers participate in the mechanism given by Table 3:

Table 3

		Bob	
		Left	Right
Alice	Top	oil	coal
	Bottom	nuclear	gas

That is, Alice chooses "Top" or "Bottom" as her strategy; simultaneously, Bob chooses "Left" or "Right" as his strategy; and the outcome of those choices is given in the corresponding entry of the matrix.[2]

2. More generally, a mechanism for a society with n individuals is a mapping $g: S_1 \times \cdots \times S_n \to A$, where, for all i, S_i is individual i's strategy space and $g(s_1, \ldots, s_n)$ is the outcome prescribed by the mechanism if individuals play the strategies $(s_1, \ldots, s_n)$.

Observe that, in state 1, Bob is better off choosing Left regardless of what Alice does: if she plays Top, then Left leads to oil as the outcome (which Bob prefers), whereas Right gives rise to coal. If she plays Bottom, then nuclear power (Bob's preferred outcome) is the consequence of going Left, while Right leads to gas. That is, Left is the "dominant strategy" for Bob in state 1. Moreover, given that Bob is going Left, Alice is better off choosing Top rather than Bottom, because she prefers oil to nuclear power. Thus, in state 1, the clear prediction is for Alice to play Top and for Bob to play Left, i.e., (Top, Left) is the unique Nash equilibrium.[3] Furthermore—and this is the critical point—the resulting outcome, oil, is optimal in state 1.

Turning to state 2, we see that Bottom is the dominant strategy for Alice in that state. If Bob plays Left, then she is better off with Bottom than Top because she prefers nuclear power to oil. And if Bob goes Right, then Bottom leads to gas, which she prefers to the Top outcome, coal. With Alice choosing Bottom, Bob is better off going Right, because gas is better for him than nuclear power. Hence, in state 2, the (unique) Nash equilibrium is (Bottom, Right): Alice plays Bottom and Bob goes Right. Furthermore, this results in the optimal outcome, gas.

We have seen that in either state, the mechanism of Table 3 achieves the optimal outcome even though (a) the mechanism designer (the energy authority) does not even know the actual state, and (b) Alice and Bob are interested only in their own preferences, not those of the authority. More precisely, because the Nash equilibrium outcomes of the Table 3 mechanism coincide with the optimal outcomes in each state, we say that the mechanism *implements* the authority's social choice rule in Nash equilibrium.[4,5]

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3. In general, a Nash equilibrium is a specification of strategies—one for each individual—from which no individual has the incentive to deviate unilaterally. Thus, if $u_i(a,\theta)$ is individual i's payoff from outcome a in state θ, strategies $(s_1, \ldots, s_n)$. constitute a Nash equilibrium of mechanism g in state θ if $u_i(g(s_1, \ldots, s_i, \ldots, s_n), \theta) \geq u_i(g(s_1, \ldots, s_i', \ldots, s_n), \theta)$ for all i and all $s_i' \in S_i$.
4. In a more general setting, mechanism g implements social choice rule f in Nash equilibrium if $f(\theta) = NE_g(\theta)$ for all θ, where $NE_g(\theta)$ of g in state θ.
5. Nash equilibrium is a prediction of how individuals in a mechanism will behave. But a number of other predictive concepts—i.e., equilibrium concepts—have been considered in the implementation literature, among them subgame perfect equilibrium (Moore and Rafael Repullo 1988), undominated Nash equilibrium (Palfrey and Sanjay Srivastava 1991), Bayesian equilibrium (Postlewaite and David Schmeidler 1986), dominance solvability (Hervé Moulin 1979), trembling-hand perfect equilibrium (Sjöström 1993), and strong equilibrium (Bhaskar Dutta and Arunava Sen 1991).

III. A Brief History of Mechanism Design

The intellectual history of mechanism design theory goes back at least to nineteenth-century utopian socialists such as Robert Owen and Charles Fourier. Repulsed by what they viewed as the evils of the burgeoning capitalist system, these thinkers argued that socialism offered a more humane alternative and sometimes became involved in setting up experimental communities such as New Harmony, Indiana.

A more direct influence on the modern theory was the Planning Controversy, which reached its greatest intensity in the 1930s. The principal antagonists on one side were Oskar Lange and Abba Lerner, who argued forcefully that, done right, central planning could replicate the performance of free markets (Lange 936 and Lerner 1944). Indeed, they suggested, planning could correct serious "market failures"—notably those on display in the Great Depression—and thereby potentially surpass markets. On the other side, Friedrich von Hayek and Ludwig von Mises staunchly denied the possibility that a planned system could ever approach the success of the free market (von Hayek 1944 and von Mises 1920).

The controversy was important and fascinating, but for certain onlookers such as Leonid Hurwicz, it was also rather frustrating. This was because it lacked conceptual precision: critical terms such as "decentralization" were left undefined. Moreover, the arguments adduced on either side often were often highly incomplete. In part, this was because they simply lacked the technical apparatus—in particular, game theory and mathematical programming—to generate truly persuasive conclusions.

