Designing markets in the real world



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Paul Milgrom has not only made remarkable academic contributions in the areas of auction theory, game theory, organization, and finance, he has also played a fundamental role in designing real-world markets, such as the U.S. auction of spectrum for cellular telephony, and has advised on bidding strategies in large auctions. Here Milgrom discusses the spectrum auctions in Brazil, rules for deep sea oil auctions, and the role of economic theory in the design of markets.

The Brazilian Economy **— How can economic theory help with design of real world markets, such as spectrum and on-line auctions? What are the main insights, advances, and recommendations we can learn, especially for public auctions?**

Paul Milgrom — Let's break the question into smaller chunks, focusing on one principle: making it cheap and easy for participants to achieve good results.

For online bidding, the principle implies eliminating the need to game the system to participate effectively. For example, advertising slots next to Internet search results are auctioned. In old systems, winning bidders needed to monitor the bidding constantly to adjust to how others were bidding. But the rules are now better informed by economic theory.

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Now winning bidders generally pay a price equaling the bid that would be just high enough to win even if the actual bid was higher. This means it is cheaper and easier for them to bid effectively.

For spectrum auctions, the situation is more nuanced. For instance, modern auctions allow established mobile phone companies that can expand coverage by purchasing spectrum in any of several bands to analyze their options when each band is sold separately in simultaneous ascending auctions. But a new entrant may have different needs. A big entrant may want to achieve efficient scale and national scope, which is hard if spectrum must be acquired piece by piece. So, the rules that work best depend on both the context and the regulator's goals.

You are well known for having devised the simultaneous auction rules that many countries have used to generate hundreds of billions from radio spectrum sales. What are the main features of those rules? And what was your role in the design?

Robert Wilson and I devised the system in 1993 and the U.S. first used it in 1994. It was inspired by a common type of charity auction, the "silent auction," in which many items are sold at the same time in the same room in ascending bids but with no auctioneer or outcry. Bids are recorded on a piece of paper related to the item being sold. Because there is a fixed ending time, bidders often game the system by waiting to bid until just seconds before the close, hoping to get a low price.

Our design makes two changes. First: the auction does not end until there is a period with no new bids. That way, nobody can sneak in a bid and hope to prevent a competitor from responding. Second, the "activity rule" I invented is now widely used. In its simplest version, no bidder can increase its activity during the auction. So, for example, to be eligible to win 10 items, a bidder has to be the standing high bidder or actively placing bids for them in every period during the auction. This rule ensured that bidders could know the amount of demand and adjust their plans accordingly, so it helps make it easy for bidders to participate effectively.

How do the rules for simultaneous ascending auctions (SAA) differ from what Brazil has done so far? Are the SAA rules still state-of-the-art?

The last auction in Brazil sold licenses for different areas in sequence rather than all together in an SAA. That makes it harder for a bidder on a fixed budget to buy multiple licenses because it does not know how much to set aside for later licenses when it bids on earlier ones.

Now there are more choices of good auctions, all of which have advantages and disadvantages. For example, if some bidders want to enter a mobile telephone market, they may need sufficient scale to make buying licenses worthwhile. The

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New "combinatorial" auctions make that easier. One key idea is that a bidder who only wants a package of items, for example five spectrum licenses, should be allowed to bid on just that. Several European countries have adopted the model, which I introduced in academic publications.

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Recently, I invented a new multi-product sealed-bid auction to compete with the SAA. Sealed bids accomplish much the same thing but much faster and more cheaply.

How different can the rules be for different auctions? Do the elements for successful design depend on the objectives (revenue, efficiency) of the designer? What kind of trade-offs must be taken into account?

Items can be auctioned one at a time or simultaneously. They can be sold with bids on an individual item or on packages, or bidders might bid a maximum price per package and an overall maximum budget. Many kinds of bids are possible.

The rules can call for a single round of sealed bids or multiple rounds of an ascending auction in which bidders can be either informed about all previous bids or given more limited information. The round-to-round bid increments can be determined in various ways. Prices can be called by the auctioneer, or by the bidders themselves. There may be a fixed ending time or an ending when a certain condition is met. Starting prices and reserve prices can be determined in a variety of ways.

