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**AUCTIONS OF CAPACITY IN NETWORK INDUSTRIES**

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# AUCTIONS OF CAPACITY IN NETWORK INDUSTRIES

## I Introduction

In recent years, there has been much interest in the use of auctions in utility service industries in the UK and in other countries. The most publicised examples have been *franchise* auctions eg auctions for 3G mobile telecom spectrum, the UK auctions of railway operating franchises, etc. However, there has also been growing interest in the use of auctions of *network capacity* – auctions both (a) for the allocation and use of existing capacity and (b) for investment in new capacity. It is these topics that are discussed in this and the other papers included in this special issue of Utilities Policy.

These papers were presented and discussed at a Conference organized by the London Business School's Regulation Initiative in April 2002. They cover the use of auctions in the electricity and natural gas transportation systems, for airport capacity and railway tracks as well as general issues on auctions and the potential for decentralization within infrastructure networks. The conference speakers were asked to consider the general theme of whether or not auctions should replace use-of-system charges. In particular, the speakers were asked to consider the following four key issues:

- (i) The ability of auctions to handle *long-run* (capacity expansion) as opposed to *short-run* (capacity allocation) issues;
- (ii) The definition of “capacity” on networks;
- (iii) Auction revenues and compensating adjustments to allowed other revenues of network operator (revenue reallocation); and
- (iv) Alternative market-based mechanisms to provide signals for capacity expansion.

The electricity and natural gas industries were chosen primarily because the UK has experience since 1999 with auctions of gas storage and National Transmission System (NTS) entry capacity. In addition, Ofgem (the UK regulator for electricity and downstream natural gas) made a number of public statements during 2001 on its intention of introducing auctions for new capacity in electricity transmission. These proposals attracted considerable criticism and the latest Ofgem proposals (October 2002) propose the introduction of tradable, financially firm transmission rights but do not explicitly mention auctions as a preferred or even as a possible trading mechanism<sup>1</sup>.

Other reasons for including electricity and natural gas is the growth of the use of auctions for allocating capacity on interconnectors between countries in Continental Europe as well as between England and France. US experience, on capacity allocation and investment in inter-state natural gas pipelines also provides a useful contrast to debates in the UK and Europe.

Auctions for allocating airport slots were chosen because there has been considerable policy discussion about the use of auctions eg to replace “grandfathering” of rights. In addition, discussion of the role of auctions for airport slots brings out clearly the crucial role of property rights – who owns what property rights. It is critical to decide whether airport slots are owned by airports, by governments or by airlines. Auctions make much more sense (at least for existing slots) if they are deemed to be owned by airports or governments than by airlines. Similar issues arise, only in a much more direct and complicated way, with railways and attempts that might be made to use market signals and auctions to allocate train paths between alternative uses and train operators.

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<sup>1</sup> Ofgem have left it to NGC (the transmission company for England and Wales) to propose a market mechanism that “reveals participants’ willingness to pay for long-term access rights” (Ofgem 2002, Para 6.10). This may or may not include auctions. Given the hostile response to previous auction proposals – not least from NGC – auctions are probably unlikely.

The papers that follow provide much more detailed discussions of all these issues. However, we also have two papers that provide a more general perspective on what market signals and auctions can reasonably be expected to handle.

For auctions to provide reliable market signals not only must it be possible to decentralise decision-making and establish clear property rights, but there also need to be a “sufficient” number of bidders, long-term and liquid futures markets, etc. If auctions are to provide reliable economic signals, it is imperative that there are a good number of competing and non-colluding bidders. The *problem of sufficient competition* has been a major practical concern in telecom spectrum auctions as well as in electricity spot markets based on advance bidding (markets which can best be thought of as repeated auction markets). This issue recurs frequently in the papers in this volume.