This is where Leo Hurwicz entered the picture. Inspired by the debate, he attempted to provide unambiguous definitions of the central concepts, and this effort culminated in his two great papers, Hurwicz (1960) and (1972), where he also introduced the critical notion of incentivecompatibility.

The work inspired by Hurwicz and others has produced a broad consensus among economists that von Hayek and von Mises were, in fact, correct—the market *is* the "best" mechanism—in settings where (a) there are large numbers of buyers and sellers, so that no single agent has significant market power; and (b) there are no significant externalities, that is, an agent's consumption, production, and information do not affect others' production or consumption.[6] However, mechanisms improving the market are generally possible if either assumption is violated.[7]

Hurwicz's work gave rise to an enormous literature, which has largely branched in two different directions. On the one hand, there is work that makes use of special, highly structured settings to study particular questions such as how to allocate public goods, how to design auctions, and how to structure contracts. On the other hand, there are studies obtaining results at a general, abstract level; that is, they make as few assumptions as possible about preferences, technologies, and so on. My own work has fallen into both categories at different times. But, in this paper, I will emphasize general results.

IV. Implementation of Social Choice Rules

Above I set out three central questions (A)–(C) about incentive-compatible mechanisms. Rephrased in the language of implementation theory, these questions become:

(A′) Under what conditions can a social choice rule be implemented?

(B′) What form does an implementing mechanism take?

(C′) Which social choice rules cannot be implemented?

In the mid- 1970s I struggled with these questions. Eventually, I discovered that a property called *monotonicity* (now sometimes called Maskin monotonicity) is the key to implementability in Nash equilibrium. Suppose that outcome a is optimal in state θ according to the social choice rule f in question, that is, $f(\theta) = \text{a}$. Then, if a doesn't fall in anyone's ranking relative to any other alternative

6. See, for example, Peter Hammond (1979)—who shows, roughly, that the competitive market is the only incentive-compatible mechanism producing individually rational and Pareto optimal outcomes— and James Jordan (1982)—who shows the same thing when "incentive compatible" is replaced by "information efficient," under assumptions (i) and (ii).
7. See, for instance, Theodore Groves (1973) and Edward Clarke (1971) for the case of public goods, and Jean-Jacques Laffont (985) for the case of informational externalities.

in going from state θ to state θ', monotonicity requires that a also be optimal in state θ': $f(\theta') = a$. However, if a a *does* fall relative to some outcome b in someone's ranking monotonicity imposes no restriction.[8]

To see what monotonicity means more concretely, let's consider our energy example from before (see Tables1 and 2). Recall that oil is the optimal outcome in state 1. Notice, too, that oil *falls* in Alice's ranking, relative to both coal and nuclear power, in going from state 1 to state 2 (Alice ranks oil higher than coal and nuclear in state 1, but just the opposite is true in state 2). Thus, the fact that gas—not oil—is optimal in state 2 does not violate monotonicity. Similarly, observe that gas falls in Bob's ranking, relative to both coal and nuclear power, in going from state 2 to state 1. Hence, even though gas is optimal in state 2, the fact that it is not optimal in

Table 4

State		State 2	
Alice	Bob	Alice	Bob
gas	nuclear	gas	nuclear
oil	oil	oil	oil
coal	coal	nuclear	coal
nuclear	gas	coal	gas
oil optimal		nuclear optimal	

state 1 is also not in conflict with monotonicity. Indeed, these verifications establish that the authority's social choice rule satisfies monotonicity (and thus the possibility of implementing it, which was shown earlier, does not contradict Theorem 1 below).

But suppose we modify the example somewhat, so that rankings and optimal outcomes are given by Table 4. With these changes, the social choice rule is no longer monotonic. Specifically, observe that although oil is optimal in state 1,

8. In a more general setting in which f can be set-valued, monotonicity requires , for all outcomes states θ, θ' and all outcomes a, if $a \in f(\theta)$ and $u_i(a, \theta) \geq u_i(b, \theta)$ implies $u_i(a, \theta') \geq u_i(b, \theta')$ for all i and b, then $a \in f(\theta')$.

it is not optimal in state 2, despite the fact that it falls in neither Alice's nor Bob's rankings between states 1 and 2 (given that oil doesn't fall, monotonicity would require it to remain optimal in state 2). Hence, we can conclude that there is *no* mechanism that implements the social choice rule of Table 4. More generally, we have:

THEOREM 1 (Maskin 1977): *If a social choice rule is implementable, then it must be monotonic.*

To see why the social choice rule in Table 4 is not implementable, suppose to the contrary that there *were* an implementing mechanism. Then, in particular, the mechanism would necessarily contain a pair of strategies (S_A, S_B) —for Alice and Bob, respectively—that result in outcome oil and constitute a Nash equilibrium in state 1.

