Institution: University of Oxford

Unit of Assessment: 18 - Economics and Econometrics

Title of case study:
Designing auctions to improve central bank operations

1. **Summary of the impact** (indicative maximum 100 words)

The banking crisis that followed the collapse of Northern Rock in 2007 resulted in an urgent need to inject liquidity into the financial system. In order to resolve these issues, the Bank of England asked Professor Klemperer, an expert in auction theory, to help re-dseign its long-term market operations to allow the Bank of England to auction loans backed by financial collateral of varying quality. Since 2010, this has been adopted as the Bank of England's standard mechanism for its long-term repurchase operations. The potential impact of the new auction design extends beyond the Bank of England to other central banks, private industry and to industry regulators.

2. Underpinning research (indicative maximum 500 words)

Professor Klemperer joined the Oxford University as Lecturer in Economics in 1985, and was appointed to his current position of Edgeworth Professor of Economics in 1995.

A large part of Professor Klemperer's research over many years has focused on auction theory, and the insights that it provides for our understanding of the operation of market economies. His earlier work focused on the benefits of competitive auctions as a mechanism for sale and procurement **[section 3, R2, R3]**; the problems inherent in multi-unit, multi-product auctions including issues of collusion and the fact that the seller has to decide how much to sell before she knows the prices (section 3, refs 1 and 5). This research played a major role in the design of the auction for British 3G Telecom licenses in 2000 **[R1]**.

Building on this earlier work, Professor Klemperer's recent research addresses the fundamental problem of how to sell goods that both sellers and buyers view as imperfect substitutes when, as in the financial context, multi-round auctions are impractical **[R6]**. His proposed solution permits different but related goods to be traded and individually priced in a single auction. Each bidder can make one or more bids, and *each* bid contains a *set* of mutually exclusive offers. Each offer specifies a price for a quantity of a specific "variety". The auctioneer looks at all the bids and then selects a price for each "variety". The idea is that the menu of mutually exclusive bids allows each bidder to approximate a demand function, so bidders can, in effect, decide how much of each variety to buy *after* seeing the prices chosen. Meanwhile the auctioneer can look at demand *before* choosing the prices. Importantly, offers for each variety provide a competitive discipline on the offers for the other varieties, because they are all being auctioned simultaneously.

The 'product-mix' auction is best understood as a "proxy" version of a 'simultaneous multiple round auction' (SMRA). Bidders input their preferences, and the auction chooses the outcome that an SMRA would select assuming straightforward bidding. Because the auction is "sealed bid", it runs instantaneously (important in the financial-market context), and therefore is less vulnerable to collusion. Another novel feature is that while standard SMRA implementations specify the number of each type of each good to be sold in advance, in the new 'product-mix' auction the auctioneer also bids its preferences about how the proportions of different varieties that it will sell will depend

upon the auction prices (the overall supply constraint). The product-mix auction yields better "matching" between suppliers and demanders, reduced market power, greater volume and liquidity, and therefore also improved efficiency, revenue, and quality of information than feasible alternatives.

3. References to the research (indicative maximum of six references)

R1] * Binmore, K. and P. Klemperer (2002a), "The Biggest Auction Ever: the Sale of the British 3G Telecom Licences," *Economic Journal*, Royal Economic Society, vol. 112, 478, pp C74-C96, March.

R2] Bulow, J and P. Klemperer (1996), 'Auctions vs. Negotiations' *American Economic Review*, 86, 1. pp 180-194, March.

R3] ** Bulow, J and P. Klemperer (2009) "Why Do Sellers (Usually) Prefer Auctions?" *American Economic Review,* American Economic Association, vol. 99 ,4, pp 1544-75, September.

R4] Klemperer, P. (2002b). "What Really Matters in Auction Design," *Journal of Economic Perspectives*, American Economic Association, vol. 16, 1, pp 169-189, Winter.

R5] Klemperer, P. (2004) *Auctions: Theory and Practice*, Princeton University Press, Princeton: US.

R6] ** Klemperer, P. (2010) "The Product-Mix Auction: A New Auction Design for Differentiated Goods," *Journal of the European Economic Association,* 8, 2-3, pp 526-536.

Research quality:
American Economic Review is a "top-5" world leading general-interest journal. It is classed as "AAA" in the Combes-Linnemer (2010) ranking. The AER was rated as "4*" by the ESRC-RES review of UK Economics.
Economic Journal is a leading general-interest journal; it is the UK's top economics journal. It is classed as "AA" in the Combes-Linnemer (2010) ranking. The EJ was rated as "4*" by the ESRC-RES review of UK Economics.
Journal of the European Economic Association is a leading general-interest journal. It is classed as "AA" in the Combes-Linnemer (2010) ranking. The JEEA was rated as "4*" by the ESRC-RES review of UK Economics.
Journal of Economic Perspectives is a leading general-interest journal that focuses on research with a strong policy dimension. It is classed as "A" in the Combes-Linnemer (2010) ranking.

