POLICY RESEARCH WORKING PAPER

1591

Competition in Network Industries

Michael Klein

Debate about whether and how to introduce competition in network industries — including transport, power, and telecommunications — is sometimes heated. Klein contends that in case of doubt, policymakers should not restrict the entry of competitive firms in such networks. If they do, he says that entry restrictions should be subject to an automatic test after a set period, and reviewed for costs and benefits.

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1. INTRODUCTION

Infrastructure privatization. A wave of infrastructure privatization activity is currently sweeping the globe affecting about 100 countries and amounting annually to over US$60 billion of business on average over the past decade. It has become increasingly clear to policymakers and firms alike that a major challenge is to ensure that such privatization activity will yield clear benefits. Existing empirical studies suggest that ownership change per se will often yield benefits particularly where it leads to reduced noncommercial government interference. However, regulation that is required in areas with natural monopoly features may become overly intrusive and undermine the progress made. To generate lasting and sizable welfare improvements the introduction of real competition is required.[1] Effective competition requires that firms can fail. This in turn tends to require private ownership as public firms may more easily count on being bailed out. It is in this sense that private ownership may be most clearly necessary for achieving lasting efficiency gains.

Questions policymakers pose. Many reforming governments want to employ competitive solutions. By way of example consider recent World Bank experience with reforming client governments. Key questions were:

- Should we allow completely free entry into all telecommunications services or is there reason to fear uneconomic duplication of investment and services?

- Should we introduce competition in power generation by unbundling generation and allow trade in transmission capacity rights such that decentralized bargaining over such rights determines dispatch?

- Should we provide an exclusivity period for gas distribution systems or allow free entry?

- Should we separate rail track from rail service operations and let the latter be competitively supplied or should we grant monopoly franchises combining track and service operations?

- Should we introduce auctions for landing slots at airports?

- Should we require that port concessionaires not be controlled by shipping lines so as not to bias access opportunities for other shippers ?

- Should we provide a measure of bankruptcy protection for private competing airlines to ensure essential service ?

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[1] A background paper summarizing the results of existing empirical work is being prepared.

Uncertain answers. The answers often remain unclear and continue to be subject to — sometimes heated — debate. First, there is the debate about whether competition should be introduced and if so how. An example of the former question is whether free entry into telecommunications makes sense given growing economies of scale in fiber optic cables. An example of the latter is the great (and expensive) confusion about California's power sector reform debate about wheeling (decentralized trade in electricity contracts) versus poolco (system optimization via central dispatch based on price bids by generators). Second, there are the questions about the regulatory implications of sector deregulation. Will regulation remain necessary, will it be easier or more complicated? Third, policymakers are worried whether private finance will come forth on reasonable terms to fund new investment in competitive segments of a network, where investors may face new and unclear risks, which they are not used to.

The need for clarification. The presumption of this issues paper is that the time is ripe to clarify and illuminate the debates about the competitive forces that may be brought to bear on network industries. The idea is not to provide perfect answers, but — in a reasonably dispassionate and intuitive fashion — to provide policymakers with broad perspectives that may help them orient themselves. The goal is to identify the key considerations and arguments and how they hang together, to clarify what is known and what is not. Examples are drawn from various sectors to obtain richer insights by relying on what amounts to a larger set of (quasi)-counterfactuals. Such a broad view of competition in networks should in particular bring out questions about the nature of networks and the nature of competition, which may more easily be glossed over in "technical" sector-specific debates.

The basic structure of this paper. First and foremost ways of introducing competition in network industries[2] are discussed. Basic regulatory requirements are sketched along the way. Implications for financing industry expansion when competition is introduced are sketched at the end.

The discussion on competition starts by sketching the concept of natural monopoly giving rise to the debates. The natural monopoly issue is then contrasted with a benchmark view of "ideal" competition in networks. This benchmark serves as a the key goal underpinning policy reform efforts, which aim at introducing effective competition in network industries. In particular the role of market-driven prices and the need for spot-markets is highlighted. This is then followed by a discussion of ways of introducing competitive forces in the following order:

Competition for the market

i) bidding for monopoly franchises (e.g. solid waste collection services);

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[2] The term network industry is used in a broad sense. For example, the whole road transport system including vehicles is considered a network, even though each vehicle is obviously physically separable from the road network. One may also think about all sort of activities that match suppliers and customers and incur some sunk costs in the process as network activities, e.g. marketing. However, the discussion here centers on network industries in transport, telecommunications, energy and water/sanitation.

Competition over existing networks

ii) **'open access'** — liberal policy towards access to monopoly segments and interconnection requirements (e.g. in natural gas, rail or telecommunications systems);

iii) **'pooling'** — introducing competition in existing networks where central dispatch optimizes network-wide service delivery of a fairly homogeneous service, while end-users and input suppliers contract competitively (e.g. in electricity or natural gas);

iv) **'timetabling'** — competitive determination of optimal service delivery in networks where non-homogeneous services need to be sent to specific end-points (e.g. auctions for airport landing slots or railway routes);

Competitive system expansion

v) decentralization of investment decisions for new capacity in networks (e.g. new transmission lines for electricity); and

Competition among multiple networks

vi) conditions under which competition among several networks or bypass within a network may be desirable, including reliance on substitute or intermodal competition (e.g. for freight transport). This is followed by a discussion of the desirability of erecting policy barriers to entry, including arguments about cross-subsidies and financing of infrastructure projects.

2. NATURAL MONOPOLY AND IDEAL COMPETITION IN NETWORKS CONTRASTED

The natural monopoly argument. Some types of networks such as water pipeline systems, railroad track, gas pipelines, and power transmission lines exhibit technical characteristics, which appear to make them natural monopolies. In other words it would be a waste for society to have several parallel networks of this type compete with each other. In fact, if they were competing only one firm would eventually survive. Indeed, competing municipal gas and water systems have not survived in the 19th century. Competing 19th century railroads in the United States ended up in monopoly areas carved up in private agreements among the companies. Competing gas transmission companies in Germany concluded demarcation agreements among themselves delineating respective monopoly areas for each company.[3]

[3] The natural monopoly argument does not imply that complete systems of infrastructure need to be owned and managed by a single firm. Complete systems, e.g. a telephone or gas system may be composed of several small interconnected systems that each are the sole provider in a particular geographical area. Examples are telephone

Potential competition. If entry into a market is easy and if it costs little (low sunk costs) then there will be potential competitors who will enter the industry when prices are "too high" and compete prices down again. An example may be trucking markets. If a single firm in one area or line of business starts charging excessive profits, other firms may simply use trucks available elsewhere and compete the excessive profits away. The equivalent example of airplanes illustrates that the fixed costs (the cost of the airplane) may be high, but hit-and-run entry is still feasible because the investment (the airplane) can be moved to alternative use in other markets.