I claim that (S_A, S_B) must also constitute a Nash equilibrium in state 2. To understand this claim, note first that Bob has no incentive to deviate unilaterally from S_B in state 2, since (i) he has no such ince ntive in state 1(by definition of Nash equilibrium) and (ii) his preference ranking is the same in both states. Furthermore, Alice has no incentive to deviate from S_A in state 2. To see this, observe that if, contrary to the claim, Alice gained from deviating unilaterally from S_A in state 2, she must thereby be inducing the outcome gas (because this is the only outcome she prefers to oil in state 2). But Alice also prefers gas to oil in state 1, and so would benefit from the same deviation in that state, contradicting the assumption that (S_A, S_B) constitutes a Nash equilibrium in state 1.

Hence, (S_A, S_B) is indeed a Nash equilibrium in state 2. But the outc ome i t generates—oil—is not optimal in that state, establishing that the social choice rule is not imp,implementable after all.

As we have seen, Tables 1 and 2 provide an example of a social choice rule that is monotonic and also implementable. However, it is not true that *all* monotonic social choice rules are implementable; see Maskin (1977) for a counterexample. Nevertheless, such counterexamples are rather contrived, and if an additional, often innocuous, condition is imposed, monotonicity *does* guarantee implementability, if there are at least three individuals in society. [9]

The additional condition is called *no veto power*. Suppose that all individuals, except possibly one, agree that a particular outcome *a* is *best*, meaning that they all put *a* at the *top* of their preference rankings. Then, if the social choice rule satisfies no veto power, *a* must be optimal. In other words, the remaining individual cannot "veto" it.

No veto power is especially innocuous—indeed, it imposes no restriction at all—when out- comes entail a distribution of economic goods across individuals. In that case, each individual will prefer a bigger share of those goods for himself or herself. So, no two of them can agree that a given outcome *a* is best: they cannot both get the biggest share. This means that, if there are three or more individuals, the hypothesis posited by the no veto power condition *cannot be satisfied*, and so logically the condition holds *automatically*.

A general result on the possibility of implementing social choice rules is the following:

THEOREM 2 (Maskin 1977): *suppose that there are at least three individuals. If the social choice rule satisfies monotonicity and no veto power, then it is implementable.*

Proofs of Theorem 2 are beyond the scope of this paper (see Repullo 1987 for an especially elegant argument), but I should mention that they are usually *constructive*. That is, given the social choice rule to be implemented, a proof lays out an explicit recipe for the construction of a mechanism that does the trick.

It is worth pointing out why Theorem 2 posits at least three individuals. Often in economics, moving from two to three persons makes things more dif-

9. That is not to say that implementation is impossible with just two individuals—indeed, our energy example of Tables 1 and 2 had only two individuals. However, as we will see below, implementation is facilitated by there being three or more individuals.

ficult.[10] But, for implementation theory, three individuals actually make matters easier. To understand why, remember that the underlying idea of a mechanism is to give individuals the incentive to behave in a way that ensures an optimal outcome. This entails "punishing" an individual for deviating from his prescribed (i.e., equilibrium) strategy. But if there are only two individuals, Alice and Bob, and one of them has deviated, it may be difficult to determine whether it was Alice who deviated and Bob who complied, or vice versa. This problem of identification is resolved once there are three people: a deviator sticks out more obviously when two or more other individuals are complying with equilibrium.

V. Concluding Remarks

This has been only a very brief introduction to implementation theory (which itself consti- tutes only part of the field of mechanism design). I have concentrated on work that was done over thirty years ago, which perhaps gives a misleadingly "antique" flavor to the paper. In fact, an especially gratifying aspect of the theory is that almost fifty years after Hurwicz (1960), the subject remains intellectually vibrant and important: new implementation papers are appearing all the time. It will be interesting to see where the field goes in the next fifty years.

10. Zero-sum games provide a classic example of this phenomenon. The minimax theorem—which greatly simplifies the analysis of behavior in games—applies to *two*-person zero-sum games, but not, in general, to the case of *three* or more players.

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ANEXO

A continuación reproducimos las notas de apoyo que el profesor Maskin ha facilitado a la Real Academia de Ciencias Económicas y Financieras y que creemos pueden completar y mejorar la comprensión del discurso.

El lector hallará en ellas tres ejemplos muy ilustrativos de la Teoría del Diseño de Mecanismos y su aplicación en casos concretos.

Fueron utilizados por el profesor Maskin durante la lectura de su discurso en la entrega de los premios nobel.

MECHANISM DESIGN THEORY:
HOW TO IMPLEMENT SOCIAL GOALS

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Institute for Advanced Study

Theory of Mechanism Design –

“engineering” part of economic theory

- much of economic theory devoted to:
  – understanding existing economic institutions
  – explaining/predicting outcomes that institutions generate
  – positive, predictive
- mechanism design – reverses the direction
  – begins by identifying desired outcomes (goals)
  – asks whether institutions (mechanisms) could be designed to achieve goals
  – if so, what forms would institutions take?
  – normative, prescriptive - - i.e., part of welfare economics

For example, suppose

- mother wants to divide cake between 2 children, Alice and Bob
- goal: divide so that each child is happy with his/her portion

– Bob thinks he has got at least half

– Alice thinks she has got at least half

call this *fair division*

- If mother knows that the kids see the cake in same way she does, simple solution:

  – she divides equally (in her view)

  – gives each kid a portion

- But what if, say, Bob sees cake differently from mother?

