Presidential Address

Privatisation and Liberalisation of Network Utilities

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Abstract

Privatisation of utilities is about ownership rather than control. Liberalisation can induce greater improvements in performance than privatisation alone. Regulation is inevitably inefficient, and adequately competitive network services may improve efficiency. History indicates that regulated vertical integration is durable so that liberalisation may be hard to sustain. Theory and evidence suggest that pricing network access and use is difficult, risking foreclosure without regulation. Progress in modelling competition over, for and between networks is reported. The English electricity industry demonstrates the importance of entry conditions and contracts, and the gains from restructuring are estimated.

JEL classification: D23, D43, L33, L51, L94, L96

Keywords: Competition, regulation, network utilities, privatisation

1. Introduction

The theme I chose for the Congress is *From State to Market*. The past decade has witnessed a dramatic change in our view of the legitimate role of the state in economic activity. The boundaries of the state started to shift with privatisation in Britain and Chile, and peaked with the transition from state-socialism to the market in Eastern Europe. To contrast state and market is not just a matter of public versus private ownership, but a contrast between modes of control - between political control exercised directly though ownership or indirectly through regulation compared with decentralised market forces. The United States is

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experiencing the same loss of confidence in the legitimacy of state control by regulation.

Privatising public utilities is primarily about ownership rather than control, as utilities can face remarkably similar regulation under public or private ownership. Liberalisation, in contrast, subjects utilities to market forces, and can induce more dramatic changes in performance than privatisation alone. Before 1984 it was accepted that the network utilities of gas, telecoms and electricity should be organised as vertically integrated monopolies centred on, and justified by, the natural monopoly of the network. In 1984, the United States liberalised access to gas pipelines and dismantled AT&T, making long-distance calls competitive. When British Telecom was privatised in the same year, its sole licensed competitor, Mercury, was granted access to its network, with the prospect of further entry in 1991. The pressure to create competition was increasing, so that by the time Britain came to privatise electricity in 1990, generation was separated from transmission in order to confine regulation to the network, and allow competition in generation. Competition is difficult to achieve within the public sector, so there is a natural complementarity between liberalisation and privatisation.

My thesis is that introducing competition into previously monopolised and regulated network utilities is the key to achieving the full benefits of privatisation. Privatisation is necessary but not sufficient. Regulation is inevitably inefficient. Replacing regulation by competition for network services can increase efficiency. But liberalisation also redistributes rents and raises new regulatory problems in managing the interface between the regulated and competitive parts of the utility. In response, economists have developed new theories to analyze competition over and between networks, and have made the study of regulation one of the most exciting branches of micro-economics.

The form of competition is strongly influenced by technology and initial endowments, and may not be sustainable in every utility, nor in all circumstances. Economists can play a key role in clarifying the determinants of successful liberalisation, and the risks of inappropriate restructuring. Opportunities for restructuring are rare and hard to reverse. Such choices need to be well-informed. We need better analytical models of network competition, informed by historical studies of regulatory institutions, backed by empirical studies of the consequences of liberalisation. We need cross-country comparisons to identify the determinants of success or failure.

Although the evidence suggests that the market can bring efficiency gains, we observe that the early network utilities started life in the free market, but were rapidly captured by regulatory institutions. One of the lessons of history is the remarkable underlying similarity in the mature form of these institutions under both public and private ownership. Will the forces that caused convergence to regulated

vertical integration reassert themselves? Are we just witnessing a transient historical episode, or can the benefits of competition be protected against the pressure to reintegrate? Perhaps the present generation of economists can prevent such a relapse by providing the necessary analytical arguments and evidence to convince competition authorities to resist reintegration. I hope to show some of the challenges and achievements in confronting that task.

2. Background

The oil shocks of the 1970s had a profound effect on economic confidence in steady and sustained growth in industrial market economies. This is most visible in the growth in demand for electricity. In Britain the growth rate was 7.0% between 1947 and 1974, but fell to 1.4% from then until 1990. The US growth rate fell from 7.3% to 2.6% between the same periods. This loss of confidence undermined the British post-war consensus on the nationalised utilities. The miners' strike of 1974 was in direct response to the oil price rise, and brought down the Conservative Government - an act that was to cast a long shadow over the future of the coal and electricity industries. When the Conservative Party was returned to power in 1979, it had as one of its central objectives to roll back the frontiers of the state. Nigel Lawson, later Chancellor, noted in his memoirs that '..privatisation was a central plank of our policy right from the start.'

A similar disenchantment with the heavy hand of regulation in the United States led to a brief but intense period of deregulation, starting with airlines in 1978. Economists like George Stigler and Alfred Kahn were influential in pointing to the perverse effects of regulation, but in Britain the move was more ideological, as in a 1981 speech by Lawson: 'The Conservative Party has never believed that the business of government is the government of business' (Lawson, 1992). In due course, the Government embarked on its privatisation programme, raising £40 billion from share sales between 1979-92, or 12% of GDP (Bishop and Green, 1995).

Figures 1 and 2 show just how dramatic the effect of privatisation has been on the pattern of ownership of capital stock and the net worth of the public sector, especially after 1983. Figure 1 charts the ownership of public and private net capital stock in industrial and commercial corporations as a share of GDP, and also shows the share of public corporations as a continuous line on the right hand scale. Between 1983 and 1991, public corporate capital fell by three-quarters from 40% to just over 10%.

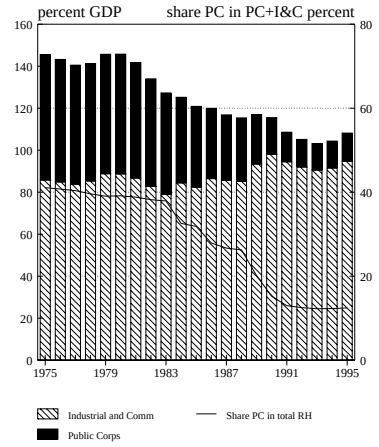

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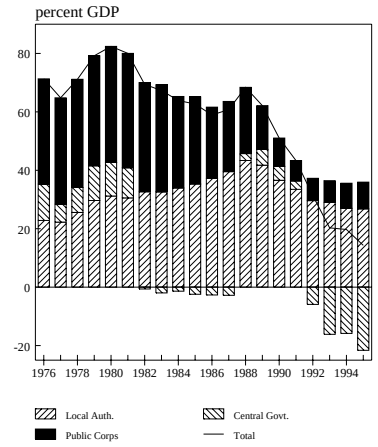
Fig. **1** UK public and private net capital stock as percent of GDP



Blue Book 1996

Fig. **2** Net worth of the public sector as a percent of GDP

Figure 2 shows the impact of these sales on the net worth of the public sector.[1] If the public corporations had been sold at market value, and the proceeds used to reduce the national debt, the net worth of the public sector should have remained unchanged. In fact, they were sold at a discount of about 25% (i.e. about 3% of GDP), so figure 2 strongly suggests that privatisation financed tax cuts and consumption, not capital formation or debt reduction. The fiscal case for privatisation was that it would reduce the burden of financing underperforming assets. The evidence, not only in Britain, but elsewhere (Galal, Jones, Tandon and Vogelsang, 1994) suggests that the exchequer often did rather poorly from privatisation, and the benefits accrued elsewhere.