Sunk costs. However, when specific investments with no economic alternative use are required to operate a network, then investments are sunk as in the case of a water pipeline.[4] If the incumbent raises prices a new firm may enter but it risks losing its investment if the incumbent lowers prices again or the incumbent may be driven out of the market. In both cases some water pipelines may lie idle eventually — potentially wasteful duplication from the point of view of society it seems. Once only a single supplier remains it has the power to earn excessive profits. This gives rise to an issue of economic regulation so as to limit profits to normal levels and pass more benefits to consumers.[5]

Physical characteristics of networks, the extent of natural monopoly and the scope for competition. In recent years received notions about which network industry or segments thereof are truly natural monopolies have been challenged repeatedly. Deregulation efforts have successfully expanded the scope of competition in various sectors with network characteristics, such as airlines, trucking, natural gas, power and telecommunications. By the same token the extent of economic regulation in these sectors has shrunk, although in some cases it has become more complicated as a result.

In some sense the various policy experiments have tried to peel away competitive layers from regulated networks and lay bare the true remaining natural monopoly. How one can peel off competitive segments varies from sector to sector depending on technical characteristics of the sector. Nevertheless it helps to look at the problem from the perspective of several sectors to sharpen the understanding of what is involved in expanding the scope for competitive forces and their nature in differing sectors. However, before exploring this agenda further it may be useful to state the importance of establishing functioning spot markets.

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franchises in Finland and Hungary (56 small systems), gas transmission in Germany, electricity distribution, water and sewerage systems, railways in the United States, road systems managed by differing regional government entities etc.

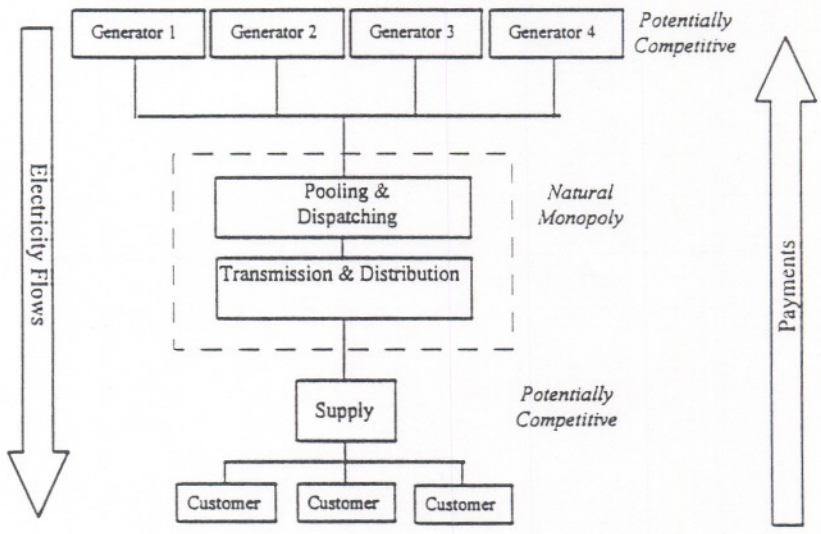
[4] It is of course physically possible to remove the sunk investments in the network, i.e. water pipes in this case. However, this would not generally be economic.

[5] Theoretically one could forgo regulation if society were prepared to accept monopoly profits, which would always be limited to some degree by competition from substitute products. However, this is usually politically unsustainable. We nevertheless see that a number of sectors are not or only partially subject to economic regulation. Such is the case when substitute product markets exist and society for some reason accepts possible remaining monopoly rents e.g. railways vs. trucks (United States, Argentina) and natural gas vs. petroleum products (Germany, Finland, Hong Kong).

Ideal competition in network industries. The creation of a spot market yielding prices that reflect market conditions is essential for the introduction of effective competition. A competitive spot market yields a set of prices maximizing welfare — absent externalities. This requires inter alia that the market is large enough to sustain a sufficient number of competitors to avoid oligopolistic behavior and that prices are free to vary by time, location and customer. When there are such market prices, regulation in this market is no longer necessary as competition will limit market power of market participants and yield efficient outcomes.

The box below shows an 'ideal' system in the case of electricity. Note, however, that even some parts termed 'natural monopoly' here could be potentially competitive. For instance, some experts believe pooling and dispatching are potentially competitive.

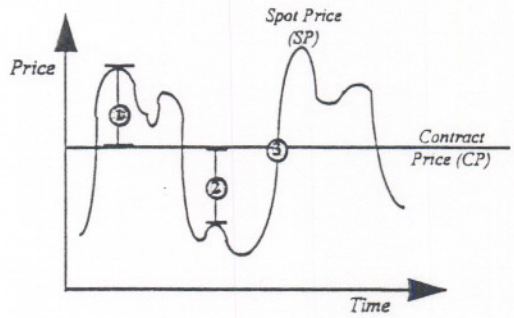
Box 1: Competition in Electricity



This diagram shows what elements of the system are potentially competitive or natural monopolies. In this diagram, supply, that is, billing, customer service, and bulk purchase of electricity, is potentially competitive, as is the generation business. The 'wires' businesses high voltage transmission and low voltage distribution, are natural monopolies. Pooling (operation of the market) and dispatch are also considered natural monopolies, although some believe that these two are potentially competitive through decentralized contract trading.

Furthermore spot markets allow buyers and sellers to buy and sell at short notice, to make up for shortfalls or excesses that may occur for whatever reason. This in turn allows buyers and sellers to conclude meaningful long-term contracts that even out price fluctuations in the spot markets and yield predictable payment and supply obligations (See box below). Long-term contracts also facilitate the financing of investments.[6]

Box 2: Long-term Contracts



In many commodity and financial markets buyers and sellers face a variable spot price. A wide variety of contracts exist to allow players to 'hedge' the risk of buying and selling at a variable price. This diagram explains the basic mechanism in the simplest case.

In a long-term contract, a buyer and a seller of a commodity agree to eliminate revenue risks caused by variations in the spot price through fixing a price at which they will contract. In the diagram above, there is a variable spot price (SP) and the buyer and the seller decide to fix the price at which they will trade (CP).

In a simple long-term contract a constant quantity (q) is traded.

(1) If SP > CP then the seller pays q x (SP - CP) to the buyer

(2) If SP < CP then the buyer pays q x (CP - SP) to the seller

(3) If SP = CP then no money changes hands

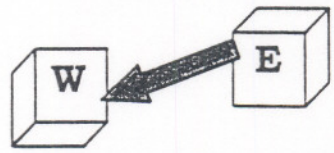
If both parties are buying and selling the amount q in the spot market then the financial flows in the financial contract will exactly offset the price variations in the spot market and essentially fix forward the price at which the trade is concluded.

Efficient spot prices are essential for decentralizing investment decisions in the network infrastructure itself. For this to be possible spot prices in a network need to reflect the capacity constraints of the network — given safety and other operating requirements. One way of thinking about this is that a bottleneck facility segments the market in several sub-markets as long as there is congestion. Prices reflecting sub-market conditions will reign at all relevant nodes in a network (see

[6] For long-term contracts to exist one needs to allow "speculators" i.e. players who develop liquidity in a market and hence support the development of contracts with a long maturity period.

box below). When capacity constraints are not binding at all, node prices will not differ and the whole system functions as one unsegmented market.[7]

Box 3: Congestion Prices



For simplicity, think of two markets, East and West, each comprising a series buyers and sellers -- assume all transport costs are zero.