  – *she* thinks she's divided it equally

  – but *he* thinks piece he's received is smaller than Alice's

- difficulty: mother wants to achieve *fair division*

  – but doesn't have enough information to do this on her own

  – in effect, doesn't know which division is fair

- Can she design a mechanism (procedure) for which outcome will be a fair division?

  (even though she doesn't know what is fair herself ?)

- Age-old problem

  – Lot and Abraham dividing grazing land

Age-old solution:

– have *Bob* divide the cake in two

– have *Alice* choose one of the pieces

Why does this work?

- Bob will divide so that pieces are equal in his eyes

  – if one of the pieces were bigger, then Alice would take that one

- So whichever piece Alice takes, Bob will be happy with other

- And Alice will be happy with her own choice because if she thinks pieces unequal, can take bigger one

Example illustrates key features of mechanism design:

- mechanism designer herself *doesn't know* in advance what outcomes are optimal

- so must proceed indirectly through a mechanism

  – have participants *themselves* generate information needed to identify optimal outcome

- complication: participants don't care about *mechanism designer's goals*

  – have their own *objectives*

- so mechanism must be *incentive compatible*

  – must reconcile social and individual goals

Second Example:

Suppose government wants to sell right (license) to transmit on band of radio frequencies

(real-life issue for many governments, including in U.S.)

- several telecommunication companies interested in license
- goal of government: to put transmitting license in hands of company that values it most ("efficient" outcome)
- but government doesn't know how much each company values it (so doesn't know best outcome)

Government could ask each company how much it values license

- but if company thinks its chances of getting license go up when it states higher value, has incentive to *exaggerate* value
- so no guarantee of identifying company that values it most
- government could have
  – each company make a bid for license
  – high bidder wins license
  – winner pays bid
- but this mechanism won't work either
  – companies have incentive to *understate*

- suppose license worth \$10m to Telemax, then
  - if Telemax bids \$10m and wins, gets \$10m – \$10m = 0
- so Telemax will bid *less* than \$10m
- but if all bidders are understating, no guarantee that winner will be company that values license most

Solution:

- every company makes bid for license
- winner is high bidder
- winner pays *second-highest* bid
  - so if 3 bidders and bids are \$10m, \$8m, and \$5m, winner is company that bids \$10m
  - but pays only \$8m
- Now company has no incentive to understate
  - doesn't pay bid anyway
  - if understates, may lose license
- Has no incentive to overstate
  - If bids \$12m, will now win if other company bids \$11m
  - But overpays

- So best to bid *exactly* what license worth

- And winner will be company that values license most

Final Example

Consider society with

- 2 consumers of energy – Alice and Bob

- Energy authority – must choose public energy source

    - gas

    - oil

    - nuclear power

    - coal

Two states of world

state 1 consumers weight future lightly (future relatively unimportant)

state 2 consumers weight future heavily (future relatively important)

Alice – cares mainly about convenience

In state 1: favors gas over oil, oil over coal, and coal over nuclear

In state 2: favors nuclear over gas, gas over coal, and coal over oil
– technical advances expected to make gas, coal, and
especially nuclear easier to use in future compared with oil

Bob – cares more about safety

In state 1: favors nuclear over oil, oil over coal, and coal over gas

In state 2: favors oil over gas, gas over coal, and coal over nuclear

– disposal of nuclear waste will loom large

– gas will become safer

State 1		State 2	
Alice	Bob	Alice	Bob
gas	nuclear	nuclear	oil
oil	oil	gas	gas
coal	coal	coal	coal
nuclear	gas	oil	nuclear

– energy authority

- wants source that makes good compromise between consumers' views

- so, oil is social optimum in state 1

- gas is social optimum in state 2

– but suppose authority *does not know* state

- then doesn't know whether oil or gas better

State 1		State 2	
Alice	Bob	Alice	Bob
gas	nuclear	nuclear	oil
oil	oil	gas	gas
coal	coal	coal	coal
nuclear	gas	oil	nuclear
oil optimal		gas optimal	

- authority could ask Alice or Bob about state
  - but Alice has incentive to say "state 2" *regardless* of truth

    always prefers gas to oil

    gas optimal in state 2
  - Bob always has incentive to say "state 1"

    always prefers oil to gas

    oil optimal state 1

So, simply asking consumers to reveal actual state too naive a mechanism

State 1		State 2	
Alice	Bob	Alice	Bob
gas	nuclear	nuclear	oil
oil	oil	gas	gas
coal	coal	coal	coal
nuclear	gas	oil	nuclear
social optimum: oil		social optimum: gas	

