Network Capacity Auctions: Promise and Problems

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Well-designed auctions work well for allocating idiosyncratic properties efficiently. If there is a sufficient number of non-colluding bidders, auctions can reveal the value of the property and maximise the revenue raised. Multiple round auctions can disseminate diffusely held information, though with additional risks of signalling and collusion. Auctions are perceived as more objective and fair then beauty contests or administrative allocation, and yield more revenue to the seller (often the state). For that reason, they are particularly attractive in developing countries with a poor record of administrative fairness and corruption. They have been used in innovative ways in privatisations in Latin America. For example, the Bolivian privatisation process invited bids for 50% of the shares plus one (giving a controlling interest to the winner) with a commitment to match the bid payment with investments of equal value. The remaining shares were then allocated to the public pension fund. This design encourages efficient investment as well as an investment commitment from foreign bidders, while protecting the privatisation receipts from current public consumption.

The attraction of using auctions for capacity in network industries is that it appears to offer a market solution for a natural monopoly that would otherwise require regulated prices. Regulation is inevitably costly and inefficient (Newbery, 2000), but market solutions may also be inefficient if they are prone to market power or other market failures. The critical question for designing capacity auctions in network industries is therefore to identify cases where market failures are less significant than regulatory failures and conversely, to identify cases which should be left to regulatory solutions.

For network utilities, apart from spectrum auctions for telecoms, most of our experience comes from auctions to allocate transport (or entry) capacity in gas and electricity networks. Rail franchise bidding falls reasonably under the heading of auctioning long term rights to idiosyncratic properties, and would therefore seem to work well, at least for the initial offering. There may be problems in subsequent rounds of franchise bidding where there are asymmetries between incumbents and potential entrants (Affuso and Newbery, 2000).

Electricity auctions

The most active capacity auctions at present are for inter-connector use in the European electricity industry, particularly between Germany and the Netherlands, but also between France and England. The Dutch inter-connector auction has been running since 1 January 2001 and involves an annual auction of annual base-load capacity, a monthly auction also of base-load capacity, and daily auctions of hourly capacity, which also handles any capacity

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not nominated from the monthly or yearly allocations. Bids are submitted a day ahead and a market clearing price established before the spot markets for wholesale electricity in Germany and the Netherlands open. The prices are published on the TSO web-site[1] and may be compared with the difference in spot electricity prices on each side of the border to test for arbitrage.[2] Although there are obvious problems and unsatisfactory features about the auction design (for example, bids for the two inter-connectors into the Netherlands are cleared separately and typically at different prices despite the lack of constraints in trading through either inter-connector), the auctions appear to work reasonably well.[3] In contrast, the inter-connector auction with Belgium frequently clears at a zero price, because of a lack of an electricity spot market in Belgium and the dominance of Electrabel in that country (and its considerable presence in the Netherlands).

Not surprisingly, for a network capacity auction to work well it helps if there are many potential participants, and if there are liquid spatial spot markets to reveal the value of capacity connecting these different markets. Electricity networks have distinctive characteristics that make the design of markets and auctions more complicated than in other markets. For example, Kirchoff's laws determine the pattern of electricity flows across inter-connectors and through networks, and these flows must be kept within well-defined limits. Transmission constraints fragment market areas, and confer potential market power where there are few competing suppliers within the isolated area. Generators may be able to precipitate congestion on distant links, and by fragmenting the market, enhance their market power. Devising efficient auctions and rules of behaviour for meshed networks remains a challenging task.

Even without these complications, though, careful auction design is necessary to avoid enhancing existing market power, and may be able to mitigate such power. Gilbert, Neuhoff and Newbery (2002) show that where producers have market power in a transport-constrained region, allowing them to secure import capacity increases the amount of output sold at the spot price over which they have some control, and enhances their market power. If traders can efficiently arbitrage prices across the scarce transmission link, then they will outbid any generator attempting to leverage his market power by securing import capacity, and will therefore reduce incumbent market power. One consequence is that single-price auctions are superior to discriminatory bid auctions, as they encourage efficient arbitrage. Pay-as-bid or discriminatory auctions induce more cautious bidding by traders when they face agents who can influence the resulting spot market, and whose bidding strategy may be hard to predict.[4]