Nevertheless, the case for privatising British Airways and other competitive industries was clear, and needs little defence. But 55% of privatisation proceeds came from the sale of network utilities where the claim that 'the business of government is (never) the government of business' necessarily fails. Privatisation provides the best opportunity for restructuring an industry to increase competition, for once sold, any such restructuring will reduce or redistribute profits and will be resisted as a breach of the privatisation prospectus. The real test is whether

[1] Defined as the value of tangible assets, as far as possible measured at market prices, *plus* the value of financial assets, *less* the value of financial liabilities. The methodology is set out in *Economic Trends*, CSO, May 1987, 92-119.

privatising these network utilities aided or delayed such restructuring. Although the initial choices were often flawed, the end result is better than expected, and better than achieved in some other countries.

Network utilities are public utilities which require a fixed network to deliver their services. They are economically of major importance - the value added of the privatised UK network utilities in 1995 was 5% of GDP, with a market value of 15% of GDP. The networks of these utilities are classic natural monopolies which create rents that will be fought over. The networks are durable and fixed, so the rents will persist. The capital of the network of the utility is large and sunk, so once created the balance of bargaining advantage shifts from investor to consumer. Finally, the networks of gas, water, electricity and telecoms are directly linked to the consumer, giving their owner potentially large exploitative power. These consumers are numerous, politically important and have no choice of network. In the telling phrase of Albert Hirschman, they cannot exit and so will use their voice.

The problem facing investors and consumers is to devise an institution that will balance these interests and powers. The tension between the investor and consumer can be side-stepped by state ownership, which has the coercive power to finance the sunk capital without requiring the assurance of a future return from the utility. Alternatively, it can attempt to reconcile private ownership with consumers' political power through regulation. Either way, network utilities operate under terms set by the state.

3. The historical evolution of regulation

Historically regulation arose as part of the contract between municipalities, who granted rights of way in exchange for quality standards and curbs on prices, starting with coal gas and piped water. Coal gas lowered the cost of lighting by two-thirds when introduced in 1806 (Falkus, 1982). This appealed to municipalities, who granted the right to lay pipes and disturb roads in exchange for concessional street lighting. Economies of scale gave monopoly power and high profits to the first entrant. Early attempts to regulate prices were ineffective in Britain, and profits could only be restrained by entry, which created obvious inefficiencies - by 1850 London had 14 gas companies (Foreman-Peck and Millward, 1994, p30). In such a competitive environment, quality suffered, often with lethal consequences, making municipal ownership look increasingly attractive.

The appeal of municipal ownership was that it kept prices reasonable, while the profits financed other local public goods and reduced local taxes. Parliament responded by creating limited life private franchises, which at their end could be bought at written-down cost by municipalities. By 1907, one-third of the net

output of gas companies was public, as were 57% of trams, 64% of electricity, and 81% of water companies (Foreman-Peck and Millward, 1994).

Water and gas were local utilities, naturally regulated or owned at the local level, but rail, telegraph and telephone are regional or country-wide utilities. A country-wide rail or telegraph network requires a degree of coordination to be developed efficiently, which decentralised markets were poorly equipped to provide. Three approaches were tried in different countries. Coordination could be achieved by central state ownership as with Belgium railways, which by 1838 were pricing at half the British level (Foreman-Peck and Millward, 1994, p21). Monopolisation or cartel agreements might prevent inefficient duplication, as in the US, where Western Union emerged as the dominant telegraph company. The third approach was monopolistic competition, the norm in Britain, where private companies failed to achieve efficient scale either by voluntary agreement or takeover.

This third approach was unsustainable - in the case of rail, cartelisation was eventually imposed in 1921, and nationalisation in 1948. All telegraph companies were nationalised in 1868 and transferred to their competitor, the Post Office. Telephones followed suit - the long-distance company was nationalised in 1896 and local companies in 1911. Electricity differed in developing at the municipal level but requiring regional interconnection. In Britain it evolved under the normal mixture of local private and municipal ownership, with the national grid built by the Central Electricity Board after 1926 - a successful and efficient public corporation. The ending of the private franchises effectively forced a choice between local and national ownership, and the industry was nationalised in 1948 as the preferable choice.

The US evolved a different institutional solution for these utilities. Initially, most cities offered a contractual franchise, starting with the introduction of gas in New York in the 1820s (Priest, 1993). These contracts typically provided for access to public rights of way and a franchise monopoly in return for restraints on prices and concessional terms for supplying the municipality. The contracts were typically for 20-30 years, long enough to repay the large capital investments. Inevitably, they had to be renegotiated as circumstances changed. Soon contracts made explicit provision for renegotiation, subject to arbitration, or reference to an independent committee, which might also monitor service quality. The power of these regulatory committees grew, and in due course evolved into state public utility commissions.

What is striking about the US experience is that with the notable exception of water this process of increasing public oversight led to improvements in the system of regulation rather than to public ownership. Only 8% of electrical utilities and less than 1% of trams were publicly owned by 1902, though more than half of the

water companies were (Priest, 1993). An embryonic form of cost-of-service regulation evolved locally which was transferred to the state commissions. It was remarkably successful in ensuring adequate finance for investment and rapid technical progress in electricity and telephony until oil shocks and subsequent sluggish growth culminated in the deregulation movement of the Carter administration.

The British experience shows that the failure to develop a viable regulatory compact for private ownership made public ownership ultimately irresistible. Public ownership also financed the rapid expansion of post-war network utilities with sufficient success to sustain support.

Summarising the argument so far, institutions evolved to ensure that investment could be financed and the rents distributed to various claimants. This was more difficult under private ownership, where the owners needed reassurance that their investment would be adequately rewarded. If profits were too high, regulators would come under political pressure to transfer them to other claimants, but if too much were redistributed, investment might be unattractive. The result in the US was rate-of-return regulation, protected by the constitution against expropriation (Gilbert and Newbery, 1994). Whether private ownership was viable depended on the availability of reliable institutions to uphold long-term agreements, as well as the transaction costs of monitoring performance and quality. The historical record and empirical studies[2] suggest that regulatory institutions emerged to handle the conflicting claims of various interest groups on the natural monopoly rents. These institutions continued to evolve until they reached a local equilibrium from which further change could be successfully blocked by these interest groups.