Authority can have consumers participate in the mechanism given by table

	Left	Bob	Right
Top	oil		coal
Alice			
Buttom	nuclear		gas

- Alice – can choose top row or bottom row
- Bob – can choose left column or right column
- outcomes given by table entries
- If state 1 holds

  Alice will prefer top row if Bob plays left column

  Bob will always prefer left column

  so (Alice plays top, Bob plays left) is Nash equilibrium

  neither participant has incentive to change unilaterally to another strategy

  In fact, it is *unique* Nash equilibrium

  – so good prediction of what Alice and Bob will do

State 1		State 2	
Alice	Bob	Alice	Bob
gas	nuclear	nuclear	oil
oil	oil	gas	gas
coal	coal	coal	coal
nuclear	gas	oil	nuclear
social optimum: oil		social optimum: gas	

	Bob	
Alice	oil	coal
	nuclear	gas

So, in state 1:

- expect that

  Alice will play top strategy

  Bob will play left strategy

- outcome is oil

- oil is social optimum

State 1		State 2	
Alice	Bob	Alice	Bob
gas	nuclear	nuclear	oil
oil	oil	gas	gas
coal	coal	coal	coal
nuclear	gas	oil	nuclear
social optimum: oil		social optimum: gas	

	Bob	
Alice	oil	coal
	nuclear	gas

Similarly, in state 2:

- expect that

  Alice will play bottom strategy

  Bob will play right strategy

- outcome is gas

- gas is social optimum

State 1		State 2	
Alice	Bob	Alice	Bob
gas	nuclear	nuclear	oil
oil	oil	gas	gas
coal	coal	coal	coal
nuclear	gas	oil	nuclear
social optimum: oil		social optimum: gas	

Bob

Alice	oil	coal
	nuclear	gas

- Thus, in *either state*, mechanism achieves social optimum, even though

  - mechanism designer doesn't know the state herself

  - Alice and Bob interested in own ends (not social goal)

- We say that mechanism *implements* the designer's goals (oil in state 1, gas in state 2)

- Have shown you mechanisms in the cake, telecommunication, and energy examples

- But analysis may seem a bit *ad hoc*

- Examples prompt questions:

  – is there a *general* way of determining whether or not a given goal is implementable?

  – if it *is* implementable, can we find a mechanism that implements it?

- Answer: yes to both questions

  see Maskin "Nash Equilibrium and Welfare Optimality," 1977

- Have looked at 3 applications of mechanism design theory

- Many other potential applications

  1) International treaty on greenhouse gas emissions

  2) Policies to prevent financial crises

  3) Design of presidential elections

Discurso de contestación por el Académico Número

EXCMO. SR. DR. D. JAIME GIL ALUJA

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La Real Academia de Ciencias Económicas y Financieras abre una vez más sus puertas a un nuevo curso académico. Y lo hace en un difícil contexto económico-financiero marcado por un proceso de recesión generalizado, en el que España participa no sólo como consecuencia del "efecto contagio" internacional sino también, y en gran medida, por nuestros propios errores y excesos.

Nuestra Real Corporación ha asumido desde el primer momento el papel que le corresponde por su historia y por el mandato de sus estatutos. Y así, con motivo de la presentación del "Observatorio de la Investigación Económica y Financiera de España", en un Solemne Acto en el Palacio del Senado de Madrid, hizo público el resultado de un proceso de reflexión interno, aportando un conjunto de medidas destinadas a reducir en intensidad y duración las graves consecuencias que sufren las capas más desfavorecidas de la sociedad.

Nuestros esfuerzos en este sentido no son recientes. Desde el siglo XVIII todo cuanto significa la Real Academia de Ciencias Económicas y Financieras ha servido a la economía de nuestro país desde el debate, la investigación y el conocimiento. "Y hoy –se dijo allí ante el Senado- tres siglos después de su creación, ante el reto que nos plantea la actual crisis, seguimos creyendo que el conocimiento, el debate y la investigación son aún las mejores respuestas, porque permiten la innovación"[1].

"Esa innovación creará un modelo de convivencia internacional y un sistema financiero que debe erigirse sobre un nuevo consenso de fondo, sustanciado en nuevas y renovadas reglas financieras, que impliquen a la Unión Europea y EE.UU en su núcleo y después a China, India, Brasil y demás países emergentes".

Para prevenir males mayores, nuestros gobiernos han adoptado medidas adecuadas e imprescindibles. Consideramos, sin embargo, que estas acciones, repetimos totalmente idóneas, deben ser completadas con una nueva **dotación de medios financieros** adicionales con los que hacer frente a la segunda y tercera ola

1. Discurso del Presidente de la Real Academia de Ciencias Económicas y Financieras en el acto de presentación del "Observatorio de la Investigación Económica y Financiera de España". Palacio del Senado de Madrid, 26 de mayo de 2009.

de falta de liquidez como consecuencia del aumento de morosidad de las economías domesticas y de las pequeñas y medianas empresas que constituyen **el tejido empresarial español más genuino.**

Decíamos en aquella ocasión que era necesario establecer los cauces para **reducir el tamaño de nuestro sistema financiero** por vía de absorciones y fusiones que proporcionen una dimensión más adecuada a las necesidades reales de nuestro sistema productivo. Nuestros gobiernos están jugando, en este sentido, una importante labor dentro de las posibilidades que permite nuestro marco jurídico.