Example 1: No Transport Link

If no transport link exists between the two markets then the two markets operate completely separately, i.e. prices and quantities are determined by supply and demand conditions in each market.

Example 2: Limited Transport

If there is a limited transportation capacity link then there is partial integration of the two markets. If the price is the E< W then it will pay suppliers to divert units to W. The prices in the two markets will tend to converge. If after the capacity of the link is exhausted there is still a price difference, then the difference is known as the 'congestion' price.

Example 3: Unlimited Transport

If transportation capacity is infinity, suppliers and customers are effectively competing in the same market.

Consider the example of a power system where electricity flow through the grid is optimized by a central dispatch system. Here contracts for power supply need not be concluded by a single, central power company. Contracting can occur directly and competitively between generators and consumers subject to the constraint that total power input into the system equals total output (including losses). Producers bid for dispatch, consumers bid for supply. The dispatch center optimizes system operations subject to operating norms about system stability, reserve margins, etc.[8] With complete pricing flexibility, the outcome is a system of spot prices, varying by time and location in the network (node prices) which reflect both the valuations of suppliers and

[7] See Schweppe (1988) for a full discussion of the applied theory of congestion pricing for power systems.

[8] Such markets for electricity have — with varying degrees of sophistication — been established for power in Chile (1978), the United Kingdom (1990), Argentina (1992), Norway (1992) and Australia (Victoria) (1994).

consumers as well as the operating norms and capacity constraints of the system.[9] The spot prices will also provide appropriate signals for capacity expansion in generation. When spot prices are expected to rise and remain high enough to fund the cost of building and operating a new power plant, a new plant will be built. In times of overcapacity on the other hand spot prices will drop to low levels and investment will be discouraged (theoretically the price should follow system short-run marginal costs which could vary widely).[10]

To hedge price fluctuations in the spot market, generators and consumers can conclude long-term contracts for power delivery at agreed prices. To be able to fulfill such contracts producers must be able to purchase or sell power in a spot market. This is equivalent to trading arrangements in markets like that for crude oil. For example, a producer of crude located in the Middle East may honor a sales contract to a customer in Brazil, by purchasing crude oil on coming from Venezuela on the spot market while selling crude from the Middle East in the spot market that may ultimately serve Europe. The contract for delivery is then separable from the actual flow of the product. This is always possible when there are multiple supply sources for the product traded and a spot market exists. The existence of the spot market makes it possible to honor long-term contracts efficiently and thus also to use them to secure debt financing.

An efficient node pricing system provides signals for new investment in "transport" capacity expansion. The difference between node prices reflects the cost of congestion and system losses. As differences between node prices grow, investment in new capacity relieving congestion becomes economical. In theory it should be possible to allow investors to come forth with investments in transmission infrastructure in response to expected node price differences.

If it is possible to create an efficient spot market that allows operating and investment decisions in all of the network industry to be decentralized i.e. left to market forces, then all that remains of regulation is "normal" anti-trust or competition policy, which should help guard against excessive concentration in relevant markets and collusion.

As in the case of any other market, competition over networks will not be effective if the total system is so small that there is only a small number of competitors, e.g. in a power system with only two or three generating stations. Even when there is a large number of producing plants they must not all be owned by a small number of firms to minimize the incentives to collude and thus undermine the effectiveness of competition. Anti-trust rules may be needed to prevent collusion or mergers between the plants. But if unregulated investor responses are sufficient to take care of efficient network expansion, then there is no issue here that is different from those in any other market with workable competition.

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[9] Such a market may be called a 'smart market', in this case embodied in the optimizing dispatch system. A 'smart market' is effectively any computer — aided market that uses a series of algorithms to facilitate the market — clearing process.

[10] A relevant analogy is the market for aluminum plants, i.e. plants with high fixed, sunk costs operating in a world market with flexible spot market prices reflecting market conditions.

Care needs to be taken in analyzing the scope for competition properly. For example, the shape of the bottleneck part of the network e.g. the transmission system, which may include "treatment" facilities (e.g. gas or water treatment plants), may effectively create a series of small, segmented markets so that many suppliers are able to exercise monopoly power in "their" part of the market.

As we will see, it may be that in some cases competing networks may sensibly be used to establish workable competition. In other cases it may ultimately be possible to create effective spot markets by means of "smart" markets. The smart (computer-based) market is an auction system, where producers and customers of a good or service bid to produce or consume the good or service, subject to the constraints imposed by the bottleneck facility including any rules governing system stability or safety or the like. The smart auction system explicitly takes these constraints into account and optimizes the use of the bottleneck facility as it exists.

The smart market thus simultaneously optimizes utilization of the bottleneck elements of a network and generates a system of spot prices based on bids for delivery and purchase of services by multiple producers and customers, who require the network for service delivery. It may thus be that the only "real" natural monopoly element left is the establishment and operation of the smart market itself, whereas new investment in network expansion can be left to "the market" based on the spot prices generated at all nodes in the bottleneck parts of the network.

Politically it will be important that customers accept the bewildering and fluctuating array of prices that is required for effective spot markets in network industries. The world of such prices is almost diametrically opposed to often preponderant notions of uniform system-wide flat rates for services of network industries. A flavor of what consumers could expect is provided by airline pricing practices in a deregulated system like the United States, where prices may differ by seat, by cancellation option, by the time of booking and are constantly adjusted by airlines on the basis of evolving demand for seats and competitors' behavior. The liberalized long-distance telecommunications market in the United States provides another example of the kind of market that might confront consumers.

If the choices are extremely complex, it is possible that brokers will come into the market and provide a simplified 'menu' of choices for consumers. This is in effect what banks do for customers: provide an interface to the financial markets and provide marketable packages for customers. An example is the provision of fixed rate mortgages: these are backed by derivatives or other hedging instruments in the financial markets, but customers do not need to know this. They simply face a choice about whether to fix their mortgage rate for a number of years and what the cost of this action will be.

3. INTRODUCING COMPETITION IN NETWORK INDUSTRIES

3.1 Competition for the Market

Franchise bidding

It has been argued that one way of bringing competitive forces to bear on natural monopoly segments of an industry is to delineate the monopoly franchise and auction it off to the bidder requiring the lowest price from consumers (Demsetz 1968). However, prices and related terms of the franchise (often known as a concession[11]) will have to be adjusted as time goes by in response to new events. There are two options to adjust prices, either by rebidding the franchise periodically or by instituting price regulation of the "traditional" kind. Only rebidding promises an escape from a return to a standard natural monopoly case requiring regulation. Indeed, monopoly franchises for such activities as solid waste collection have been auctioned off periodically with documented efficiency gains over regulated systems.