This *interest group theory of regulation* has a number of important implications of which the most relevant is that bargaining over the rent will be inefficient, as it provides incentives to conceal information. The obvious analogy is with public finance, where taxes to transfer income from one group to another are inevitably distortionary. The theory predicts important similarities and differences between public ownership and regulated private ownership. Under public ownership, interest groups will compete in the political market place for benefits, while under private ownership, the regulator will represent the interests of the non-owning groups. This can be clearly seen by comparing the electricity industries in Britain under public and subsequent private ownership with private integrated electricity companies in Germany and Spain. Regardless of ownership, all three countries evolved systems of protecting high cost domestic coal producers and recovering

[2] Kaserman, Mayo and Pacey (1993) and Caudill, Im and Kaserman (1993) test the interest group theory of regulation, while Ellig (1991) examines the dynamics of regulatory reform. The earlier historical record is presented by Priest (1993).

these costs from electricity consumers, though in Britain subsidies fell dramatically when the market was liberalised.

The best way to create and protect rents for distribution to the incumbent interest groups is to maximise the horizontal and vertical extent of the utility's monopoly, and the best way to shift the balance of bargaining advantage towards consumers is to minimise both extensions of monopoly. The fact that these industries are so often vertically and horizontally integrated suggests that well-organised groups have succeeded in capturing the rents at the expense of consumers. But how should this be if one of the main reasons for public ownership or regulation is to defend the interests of voting consumers?

There are three related and supporting answers. First, vertical integration enhances the utility's ability to control information to defend its interests. Second, the utility can argue that economies of scale and scope make integration efficient. Third, unbundling the different stages increases risk as prices for intermediate services reallocate profits up or downstream, while competition increases risk directly. A franchise monopoly protected against entry lowers the cost of capital by reducing market risk, and enables politically desirable cross-subsidies to be financed by implicit rather than explicit taxation (most visible in the transfer from long-distance to local calls in telecoms). Cross-subsidies buy political support to protect the franchise.

If both public and private utilities suffer from a similar inefficient balancing of interests, wherein lies the difference between the two forms of ownership? I have argued that public ownership is the default where the government cannot credibly guarantee private investors an adequate return on their investment. Sappington and Stiglitz (1987) argue that the government's inability to commit its future actions has further efficiency consequences for public ownership. Ownership goes with control over the residual rights, that is, those rights that are not subject to contract or control. Ownership lowers the transaction cost of intervention, but this can have adverse incentive effects.

The difference is thus one of the degree of commitment to delegated authority, and it can be exaggerated - some systems of regulation lack commitment, while some public utilities may be given very considerable autonomy and operate on the expectation that this will continue. In Britain, the publicly owned Central Electricity Board was left free to complete its task under its very competent engineer managers in the 1930s. Oftel, the British telecoms regulator, wants the power to restrain anti-competitive practices immediately, without having to renegotiate the licence. BT argues that freedom to intervene on a daily basis undermines any commitment to stable regulation.

The value of regulatory commitment depends on the power of the regulatory incentive scheme. High-powered schemes like price-caps allow the utility to retain

a large share of any efficiency gains, but the resulting higher profits increase the temptation for the regulator to renegotiate the controls, and are only viable with robust institutions to uphold the regulatory compact. Low-powered rate-of-return regulation reduces the temptation for the regulator to capture profits and makes the compact more credible.

Public ownership is like rate-of-return regulation. There is no problem if high-powered incentives are unnecessary or unsuccessful in delivering efficiency gains, for then commitment problems can be avoided with low-powered regulation. High-powered incentives are only attractive if they deliver efficiency gains. For these gains to be realised, the regulator must be held to the regulatory compact, and the state must be able to ensure that the regulator is not over-ruled. The British solution enshrines the price-cap (RPI-*X*) in a legally enforceable contract set for a fixed period. At the end of this period prices can be reset to reflect continuing cost reductions, on the understanding that past profits are not clawed back. This understanding is currently under threat from the opposition Labour party, which would like to impose a retrospective windfall profits tax to recoup 'excessive' post privatisation profits. This demonstrates the difficulty of creating the necessary legislative commitment to high powered regulation in an adversarial parliamentary democracy, and is one reason why cost-of-service regulation is a more durable if less efficient equilibrium.

4. Restructuring to improve incentives and commitment

If prices have to be held down by a regulator or set by the public owner, then there is an inevitable tension between incentives and the credibility of the commitment not to claw back efficiency gains. The ideal solution is for competition to provide both the incentive for efficiency and the means to transfer the gains to consumers, so that there are no rents left for renegotiation and hence no threat to the credibility of the arrangement. The logical place to introduce competition is for the services provided over the network, and the aim of liberalisation and restructuring is to confine regulation to the core network and reduce the extent of regulatory inefficiency.

Any restructuring is likely to be strongly opposed by those enjoying rents, and needs the support of groups who would gain from reducing these rents. The leading examples include deregulating US natural gas after 1984, restructuring British Gas after 1994, the break-up of AT&T in 1984 and liberalising access to telecoms elsewhere and, most dramatically, the vertical de-integration of the English electricity supply industry in 1990, anticipated by similar restructuring in Chile, and widely copied elsewhere. Each case required a powerful constituency

that would benefit from reform, either as network users or politicians hostile to one of the interest groups benefiting from the integrated utility.

One of the more potent forces for restructuring is a fall in the cost of reneging on the commitment to reward investment. In times of steady growth, consumers are willing to pay for past investment rather than jeopardise the finance of current needed investment. But if growth falters, or technical progress allows new suppliers to deliver cheaper services, then the regulatory compact comes under stress (Gilbert and Newbery, 1994). Low growth reduces the need for investment, while cheaper alternatives encourage some consumers to threaten exit to avoid paying for what now seem excessive past sunk costs. Rebalancing tariffs becomes critical, and restructuring may be the only way to restore equilibrium.

Gas liberalisation in the US and later in Britain only took place after the network of pipelines, financed by either a vertically integrated industry or equivalent long-term take-or-pay contracts, had reached maturity, and in the US case, excess capacity. In the case of AT&T, technical progress lowered the cost of providing long-distance service relative to local calls, but regulation kept long-distance tariffs high to cross-subsidise local access and universal service. Local regulators supported this cross-subsidy, which the Federal Communications Commission put at risk when it allowed competition in 1959. When AT&T responded by Ramsey pricing, the Justice Department filed suit for monopolising interstate communications. In due course, AT&T realised that the only resolution to the problem of cross-subsidy and interstate competition was to divest the local operating companies, which it did in 1984.

By the time the UK government came to privatise electricity, there was growing disenchantment with privatising utilities as monopolies. British Gas had demonstrated the difficulty facing competitors needing access to a vertically integrated network monopoly, and although BT had been privatised as a duopoly, Mercury provided little effective competition. But there was an additional reason for wanting to restructure electricity before privatisation. The British electricity industry was heavily dependent on high cost British coal, and the powerful mining union had already caused the collapse of one previous Conservative Government, and had just staged a political, costly but unsuccessful year-long strike in 1984. The most direct way of reducing the power of the public sector unions of coal, rail and electricity was to introduce competition into generation, so that decisions were taken on economic rather than political grounds, and rents transferred beyond the grasp of the upstream suppliers.