** denotes publication returned as part of RAE 2008*
*** denotes publication returned as part of REF 2014*

4. Details of the impact (indicative maximum 750 words)

The collapse of Northern Rock in 2007 gave rise to an urgent need to inject liquidity into the financial system. Given this, the Bank of England was willing to accept a wider-than-usual range of collateral against loans, but it wanted a correspondingly higher interest rate against any weaker collateral that it accepted. The Bank's existing mechanisms for injecting liquidity into the markets raised a number of significant operational issues (See Fisher et al (2011) for further details – **[section 5, C5]**). To resolve these issues, the Bank of England consulted Professor Klemperer, a

leading researcher in auction theory who had played a major role in the design of the auction for the British 3G telecom licenses in 2000 **[C5, p.4 and C6, p.9].**

Professor Klemperer's 'product mix' auction, described in section 2, directly addresses the Bank of England's problem. In the context of long-term repo operations, the 'bidders' in the product-mix auction are the Bank's counterparties, the 'differentiated products' or 'product varieties' correspond to loans of central bank reserves that the Bank makes against the narrow or the wider collateral set. The prices at which counterparties bid are expressed as a spread (in basis points) to Bank Rate (subject to a minimum spread of zero). The 'overall supply constraint' is the pre-announced quantity of central bank reserves that the Bank is willing to supply through the auction.

The product–mix auction meets the Bank's objectives of:

- Allowing a broader range of collateral;
- Charging different interest rates for the loans depending on the quality of the collateral in order to reduce moral hazard;
- Allowing market conditions, as revealed by the bids, to determine both the interest rate premium for inferior collateral and the proportion of inferior collateral accepted; and
- Permitting borrowers to specify how the collateral they supply will depend on the auction outcome.

In 2010, the new auction was adopted as the Bank's standard mechanism for long-term repo operations **[C1, C2, C3]**. The considerable advantages of Klemperer's new auction over earlier mechanisms are set out in a recent Bank of England paper **[C5]**. Expressing the bids as spreads to Bank Rate (with a minimum spread of zero) eliminates the interest rate risk arising from unexpected movements in the spread of market rates to Bank Rate. Moreover, the spread that the Bank charges to lend against weaker collateral is determined within the auction – as the market becomes more stressed, counterparties are willing to pay more to borrow against weaker collateral – and so the Bank no longer has to make a judgment about the appropriate spread to charge counterparties. As market stress increases, and the spread between the rates on wider collateral-backed and narrow collateral-backed loans widens, the auction design automatically allows the range of collateral accepted to increase. As a result, the Bank of England is better able to manage the liquidity of the financial system, particularly during periods of stress. A review of the performance of the new auction design after one year of operation concluded that "based on the operations to date, the Bank is satisfied that the operational framework meets the objectives of the ILTRs" **[C5, p.14]**.

The auction design is highly innovative in the field of central banking, and was a first of its kind in any field. Commenting in a magazine article in 2010, Paul Fisher, Executive Director, Markets and Member of the Monetary Policy Committee noted "'the Bank's Indexed Long-Term Repo [auctions] represent a world first in central banking…This is potentially a major step forward in practical policies to support financial stability" **[C10, p.14]**. In a speech in March 2011, Paul Fisher observed "the academic profession can make a significant contribution to the field of central bank operations. In this paper I have highlighted one example in particular where our thinking has benefitted considerably from such insight" **[C6, p.15]**. More recently, The Bank's Governor, Sir Mervyn King, observed "The Bank of England's use of Klemperer auctions in our liquidity insurance operations is

a marvellous application of theoretical economics to a practical problem of vital importance to financial markets." **[C4]**.

The product-mix auction design has potential to be used in a wide range of contexts: for instance Klemperer and several other auction theorists suggested that the US government use this form of auction to buy up "toxic assets" from troubled banks in 2008. In the event the US government changed direction and decided not to buy troubled assets after all. Looking outside financial markets, other potential applications include auctions for electricity transmission networks **[C7, pp.14-15]**; for planning permission on brown-field v. green-field sites **[C9]**.

5. Sources to corroborate the impact (indicative maximum of 10 references)

C1] Bank of England (2010a), "The Bank's new indexed long-term repo operation", Bank of England *Quarterly Bulletin*, Q2, p 90-91.

C2] Bank of England (2010b), "Bank of England position paper: proposed framework for permanent long-term repo operations", March, 23rd. http://www.bankofengland.co.uk/markets/positionpaper100323.pdf

C3] Bank of England (2010c), "Bank of England market notice: Sterling Monetary framework indexed long-term repo operations" October 3rd. http://www.bankofengland.co.uk/markets/marketnotice100615.pdf

C4] *Economist* (2012) "The golden age of micro", October 19th http://www.economist.com/blogs/freeexchange/2012/10/microeconomics

C5] Fisher, P., Frost, T and O. Weeken (2011), " Pricing central bank liquidity through product-mix auctions – the first anniversary of the Bank of England's indexed long-term repo operations", *mimeo Bank of England* (October) http://www.ecb.int/events/conferences/shared/pdf/pocrides_opfram/Frost.pdf?4d9581e4898cb8670761bbb78613de6f.

C6] Fisher, P. (2011) "Recent developments in the sterling monetary framework", Speech given to Manchester Economics Seminar, University of Manchester, 30 March 2011.http://www.bankofengland.co.uk/publications/speeches/2011/speech487.pdf

C7] Greve, T and M. G. Pollitt (2012), "Designing electricity transmission auctions: an introduction to the relevant literature" *Electricity Policy Research Group Working Paper* 1221, October 2012.

C8] *Guardian*, (2013) "How geometry came to the rescue during the banking crisis", Newton Channel, Editors Choice, July 13th. http://www.guardian.co.uk/science/video/2013/jul/12/geometry-banking-crisis-video

C9] Harford, T. (2011). "Why banks are going to auction", *Financial Times*, April 9th http://www.ft.com/cms/s/2/5f8c0aea-5fec-11e0-a718-00144feab49a.html#axzz1J0Y9ASpE

C10] Milnes, A (2010), "Creating confidence in cash", Oxford Blueprint, October 2010, p. 14.