*Highly meshed networks* like electricity transmission networks, the UK and other rail networks also create particular difficulties and the much more adverse reactions to Ofgem’s proposals for auctions of electricity transmission capacity relative to gas transport are, not least, because, in the UK (as in other countries) electricity transmission networks are much more highly meshed than their gas equivalents. Definitions of “capacity” become crucial with highly meshed energy networks not least because of loop flows in electricity and the natural gas equivalent which means that additions to networks in highly interconnected areas can lead to major changes in flows in surrounding lines and pipelines (positive and negative) for considerable distances around the initial investment. For electricity and gas interconnectors between separately dispatched systems (eg England and France or Holland and Germany), this is a second-order rather than a first-order problem; but, even here, short and long-term auction arrangements must take account of the considerable complications that can arise from these flow change issues.

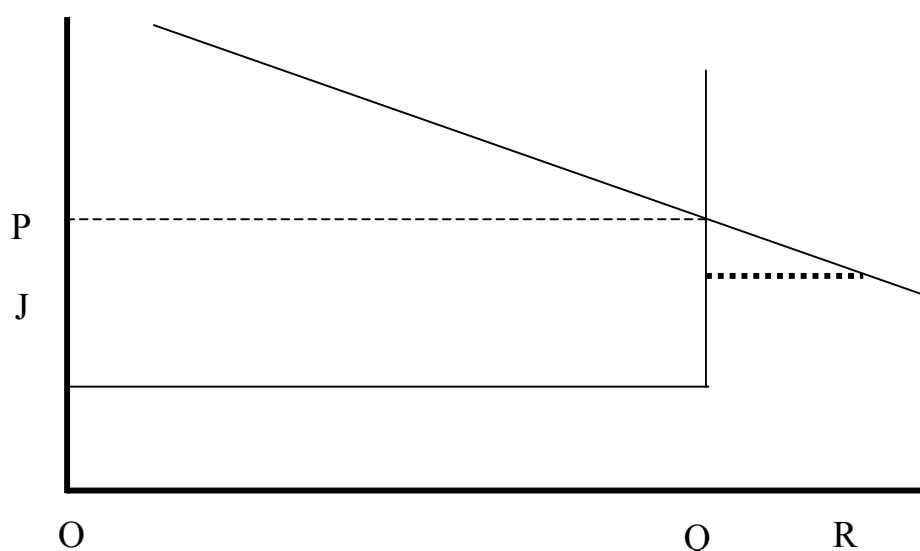
In the rest of this introductory paper, we present some simple analytics of auctions and discuss some of the main issues that have arisen in practice. We then provide an overview of the key issues outlined above and discussed in the subsequent papers.



## II Some Simple Analytics

The following sets out the essential analytic issues in as simple a manner as possible. In particular, we abstract from all competition, meshed network and other complications. Hence, we consider a partial equilibrium approach to the allocation of and investment in a piece of infrastructure. This simple model would be most directly relevant for a non-interconnected pipeline or railway line from Locations A to B but is a good starting point for more complicated cases with interconnection.

Suppose that the demand curve for the relevant piece of network infrastructure is as shown and that the existing available capacity is indicated by the position of the vertical part of the short-run marginal cost curve at  $Q$ .



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There is a choice between (a) fixing the *quantity allocated* and (b) fixing the *price*. Hence, the infrastructure provider (or the regulator) can auction the use of  $OQ$  capacity or alternatively set a price of  $OP$  and allow users to demand  $OQ$ .

The second procedure has the obvious disadvantage that it (unrealistically) requires the provider to know the precise position of the demand curve. If the provider gets it wrong and sets the price too high, capacity will be under-utilised, while if it

sets the price too low some users will have to be “constrained off” either by non-price rationing or by buying back the right to use capacity from some of the users.

Now consider the long-run. Suppose that the long-run marginal cost of expanding capacity is as shown by the heavy dotted line extending to the right of the vertical section of the short-run marginal cost curve. A capacity expansion of  $QR$  with a price reduction of  $JP$  is clearly desirable. However, it will be difficult to get this right:

- Although the fact that  $OP$  exceeds the long-run marginal cost of  $OJ$  clearly indicates that a capacity increase is desirable, it provides no clue as to the desirable magnitude of that increase.
- If the infrastructure provider reduces the price to equal the long-run marginal cost of  $OJ$  it will need to estimate (or guess) how much extra capacity will be demanded at that price.
- If, however, the infrastructure provider follows an auction procedure and obtains competitive bids for extra capacity, the size of the desirable increase can, in principle, be determined. But, achieving this raises difficult questions as to the nature (eg firmness) and duration of the contracts between the infrastructure provider and the future users.