The 1989 *Electricity Act* divided the Central Electricity Generating Board (CEGB) into the transmission company, NGC, two conventional generating companies, PowerGen and National Power, with the nuclear stations transferred

to Nuclear Electric. With the exception of Nuclear Electric, these and the twelve distribution companies or RECs were privatised in 1990-91.

In the United States, pressure to restructure electricity had parallels with the deregulation of gas - in an era of excess capacity and the excessive sunk costs of nuclear power, large consumers wanted access to power at the lower cost of new gas-fired generation, but efficient entry required a market in which entrants and incumbents could compete with equal access to transmission and distribution. Once again, the only viable solution was to separate transmission from generation.

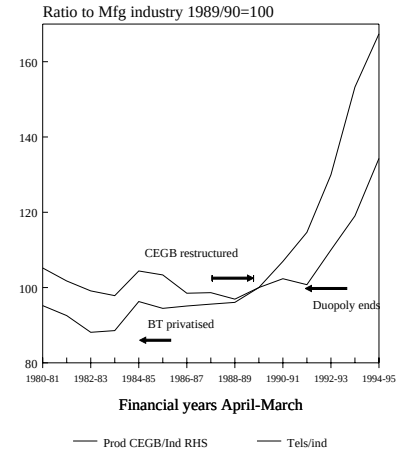
5. The theory and practice of liberalising network utilities

The analysis of network competition is relatively recent, but is central to the debate over the desirability of liberalisation. Will the liberalised markets be adequately competitive and can they achieve adequate coordination? My main examples will be taken from electricity, where I shall look at competition in the service supplied over the network, and competition for access to the network. The market for bulk electricity has special features that pose subtle modelling problems, and the main questions are how the number of players, the form of contracting and the prospect of entry affect market power.

Competition for the network raises issues of whether markets can properly price interconnected networks to achieve the potential benefits of coordination. The network itself is a regulated natural monopoly, but existing network capacity is divisible, offering the prospect of market solutions, particularly for gas and telecoms. But a market in such an essential facility raises issues of foreclosure and opportunities for tacit collusion in downstream markets. This is important for gas pipelines, and for interconnection between telecoms networks. Issues like this are at the heart of the rapidly growing literature on network economics.

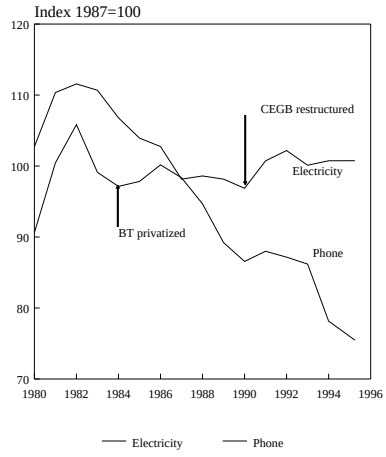
The argument for liberalisation is that competition provides stronger and less manipulable incentives to efficiency than regulation. Perfect competition would provide the strongest incentives for efficiency and would transfer all the gains to consumers and thus solve the problem of bargaining over rents. But competition is never perfect, and the practical question is how competitive markets have to be in order first, to yield higher efficiency than regulation, and second, to transfer efficiency gains to consumers. The following figures show that the two questions need not have the same answers.

Fig. 3 shows the evolution of the relative productivity of the CEGB (ie electricity generation and transmission in England and Wales) and also that of BT.[3] BT was privatised with no restructuring in 1984 but there was little change in its relative rate of growth of productivity after privatisation until the entry of a large number of new competitors after the Duopoly Review of 1991. In contrast, the CEGB's productivity growth, which had been about the same as UK industry until privatisation in 1990, dramatically accelerated thereafter as a result of restructuring and competition.



Newbery and Pollitt (1996); CRI (1995)

Fig. **3** Productivity of CEGB and BT relative to UK manufacturing industry



CSO Monthly Digest of Statistics

Fig. **4** Real phone and electricity prices for UK domestic customers

Fig. 4 compares the real prices (ie deflated by the RPI) of domestic telephone services and domestic electricity. Real telephone prices rose somewhat after privatisation in 1984 as a result of rebalancing, but then fell by a quarter, whilst real electricity prices rose slightly. Tight telecoms regulation transferred the efficiency gains to consumers, while competition in electricity cut costs but raised profits rather than lowering prices.

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[3] Relative productivity is defined as real output per person of the industry divided by output per person employed in UK manufacturing industry. CEGB productivity is an index of kWh per person employed in the CEGB or successor companies, taken from Newbery and Pollitt (1996). BT's productivity is measured as real turnover per person employed, deflating the value of turnover by the index of retail prices of domestic telephones (CSO, 1996). (Turnover before 1984-5 is taken from Armstrong, Cowan and Vickers (1994), and after from CRI (1995).) If, as seems likely, business prices fell faster than domestic prices, then productivity growth will be understated.

5.1 Introducing competition in electricity

The English experiment in restructuring electricity in 1990 was not the first radical unbundling of the industry, but it was the most ambitious attempt to introduce market solutions. It served as the reference model for later reforms in other industrial countries, so the solutions it adopted repay close study. Electricity networks have special characteristics that constrain the design of market solutions and complicate their analysis. Briefly, electricity demand and supply must be kept in balance minute by minute to maintain frequency and voltage. These requirements are normally met by giving a system operator direct control over despatch of generation. In a vertically integrated system the operator minimises total system costs, but in the English system competing generators bid into the wholesale market or pool to be despatched. The system operator computes the least financial cost solution, arranges despatch, and the pool price is set each half-hour to clear the market at the marginal bid, with buyers and generators paying extra for transmission (Newbery, 1995; Green, 1996a).

The main question to address in restructuring is how many generating companies are needed for effective competition. In a pool bidding system on the English model, the answer has several dimensions. The half-hourly price is set by mid-merit and peaking plant (i.e. the higher variable-cost plant that runs when required rather than on base load). In England up to 1996 the two major fossil generators continue to set the price 90% of the time even after substantial entry by new competitors. The long-run average around which the daily price fluctuates depends on the overall balance of demand and supply, which depends on capacity and hence on entry and exit decisions. The theoretical question is how best to model this first-price sealed bid repeated auction to determine the equilibrium daily price schedule.

There are two contending models, the first based on Klemperer and Meyer's (1989) supply function equilibrium model, the second based on an explicit discrete bid auction model. I shall argue that any equilibrium of the first is also an equilibrium of the second, but not necessarily vice versa. It is an open question whether there are non-supply function equilibria which provide a better description of market behaviour.