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[1] At http://www.tso-auction.org/

[2] Dutch spot prices are available at http://www.apx.nl/home.html and the German (LPX) spot prices at http://www.lpx.de/index_e.asp

[3] The average (time-weighted) price difference between spot prices in Germany and The Netherlands from 1 Jan 2001 to 30 June 2002 was 7.31 Eur/MWh, and the average (time-weighted) daily interconnector auction price was 3.71 Eur/MWh. The average arbitrage profit was 11% of the average APX spot price, indicating that the markets were not efficiently arbitraged, or that the risk premium for speculatively buying interconnector capacity before knowing spot prices was rather high. The arbitrage profit fell to 2% of the average APX price for the first half-year of 2002, suggesting some increase in efficiency.

[4] Indeed, the optimal behaviour of oligopolists is to play a mixed strategy in the bidding game, confronting the traders with the risk that if they bid high they will face a winner's curse.

It is also possible to show that in some circumstances when the inter-connector capacity is fully used, oligopoly producers would wish to export while traders wish to import. The reason is that exporters selling into a (more) competitive market compare the price they receive there with marginal revenue in the home market, which may be below the foreign price even when that is below the domestic price. It can then be pro-competitive to allow generators to bid for export capacity, and to offer import capacity to the inter-connector capacity *plus* any *firm* exports.[5] Exporters would receive the market clearing bid for importers, and in effect the auction will be for the algebraic sum of directional flows (exports count as negative imports) at directional prices. At present no European electricity auction provides for this kind of superposition (or "netting trades"), although this is certainly under discussion for the German-Netherlands inter-connectors.

As part of the restructuring process prompted by the Electricity Directive, legacy long-term import contracts were often allocated to the incumbent generation companies. Where these companies have market power and are in import-constrained zones, the import contracts increase the volume of sales exposed to the local price. That increases the incentive to raise that price (either by bidding in to the spot price at higher levels for each quantity offered, or by demanding higher prices for contracts, or both). These contracts should be allocated to the auction, with the revenue returned to the company.

Otherwise, the agreement reached by the European Transmission Systems Operators is that interconnector auction revenue should be dedicated to enhancing cross-border transmission capacity. This makes obvious sense, as at present only 8 percent of total EU generation is traded across borders, 'much lower than could be expected of an integrated European market' (OJ, 2002, 2.6). There is an additional reason, in that several electricity generation companies are owned by companies that also own transmission (Electrabel, Electricité de France, E-on, RWE, etc). In some cases vertically integrated incumbents with the power to raise prices in the home market above that in neighbouring markets (because of inadequate import capacity) are likely to resist proposals for increased import capacity. The requirement that auction revenues be used for this purpose may go some way to countering this resistance.

Gas auctions

Auctions for entry capacity into the British National Transmission System for gas were introduced in September 1999 (McDaniel and Neuhoff, 2002) and replaced an earlier system in which shippers could buy potentially unlimited annual entry/exit capacity at regulated prices related to long run marginal cost. These LRMCs were calculated from a computer model, Transcost,[6] that estimated the annualised cost per cubic metre of increasing injections at any entry point and a corresponding off-take at any exit point. As there are five entry points and 37 off-take points, there are potentially 185 distinct LRMCs, but Transco aggregates these into five entry and 37 exit prices, giving 42 distinct prices.

There are considerable problems in defining the correct concept of LRMC, particularly if increments in demand are not uniform across years, and if the underlying pattern of flows changes over the time horizon considered. There are further problems in reflecting the 185 underlying LRMCs in 42 basic price components, but there is a far more

[5] Export bids must be obligations, not options, with imbalance penalties for failure to deliver.
[6] Downloadable from http://www.transco.uk.com/

fundamental objection to using these prices for allocating scarce capacity. For that, the appropriate concept is the short-run marginal cost, or the opportunity cost in the case of excess demand. Auctions would seem to offer the natural solution to finding these short-run scarcity prices, provided, as seems to be the case in the North Sea, there are sufficiently many competitive bidders. Entry prices matter as producers may have varying degrees of flexibility in when and where they deliver gas, while consumers are typically relatively insensitive to the transport cost of gas to different locations, as they cannot easily relocate. Consequently, there is little allocative inefficiency in charging exit prices based on LRMC (the present system), particularly as by good fortune these need little adjustment to generate the revenue required under the price-cap regime.