Thus auctions *appear* to provide the right answers, both as regards the short-run utilization of existing capacity and as regards capacity expansion. However, the infrastructure provider will be reluctant to undertake this expansion unless it receives compensation for the loss of  $OQ \times JP$  revenue from its existing capacity. In the absence of such compensation, unless other measures are taken (eg via regulatory licence conditions), there is likely to be a strong bias towards *under-provision* of new capacity from the use of auctions for investment. Auctions would provide the correct signals for the short-term allocation of the existing capacity but not for long-run investment decisions.

This problem is, of course, greatly worsened in practice if (as is the usual case), it would require a long period (eg 10 years) for demand to grow sufficiently to

utilize the new capacity fully. In these circumstances, not only would the price of existing capacity be reduced from OJ to OP (or lower during the transition); but, in addition, revenues from the new capacity would fail to cover the economic costs of its provision for a number of years. This issue affects the transition between the initial pre-investment equilibrium and the eventual new post-investment equilibrium.

In addition, as will become clearer in subsequent papers, other factors may further exacerbate the bias towards under-investment eg if the owner of the infrastructure facility also owns the business (electricity or natural gas or train service) that makes use of the facility. In those circumstances, profit maximization across both products is likely to lead to the facility provider making sure that there is as little spare low priced network carrier capacity as possible for his competitors to use and thereby build-up their energy or train service business.

The analysis in the diagram is not affected if users pay both variable Use of System Charges and an auction price. In this case the demand curve in the diagram must be taken to reflect willingness to pay net of these charges, being shifted downwards by their amount. Nor is the analysis impugned, though it is a little more complicated, if the short-run marginal cost curve curves upwards before becoming vertical, reflecting gradually increasing congestion costs as the degree of capacity utilisation rises<sup>2</sup>. In such cases congestion, i.e. service quality, as well as quantity and price have to be considered, but the theoretical virtues of auctions, whether alone or on top of variable Use of System charges, still hold.

Rights to system use can be allocated to users not only by auction but also in some more or less arbitrary way, notably by “grandfathering”<sup>3</sup>. This obviously deprives the infrastructure provider of revenue, awarding scarcity rents to those users who receive the rights. But, a competitive process of private transactions between users will reallocate them to those users whose willingness to pay is greatest, *iff*

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<sup>2</sup> See the discussion of congestion costs in R. Turvey: "Infrastructure pricing and lumpy investments", *Utilities Policy*, 9 (2000) pp.207-218.

<sup>3</sup> "Grandfathering" Is the allocation of capacity rights on the basis of previous use. Airport slots are usually "grandfathered".

- those rights can genuinely be made subject to use-it-or-lose-it conditions;
- they are freely tradable;
- transactions costs are low; *and*
- the technical specification of the capacity required by different users is identical (cf. electrons on an electricity transmission network as opposed to slow/stopping trains and fast/express trains on an unsegregated railway network).

However, these conditions are clearly stringent and may be difficult to meet in practice.

A system based on private trading between users should lead to the same level of allocative efficiency as auctions; the difference being a matter of the distribution of wealth and income between the infrastructure provider and users. However, with grandfathering and the associated rents, it can be extremely difficult to establish the true economically justifiable demand for new capacity.

Clearly, auctioning and/or secondary trading are only possible if the capacity ownership and use rights are clearly defined. It might be supposed that their aggregate volume must be set equal to a precise and accurate measure of capacity, or of capacity increase. However, once again, if capacity has been incorrectly measured, secondary trading can restore the equilibrium – provided there are enough players in the market. So long as the infrastructure provider can freely trade in the secondary market and this market is competitive, the provider can buy back rights if the volume awarded was too great and sell additional rights if it was too small. (This also allows adaptation to changes through time in the volume of capacity available.) Once again, although allocative efficiency will be achieved, there will be a distributional effect, the provider having to pay for bought-back rights and profiting from the sale of additional rights.