However, if there are significant sunk costs involved assets need to be transferred at the end of the franchise period under a system of rebidding. These assets will have to be valued. One way is to let new bidders bid a value for the assets. For that they need to have information on future prices, which need to be given exogeneously. That could only be done by a "regulator" as — by definition — there is no market setting the price(s). The other way is to value the assets and let the bidder offer the lowest price to consumers. The valuation, however, needs to compensate the incumbent such that incentives to invest and operate efficiently are maintained. Such a valuation exercise is almost identical to a rate review by a regulatory agency (Williamson 1976). If the value for the assets is too low the incumbent will have weak incentives to invest in and maintain the system. If the value is too high it will lead to excessive prices for consumers under the new bids.[12]

De facto, there will always be challenges to incumbents in monopoly franchises. Such challenges may be infrequent and may not follow any prescribed set of rules, but no incumbent will forever be efficient and politically acceptable. The difficulties of setting appropriate franchise periods and of valuing assets — explicitly or implicitly — at the end of the franchise period will

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[11] There are a variety of other similar forms of contracts, for instance leases, BOTs etc. The differences between contracts depend on the degree of responsibility of the private operator (for instance whether they are responsible for financing new investment) and whether the contract is to operate existing infrastructure or to build new assets.

[12] One alternative mechanism to avoid these problems was developed in Argentina and used for concessions in electricity distribution and transmission. In this scheme, the incumbent and the entrant bid. If the entrant outbids the incumbent, the value of the bid is paid to the incumbent. If the incumbent wins then no money changes hands. Theoretically, this system should overcome some of the problems described above. The difficulty with this scheme is that the customer derives no benefit from these periodic competitions. This scheme therefore either has to be accompanied by regulation, i.e. the customer receives the benefits of competition through periodic price reviews in which case the scheme does not eliminate the need for regulation, or a proportion of the proceeds of the auction have to be returned to the customer at the auction, e.g. 25% of the value of the auction is returned to the customer. This then raises the traditional problems of franchising, i.e. the danger of less than full compensation for the transfer of assets and the potential advantage of the incumbent in bidding for the franchise.

then be encountered by necessity. Historically, occasional albeit infrequent challenges to incumbents in monopoly franchises have often yielded at least temporary reductions in prices and efficiency gains (gas distribution in 19th century Canada, water concessions in France, power generation plants in the United States after 1978).

By placing limits ex ante on franchises and requiring some form of competitive bidding for renewal of the franchise, Governments will ensure that regular challenges are possible. If many different franchises exist there will be constant competition for renewal of some franchise, e.g. if there are 10,000 water franchises with an average length of 20 years, 500 will come up for bid annually. As long as firms are allowed to operate franchises in several jurisdictions they will then have an incentive to maintain some reputation to be able to be prequalified for bidding at renewal time. The incentive to maintain reputation will somewhat reduce the temptation to slacken efforts in franchises they currently hold.[13] However, during the life of long-term franchises economic regulation will continue to be required and the valuation problem at the end of the franchise period will remain.

3.2 Competition over Existing Networks

3.2.1 'Open Access'

Open access to the bottleneck facility.[14] Some times, segments of a network industry have been identified as potentially competitive, e.g. long-distance services in telecommunications, power generation in electricity systems, gas production in natural gas systems etc. However, for competition in one segment to be effective, access to remaining natural monopoly-type bottlenecks is required. As long as the network owner(s) are not engaging in predatory behavior competitive suppliers will have access to the bottleneck facility provided there is available capacity. An example might be rival gas suppliers using a single gas pipeline (the bottleneck facility). In the case where the pipeline owner has no interest in supply, it will always pay for them to allow additional access. The marginal cost and hence the price of capacity will be close to zero. For interruptible[15] service, gas suppliers and their customers can thus count on available transport capacity and there will be an effective competitive spot market for interruptible service with the possibility of writing longer-term hedging contracts.

When capacity constraints are binding, there will have to be rationing of access (interconnection) to the bottleneck. This can be achieved efficiently without regulation. An efficient

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[13] Such reputational effects have been shown to exist in the only larger study of the issue that we know of i.e. a review of experience with the results of competitive award of cable TV franchises in the US (Zupan 1989).

[14] This is sometimes known as 'common carriage'.

[15] 'Interruptibility' in gas refers to the ability of the pipeline owner to stop services to customers on interruptible contracts when demand is high. The conditions on which Interruptibility can occur e.g. number of times, length of interruption etc. varies by contract. Unless the demand for gas is relatively constant, therefore, it is likely that some types of interruptible contracts will be possible in every gas system.

outcome would be approximated if the owner of the gas pipeline could charge prices for the transport of gas that reflect the difference between consumers' willingness to pay and producers' marginal cost. The allocation of resources would then be optimal in the sense that the cheapest producers would sell gas to the consumers with the highest willingness to pay, i.e. the ones valuing gas the most.

In this case, the owner(s) of the bottleneck facility would receive monopoly profits. There is therefore again the need for regulation of prices charged by the owners of the bottleneck facility for access and of prices for any services they provide to final customers of the network industry. This could for example be achieved by way of a "global" price cap on a basket of prices for all services rendered by the bottleneck facility including the price of access (Laffont and Tirole 1994).

Open access and interconnection rules

So far it has been argued that a market for capacity rights will not eschew the need for regulation. This was on the assumption that owners of the bottleneck facility do not engage in predatory behavior. However, there may be incentives for them to do so particularly when they themselves own part of the competing supply facilities e.g. power plants or gas fields or long-distance telephone transmission facilities. In those cases they may seek to raise access prices to the network to prevent competitors in the non-monopolistic segments of the network from gaining business and eventually to drive them into bankruptcy.

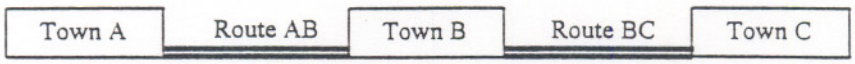
To prevent this from happening regulators may impose certain access obligations and matching pricing principles to prevent owners of monopolistic segments from engaging in predatory behavior. This rationale for regulation is thus different from the attempt to simply limit profits in the monopolistic segments. The former regulation is there to enable competition "over the network" to take place and to prevent owners of the bottleneck facility from reaping excess profits, whereas the latter is there only to limit profits of the bottleneck owner. Of course, the limitation of profits on the bottleneck facility may well be the reason why its owner might want to establish and exploit market power in the competitive segments. This then argues to impose limits on vertical integration and separate ownership in the bottleneck facility from that in other parts of the system — a time-honored way of ring-fencing the natural monopoly element since the time of canals in 18th and 19th century United States where at times canal operators were not allowed to operate barges on the canal.

As soon as access rights and prices are to be regulated, there may have to be non-price based rules rationing access, such as first-come first-served (at the regulated access price). It is then no longer clear whether the outcome will be optimal. In particular, there may be excess demand for capacity, which may lead to excessive network expansion, if the network owner is obligated to provide access at given (low) rates.