Pero junto a la **decidida intervención** en nuestro sistema financiero es necesario también **replantear nuestra política industrial,** renunciando de antemano al proteccionismo. Y es ahí donde todos -empezando por los gobiernos- debemos realizar sin timidez y de manera urgente un significativo esfuerzo en la **formación y la recalificación profesional de la mano de obra no especializada** expulsada de la construcción, que es también la más difícil de absorber, y lo será incluso cuando, esperemos que muy pronto, nuestra economía empiece a dar señales de recuperación.

Advertíamos, también, y así está sucediendo, que el **turismo** merecía un serio aviso: que iba a faltar demanda por la propia crisis y por la competencia de otros destinos más baratos. Así que, de nuevo, aparece la necesidad de invertir en formación de nuevos profesionales capaces de especializarse en cualquier cometido para evitar la subvención de especialistas en paro de larga duración.

Otro sector que fue objeto de nuestra reflexión, **la automoción**, que en su día constituyó otro pilar del crecimiento español, se está beneficiando sin duda de **las medidas de estímulo de la venta, pero sólo a corto plazo**, porque –insistimos- sólo la formación y la capacitación profesional para los nuevos retos tecnológicos permitirá crear empleo de calidad y duración.

Señalábamos, entonces, que una tarea de tan amplio calado tendría difícilmente éxito si no lograba reunir en una mesa a todos los agentes de nuestra sociedad en un **"gran pacto nacional"** con participación de todas las fuerzas políticas, empresariales y sindicales con objeto de efectuar las reformas necesarias, preparando con ello la recuperación de nuestra economía encauzándola hacia **un progreso sostenible basado en la inversión en conocimiento.**

Aún cuando mucho se ha hecho para taponar los requisitos y aún cuando las fallas de nuestro sistema económico-financiero, en este intento de amortiguar la caída de la actividad productiva y los efectos inmediatos de la depresión, queda un largo camino por recorrer para enfocar el futuro lejos de las insensatas alegrías de nuestro pasado inmediato.

Este breve balance y estas reflexiones no pretenden ni la complacencia ni el remordimiento por aquello que ha sido, más bien desean ser un adiós a comportamientos indeseados y la esperanza de un cambio renovador en la percepción de lo económico.

La Real Academia de Ciencias Económicas y Financieras, con la llamada a la incorporación del Premio Nobel de Economía Eric Maskin en su seno, pretende reforzar su actividad al servicio de la sociedad, con uno de los científicos más prestigiosos del mundo. Creemos que no es posible avanzar con solidez en la construcción de unas nuevas estructuras económicas sin que éstas se hallen cimentadas en rigurosas bases teóricas. Consideramos que, por su trayectoria personal, sus amplios conocimientos y por su probada capacidad de insertar los hallazgos científicos a las realidades más complejas, es el profesor Maskin quien mejor puede colaborar en nuestra importante labor.

Eric Stark Maskin nace en New York City el 12 de diciembre de 1950. Después de sus estudios universitarios en la Harvard University obtiene en 1976 su doctorado en Matemática Aplicada en esta misma universidad. Su actividad docente es amplia e intensa desde su incorporación, en 1977 como profesor asistente en el M.I.T., Massachussets Institute of Technology, y más tarde, en 1985, como profesor de Economía en la Harvard University hasta sus actuales ocupaciones como profesor de Economía en la Princeton University desde el año 2000 y como profesor de ciencias sociales del Institute for Advanced Study (Albert O. Hirschman), también desde el año 2000).

Precisamente en ese instituto, que reúne a las mentes más preclaras de la ciencia y la tecnología mundial, el profesor Maskin habita la que fuera residencia de Albert Einstein en Princeton. Un privilegio, el de dormir, comer y despertarse en la misma habitación que utilizara el precursor de la Relatividad que estoy seguro que despertara la curiosidad de los señores académicos y todos cuantos presencian este acto y sobre el que podrán preguntar más tarde al nuevo académico.

En la actividad investigadora del profesor Maskin destacan sus más de 100 profundos trabajos insertados en las más prestigiosas revistas, desde el *"Theorem on Utilitarianism"* en la Review of Economic Studies, en 1978, hasta sus 4 últimos artículos en fase de publicación: *"On the Fundamental Theorems of General Equilibrium"* (con K. Roberts) en Economic Theory; *"Sequential innovation, Patens and Imitation"* (con J. Bessen), en Rand Journal of Economics; *"Public-Private Partnerships and Government Spending Limits"* (con J. Tirole) en International Journal of Industrial Organization; y *"On the Robustness of Majority Rule"* (con P. Dasgupta) en Journal of European Economic Association.