The key points that emerge from the analysis of this simple case are:

- Auctions can, in general, be expected to provide good economic signals for the short-term allocation of existing capacity – provided there are sufficient bidders;
- Auctions should, in principle provide good economic signals for new investment, but the circumstances in which this is likely to happen are stringent (and include compensation for lost revenues on existing capacity);
- Auctions are unlikely to provide good signals for the required *amount and timing* of new investment, except in particular circumstances;
- For a variety of reasons, auctions are likely to result in *under-provision* of new network investment - unless supplemented by additional regulatory measures;
- The existence of secondary markets for trading capacity can, with defined property rights, provide many of the benefits of auctions.

The points above suggest that, even in simple cases, the use of *auctions alone* is likely to be unable to establish the appropriate amount and timing of investment in new capacity. But, in some cases, auctions may still have a significant role to play even there if combined with other mechanisms. The key questions in those cases (discussed in several of the papers) are then: (i) *what* other mechanisms and (ii) what should be the *relationship and relative priority* between the role of auctions and the role of the other mechanisms.

It is also worth emphasizing that this discussion of the economic merits of auctions for capacity applies to the infrastructure facility per se. Even if auctions for new capacity are rejected, there is still a strong economic rationale for the use of auctions for providing the finance for the investment, constructing the new investment, etc.

### **III Some Complications**

In this section, we introduce some complications into our initial simple model. As we shall see, these complications raise further difficulties for the simple application of auctions to network capacity – particularly as regards its use for estimating the amount and timing of new investment.

#### **(i) Revenue adjustments**

For a regulated infrastructure facility, regulation seeks to ensure that a firm's revenues will not exceed its approved operating costs and reinvestment costs plus a reasonable return on its regulatory asset base. The regulatory process thus involves forecasting, and forecasting the revenue from auctions is subject to particular uncertainty. If this revenue turns out to be greater or less than was anticipated, there will therefore have to be some subsequent adjustment to other components of allowed revenues. The way in which this is done may have favourable or unfavourable effects, moving other charges away from or towards marginal costs.

In its proposals for electricity and gas transmission network capacity expansion, Ofgem have been careful to separate the revenues from sales of transmission rights from the revenues associated with the agreed baseline level of investment which are covered by the price control. Indeed, it can be argued that the key argument for the use of auctions for future gas capacity is information revelation which allows the regulator to concentrate on the minimum necessary baseline investment programme and deregulate additional investment requirements. This information and deregulation argument for UK gas industry network investment is presented in George Yarrow's paper.

However, the general issue of revenue allocation affects auctions of existing capacity as well as auctions for new capacity. (See the discussion of the use of auctions for allocating UK gas storage capacity, gas entry capacity and gas network investment in the paper by George Yarrow. For a discussion of this issue in the context of airport slots, see the paper by Dan Muldoom.)

(ii) **Network complexities**

There can be very considerable interdependence between the functioning of different parts of a meshed gas, electricity or rail network and this can create substantial complexities for the use of auctions.

In an interconnected network the maximum injection (or number of departures) at any given point which is to be withdrawn (or is to arrive) at some other given point depends on all or most of the other flows in the system — unless there is spare capacity throughout. Thus, feasible maximum point-to-point or separate entry and exit rights cannot be set independently of one another. The maximum possible number of Brighton line trains per hour arriving at Victoria cannot be determined unless other Victoria arrivals are known.

There are also some temporal interdependences, at least for trains and airport slots. Whereas electrons and gas molecules are indistinguishable from one another, the individual train or plane moves through time and space as a unit. An airline or train operating company cannot use a departure slot unless it also has a slot for the return of the plane or train and will want subsequent slots for subsequent movements of that plane or train. In addition, the airline or train operator must have access at the necessary time to terminal or platform use and other complementary facilities as well as the runway or train-path for which auctions are being carried out. Also, the value of a slot will depend upon the timing of competitors' slots; a departure at 10.15 is less valuable if a competitor has a departure shortly before.