A well-known benchmark pricing rule for the regulator trying to preserve competition over networks is the efficient component pricing rule. It essentially says that the access price charged by the bottleneck owner should compensate for the full cost of providing network access to a competitor in the competitive segment. That full cost consists of the marginal cost of access as well

as any losses of profits that may be the result of new access. Clearly the bottleneck owner will then maintain its prior profitability, whether that included excessive profits or not. New entry will bring benefits to consumers under this rule if the new entrant is more efficient and can deliver a final service for a total price that is less than others charge including for example a vertically integrated firm with control over the bottleneck. For the vertically integrated firm it will be economical to shut down its own capacity in the competitive segment, because it will be compensated for this through the access price.

Box 4: The Efficient Component Pricing Rule



	Marginal Cost (AB)	Marginal Cost (BC)	Joint Cost	Access Price*	Price (Average Cost over AC**)
Incumbent	5	5	10		20
Efficient Entrant		4		15	19
Inefficient Entrant		6		15	21

This is a simple example of the Efficient Component Pricing Rule developed by Baumol as a principle for setting access prices. In this example, due to Baumol, a vertically integrated incumbent offers a rail service between towns A, B and C. An entrant wants to develop a rival rail service between towns A and C but has to pay for access to the vertically integrated incumbent for its bottleneck service between towns A and B (route AB) and will provide the service itself between towns B and C (route BC).

The costs of the service are as follows. There is a marginal cost (assumed constant) of service for each leg of the route AB and BC of 5. In addition, there is a joint cost of service of 10 (an average fixed cost incurred by the incumbent for operation of the entire rail network) so that the average cost of the service AC is the sum of the marginal costs and the joint cost, ie 20. The incumbent charges the average cost of the service (20) and the entrant charges a price equal to its marginal cost over BC and the access price to AB.

As illustrated in the table above, the Efficient Component Pricing Rule states that the correct access price to charge the entrant for the bottleneck service (route AB) is the sum of the marginal cost of access to the bottleneck AB which equals 5 and the joint costs of service 10 (the opportunity cost of entry to the incumbent). The efficient access price is therefore 15.

This example is illustrated by two entrants. The first, the efficient entrant, has marginal costs of 4 over the route BC. It therefore can profitably enter at the ECPR access price of 15 and undercut the incumbent with an average cost of 19, which is less than the incumbent's average cost of 20. If an inefficient entrant has marginal costs for the route BC of 6, then it will have average costs of 21, ie more than the incumbent and hence will not enter. In other words, the correct access price induces efficient entry. An access price less than the ECPR (in this simple example) will induce inefficient entry.

* Access Price (under ECPR) = MC(BC) + JC

** Average Cost (to incumbent) = MC(AB) + MC(BC) + JC
Average Cost (to entrant) = MC(BC) + AP

The efficient component pricing rule defines in effect an upper limit for access prices, because it still allows the incumbent vertically integrated firm to make excessive profits — as in the past. A lower bound is set by the marginal cost of granting access to the network. The marginal cost

may, however, fail to compensate the network owner for fixed costs of maintaining the network. Such costs should also be incorporated in the access price possible in the form of a two-part tariff — with a fixed charge covering network establishment costs (including the capital cost of the network owner) and a variable one covering the short run cost of access. In effect such an access price would be equivalent to the efficient component rule without compensating the incumbent for loss of excessive profit.[16]

Procompetitive regulation. Sometimes access rules and prices are used to provide an advantage to new entrants relative to the incumbent. The rationale for such entry assistance is presumably similar to that for infant industry protection, i.e. ultimately based on arguments about learning externalities. It would also follow that such protection should be limited in time.

Resale of capacity.[17] Users of the bottleneck facility may buy rights to use capacity and may be allowed to resell them in various ways. The question is what type of competition such a resale market can provide. Resale can yield more complex pricing of capacity than may be allowed under regulation for the primary sale of capacity by the bottleneck owner. Also parties not having access to capacity because of some type of quantitative rationing may be able to obtain access through purchase in the retail market. If pricing in the retail market were unregulated, then the ultimate pricing structure would be the same as that of a monopoly selling directly. Regulation would simply create a rent for "primary dealers," i.e. companies buying capacity rights from the owner of the bottleneck. Therefore, for regulation to be effective it has to apply to resale of capacity in monopolistic segments as well. Consequently, prices for capacity can not be set in a free market for capacity rights based on access regulation.

While the creation of an open access system is plagued by many detailed regulatory challenges it can serve effectively to promote competition in competitive segments of the industry. An increasing number of examples across sectors illustrate the benefits of creating open access systems in rail, telecommunications and gas. Note that this issue is often combined with issues associated with the creation of new duplicate networks, for instance in telecommunications i.e. the price at which a new long distance fiber-optic network can access the local network to provide a full service (see section 4.1).

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[16] Kay J (1995) argues that recent advances in accounting theory, in particular the activity based costing rule have to a large extent eliminated the distinction between costs that can easily be allocated to a specific activity and general overheads. Further progress could lead to a situation where access prices can "simply" be based on the marginal cost of access provision without the need for further fixed cost compensation.

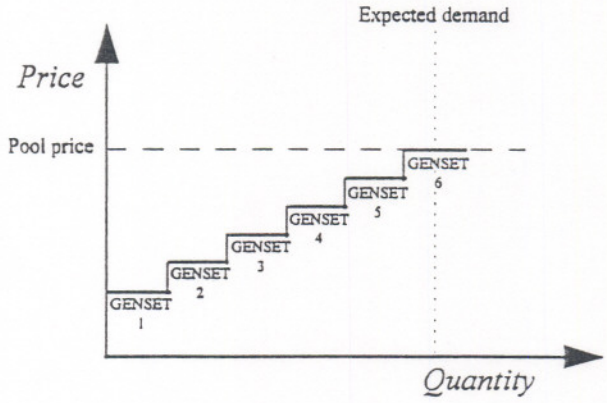
[17] This is also known as 'contract carriage'.

3.2.2 'Pooling' — Open Access Without Predetermined Rights to Use Capacity

The open access rules outlined above attempt to enable competition over the network by selling rights to network capacity to competing firms on a non-discriminatory basis. However, it may be difficult to define, adjust and enforce such rights in a manner that allows effective competition to take place. For example, in power systems a complete set of access or capacity rights may be undefinable. Power flows through a network according to Kirchhoff's law. What capacity is used or unused at any moment in any part of a power system is a function of all physical flows throughout the system and not a function of bargaining or individual transport decisions. It may not therefore be practical to define capacity or access rights for power systems. What can be done, however, is to have a central dispatch system that optimizes system flows, instantaneously matching supply and demand. There is open access in such a system in the sense that the power of winning bidders will always — and by definition — be dispatched. The use of capacity is then flexibly determined by the dispatch system. There is no need for trade in capacity rights e.g. in response to short-term shutdowns of power plants and no need to compensate holders of capacity rights for the effect of power flows on available capacity.