Green and Newbery (1992) followed the first approach as both a natural description of bidding behaviour in a pool and one that can be calibrated empirically and solved. Each generating company i submits an increasing continuous supply schedule $q_i(p)$ giving the level of supply available for despatch at each price p the next day. An equilibrium in this bidding game is a set of such functions and a price at each moment, $p(t)$, which equates demand $D(p(t))$ to supply $\Sigma q_i(p(t))$ at that moment, and which is each generator's best choice given

the choices of the other players. They showed that there would normally be a continuous range of supply function equilibria of the short-run non-collusive bidding game, lying between a high-price function that would maximise collective short-run profit, and a low-price function. Any one of the possible equilibrium supply functions would be self-enforcing, in that any generator deviating while the others continue to supply as before would reduce his profits.

The other approach is exemplified by von der Fehr and Harbord's (1993) model in which each generating company submits a single price per generating set. This gives a step-like supply function rather than a continuous schedule. They showed that for some patterns of demand and allocation of capacity there was no equilibrium in pure strategies. Prices would be inherently unstable as in Edgeworth duopoly, and they claimed that observed pool price behaviour revealed such instability. They suggested that the correct way to think of the problem of setting up an electricity market was one of auction design, which is useful in identifying the relevant theoretical literature (eg McAfee and McMillan, 1987). Unfortunately, it is hard to solve for mixed strategy equilibria, leading to an apparent impasse - there is a tractable modelling approach that assumes continuity but indivisibilities drastically alter the nature of equilibrium.

This impasse may be more apparent than real. Newbery (1992) argued that the supply function approach can be adapted to deal with discontinuities caused by the discreteness of each generating set. In the English system, each set can submit bids for up to three specified tranches of the set's capacity. If the bids for each tranche are chosen appropriately, and the sizes of the tranches randomly chosen from an appropriate probability distribution, any monotonic supply function can be constructed which is continuous in expectation. Any equilibrium continuous supply function can thus be replicated by introducing a very small amount of randomisation.

Green and Newbery (1992) modelled the short-run equilibrium in the pool on the assumption of no collusion between generators, no contracts, and initially no threat of entry. They calibrated the model to describe the proposed market structure and cost functions at the time of privatisation. The model predicted a wide range of possible equilibria. If the generators coordinated on the high price equilibrium, they would be able to raise average prices well above costs, and the resulting equilibrium would create large dead-weight losses. Had the generating plant been divided among five equal-sized companies, then each generator's market power would dramatically decrease, and deadweight losses would fall to a negligible percentage of turnover. This result is reminiscent of the effect of varying the number of competing Nash-Cournot oligopolists, n, supplying a market with linear demand and constant marginal cost. In that case total deadweight loss falls as $1/n^2$, and moving from two to five firms reduces the deadweight loss to

only 16% of its former value, although in the supply function case losses would have been reduced to only 6% of their duopoly value.

The existence of a wide range of self-fulfilling equilibria is somewhat troubling for an applied economist wishing to make firm predictions, and much subsequent research has concentrated on narrowing down this range. One obvious extension is to fix the average price at the average cost of new entrants. Green and Newbery (1992) solved for the equilibrium in which the average price was effectively set by entry, with the amount of entry determined by the bidding strategy of the incumbent price-setting generators. If there is no threat from entry, coordinating on high price strategies is profit maximising, but if entry threats fix a firm upper limit on average prices, the best the incumbents can do is bid at the entry deterring price, provided that this is an equilibrium, or failing that at the lowest equilibrium price. With five companies, competition was sufficiently fierce that no excess entry occurred, but without contracts to commit their future behaviour, two companies were not able to deter entry even bidding low. Nevertheless, dead-weight losses (including the extra fixed costs of excess entry) fell to 60% of their previous value. Credible entry threats reduce inefficiency by encouraging incumbents to restrain their short-run market power when bidding. The problem was that the duopolists' market power induced excess entry, reminiscent of earlier arguments for controlling entry into natural monopolies to avoid such waste.

Soon after privatisation, it became clear that entry threats from independent power producers (IPPs) were indeed credible, as the prospective entrants could line up 15-year contracts not only to buy gas, but also to sell electricity to the RECs, and to borrow money to purchase a turn-key combined-cycle gas turbine station, thus essentially removing all the risk attaching to the post-entry price. The RECs were happy to sign contracts provided their terms were as favourable as those offered by the incumbents. In the event, a rush of such entry occurred in the 'dash for gas', in whose wake half the deep coal mining industry was forced to close.

Contracts were thus critical for making entry contestable, but they also proved critical for the competitive operation of the pool. In response to the considerable volatility of pool prices (which might vary over a range from 4:1 up to a high of 100:1 over a single day), price risks are hedged through financial contracts. The normal contract is a Contract for Differences or CfD, under which a generator receives, in addition to the normal pool price for any sales, a sum equal to the specified strike price *less* the pool price, multiplied by the specified number of units contracted. If a generator sold CfDs exactly equal to the amount despatched in some period, then its income would be entirely determined by the strike price of the CfD and its dominant strategy would be to bid at short-run avoidable cost.

Equilibrium in the spot market is now found by looking only at the net uncontracted supply functions, so if generator i sells x_i contracts and bids $q_i(p)$,

then $y_i(p) = q_i(p) - x_i$ is the net supply function. The larger the fraction of output contracted the less the incentive to bid up prices and the more competitive the market will be. This proved to be important in understanding the behaviour of pool prices in the first year after restructuring, when prices were much closer to avoidable cost than predicted by models that ignored contracts. The generators had been privatised with CfDs for almost all of their output, and initially bid close to avoidable cost. As the contracts came up for renewal, they had more incentive to raise prices to signal the equilibrium that could be sustained with lower contract cover. Pool prices drifted steadily upwards over the first three years as contracts came up for renewal.

Wolfram (1996) demonstrated econometrically that the generators bid closer to avoidable cost than the simple model without contracts would suggest, using several thousand observations of half-hourly prices. A number of other papers (Helm and Powell, 1992; Gray, Helm and Powell, 1996; Green, 1992, 1996b; Powell, 1993) demonstrate empirically and theoretically that contracts will reduce market power, and that as contract cover is reduced, pool prices would and did rise.

The challenging theoretical question is how to determine the simultaneous equilibrium in both the contract and pool markets. In a rational expectations equilibrium of risk-neutral agents, the CfD price must equal the expected pool price. An equilibrium is then a supply of CfDs by each generator, x_i, that in aggregate equals total demand for CfDs at a price, f, that is equal to the expected pool price, Ep.[4] The pool price equates demand to aggregate supply, where each generator's supply function has been shifted left by the sales of CfDs, x_i. The problem is that the supply functions offered in the pool depend on the number of CfDs already signed, which depend on the anticipated equilibrium pool price. If each pool supply function depends on a CfD supply function, and if there may be many possible CfD functions for each pool supply function, the challenge is to avoid the curse of dimensionality.