For either of these two reasons, auctions of particular rights to transmit or move would have to be combinatorial or simultaneous multiple round auctions, as offers for rights would have to be contingent upon the auctions results for other particular rights. Such auctions would be extremely complicated, difficult to monitor and understand and a lot would hinge on the degree of competition for the various rights. These issues are discussed in more detail for airports in the papers by Dan

Muldoom and Andrew Sentance and, for railways, in the papers by Stephen Gibson and Luisa Affuso.<sup>4</sup>

The same problems would afflict secondary trading in these industries as well as initial auctions. A capacity right from  $A$  to  $B$  would be tradable, but trading a right from  $A$  to  $B$  with a right from  $A$  to  $C$  or from  $C$  to  $D$  would only be possible if the participants knew how great an increase in  $AC$  or  $CD$  flows could be accommodated by a reduction in  $AB$  flows.

The degree of combinatorial complexity is obviously a function of how aggregatively the rights are defined. If injection and withdrawal points can be grouped and/or time periods lengthed and so diminished in number, this will lower the number of rights to be auctioned, so reducing the complexity of the auctions. It will have the important further advantage of raising the number of participants competing for each right. But it will have the disadvantage that some other mechanism will be required to deal with interactions within each group or period. Thus if north-eastern electricity generators' rights to inject power were sold as parts of a single north-eastern bundle, different combinations of their separate outputs would meet different transmission constraints both within the north-east and between the north-east and the rest of the grid. Potential infringements of these constraints would require the System Operator as part of its daily operations to buy back or annul some rights and to secure compensating generation increases from other generators.

It is also worth noting that these problems can arise in apparently more straightforward circumstances. Who is allowed to bid for what and on what terms on standalone electricity and natural gas interconnectors can have varied and substantial effects on quantities and prices in the connected (and neighbouring) systems. In practice, this is usually more of an issue for electricity given the much higher degree of meshedness of networks (and the impact of Kirchhoff's Law). These issues are discussed in more detail the papers by David Newbery and Tanga McDaniel.

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<sup>4</sup> See also the detailed discussion in *Auctioning Airport Slots: A report for HM Treasury and the Department of the Environment, Transport and the Regions*, Dot Econ Ltd, 2001. [www.dotecon.com](http://www.dotecon.com)

At the heart of the problems over using auctions for complex and highly meshed networks is the issue of *limits to decentralization*. The experience with railways in dense commuter routes and experience with electricity networks shows up clearly the limits to decentralization even for the allocation of existing capacity. The notion that auctions can provide the only or main source of information for decentralized planning and investment is even less likely – particularly when the potentially very large costs to users and the wider economy from supply interruptions arising from insufficient capacity are set against those of (moderate) excess capacity. This is a particular concern for electricity and gas networks where the costs of supply interruptions from insufficient network capacity can be huge. (These issues are discussed in detail in the paper by Dieter Helm and also addressed by David Newbery, George Yarrow and others.)

(iii) **Investment in Complex Networks**

The auction of long-term rights as well, employing them as the means of determining and paying for capacity additions raises additional issues which we discussed in Section II above for the simple case but which need to be elaborated in the case of complex networks.

In an interdependent system, the effects of any particular capacity augmentation proposed by the infrastructure provider will be diffused, because it would affect flows throughout much of a meshed system. Hence, expanding bottleneck capacity at one point may relieve or exacerbate other bottlenecks, allowing changes in the maximum feasible volume of rights at *many* injection and withdrawal points. Thus auction offers to pay would, in principle, have to be sought from all participants whose flows would be affected.

This issue may be manageable in situations where the network is owned and operated by a *single* company (eg NGC for UK electricity transmission and Transco for UK natural gas). However, in the US and in many Continental European countries, electricity transmission is not owned or even managed by a single, unified grid company; in Germany and elsewhere, transmission is owned and sometimes

operated by generating companies. For the European Union, even if each member state had its own unified transmission and dispatch company, the problems of how to handle the changes in flows in an auctioning procedure for interconnector capacity would still arise. Such concerns have led to suggestions for an EU-wide electricity transmission company (and/or an EU wide electricity regulator<sup>5</sup>. This, and other EU-level issues, is discussed in the paper by David Newbery.