Auction prices as potential signals for investment in capacity

Prices in normal markets are useful not only for allocating existing output among competing buyers, but also for signalling the need for increased or reduced output, and hence for guiding investment decisions. One of the hardest parts in regulating network utilities is to determine the amount of revenue required to finance future investment. Cost-of-service or rate-of-return regulation in the United States was criticised for encouraging over-investment or gold-plating as it assured investors of a "fair" return on their investment. The more they invested, the more profit they were allowed to earn, provided only that the investments were "used and useful". Price-cap regulation was designed to mimic the market by encouraging delivery of services at least cost, for which ideally the price-cap should be related to the cost of efficient operation and expansion of the network.

Where there are many comparable regional networks, as for distribution companies in electricity and water companies, benchmarking and yardstick regulation has the attractive property of providing efficient incentives to individual companies while reflecting general cost characteristics facing the industry as a whole (Pollitt and Jamasb, 2001). However, for national electricity grids and national pipeline systems, benchmarking is relatively powerless, as international comparisons are problematic. It is therefore difficult to avoid basing the price-cap on investment forecasts made by the utility, although regulators invite independent engineering consultants to assess their value and cost. If the prices emerging from capacity auctions could be used to guide investment decisions, then the problem of financing and determining the efficient type of investment might be solved by market rather than regulatory means. Deciding when and whether capacity auctions give appropriate investment price signals is therefore a critical question for regulation.

If we consider the Dutch electricity inter-connector auction, the yearly auction gives the perceived value of a (marginal) megawatt of capacity on the inter-connector in the current year. It would seem to be the appropriate *ex ante* measure of value,[7] based on a year-ahead view of the relative prices in the adjacent markets. As expected, it has traded at a premium to the average of the underlying day-ahead inter-connector markets, as there is value in the hedging or insurance offered, and there is a better match with a typical yearly energy

[7] The value is to those winning the auction (which, for import capacity, ought to be traders selling to final consumers or arbitrageurs), based on possibly distorted market prices in the exporting and importing markets. There may be additional social values from increased supply security and reduced market power that are hard to reflect in market price signals and which may therefore be absent from the valuation.

contracts signed with customers. For the year 2001, the year-ahead annual auction price was 10.72 Eur/MWh (averaged for the two inter-connectors), compared to a difference in the year-ahead OTC base-load contract prices of 10.23 Eur/MWh, suggesting efficient arbitrage at this stage. Probably more by luck than judgement, the predicted value of the inter-connector a year ahead was remarkably accurate, as the average price difference across the border (for cases when the price was higher in The Netherlands than Germany) was 11 Euro/MWh. The average of the daily auction over the whole year was 4.43 Euro/MWh, which is substantially below the average of the daily spot price differences (suggesting inefficient arbitrage). More to the point, it is substantially below the annual inter-connector auction price, revealing the option value of the longer-term contract. Liquid spot and auctions markets allow traders to arbitrage between the yearly, monthly and daily auctions, so that the risk premium should give a reasonably accurate measure of the option value of access to the inter-connector.[8] This option value is an important component of the benefit of transmission capacity, and needs to be included in any investment appraisal.

There is, however, a considerable difference between an auction for existing capacity and an auction for long-term access to additional capacity. Major gas pipelines and electricity grids have a life of 50 years or more, and in the past long-term contracts for gas transport were typically of 20 years duration. Presumably, investment decisions would need to be based on comparably long-term contracts. In an ideal world, it would be possible to offer annual or multi-annual contracts for capacity for a sufficient number of years ahead to attract enough offers to build the efficient capacity. The offers and bids would establish both the yearly price and annual investment plans for capacity. One obvious problem with this design is that it runs counter to the spirit of the Electricity Directive, which deems long-term contracts potentially anti-competitive. The Directive reflects the concern that if incumbents control access to transmission, they can foreclose entry and maintain their market power. One solution would be that any multi-year contracts had to be subsequently offered to the shorter term (one year or less) auction market. Ensuring that the capacity is subsequently traded would encourage traders as well as producers to participate in the auction and would give clearer indications about market manipulation.