This solution to competition over power transmission systems has by now been tried in several countries. Chile introduced a competitive power pool in 1978, when its system was still publicly owned. Least-cost dispatch continues to be on the basis of audited costs of power plants, not on continuous price bids by generators. Bidding thus takes place implicitly as costs are reset. The United Kingdom introduced a competitive bulk power market on the basis of half-hourly price bids in 1990. However, both Chile and the United Kingdom continue to suffer from high market concentration in the generation segment and a lack of barriers against vertical integration. The Argentine system introduced in 1992 places strict limits on horizontal and vertical integration thus effectively creating the conditions for workable competition. However, so far "bids" are based on audited cost data rather than price bids by generators. All the foregoing systems set transmission prices in an essentially administrative way, i.e. they do not allow congestion prices to be established by the smart market. Norway introduced its competitive pool in 1992 and is trying to generate prices by the smart market including congestion prices. Most recently the Province of Victoria in Australia is introducing a competitive bulk market for power. Results from the introduction of competition remain encouraging. In the United Kingdom productivity of generators has roughly doubled within four years, including for the remaining public nuclear power operator. Productivity in the industry segments not subject to competition i.e. distribution has also increased, but only by about 10 percent. In Argentina, the switch to a private competitive system quickly resolved all of the urgent problems of power shortages and created a situation of temporary excess capacity essentially because the new generating firms efficiently rehabilitated and operated existing plants.

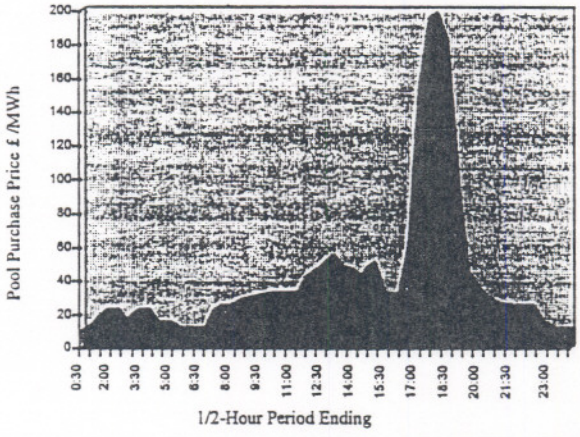
Box 5: The UK Pool



The price in the Pool in England and Wales is determined on the day ahead of operation. The price is determined by ranking the bids (the price at which it will generate and the quantity it can generate at that price) of each generating turbine (genset) in the system. The price is determined by taking the highest price bid needed to meet expected demand in every half-hour period in the day ahead as shown in the diagram above. The Pool price is therefore determined for every half-hour period on a given day. A sample of prices taken from Financial Times is shown below.

Note that this is a very simplified explanation of the mechanism. In practice, there are other elements to the price and the bids are complex non-linear functions.

UK Pool Prices 01/23/96



Source: Energy Settlements and Information Services Limited, 01/23/96

It might be argued that one could define and enforce capacity rights in systems with directed flow like natural gas transmission. However, trades may still be too complex to obtain efficient gas transmission on the basis of trade in capacity rights. In effect, the notion of trade in capacity rights entails that a complete path for the transport of gas from seller to buyer be obtained through purchase of a series of capacity rights, which are available at the time they are needed. Constructing such a system of "straws" through a pipeline system that efficiently matches capacity rights with energy delivery may be so complex that efficient solutions may not obtain. The experience of the deregulated U.S. gas industry is suggestive in that there are efficient spot markets for interruptible gas supply, i.e. supply flowing in times when pipeline capacity does not impose an

aggregate constraint on the energy trades that are possible. Such markets are still rudimentary for trades when capacity constraints are binding, i.e. when capacity has value. A conceptual solution currently being investigated in the U.K. gas industry is to use a central optimizing dispatch system as in the case of power mentioned above. It remains to be seen whether such a system can technically be put in place.

One might argue that rather than relying on a single optimal dispatch system one could conceive of a system where transport rights through a pipeline are originally allocated to several owners, who can than sell these rights. Private brokers could construct optimizing models that would match energy and capacity trades in the way a dispatch system would. The result of these trades would then yield the instructions to the actual dispatch center. For electricity such a system would simply have high transaction costs unless different brokers were to develop competing optimizing systems and unless such competition between optimizing systems were to yield sufficiently large benefits to offset the cost of the whole brokerage system.[18] That includes the issue of whether instructions generated by competing optimizing systems could generate a feasible and efficient set of instructions for the dispatch center.

Under the solutions described above the transmission systems remain natural monopolies and require regulation. There is no need to design an interconnection regime as discussed in the previous section. Rather regulation of the cost of utilizing the transmission system appears to be equivalent to regulation of any bottleneck transport facility, e.g. regulation of a monopoly railway franchise. Regulation may thus be a little less complex than that required in the case of an interconnection regime, which does not rely on market structure regulation under which the bottleneck facility is vertically separated from the competitive segments.

3.2.3 'Timetabling' — Establishing Optimal Delivery Schedules

In the case of power or natural gas it does not matter, whether a customer receives electrons or molecules produced by the supplier with whom he has contracted for delivery, because the product shipped is sufficiently homogeneous. A different issue arises in transport ventures like airlines, railways or telecommunication, where a freight or passenger or caller need to reach a particular customer or point in the network. This imposes a more complex set of constraints on the network optimization problem than the "simple" requirement that total inflows match total outflows (including storage). This problem is equivalent to the previously discussed issue of constructing an optimal set of "straws" for natural gas systems — and adjusting it efficiently in the face of changing supply and demand conditions. However, for the sectors now considered the issue cannot be eschewed as in the case of the previously discussed industries.

For example, if one were to define rights to use the rail tracks and allocated them to multiple parties, secondary trading should yield the optimal set of paths (straws) through the network that maximizes welfare given the valuations by producers and consumers for the service in

[18] Logistics networks are a case where "brokers" compete with competing optimizing methods. Markets for trucking and taxi services also see competing dispatchers.

question i.e. person or good x delivered to point y at time z. The optimal set of paths forms the optimal deliver schedule or timetable. The problem is whether an optimal timetable can be generated through decentralized bargaining or whether a smart market is needed that simultaneously generates the optimal set of paths through the network and the prices for all the paths contained therein. Because the value of each right to use a piece of track at a particular time is dependent on what happens with all adjacent pieces of track (all pieces are indirectly adjacent to all others) one may need a single optimizing smart market.[19] A further issue is whether short-run adjustments to the optimal schedule e.g. due to mechanic breakdowns or other emergencies can be made in a timely manner by the smart market/dispatch center or whether the loss of vertical integration translates simply into higher transaction costs.

While the structure of the problem may be clear it may also be too complex to solve for many systems.[20] Potential applications are conceivable in railways and airport slot auctions (to obtain an optimal timetable pairs of slots need to be auctioned i.e. a path through the "network" of airports.)[21] Sweden and the United Kingdom are currently investigating whether such smart markets can be established for railways. Experiments with such smart markets have been conducted in experimental laboratory settings.[22]

Implicit timetables

Timetables need not be preannounced. Optimal routing may be obtained through smart markets in other ways. Ideally, transport and congestion prices could be determined through competing segments of the transport network each of which competed to provide the service. Through demand and supply conditions, prices on individual segments could be set independently and competitively. These systems have been the subject of experiments, particularly in the case of gas and electricity where joint competing owners of transport infrastructure, i.e. specific gas pipelines have been proposed.[23]

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[19] Once a set of paths is established the right to use the paths in a specified way e.g. by running a container train over set of tracks could be auctioned to — in this case — train service companies. The right to use capacity on the trains can in turn be allocated by price or queuing mechanisms or a mix thereof.