Conocidas son sus aportaciones a la teoría de juegos en la década de los 80, sobretodo en la búsqueda de equilibrio en el ámbito de la discontinuidad y cuando la información es incompleta, que consolida en un trabajo publicado junto a D. Fudenberg en la revista "Econométrica" en 1986: *"The folk Theorem in Repeated Games with Discounting or with Incomplete Information"*. El problema de la renegociación en condiciones de asimetría e información incompleta es otra de sus preocupaciones durante más de una década. Su profundo estudio de los hallazgos de John Forbes Nash le permiten interesantes reflexiones en algunos de sus trabajos como: *"Implementation and Strong Nash Equilibrium"* (1979); *"Nash and Dominant Strategy Implementation in Economic Environments"* con J.J. Laffint (1982*); "The Theory of Implementation in Nash Equilibrium: A Survey"* (1985); *"Nash and Perfect Equilibrium of Discounted Repeated Games"* con D. Fudenberg (1990); *"Feasible Nash Implementation of Social Choice Rules when the Designer does not Know Endowments or Production Sets"* con L. Hurwicz y A. Postlewaite (1995); *"Nash Equilibrium and Welfare Optimality"* (1990).

Si se deseara resumir en breves trazos la dirección de la labor investigadora de Eric S. Maskin citaríamos, además de la teoría de juegos, la economía de la incentivación y la teoría del contrato. Dentro de este marco investigador recorrieron las mesas de trabajo de institutos y laboratorios de búsqueda de nuevos horizontes sus hallazgos sobre diseño de mecanismos y teoría de la implementación. Más reciente son las publicaciones sobre las causas del crecimiento inarmónico, la formación de coaliciones y la de ciertos componentes de los procesos inciertos. En una interesante entrevista en *"la contra"* del periódico "La Vanguardia"[2] afirmaba que "*los mercados nos permiten muchas cosas buenas y asignar bienes y recursos y crear riqueza para todos, pero hay otras funciones imprescindibles que no saben hacer… Nos dieron el Premio Nobel por diseñar mecanismos suplementarios de mercado para hacer esas cosas imprescindibles que no hacen los mercados, como combatir la pobreza o la contaminación: lograr aire respirable", para añadir "incentivar es más eficaz que prohibir u ordenar"*.

El prestigio alcanzado por Eric Maskin le ha valido para ser llamado a ejercer amplias responsabilidades en las más altas instituciones del asociacionismo científico de su especialidad. Sirvan de ejemplo su actividad en la American Economic Association; en la Econometric Society de la que fue presidente en 2003; en la Society for Social Choice and Welfare; en la Game Theory Society, en donde ha sido elegido presidente para el próximo trienio; en la European Economic Association; y en la Global Economic Society, de la que es miembro fundador.

Numerosas distinciones acompañan los interesantes trabajos científicos y la labor docente de Eric Maskin. Destacamos, entre otros, el "Premio Galbraith Teaching" de la Harvard University otorgado en 1990 y en 1992; "Miembro numerario" de la American Academy of Arts and Sciences, elegido en 1994; "Miembro correspondiente" de la British Academy, elegido en 2003; "Miembro numerario" de la European Economic Association, elegido en 2004; ha recibido el "Kempe Award in Environmental Economics" entregado en 2007, el "EFR-Business Week Award" en 2008; es "Miembro" de la National Academy of Sciences, elegido en 2008; "Miembro Distinguido" de la House of Finance de la Universidad de Frankfurt desde 2008 y ha recibido recientemente la "Gran Medalla de la Ciudad de Marsella" (2009).

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2. Amiguet, L.: "La Contra". La Vanguardia, 30 de junio de 2008 pág. 72

Ha sido objeto de los honores máximos del profesorado por parte de 6 Universidades. Así es: Monash Distinguished Visiting Scholar de la Monash University, concedido en 2003 “Profesor Honorario” de la Wuhan University, incorporado en 2004; “Miembro Honorario” del St. John’s College de Cambridge, elegido también en 2004; “Profesor Honorario” de la Tsinghua University, nombrado en 2007; “Profesor Honorario” de la State University-Higher School of Economics de Moscú, nombrado en 2008 y “Profesor Honorario” de la Shenzhen University, incorporado también en 2008.

Pero la consagración definitiva a nivel mundial tiene lugar con la concesión del Premio Nobel de Economía en el año 2007.

El 8 de diciembre de 2007 se entrega a Eric S. Maskin el Premio Banco de Suecia en Ciencias Económicas en Memoria de Alfred Nobel *“for having laid the foundation of mechanism design theory” (haber puesto los cimientos de la Teoría del Diseño de Mecanismos).* Se premiaba así, uno de los logros más importantes para el proceso de formalización del comportamiento en la asignación de recursos en una economía cuando los agentes no disponen de ciertas informaciones.