The key question is whether such an auction could be relied upon to deliver the socially optimal amount of investment. This would require at a minimum that auction participants be confident about the terms on which future capacity were supplied, and hence the future value of access to capacity. Most participants are likely to believe that regulators would intervene to increase capacity if they decided that the investment was inadequate to support a competitive market. If so, then bidders face a risk when acquiring capacity that its future value is likely to decrease. They will be reluctant to pay as much or buy as much capacity as is needed. A high risk-premium would lead to under-investment and precipitate precisely the response from the regulator that the participants had anticipated.

There is a further tension between leaving investment decisions to the market, and the regulatory desire to ensure that the liberalised markets work efficiently. Inadequate

[8] For 2002, the annual inter-connector auction was 18 Euro/MWh, but the year-ahead OTC price difference was only 9.5 Eur/MWh. This may have been because of heavy demand for importing subsidised 'green' electricity from Germany. The average daily inter-connector auction for the first half-year was 2.3 Euro/MWh, and the average (positive) spot price difference was 4.3 Euro/MWh, suggesting some convergence between the daily inter-connector auction and the spot price difference.

transmission capacity increases market power and raises the value of transmission and also the value of generation. In the absence of a less than perfectly contestable market for generation and transmission, one would expect under-investment and exacerbated problems of market power. Regulators may consider that the most effective way of increasing competition is to over-invest in transmission to increase the number of producers that can actively compete against each other. Over-investment in transmission would drive the price below the "efficient" level, where efficiency is to be interpreted as the perfectly competitive solution. Again, even the suspicion that future regulators might take this view about transmission investment would discourage bidding at the auction and again precipitate or increase the likelihood of such future regulatory action. In short, the lack of an adequate set of sufficiently distant futures markets, and the perceived inability for the regulator to commit his future actions create serious market failures for long-term capacity auctions.

There are additional practical problems in designing long-term capacity auctions for meshed networks, whether electricity or gas. Typically, the capacity of a given link or entry point will depend upon the pattern of flows on the whole system. On the Dutch inter-connectors, for example, the amount of capacity made available in the daily auctions varies substantially from hour to hour and from day to day, being determined as the residual remaining after meeting monthly and annual claims and the amounts needed for system security. These system security requirements depend upon the pattern of flows through the entire European network, and are only known a relatively short time before despatch. There are therefore obvious problems in deciding how much capacity is actually made available in response to a given investment, whose cost may be well defined. Whether this is a serious problem will depend upon particular circumstances, and it may be sufficient to require that the transmission operator buy back any capacity needed for security in the daily spot auction. The problem is almost certainly less serious for inter-connector capacity between separately dispatched regions in electricity grids, where the security requirements in terms of MW ought not to vary with the total inter-connect capacity (at least, in the short-run).

Auctions are therefore unlikely to be adequate by themselves for providing capacity investment, even if the auction prices can provide some short-term guidance on where extra investment is most urgently needed. Traditional central planning guided by intelligent price-cap regulation is the obvious default in isolated systems, like Britain, but has not worked well for providing inter-jurisdictional interconnection, either on the Continent or in the United States. The appeal of decentralised market solutions such as auctions is that they avoid the need for supra-national or federal level regulation, where agreement with individual jurisdictions may be difficult and time consuming. The Federal Energy Regulatory Commission has considerable power to act in the U.S., though it is still trying to reach agreement on how to finance and operate Regional Transmission Organisations. Various commentators in Europe have argued that eventually the European Commission will need to create a EU counterpart to FERC if cross-border trade is to be stimulated.

The Economic and Social Committee of the European Commission has argued that Californian-style supply risks requires that independent regulatory authorities are given responsibility for monitoring the supply/demand balance, and grid operators are required to maintain and develop the network (OJ, 2002, 6.2.1). The Economic and Social Committee also argues that the cost of providing this security should be met by the whole system 'either

at national level or through a Community-wide system.' (6.2.3).[9] These supply risks could be alleviated if cross-border interconnector capacity were increased, while recognising that the current low level of interconnection reflects the difficulties of reaching agreement between countries.

