

Product-Mix Auction:

How Auction Theory came to the rescue during the banking crisis



Professor Paul Klemperer

Interview with Paul Klemperer

by Georgios Petropoulos

Paul Klemperer is the Edgeworth Professor of Economics at Oxford University. He works mainly on industrial economics, competition policy, and auction theory.

He was a Member of the UK Competition Commission from 2001–5. He was elected a Fellow of the Econometric Society in 1994, a Fellow of the British Academy in 1999, and a Foreign Honorary Member of the American Academy of Arts and Sciences in 2005.

He is the author of the book “Auctions: Theory and Practice”, which provides a non-technical introduction to auction theory and emphasises its practical application.

At the beginning of the financial crisis, Paul Klemperer invented a new auction design, the “Product-Mix Auction.” In late 2007, after the Northern Rock bank run, the Bank of England urgently wanted to lend money to banks to keep them liquid, so it was willing to take weaker-than-usual collateral in return for a higher interest rate. To do this, Paul Klemperer designed an auction that would sell multiple related goods in an easy, informative and efficient way, and could be run fast. In the simplest version of Klemperer’s design, each bank (bidder) could bid for two substitute “goods”: three-month loans against strong collateral (e.g. UK sovereign debt) and/or 3-month loans against weak (“extended”) collateral (e.g. mortgage-backed securities). Mervyn King, then Governor of the Bank of England, told the Economist that the Product-Mix Auction was “a marvellous application of theoretical economics to a practical problem of vital importance to financial markets” (Economist, October 2012).

We interviewed prof. Klemperer on the occasion of 2015 ECORES summer school in Brussels where he was one of the invited speakers.

1. You have an engineering bachelor degree and from young age you showed to have an inclination to mathematics and geometry. Why did you decide to become an economist?

I always enjoyed the beauty of mathematics when I was young, so it was natural for me to want to study mathematics. But I also wanted to do something useful with it. So I have an engineering degree because Cambridge taught the more practical mathematics through engineering at that time. But I don’t know very much engineering – I really studied operations research, which is just practical applications of maths.

I then started working in operations research consulting, but economics seemed to present some even bigger and more important problems, so that’s why I went to do an economics degree at Stanford.

At Stanford I got interested in oligopoly theory. Jeremy Bulow and John Geanakoplos and I invented the ideas of strategic complements and substitutes; I wrote my PhD thesis about markets with consumer switching costs; Meg Meyer and I analysed supply function equilibria which turned out to be useful

in understanding electricity auction markets.

2. Why did you decide to study auction theory?

The way I got into auction theory was not because I was expecting to run real-life auctions, but because an auction is such a simple economic structure. In principle we know what people are trying to do in an auction, and the game they are playing – what the rules are. In practice, of course, things are usually more complicated. We don't know exactly what peoples' utility functions are, whether they may try to help or hurt other competitors, whether they enjoy playing the game, or their participation costs. And the rules may be fuzzy: people may try to bend them or cheat. But more than in most economic contexts, we have at least a rough sense of what people are trying to do and what the rules of the game are. So an auction is a very simple structure that we can try to understand.

I thought that if we couldn't understand auctions, then we probably couldn't understand how the whole economy works. But by learning about auctions, we could learn about more complex environments, and auction models could be the building blocks for modelling more complex economic systems. In fact, one kind of work I have done is taking auction ideas and applying them in other contexts, for example, in models of political competition and financial markets.

Although I did not particularly expect to find myself running actual auctions, I always wanted to do things that were applied. I loved academic work for the beauty of the ideas, but I also wanted to do something applicable. That is why I did economics. But that did not necessarily mean that I was going to apply it myself.

3. How did you move from the theory to practice?

Because I became an expert on auctions, I was approached when the British Government wanted to sell its 3G mobile-phone licences. So Ken Binmore and I designed that auction together, and that then led to me running other auctions. For example, I helped the UK government run the world's first auction for greenhouse gas reductions. After all the hype about how much money our 3G auction raised – it was 2½% of our GNP – it was nice to show that auctions can achieve more important objectives than just raising money, in this case reducing global warming.

I also suggested new auction designs. For example, the "Anglo-Dutch" design I proposed 20 years ago has been used to procure automobile parts, to sell real-estate, and in several electricity auctions.

More recently, some of the most exciting work I've done has been helping the Bank of England by inventing a new kind of auction to distribute cash to banks that needed it. It seemed to me to be the most useful thing I could do to help in the



The Microcosm of London (1808), an engraving of Christie's auction room

financial crisis, and in fact the Bank described it as "a major step forward to support financial stability" – again much more important than just raising money.

4. Of course, you are referring to your famous "Product-Mix Auction." Why did you feel that a new auction mechanism was needed? Why not rely on an already existing one? Why not apply, for example, a similar mechanism to the one that the U.S. Federal Reserve used to supply liquidity during the crisis?

I have done quite a lot of government advising in my time, and in most cases the right thing to do is to take something off the shelf that has already been tried and tested rather than invent new theory. For the Bank of England, the simplest thing would have been to run a separate auction for each "type" of money. (In this case, a "type" of money is a loan using a specific type of collateral). That is, in fact, exactly what the Federal Reserve did at roughly the same time as the Bank of England's auction.