La teoría del diseño de mecanismos iniciada hace casi 50 años por Leonid Harwicz es desarrollada por Roger B. Myerson, reconocidos ambos también Premio Nobel, y por Eric S. Maskin quien aporta un elemento clave: la “teoría de la implementación”. A partir de este momento se suceden las aplicaciones para la solución de un amplio abanico de problemas que las complejas realidades plantean.

Tal ha sido el interés suscitado por el diseño de mecanismos que todavía hoy, medio siglo después de la propuesta inicial de Hurwicz, continúan apareciendo trabajos de implementación en los más variados sectores económicos. Y es que las hipótesis establecidas en los estudios clásicos de economía según las cuales los mercados se auto regulaban por aquella especie de *“mano invisible”* de Adam Smith dejaron paso, desde hace tiempo, a unas realidades que no permiten garantizar un funcionamiento eficiente por la propia dinámica del sistema.

Gracias a los trabajos de Hurwicz, Myerson y sobre todo gracias a las posibilidades de implementación aportadas por Maskin, es una realidad la asignación de recursos de forma más eficiente incentivando a los agentes del mercado. La idea de Maskin de que *"los incentivos logran más que la ética o las prohibiciones"* alcanza aquí toda su significación.

Deseamos agradecer a Eric S. Maskin el esfuerzo que ha realizado para hacer asequible a un amplio sector de la sociedad sus profundos trabajos. Una muestra palpable de ello es el discurso pronunciado hoy con el que se incorpora como académico en nuestra Real Corporación. Su contenido es una versión revisada de la alocución que tuvo lugar el 8 de diciembre de 2007 en el citado acto de entrega del Premio Nobel, en esta ocasión formulada a través de tres casos que representan distintas situaciones muy habituales en nuestra sociedad.

A través de ellos aprendemos que la dirección de las preguntas se invierte, ya que se inicia el proceso por identificar los objetivos sociales, se pregunta después si "sí" o si "no" un determinado mecanismo ha sido diseñado para conseguir un determinado objetivo. Si la respuesta es positiva,. se busca la forma que debería tener este mecanismo. Además, de manera casi imperceptible se muestra la implementación de la teoría.

Evidentemente los objetivos sociales (que técnicamente se designan como *"outcome"*) son distintos en cada problema. También los estándares de "deseabilidad" o bien "optimalidad" de un *"outcome"* depende del escenario en el que se sitúan los hechos. Un mecanismo puede ser tanto una institución, un procedimiento, o un juego para determinar *"outcomes"*. La mayor dificultad reside en la falta de información, porque quienes diseñan los mecanismos en general no conocen previamente cual de los *"outcomes"* es el óptimo.

Una gran parte del trabajo de diseño de mecanismos, según Eric S. Maskin, se halla directamente ligado a dar respuesta a las siguientes preguntas:

- ¿Cuándo es posible diseñar mecanismos incentivo-compatibles para conseguir objetivos sociales?

- ¿Qué forma pueden tomar estos mecanismos?

- ¿Cuándo la teoría excluye estos mecanismos?

La teoría del diseño de mecanismos ha generado una gran cantidad de trabajos principalmente en dos direcciones, La primera de ellas comprende las investigaciones realizadas para la obtención de soluciones a problemas concretos y específicos como: la asignación de medios financieros públicos, el diseño de subastas y la estructura de contratos, entre otros. La segunda va dirigida a la obtención de resultados con un alto nivel de abstracción.

El profesor Eric S. Maskin ha puesto de manifiesto en su discurso que desde mediados de los años 70 se ha ido preguntando en qué condiciones los objetivos sociales son susceptibles de implementación, qué forma debe tomar la implementación y en qué circunstancias es objeto de exclusión. Descubrió que la llave de la implementabilidad en el equilibro de Nash era una propiedad llamada "monotonía", que ha tomado el nombre de "Monotonía de Maskin". Enuncia, entonces, dos teoremas:

- Si una norma social elegida es implementable, entonces debe ser monótona.

- Se supone que se tienen por lo menos tres individuos. Si la norma social elegida satisface la monotonía y no existe poder de veto, ésta es implementable.

Tienen aquí un resumen de uno de los grandes avances en teoría económica y social de nuestro tiempo y ante ustedes a su autor, el profesor y premio nobel de Economía Eric Maskin a quien a partir de ahora podremos llamar también con orgullo ilustrísimo señor académico.

La "virtud del trabajo" ha sufrido un deterioro en los últimos decenios a favor del concepto de "imagen". Los resultados son palpables. Nos hallamos en tiempos difíciles, de recesión económica y social, sí, pero también de oportunidades si van acompañadas del trabajo. "Wellcome to the Academy, Mr Maskin, and now let´s work together”. Porque este mundo necesita de científicos como usted y de instituciones como la nuestra, que sean capaces de explicarlo para poder mejorarlo después.

Gracias a todos.