Various attempts have been made to solve for the joint equilibrium. Green (1992) considers generators with linear increasing marginal costs facing linear demand, and selects from the set of possible equilibrium supply functions the unique linear case. Corresponding to this there are a set of CfD supply functions, any one of which could be an equilibrium. Newbery (1993) constructs a simple model in which the supply functions can be solved analytically for any level of contracts. IPPs can enter at any scale fully contracted at a given long-run average

[4] The simplest case to consider is a base-load (ie constant) CfD, and the relevant pool price is the time-weighted price (ie the simple average over the period of the CfD). More complicated CfDs would be made up of simple contracts that specified the set of hours for which the contract is valid. Piecing together a supply function for a day ahead only some hours of which are contracted involves an additional level of complexity.

cost. This defines the entry-deterring level of the contract price. The supply of contracts is adjusted to produce the most profitable supply function equilibrium consistent with minimal entry, completing the solution. Kwok (1995) goes one step further and imposes a small cost per unit of capacity declared available, which provides another way of selecting among possible equilibria in the spot market. The problem of finding a general solution for equilibrium in spot and contract markets when entry is not a threat remains unsolved.

What empirical predictions do these various theoretical models make and how do they match up with the record? We have already noted one that has been confirmed - that contract cover diminishes market power. More important, contracts credibly commit generators to behave competitively in the future, and hence can deter entry when this would not be possible without contract cover. The models also predict that the smaller of the two generators will earn a higher rate of profit, and rely on the larger company to keep pool prices high, both of which have been observed. Next, if generators are free to choose the level of contracts, they would undercontract if they thought entry could be deterred by other means, but would be willing to sign contracts at the entry-deterring price if contract-backed entry posed a real threat. This has been difficult to test, as the regulator, concerned at the market power of the generators, reached an agreement under which they would bid to keep prices below a price-cap, and divest 6,000 MW of mid-merit plant, to avoid a reference to the Monopolies and Mergers Commission. We would expect that their bidding behaviour would be tailored to maximise profits subject either to the entry-deterring price, or to these price-caps (which were set below the entry price). Theory predicts that this would be achieved by maximising the spread between peak and off-peak prices (because high prices are associated with high sales, so a mean-preserving spread raises profits). Pool volatility has indeed increased. Finally, Green (1996b) used the model to simulate the effect of the divestiture of the 6,000 MW of plant (about 15% of their combined capacity), and demonstrated that this might cut deadweight losses by 60%, substantially more than encouraging further entry, and comparable to breaking the larger company, National Power, into two. The divestiture took place in June 1996, so it is too soon to observe its effect on bidding behaviour.

5.2 Did restructuring electricity reduce costs?

The most important empirical question is whether the restructuring and privatisation of the CEGB was worth it - whether competition was adequate to deliver the promised efficiency gains, and how these gains were distributed. Newbery and Pollitt (1996) have addressed this question, reconstructing the accounts of the four successor companies to the CEGB and comparing the out-turn

with various counterfactuals about what might have happened without such restructuring. In the five years since 1990, labour productivity in the successor companies has more than doubled. Delivered coal prices fell by 20% in real terms and purchases of British coal fell from 74 million tonnes to 30 million tonnes a year. Fossil fuel costs per kWh fell by 45% in real terms. The switch from coal and the 'dash for gas' has reduced the number of British coal miners from nearly one quarter of a million at the time of the 1984-5 coal miners' strike to about 7000 in the now privatised coal industry, and has contributed to the substantial drop in acid rain and CO_2 emissions. The collapse of the British coal market was the subject of a Parliamentary inquiry and resulted in a clear statement of the Government's commitment to market forces as their energy policy. The events of the past five years have therefore transformed British energy policy as well as the electricity and coal industries.

The fall in unit costs was not translated into corresponding falls in prices, but into increased profits, and since privatisation, electricity share prices have outperformed the stock market by over 100%. Prices to all classes of final consumers net of fuel costs have risen by almost 0.5p, or by nearly 25% of the industrial average markup over fuel costs, though real final prices (including fuel costs) fell by varying amounts. In current cost accounting terms the successor companies have tripled their return on assets from 3% to 11%, now $1\frac{1}{2}$% higher than non-North Sea British companies.[5]

Discounting at the public sector discount rate of 6% real, Newbery and Pollitt (1996) found the net cost saving of switching from coal to gas was £2 billion. The £3.2 billion saved by abandoning the British nuclear construction programme was largely transferred to Electricité de France by allowing them to sell their nuclear power into the English pool at the specially favourable nuclear price. Valuing the reductions in sulphur emissions at £250/tonne and CO_2 at £12/tonne carbon gives environmental benefits worth £2.3 billion, more than the fuel benefits alone. Restructuring cost £2.9 billion, but the efficiency gains from cutting non-fuel costs were worth £7.2 billion. The final balance sheet shows a present value of net gains of £6.9 billion ignoring the environmental benefits, equivalent to a permanent reduction in generation costs of 5%. If the environmental benefits are added, the present value rises to £9.2 billion, about 35% of the capital value of the CEGB of £25 billion. The present values are roughly halved at 10% discount rate, though the permanent cost saving only falls from 5% to 4% of generation costs (ignoring environmental gains).

[5] The conventional historic cost accounts show a rise from 14% pre-privatisation to 24%, but historic asset values for such a long-lived industry are highly misleading.

The most unsatisfactory feature of the restructuring was the market power of the fossil generators, which could have been avoided by creating five successor companies rather than just two. This would probably have led to more aggressive prices for contracts, and less entry of new gas-fired generation, delaying and reducing their investment costs though also delaying environmental improvements. Other countries considering similar restructuring have taken this lesson to heart, and in the case of Australia, the report on restructuring cited Green and Newbery (1992) as providing quantified arguments for creating five competing companies.

5.3 Markets for network use: the case of electricity transmission

Electricity is transmitted between different locations by a network according the laws of physics, not the contracts between generators and buyers. The efficient solution to generating and delivering electricity over a constrained network with losses has associated with it the normal set of dual prices, one for each node. Are these shadow nodal prices just notional, or can they be made manifest in markets and use for decentralised decision making? This may sound like an abstract question but is at the heart of debates on how best to restructure the US electricity system, where different parts of the interconnected network are under different ownership and control. Let us compare two solutions to operating the transmission system.

The English solution is to ignore differences in nodal prices, and adopt the single integrated market as the benchmark, with a contractual right to transmission. Where transmission constraints prevent the despatch of stations in merit (ie having a bid below the System Marginal Price or SMP), they are compensated with their lost profit (SMP *less* the station's bid). Stations that bid above SMP but are required to run are paid their bid price. The extra cost is then recovered from all consumers, not just those whose demands caused the extra cost. In the longer run, connection and use-of-system charges are regionally differentiated so that consumers and generators take transmission costs and constraints into account when choosing where to locate.