[20] We know now that in the case of electricity a smart market can be made to work, in which paths through the network need not be explicitly defined. Setting up smart markets that can derive optimal sets of paths would imply also that, in principle, capacity rights could be traded "in" the smart market.

[21] In the future remote intelligent traffic management systems could also bring the world of smart markets to road transport.

[22] See McCabe et al (1989)

[23] See Cara Funk (1992). This system would essentially work by splitting up individual pipeline ownership into a series of individual owners competing to provide the transport service. Although there may be some difficulties monitoring the contracts and entitlements, this would not necessarily be impossible using advanced metering and computer systems.

How might this work in practice? Two examples are provided here. The first is of a telephone network. Optimal use would be obtained if users of the system faced prices that lead them to use the system optimally. For pricing in a phone system one might — as a thought experiment — imagine the following system. The caller would dial. The system optimizes (numbering plants and switching facilities in the case of telecommunications) would then determine the optimal path at the desired time and quote a price that would appear on the phone. The customer could then "conclude" the contract by pressing a "yes" button or abort the call attempt. This would yield a system of spot prices on the basis of which longer term contracts could be established enabling callers to have assured call rights at given prices at certain times. In a sense the price schedules of the phone companies mimic this "long-term" market directly without explicitly letting callers make a spot market. Indeed, the information over the Internet already is conducted on a similarly decentralized basis with individual 'packets' of information being sent across different routes of the network.

The second example is the road network. In theory, each road, or even lane of a road could be under separate ownership with each segment profit maximizing given the constraints of competition from other routes and transport substitutes. Subject to the prices that arise from these routes, individual shippers, logistics firms and other road users will decide on the traffic flows, hence establishing an 'implicit' timetable. Note that this is simply the price 'dual' of the quantity rationing which exists today, certain routes are more congested than others and the time costs associated with heavily used routes determine traffic flows on a decentralized basis.

Why are some routes decided on a decentralized basis and others on a centralized basis? Clearly the answer is not necessarily to do with the cost of congestion which is substantial in roads and still the subject of 'decentralized' timetabling. Part of the answer, at least historically, may be to do with the cost of short-term supply/demand imbalances which are catastrophic in systems that have been traditionally centrally dispatched, i.e. railways with the danger of collisions and gas and electricity with the danger of explosions or blackouts respectively. The other answer clearly is that timetabling and dispatching grows more complex as the number of players/routes etc. increases making 'central dispatch' infeasible in the case of transport over the road network. New computer and monitoring systems, however, may reduce the need for centralized dispatch in future in the other infrastructure sectors, particularly telecommunications.[24]

3.3 Investment in Expansion of the Bottleneck Facility

Under the various schemes for organizing competition over existing networks users of the network will somehow have to pay for investment and operating costs of the network. It is

[24] The airline industry exhibits some features of this decentralization as well. In a deregulated system airline seats are continuously repriced to reflect demand and supply conditions. Customers have a choice of buying in the spot market — sometimes literally bidding over seats in overbooked aircraft — or buying longer-term contracts that guarantee a seat at a price. However, as mentioned before airline routes are not yet competitively allocated. Therefore seat pricing currently optimizes given a route system i.e. given a timetable.

notoriously difficult to allocate such costs in an economically meaningful way. The danger thus exists that sub-optimal charges for the bottleneck facility e.g. power transmission will result in bad location of facilities in competitive segments (power plants) or bad transmission expansion decisions (Newbery 1995).

Decentralizing investment decisions

The more information is reflected in prices the better investment decisions can be and the more scope there is for decentralizing decisions. We have above considered arguments why price (and simultaneously scheduling) systems may require a — potentially unique — smart market, i.e. a natural monopoly of sorts. But once prices are established they can then guide decentralized decisionmaking. If one can obtain a price system that reflects opportunity costs by time as well as location then it should in principle be possible to decentralize all trades and also investment decisions.

Consider the above railway path/airport slot auction problem. Suppose a pure price system could operate that would yield different prices at different locations and times for the use of capacity train or airplane capacity. These prices would feed back into the valuation of complete paths. Prices would then reflect congestion costs. This is equivalent to node pricing referred to above for power systems.

At some point the cost of congestion should lower the value of sales to producers so much that it would pay to invest in congestion-reducing infrastructure. Equivalently the value of calls or travel might be so reduced. Will this lead to efficient decentralized investment decisions? Network customers e.g. power plants would need to form expectations about future node prices and the difference between them i.e. congestion costs. That may not be more difficult than assessing future market conditions in any other competitive market.

Network customers or groups of customers or developers on behalf of customers could then invest in extra capacity to relieve congestion. However, it may often be difficult to determine who benefits to what extent from the new capacity. For example, the owner of the existing "path" or a part thereof may neglect maintenance and still not suffer much, because the new investor(s) have relieved congestions sufficiently. Or some firm could not be persuaded to join the consortium but still has access to the system e.g. because access is rationed by price only. The question is whether sufficiently strong consortia can be formed that feel they can ignore the beneficial effects on others. In reality some such attitude always prevails, e.g. when a firm constructs its own captive infrastructure thereby relieving constraints on others. The builder(s) of new infrastructure capacity benefit by collecting higher sales prices and by receiving future congestion rentals between the nodes that the new capacity connects.

Where free rider problems are serious, whether in the "maintenance example" or the "consortium example" the key is to write contracts ex ante between the concerned parties that can be enforced ex-post, e.g. maintenance obligations could be contractually specified or payment obligations under the consortia and other participants in the power system could sue when contracts are breached. What remains to be shown is that the solution to the free rider problem is

substantially different from "regulation." Also, if solution of free rider problem increases incentives and opportunities to collude, is anti-trust sufficient to deal with this threat? [25]

One may ask: If new investment could be decided upon in the above decentralized way, why could trade in that capacity not occur in the first place? Maybe the answer is that a smart market — not decentralized bargaining — is first needed to establish prices that can then support a decentralized investment response.

3.4 Remaining Natural Monopoly and the Role of Competition Policy

In a sense the scheduling mechanism is the one that grants access to a system that is otherwise operated, maintained and expanded in a decentralized and competitive fashion. In some sense scheduling is equivalent to a permitting system that allows firms to operate in an otherwise reasonably competitive market. Scheduling should therefore always be (vertically) separated from the rest of the system and probably be run as a non-profit organization, which represents all participants and in particular the users. That is in analogy to "governmental authorities" or self-regulatory bodies, which govern and operate permitting or licensing systems in other parts of the economy.