There are many more decisions, too: Will there be limits on what bidders can buy? Are only cash bids allowed? Will the seller finance bids? What is being sold? Will the government impose build-out requirements? Or require service across an entire nation? The questions go on and on.

A successful design naturally depends on how success is defined. Sometimes, a government wants to encourage, say, rapid development of the industry, wide roll-out of services, or participation by small businesses. If the government cared only about revenue, it might limit the amount of spectrum for sale, creating more intense competition. Or it might divide the spectrum into big chunks so that bidders find it hard to coordinate to share what is available. There are other kinds of trade-offs, too. We like auctions to be as simple as possible so that the public can be sure there

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are no shenanigans. But we need to add features to accomplish certain objectives, like deterring collusion or advantaging weaker bidders.

In the last spectrum auction in Brazil, 5 bidders[1] bid on some 90Mhz of spectrum. For each local market licenses were auctioned sequentially. Is this a good design for maximizing revenues? How about for increasing the odds that an entrant can win enough licenses to be a viable competitor?

The first goal of a good design should be to encourage a market structure that provides useful services for consumers. With that goal in mind the government should decide how many licenses to offer and how much spectrum to allocate to each. That is the single most important decision.

Next, a major step in designing a successful auction is getting to know the bidders and their needs. To encourage entry into the wireless communications business, the designer might offer an entrant the chance to bid for what it needs all at once rather than forcing it to bid for one license at a time. If the entrant can succeed just by entering in big cities, the best sequenced auction would have bidding on those cities first, so that the entrant can decide which licenses to bid for. Evaluating what the government did depends on a detailed knowledge of the particulars.

Equally important is avoiding collusion, which keeps prices low in many poorly run auctions. Selling items in sequence, as in Brazil, is not especially vulnerable to collusion, so that part of the rules passes muster.

In 2011 band H spectrum will be auctioned. The government wants to suppress auction competition to guarantee product competition. Is that a good idea? Or can we have both? How can we balance desirable aims?

There is established economic analysis showing that incumbents have an advantage in auctions even if they are less efficient than new competitors because they can count on higher profits from market concentration. The whole point of entry from the government's perspective is to make the market more competitive, which makes it less profitable for entrants.

The government has two main options: First, set aside some spectrum for entrants, which I understand will be done for band H. The second, which trades off competition in the auction for competition in the retail market, allows entrants a discount when they acquire spectrum. For example, an entrant might only be required

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to pay 75% of its bids if it wins. That encourages entrants and still allows active competition in the auction. But it's necessary to get the discount right.

The Brazilian government will auction off the right to explore deep sea oil blocks worth billions of dollars. Can economic theory contribute to design of those rules and bidding options for entrants?

Absolutely! The starting point is to analyze the industry and the government's goals. Who are the potential bidders? Does the government want a long-term revenue stream or a big initial cash payment? How important will follow-on auctions be, and how might the industry structure affect revenues from them?

To get a high price, it is also important to make sure that weaker bidders are not too disadvantaged. What do they want to buy? Is it easy for them to bid for that?

I have been working on some new ideas about how to encourage bidders with limited budgets. The idea is to allow them to express maximum bids for individual properties plus a maximum overall budget and to take both into account in awarding mineral rights.

The Brazilian government will cede rights to Petrobras (Brazilian state oil company) of deep sea blocks that adjoin existing Petrobras blocks because Petrobras has "better information on the viability of these blocks." Is that a good idea?

This appears to be a classic example of the "winner's curse." It also describes a situation in which the auctioneer does best by distinguishing between weak and strong bidders. The winner's curse works like this: if one bidder — say Petrobras — is much better informed than others and a less-informed bidder wins the auction, that bidder is cursed: the rights probably aren't worth much — because if they were, Petrobras would have bid aggressively to win.

One simple way to deal with the winner's curse is to exclude the well-informed bidder. Whether that is a good idea requires careful analysis. For example, Petrobras might distort the outcome anyway, by selling or trading its information. Another issue is the number of other bidders. And there may be ways to mitigate the winner's curse that are less costly than excluding Petrobras.

Should the Brazilian government auction off all deep sea blocks at once, or do it sequentially?