This concept of a single country-wide price with station-specific adjustments may be contrasted with nodal pricing, where all suppliers and consumers within a zone (defined as having no internal transmission constraints) face the same price, which may differ between zones. The choice between these two concepts of the market is fundamental and problematic. The English system is simple to operate, but faces the objection that generators have an incentive to exploit any capacity constraints by manipulating their bids. The same is also true with nodal pricing, but with an important difference. Generators in an importing zone can exploit the transmission constraints to raise zonal prices, but those in an exporting zone will

only be paid the SMP (the bid price of the most expensive generator) within that zone, which will be less than the system-wide SMP. Zonal pricing thus penalises exporters rather than compensating them as in the English system. Given that there will typically be a range of equilibrium bidding strategies and resulting prices, the real question is whether the threat of entry somewhere into the system better restrains bidding behaviour when prices are set zonally, or when there is a system-wide price directly affected by entry anywhere.

The attraction of nodal prices is that they define the value of the transmission link connecting adjacent nodes and provide an appealing solution to two difficult problems - how to signal where consumers and generators should locate, and how to decide when and where to build additional transmission capacity. The main criticism of vertical de-integration is that generation and transmission investment must be coordinated to minimise total system costs - it may be cheaper to pay more to locate generation near demand to avoid the cost of building extra transmission. The English solution of signalling where to locate by a centralised calculation of regional connection charges was revealed to be flawed in the 'dash for gas' as new entrants located in areas of excess supply. Perhaps markets could do better. The problem is that any power flows between two nodes changes the pattern of flows over the whole network, creating the kinds of externalities that normally cause market failure. It is now well-known that it may be profitable to build a network link (paid for by the flow times nodal price difference) that actually increases total systems congestion and cost (Braess' paradox - see eg Kelly, 1991; Bushnell and Stoft, 1995).

The counter argument is that market power and externalities can be handled by contracts. These will be necessary in any case, as market-determined nodal prices would be even more volatile than pool prices. The natural counterpart to system-wide English CfDs are nodal CfDs, or, equivalently, a single CfD plus a set of transmission capacity contracts (TCCs) that allow the holder to receive the difference in nodal prices at each end of the transmission line for each MW contracted. As before, the incentives for non-competitive behaviour are eliminated if agents are fully contracted (Green, 1992; Newbery, 1995). Bushnell and Stoft (1995) claim that if all agents are fully contracted (defined as a set of TCCs and CfDs corresponding to a feasible despatch) then no party has an incentive to make disadvantageous grid investments - the investor would effectively have to compensate all other agents for externalities. This approach of 'completing the market' for externalities (Newbery, 1989), coupled with full contracting to eliminate market power, has considerable theoretical appeal, but doubtful practicality. Such an approach might work in a completely predictable world, but competitive nodal prices change on a timescale of hours, while grid investments

may last for decades. Nor is it clear why agents would choose to be fully contracted and forgo their market power.

At the heart of the debate between nodal pricing and a single pool is the question how well markets might work in practice. We have experience with pools, but not with market determined nodal pricing, except in laboratory settings. Here Vernon Smith's (1996) results suggest that generators are adept at exploiting their market power at the expense of transmission owners when uncontracted, but we have no idea whether agents would be willing or able to sign the very large number of TCCs needed for zonal pricing which would be needed in addition to the normal pool CfDs. Nor do we know what degree of contract coverage they would seek, and whether that would be enough to improve on the alternative single pool. As economists, we should hope that some state is willing to conduct the experiment for real.

5.4 Markets for bottleneck facilities: the case of gas

Similar problems of market power in transmission over the network arise with gas in a more acute form. Gas flows are physically controlled, and the natural contract is for the right to a certain amount of the capacity of a specific pipeline. Electrons follow the laws of physics, not the contract path, and the capacity to deliver electricity at a particular point is a property of the whole network, not of any one link. Contracts are typically financial, not physical, and not limited by the capacity of the link. Gas pipelines are essential or bottleneck facilities, and control of the bottleneck offers the prospect of extracting rents from upstream and downstream buyers. Such bottlenecks are regulated, but should traders be allowed to create a market in capacity rights to allocate scarce capacity? The theoretical question is - how can a trading system be set up to reveal the efficient allocation of capacity, ideally in the form of prices, without creating opportunities for market power whose inefficiency outweighs any allocative gain. Is it necessarily better to create markets to trade access rights or might it be better to use crude centralised rationing procedures?

Newbery (1996) has constructed a simple model in which two suppliers compete imperfectly in a single downstream market and pay a regulated fee for the pipeline that connects the market to upstream gas producers. If the suppliers are free to trade capacity rights, they can use the price of these rights to support the joint profit-maximising downstream price. The outcome may be less efficient that a system of central allocation of transport rights with no right of resale ('use or lose'). Depending on the allocation mechanism for pipeline capacity, it may also pay a dominant downstream supplier to pre-emptively bid for all the capacity if the number of rivals in that market is small enough. How serious this problem might

be in practice will depend on the number of alternative routes able to supply any given market and the degree of contestability of the upstream and downstream markets - in the US which has a dense network of pipelines the problem may not be very serious, but in Europe with fewer, larger and longer pipes it may be more so. Britain is currently experimenting with liberalising the entire downstream market and a spot market for upstream gas has recently emerged, so we may be able to observe the market outcomes in parallel with developing the appropriate theory. Modelling airline mergers which increase market shares at critical hubs or links raises similar problems of network analysis.

One area where leasing capacity on bottleneck links has been pro-competitive has been in long-distance telecoms. After the break-up of AT&T, different operators were able to enter by leasing shares of the existing network to provide competitive services without the need to duplicate lines. As a result, the number of long-distance carriers with access to the local loop rapidly increased to over 400 by the end of 1994, and major metropolitan areas typically have 20-30 competing suppliers (Kaserman and Mayo, 1994). The competitive outcome in telecoms may owe much to the low cost of duplicating lines, and the rapid growth in demand which created the need for additional capacity anyway, and these conditions may not be so favourable in other network utilities.

5.5 Competition between networks

Telecoms liberalisation has responded to and stimulated rapid technical progress that has made an increasing share of the market contestable. The break-up of AT&T confirmed that long-distance was no longer a natural monopoly, while mobile telephones have provided an alternative to the local loop. More recently, Ionica has introduced a wireless local system while cable television companies can also offer telephone services to domestic customers. The end of the statutory duopoly in 1991 created a flood of new entry in Britain. By 1995 there were over 150 operators licensed to compete with BT, including 125 cable TV companies who can offer telephony with cable (of which 80 were actually providing service). (Bell, 1995). If there is more than one network, subscribers to each network will require access to the subscribers of other networks. In Britain, Mercury was initially free to negotiate access charges with BT, with the right of appeal to the regulator in the event of a dispute. Mercury immediately appealed and was granted favourable interconnection terms. The question is whether or when interconnection agreements can be left to the unregulated market.