But, it was clear that this approach would not do everything that the Bank of England wanted to do. The Bank of England wanted to be able to loan different types of money in a single auction, and set different prices for the different types of money in a single auction, because that would get a more efficient outcome.

Let me give you an example: I might be selling fruit, and you might want an apple or an orange for lunch. You might prefer apples to oranges but, if apples are much more expensive than oranges, then you would rather buy an orange. So, if I run separate auctions for apples and oranges, you don't know which auction to enter, because you don't know which auction will offer you the better deal. So running two separate auctions creates a dilemma for you. And it can also create a problem for me, because I have to decide how many apples to sell in the apples-auction, and how many oranges to sell in the oranges-auction, before I know anything about the market demand for either kind of fruit. So, we may both be better off if I sell all my fruit together in a single auction that can take account of all the bidders' preferences, and also of the seller's preferences, all at the same time.

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In the context of the Bank of England's loans, some borrowers might only have good collateral, and others might only have inferior collateral, but some borrowers might have a choice (and as financial institutions become more sophisticated in managing collateral, more of them are likely to have choices). And the amount of money the Bank of England was willing to lend against inferior collateral depended upon the interest rate difference. Only if there was substantial stress in the financial markets, which would be reflected by a large difference in the interest rates bid on the different collaterals, would the Bank of England be prepared to lend much money against inferior collateral. So we wanted to take all the bids on all the collaterals at once, to understand the extent to which there were stresses in the market, so that all the interest rates and all the amounts of money allocated against the different collaterals would depend upon all the information—which would be much more efficient than just running separate auctions for the different collaterals.

5. Could alternatively the Bank of England fix the interest rates difference between different collaterals?

That only works well if you know what the right interest rate difference is. The Bank of England felt it did not have very good information about that. Furthermore, even if it had good information, it might not wish to signal this information. And it also wanted to obtain as much information as it could from the market – by having bidders express their preferences between the different collaterals, it could learn from the auction what the stresses in the market were. For all these reasons it wanted to do something more sophisticated than what had been done in the past.

6. In the Product-Mix Auction you assumed that bidders behave competitively. How well does this auction work with small number of bidders?

That's an excellent question. Competitive behaviour seemed a good assumption in our context, but small-numbers issues may be relevant to other applications. It seems likely that the non-cooperative equilibrium of the Product-Mix auction game is more efficient than the outcome of running independent auctions (or of a single auction with fixed price differences between goods); and also that collusion is harder in a Product-Mix auction, because collusion would require a complex form of cooperation over multiple types of goods and also would likely require involving more bidders. But some game-theoretic analysis (or perhaps experiments) would be very useful. I encourage your readers to explore this!

7. When you design a mechanism you can never be sure how it will work in the real market as some of the assumptions you make may not be so accurate. Did the Bank of England have

concerns about the actual outcome of the Product-Mix auction, especially since it was based on a new mechanism that had not been tested in the past?

We introduced the auction in stages. We started with a slight improvement on the Bank of England's old auction. And early on in the crisis, I was also advising the Bank of England on running auctions to improve the functioning of the corporate bond market, and I introduced some of my new ideas then. That helped make the Bank more comfortable when I used the same ideas later in the Product-Mix auctions. So, we evolved to a more sophisticated system in stages. And that evolution has continued.

8. So what were the following steps in the evolution of the mechanism?

After a few years running the first Product-Mix auction, the Bank of England developed it further by extending it to more varieties of goods (that is, separating collateral into more different classes), and also by allowing the Bank of England to express more complex preferences. Both these steps increased the auction's efficiency further, and two years ago the new Governor announced that the Bank would make greater use of the auction. So we have moved through a series of stages to a more sophisticated mechanism that uses more information.

9. In the Product-Mix auction the dimension of time is fixed. All the offered loans had the same maturity. Why not offering loans of different maturity?

That is another very good question. I do not claim any expertise in what are the right choices to offer bidders. My expertise, if I have one, is in how to run auctions to meet specified objectives in specific sets of circumstances. So, in this case, my job was to solve the general problem of how to run an efficient auction for multiple varieties of a good, when the auction has to be run very fast (so bidders each just make a single bid or a single set of bids, simultaneously, at a single point of time). Indeed my design isn't specific to this application – it could apply to many other contexts. But whether bidders should be offered alternative loan maturities, or how different collaterals should be treated, is not my expertise. I think it is important that we, as economists, are not only clear not only about what we understand, what tools we have available, and how we can improve the workings of government or other institutions, but that we are also clear about what we do not have expertise in; we should be careful not to present ourselves as knowing more than we do.

10. Did your involvement in the design of the Product-Mix auction influence your future research agenda?

Very much so – it turned out that thinking about developing the auction led Elizabeth Baldwin and me to new results about when a competitive equilibrium exists when goods are indivisible; and thinking about bidders' preferences led us to a theory of "demand types" which gives a new way of thinking about substitutes, complements, etc.

But most important, I think the Product-Mix auction is an important new auction form, so we have been developing it further for other applications. ■