The Commission's response to these difficulties has been to propose a Regulation with "measures:

- establishing compensation mechanisms for flows of electricity;
- defining harmonised principles for cross-border transmission tariffs; and
- allocating available interconnection capacity between national transmission networks" (4.1).

The Economic and Social Committee expressed its reservations about according the Commission such wide-ranging powers (at 6.11.3) and called on the Commission to "take account of the principle of subsidiarity." The Commission would have to verify that the problems could not be resolved at the national level, and would yield clear net benefits over actions that could be taken at the national level (6.11.5). This raise the question whether adequate interconnection can be agreed by national regulatory authorities by, for example, discussions at the Florence Forum and/or the Council of European Regulators.

It may be sufficient to establish an independent technical body to assess the desirability of cross-border capacity investments, and to propose an algorithm for recovering the costs of such investments from country transmission operators (and via their local charges, from generators and consumers). The problem is essentially one of finding a cost-sharing mechanism for what is largely a public good, and which delivers Pareto-superior outcomes to the present state of quasi-anarchy. While this may not be fully optimal, it would almost certainly be an improvement on the present system. At the individual country level, the past evidence is that adequate transmission was readily financed and largely adequate. Whether that will continue to be true in the future liberalised markets will depend on the quality of regulation, the degree of opposition of 'green' activists, and blocking tactics of politically-represented consumer groups (in export zones whose prices may rise with more trade, as in Quebec), or producers in importing regions.[10]

Conclusions

Scarcity of network capacity (an inevitable consequence of efficient investment decisions) will limit the number of competing producers and consumers in the market delimited by capacity constraints. Market power problems are therefore likely to be endemic, and auction design will need to pay attention to mitigating such market power. As a general rule, if producers secure access to capacity that delivers power (gas or electricity) to the same market in which they sell most of their output, their interest in raising the market price will be increased, and hence their market power will be enhanced. Conversely, where capacity gives those with market power access to markets whose prices are disconnected from the

[9] References to paragraph numbers hereafter are to (OJ, 2002).

[10] In some cases, generators have even financed green activists to block transmission line proposals, gaining ecological kudos and retaining market power at the same time. It may take a California-style power shortage to introduce realism into this debate.

oligopolist's home market, capacity auctions can act as commitment devices and hence increase competitiveness. Single price auctions allow more efficient arbitrage by traders whose presence mitigates market power, while discriminatory auctions are likely to be less efficiently arbitraged and hence traders will be less effective in mitigating producers' market power. Allowing producers to retain grandfathered rights to transmission capacity risks enhancing their market power and forced sales to arbitrageurs (at competitive prices) would seem to be a non-expropriative remedy to this problem.

In the short run, before the EU has found effective ways of ensuring efficient cross-border network investment mechanisms, requiring that capacity auction revenue be set aside for capacity enhancements has obvious attractions. Where producers are vertically integrated with transmission, there is a risk that incumbents will under-invest in interconnection capacity in order to protect home markets. In such cases, price differences across borders are likely to be significant, and auction revenues may generate considerable revenue for investment enhancement. Nevertheless, liberalised markets probably require a degree of excess capacity in transmission to secure the additional social benefits of increased competition. Auction revenues will fall to zero before the socially optimal level of investment has been financed and additional mechanisms will be needed to finance this additional investment.

Long-term capacity auctions by themselves are either not credible or not sufficient as a mechanism to secure adequate investment in network capacity, particularly where this capacity is critical for the efficient and secure operation of the system. Nevertheless, auctions can work well for allocating existing capacity where there are a sufficient number of potential bidders, and particularly well where there are liquid spot markets that give indications of scarcity values and allow arbitrage. Even in these favourable circumstances, short-term capacity auctions undoubtedly reveal additional and useful information to guide longer-term investment decisions. The regulatory problem is to specify the default investment mechanism which would compliment any proposed long term capacity auction or reservation system, so that participants can make better informed judgements about future supply.

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