Armstrong (1996) and Laffont, Rey and Tirole (1996a, b) have demonstrated that this is a subtle and complex issue. Not surprisingly, if a small entrant faces competition from a dominant incumbent, then it can pay the incumbent to charge

a high access price to disadvantage the entrant. The more interesting question is what happens when competing networks are of comparable size so that market dominance is no longer an obvious issue. The answer depends very much on the nature of price competition - whether the networks are free to price discriminate, and whether they are free to use non-linear tariffs.

In the simplest case networks are differentiated but symmetric (ie if they charge the same price they will each share the market) and are not allowed to discriminate, which can have two interpretations. Armstrong (1996) takes non-discrimination to mean that operators must charge subscribers the same charge for calls delivered on or off net - ie BT charges the same to connect to a BT customer as to a comparable Mercury customer. Armstrong shows that negotiations over the interconnection charge may facilitate joint profit maximisation in the final market, provided the two networks are not too close substitutes. If the networks set interconnection charges non-cooperatively, they would be set above the joint profit-maximising level, and the double marginalisation harms them as well as customers. If the networks are sufficiently close substitutes then low interconnection charges emerge, making regulation unnecessary.

Laffont, Rey and Tirole (1996a) take non-discrimination to mean that the operators must agree the fee for completing a call from the rival network. With linear pricing, the access charge again provides an instrument for tacit collusion, under which each network raises the prices charged to final customers. The situation is similar to allowing users of a bottleneck facility to set a transfer price for trading capacity to raise prices in the downstream market. As before, if operators set access charges non-cooperatively there will again be double-marginalisation and a final price above the monopoly price.

If network operators can charge two-part tariffs, they may extract rent through the fixed charge, and let usage charges, including interconnection charges, move towards marginal costs. However, the incentive towards efficient pricing is constrained by the heterogeneity of consumers, and the tentative conclusion is that unregulated reciprocal or non-cooperative access pricing may still be excessive. The full analysis of this case remains to be undertaken.

Finally, Laffont, Rey and Tirole (1996b) show that the nature of competition changes considerably if networks can discriminate in the charges for calls terminating within or outside the network. As with other cases of price discrimination, the welfare effects are ambiguous. Price discrimination allows more intense competition at the margin, but because it is not related to final demand or prices, it introduces an additional pricing distortion. Not surprisingly, the detailed modelling of pricing strategies and the empirical evidence about both the industries' cost characteristics and the consumers' perceived costs of switching between rival operators will be needed to assess the benefits of unregulated

competition. The evidence from the United States suggests that flexible rather than detailed regulation is preferable (Kaestner and Kahn, 1990). States that offer greater flexibility to companies in setting tariffs have about 7% lower charges than those that do not (Mathios and Rogers, 1989).

5.6 Issues in vertical integration

Vertically integrated utilities formerly held a monopoly in both the network and the services supplied over it. They enjoyed the benefits of secure and reasonable profits, as well as lower effort and other benefits that could be concealed in the cost base. Re-creating vertical integration has obvious attractions, particularly if competitors can be disadvantaged. Regulated network monopolies also benefit from expanding into the supply of network services if they can shift some of the competitive costs into the regulated cost base. The RECs became equity holders in IPPs with whom they signed long-term contracts which could be passed through to the franchise market, raising the worry that they could shift profits into this unregulated business. These contracts are subject to regulatory scrutiny and accepted, thus making generation contestable.

The most contentious attempts at vertical integration were the two successive bids by the two major UK generators for two of the largest RECs in autumn 1995. They were referred to the Monopolies and Mergers Commission (MMC). The MMC found that although the mergers 'may be expected to operate against the public interest' they recommended that they be 'permitted to proceed if undertakings are provided ...' (MMC, 1996).

The majority report recognised the market power of the duopolists, but argued that the mergers between generators and the RECs did not make competition in the pool less competitive, nor did it prevent the nine other unintegrated RECs from signing contracts or buying in the pool, nor did it affect the market power of the integrated RECs. Indeed, by reducing risk and improving information flows between generators and the RECs, competition in the final market might intensify. The opportunity for this will come in 1998 when the RECs' franchise monopoly ends, after which all customers can buy from any supplier, though charges for using the distribution system would continue to be regulated.

The minority dissenting report noted 'that the mergers presently proposed are likely to accelerate the restructuring of the industry in the direction of four or five similarly integrated players' and argued that entry would become more difficult (MMC, 1996). In the event, the Secretary of State blocked the mergers and promised to block any future bid involving the major generators until competition in electricity generation had become fully established.

Is this kind of vertical integration which maintains the market for the intermediate input - electricity traded in the pool - pro or anti-competitive? There are three arguments that it might be anti-competitive. The first and standard one is that combining competitive and regulated activities offers scope to shift costs onto the regulated business, disadvantaging both consumers and rivals. The effects here are ambiguous (Vickers, 1995). The second is that competing RECs may be less willing to sign contracts with generators who can sell directly in competition with them in the downstream market, and more willing to buy in the pool. This would reduce the contract cover of the duopolists and increase their incentive to raise pool prices. Normally this would be restrained by the threat of entry, so the third and critical argument is that vertical integration makes entry harder. Again, the argument is inconclusive, and turns on whether vertical integration can raise the cost of entry. The duopolists might have an incentive to increase pool volatility to raise rivals' costs and make uncontracted entry more risky. The end of the franchise monopoly may destroy the willingness of RECs to sign long-term contracts which would otherwise hedge this risk. On the other hand, extra volatility might provide greater incentive for rival RECs to sign contracts with entrants, effectively becoming more vertically integrated themselves in response to vertical integration elsewhere.

6. Conclusions

What lessons can we draw about the contributions of economists to the debate on restructuring network utilities? First, economists have responded to the need for new models which capture some of the special features of competition over networks. Second, the gap between rather abstract theoretical models and the important specific features of each utility is narrowing - we now have more models that are specific to telecoms, or electricity, or gas, rather than to a highly stylized schema. Of course, we need both - we need to know whether the results of models depend on specific modelling details or are general. Unfortunately, the generic model typically tells us that allowing a certain kind of competition may increase or decrease welfare, depending on the fine detail of the model and the industry's cost structure. Finally, and supporting my thesis, they have studied and quantified some of the results of different restructuring and regulatory experiments, generally confirming that market forces have reduced costs and sometimes also prices. In conclusion, the variety of experiments under way in an increasing number of countries, and the flow of good technical information about these industries, offers a tempting menu of problems to keep economists intellectually stimulated, financially rewarded, and socially productive.

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