Network complexity issues of a related type arise with airport slots where airlines have to have access to runway take-off as well as landing slots, terminal capacity, etc. Hence, auctions for landing slots would have to be for a *bundle* of property rights. As explained in Dan Muldoom's paper, this implies the need for a set of combinatorial auctions with careful monitoring to ensure that incumbents do not use the auctions significantly to enhance their market power. Auctions for railway train paths would also need to be combinatorial auctions and Luisa Affuso points out the potential complexities. In general, the more complex the auction design, the harder it is likely to be to produce a transparent and readily justifiable set of allocations and the greater the likely risk of anti-competitive outcomes. Such concerns seem to explain much of the considerably greater scepticism over the practicality of auctions for airport slots and train paths by the industry economists, Andrew Sentance and Stephen Gibson.

(iv) **Competition Issues**

A critical issue for the usefulness of auctions is the potential number of bidders. For auctions to provide reliable signals on future demand and prices, there must be a sufficient number of companies willing to bid for network capacity. The smaller the number of bidders, the greater are the risks of collusion. In general, as discussed in the paper by Tanga McDaniel, a small number of bidders is less likely to result in actual prices emerging that represent the competitive optimum. The

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<sup>5</sup> The EU debate on this has obvious parallels in the discussions of the role of FERC for US electricity transmission structures and planning viz. the current debates over Regional Transmission Organizations (RTOs).

appropriate design of the auction also becomes more complicated – and more sensitive<sup>6</sup>.

A practical example of these problems is in UK natural gas, as discussed in the paper by George Yarrow. The pipeline by which most North Sea gas is landed is into St Fergus in Scotland. There is probably enough competition from upstream producers and downstream shippers to support an auction, provided it was made clear what was being auctioned and what contractual rights and obligations were attached. Hence, not surprisingly, the Ofgem discussions of auctions for network capacity have frequently taken the expansion of the St Fergus bottleneck as an example of where auctions for investment might be useful. But, even if this were correct, it is unlikely that auctions for investment in the Barrow landing point or others would interest sufficient numbers of producers and shippers to support an auction process likely to generate reliable signals. Similar issues are likely to affect inter-country electricity interconnectors, airports etc.

Because of limited competition and other issues, it is likely that auctions will need a considerable degree of regulatory oversight. The expected results – let alone actual results – are very sensitive to the precise design of the auction process: the devil is really in the detail. Hence, the need for (a) laboratory experiments and other practical tests (as recommended by Tanga McDaniel); and (b) caution in how much weight to assign to auctions both for reliable information revelation and for driving investment decisions (See McDaniel, Yarrow, Helm and Muldoom.)

(v) **Radical System and Policy Changes**

If capacity investment is exclusively or very largely determined by auctions., the question arises as to whether due account will be taken of future changes in circumstances. But, radical changes may lead to major changes in the structure of industries and the appropriate configuration of networks.

This issue is most obvious in the case of electricity and natural gas. Environmental pressures and other concerns are leading to government mandated

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<sup>6</sup> For an excellent recent survey of auction design, see Klemperer 2002.

shifts towards renewable energy, increased gas import dependence and decommissioning of nuclear plant. This is obvious in the UK and across the EU, particularly in Germany and Scandinavia. Failure to adapt to such changes could result in unacceptably severe environmental consequences (eg global warming) possibly coupled with energy shortages.<sup>7</sup>

Rightly or wrongly, governments are unwilling to leave all adaptation to market forces. This is partly because they have different risk preferences from market participants — they will be blamed much more for shortages than for over-provision. The same holds if the infrastructure provider is held responsible for quality of supply; it may well wish to undertake some system reinforcements which an auction procedure would not authorize to preserve its reputation against outcries from inadequate capacity.

At a more mundane level, a movement towards 20% or more of small-scale renewable energy (as has been suggested by the UK government as a potential target for 2020) would transform the amount and necessary location of transmission required. Generally moves to more embedded generation, local and even household combined heat and power systems would dramatically reduce the need for long distance, high voltage transmission. This is something that would need central planning and co-ordination and could not reasonably be left to estimates of future prices arising from an auction process based on current industry and market structures.