By sequentially, you mean over a period of years. Often, for large finds, that's the best strategy, because exploration and development takes years anyway. But there is far too much money at stake to answer a question like this casually. In large auctions, the economic analysis looks at all the

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options, sees who the bidders might be and how that might change over time, looks at regulatory and political constraints, and then formulates feasible choices.

Until now, bidders in oil auctions bid on signing bonuses — fixed amounts for the right to explore the block. Now they bid on equity — the share they want to retain from future oil development. What are the advantages and disadvantages of each?

For an auction like this to work well, the details really matter. Many things can go wrong. First, because payments are not due until the future, there is a risk that the terms might be renegotiated, or that a bidder might default. The auction needs to account for that. Second, the equity share needs to be based on something easy to measure, so that the government is not exploited by accounting tricks. Third, if net revenues are the basis of payments, bidders may have little incentive to develop marginal properties, for which they incur all the costs but enjoy only a portion of the revenues. Fourth, if the government is responsible for environmental or other regulations, it could come under pressure to relax them to ensure a flow of revenue. There may be tax accounting issues, too.

But there are also real advantages to collecting payment in the form of equity. The government ensures that it collects something of value if the rights are valuable. If the developer is worried about being held up, it might welcome an alignment of interests in developing the rights, and the government might find this a good way to make such a commitment. Also, if bidders are financially sound and the other issues are well resolved, economic theory tells us that this sort of auction can generate high revenues.

You have advised bidders in many government radio spectrum auctions. Can you give us some examples of specific advice you have given, and how it worked?

My single biggest success was in the US$14 billion auction in 2006 for wireless spectrum band Advanced Wireless Services (AWS-1) in the U.S.. My client paid about US$2.4 billion to buy more spectrum than T-Mobile acquired in the same auction for US$4.2 billion. Most spectacularly, we made a US$750 million jump bid in the middle of the auction to achieve a particular strategic objective. This bid drove satellite telephone companies that were competing with us out of the auction. Even more important, my client bid to acquire coverage of large areas by assembling a collection of many small licenses, which we correctly forecast would be much cheaper than covering the same area with big licenses. We wound up paying much less than the other big bidders, such as Verizon, T-Mobile, AT&T, and Cingular (which was then a separate company).

How do different rules and different types of bidders affect the type of advice you give?

Here is an example: Recently there were two giant spectrum auctions, in Germany and India. In Germany there were just

four bidders for a large amount of spectrum — 290Mhz of "paired" spectrum for mobile phone services plus a large amount of "unpaired" spectrum for new data services. The government hoped for intense competition and estimated bids would total about 9 billion, but they got only 4 billion. The best advice for bidders in an auction like that is to find a way to coordinate expectations about who would buy what and minimize direct price competition for most of the bands.

In India, the situation was very different. With about 30MHz of spectrum available and seven large bidders, there was bound to be intense competition, and bidders needed to prepare for that.

Do you also advise governments on auction rules? Is there a right way to set the rules, or does it always depend on the government's objectives?

Is there a right way to build a bridge? There are principles and tried-and-true designs, but the best construction depends on a long list of factors.

The auction consultant asks about a range of circumstances surrounding the auction, its goals, the amounts at stake, the risks of collusion and coordination among bidders, and so on. The government can select a simple, standard design, make a small change to a standard design, or tailor the design to the unique circumstances.

What is next? What questions remain to be studied, and for what type of markets?

I spoke to this in my Nemmers Prize lecture at Northwestern University last year. There is still a gap between the theories published in academic journals and the challenges of running real auctions. We need more relevant theory to close the gap. But the real problems are hard and varied, while theorists have the advantage of being able to study idealized situations.

The main issues lie in markets with multiple different but related goods for sale, or markets where the value of the item depends on subsequent decisions, like mineral rights whose value depends on later development decisions. Those are the areas where I expect to see continuing work.

Has market design anything to say about the causes of the 2008/09 financial crisis, or about the new regulations being discussed for financial markets?

That is a whole other subject. Good auction design involves paying attention to what is being sold as well as how it is sold and how performance can be assured. ■

[1] Vivo (Telefónica de España), TIM (Telecom Italia Mobile), OI (the Brazilian player), Claro (Mexico's America Móvil), and Nextel.

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