So long as government and/or the infrastructure provider accepts a default responsibility for maintaining service and achieving changes that are deemed necessary, it is difficult to see how auctions can play a dominant role in the future planning of investment volumes and their timing. This is more so the greater the possibility of major policy or other structural changes within the lifetime of the investment.

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<sup>7</sup> See *The Energy Review*, A Performance and Innovation Unit Report, The Cabinet Office, London, February 2002.

Whether or not it is justifiable for the government and the infrastructure provider to undertake this obligation and whether or not they actually get it right, the very fact that it is so (or even that it is *expected* that future governments are likely to wish to intervene) will prevent the auction market mechanism from enabling and financing some appropriate private investment. This is most obvious for electricity because of the massive costs of blackouts but it applies to a considerable extent to the other network industries. This is demonstrated by the furore that both the UK Government and Railtrack have faced over the state of the UK railway network and concerns over its past lack of investment. In general, it is unreasonable to expect private sector investors to put in auction offers to pay for future security which they expect will be provided in any case.

#### **IV Implications**

In conclusion, apart from exceptional circumstances, as powerfully argued by most of the authors in this special issue, auctions cannot *replace* capacity planning (at some level) – at least for electricity and downstream natural gas, airports and railways. There are limits to decentralization. Dieter Helm and David Newbery both clearly express the need for regulatory safeguards and complementary mechanisms to auctions for new capacity – what Newbery calls a “default investment mechanism”. In the UK, Ofgem seem to have accepted this general perspective in their proposals for gas network investment, but, so far, they are placing more weight on the auctions than on the planning context. This is echoed in George Yarrow’s paper. For airport slots and - in particular - for railways, the practical as well as the theoretical problems suggest that the practical implementation of auctions in network capacity allocation is highly unlikely in the near future, let alone the use of them to replace planning mechanisms. Indeed, Muldoon, while strongly supporting the use of auctions for airport slots, is clear that auctions can usefully supplement but cannot replace planning or regulation of airport capacity expansion.

Regulators may fervently hope that auctions – or other market mechanisms – may replace or at least provide a check on the amount of investment that network operators say that they require. It is natural to look at auctions as a way of trying to

find an objective test for the claims of infrastructure providers, particularly when they have strong incentives to plan for capacity margins so that they would never ever be short of capacity. But, although auctions may have many uses for allocating and expanding network capacity, the key conclusions of this paper and the other papers in this volume are:

- There can be a good case for using short-term auctions to allocate existing capacity in some cases (eg gas storage, electricity and gas interconnectors but not railway tracks in dense networks);
- In meshed networks, auctions have to operate within a planning process and cannot substitute for it – there are very real limits to decentralization;
- Auction processes for investment are likely to be complex and dramatically to increase in complexity as network complexities increase; and
- The reliance that can be placed on auction processes for private investment depends critically on whether or not radical changes in structure or demand are likely over the life of the investments.

Perhaps the most critical issue is that it is difficult to see how auctions for private investment in networks would ever *over-estimate* the amount of new capacity required and forthcoming, but there are many reasons why they might *under-estimate* it. Since, the optimal position for the networks we are considering is a small but prudent over-supply in terms of both quantity and quality, heavy reliance on auctions to replace current centralized planning by network providers under regulatory oversight seems both inadvisable and unlikely. There may be exceptions (eg for long-distance US gas pipelines or trunk railway lines in long, thin countries), but they are unusual, at least in the UK and the EU.

Nevertheless, our view – and the general conclusion arising from the papers in this issue – is that auctions can have some role in providing long-term as well as short-term information on capacity requirements for network companies and regulators but that this role is limited. This is also the position

that Ofgem appears to have reached for the UK gas industry, although Ofgem appears to be willing to adopt a larger role than most (but not all) of our contributors would recommend.

It is also clear that the relative role that auctions can play in capacity allocation and investment varies significantly between industries. It seems to be easier for natural gas networks but a lot harder for electricity transmission and railways (at least in small countries) and probably also for airport slots.

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