By vertically separating the core natural monopoly element, namely scheduling from the rest of the system there can also be more latitude for allowing vertical integration in the rest of the system. If scheduling/dispatch is carried out separately, the actual ownership of the transmission part of the network will not provide much in the way of monopoly power unless the owner can obstruct competitors by scheduling maintenance work in anti-competitive ways. While vertical unbundling may thus be not so important after all, a sufficient number of competitors (horizontal unbundling) may be required to achieve lasting benefits of competition. In many ways this is similar to basic principles of competition policy elsewhere i.e. vertical integration is not much of a problem as long as the integrated company has no monopoly power in any part of the vertical supply chain.

4. COMPETING NETWORKS AND POLICY BARRIERS TO ENTRY

4.1 Competition Among Networks

Natural monopoly elements in the scheduling function or the limit of smart markets. The foregoing arguments suggest that the hard core of natural monopoly is the smart market whether in its incarnation as dispatch or timetable optimizes. When will there be a single smart market or "scheduling system?" In general, scheduling is necessary when temporary congestion is extremely costly i.e. systemwide black-outs in the case of electricity and problems to a lesser extent in gas networks. It is in these networks that a 'hard core' natural monopoly in terms of centralized scheduling is likely to remain.

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[25] The answer to this question will also determine whether cotenancy schemes such as "competitive joint ventures" are significantly different from "straight" regulation.

In a world of complete information "traffic flows" should be centrally scheduled and dispatched accordingly worldwide and across different types of networks — what the just-in-time logistics network tries at the level of competing firms, should be done centrally for the world by a (benevolent and efficient) scheduler. The whole world would thus be a natural monopoly with regard to scheduling.

But as we know, there may be a lack of benevolence and efficiency in monopolies and the problem is probably too complex anyway — just as the somewhat equivalent proposition of central planning that wanted to reduce the chaos of markets and its attendant costs.[26]

We also see a number of competing networks e.g. petroleum product distribution systems competing with natural gas systems or railways competing with trucks, cases where the theoretical benefits of complete and integrated scheduling are probably less important than the practical benefits from competition among networks. Competition is most useful where the central planning problem is hardest i.e. where uncertainty and/or complexity is great. There are thus dynamic or informational benefits from incomplete scheduling, which allows competition on the basis of some level of "redundancy" or duplication. Such redundancy can — by definition — only be suspected but not unambiguously identified. Redundant capacity is necessary for new things to be tried out and for monopolistic behavior to be checked.[27] For example, the introduction of competition for long distance services in Chile's telecommunications industry in 1993 led to market entry by eight long-distance carriers and a fall in prices by 50 percent by 1995.

The shifting economics of scheduling. But as knowledge and practices evolve the (ambiguous) boundaries of where the realm of redundancy starts and that of tight scheduling ends will shift. Practical questions that arise and have no set answer are: should port dockage slots be auctioned in pairs like airport slots to benefit from tighter scheduling? Or because in most parts oceans are still uncongested there might not be significant benefits from tighter scheduling, which should normally arise from reduced investment requirements. The obverse may be true with roads, which are currently inefficiently priced and not naturally abundant. For example, if roads were to be priced electronically a lot of long-distance freight traffic might shift to rail, where it can be more tightly scheduled (higher throughput) and causes less maintenance costs.[28] Scheduling economics

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[26] See for example Vickers (1994) which outlines the trade-offs in terms of a simple model where the incentive benefits of a number of competing firms is weighed against the duplicated fixed costs of entry.

[27] Once upon a time the socialist critique of market economies pointed to the allegedly wasteful duplication in chaotic markets, of which marketing appeared to be an obvious case. But while there might be some duplication in markets, the pressures generated by chaotic competition to work hard, to learn and to innovate apparently outweigh many costs of duplication. The theoretical benefits from coordination or planning on the other hands are difficult to achieve when matters get complex and markets tend to be better at generating useful information than planning bureaus. In other words what some call dynamic benefits of competition appear much more important than static allocational benefits in many settings.

[28] The channel tunnel provides a real world example that when costs matter it is cheaper to put trucks on wagons than to build a tunnel for trucks. This does not essentially depend on the higher cost for ventilation under a truck-on-road

also appear to be behind the debate of whether one should allow free entry into urban public transport e.g. bus systems or whether routes or set of routes should be (competitively) awarded as monopoly franchises. Likewise the empirical finding that free entry into solid waste collection services is less efficient than competitive award of monopoly franchises is likely to result from the advantages of tighter scheduling under the monopoly franchise.

As it is never quite clear ex-ante what the extent of natural monopoly is. So it might be useful to let markets determine whether monopoly is indeed natural. If a natural monopoly is truly such then only one firm will survive under unregulated competition for a franchise.

Competition is often valuable for the very same reason that it is impossible to quantify ex ante that it will be valuable. A review of the deregulation experiments in the United States highlights the role unexpected new ways of doing business have followed deregulation and led to welfare gains (Winston 1993). If one could predict innovation, whether organizational or technological, any old protected monopolist could match the competitive outcome. It is precisely, because one cannot predict innovation that competition is beneficial and by the same token one cannot ex ante quantify its benefits.

The view is also supported by specific examples of the behavior of protected monopolies. In many cases administrative entry restrictions have clearly retarded investment and better service — witness the behavior of monopolists like India telecom. At the same time the monopoly holder has often de facto charged market-clearing prices to customers by asking for bribes or other special payments for example for the installation of telephone service.

Many such monopolists were and are public enterprises and the lack of profit motive for the firm as a whole may explain their lack of dynamism. But other examples show that the private profit motive alone may not be sufficient to instill a monopolist with dynamism. As long as Ghana had only one cellular company the company invested slowly and planed to expand only as retained earnings easily allowed financing of expansion. As soon as a second cellular operator was allowed, the incumbent started to invest aggressively ahead of the previously announced schedule.

Essentially all of the preceding arguments against erecting policy barriers to entry revolve around what some call dynamic benefits of competition, i.e. benefits originating in better incentives to expend effort, learn, and innovate.

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system, but on the possibilities to increase throughput with tighter truck-on-rail scheduling and smaller tunnel diameter, because safety margins are less — in other words two benefits of tighter "scheduling".

4.2 Costs of Competition and Policy Barriers to Entry

In some cases policymakers will be reluctant to allow free entry for seemingly sound reasons. For example it may be difficult to see the benefits of allowing multiple water companies to tear up roads and sidewalks or to allow multiple garbage collection trucks to fight for the trash of the same community. However, in the first case — if the costs of tearing up the "street" are clearly imposed on the private firm including a tax for externalities such as disturbing traffic and general quiet — it is hard to see why anybody would enter the market, particularly if corporate take-overs were allowed, unless the new entrant had a superior solution for the problem of delivering water. In the second case it is again questionable why anybody would enter the trash collection market if prices could be freely set. An area monopolist should be able to offer better terms than to everybody than competing firms, unless competition yielded other benefits. Competitors would at all times be free to offer a new set of contracts to area residents and if they could sign up enough clients, they would oust the incumbent.[29]

But there may still be costs to letting markets pass the verdict on natural monopoly:

- The process of establishing the natural monopoly outcome may be wasteful and costly e.g. when water companies competed in the 19th century by laying parallel lines. Today studies suggest that competition among solid waste collection companies for the same customer group is less efficient than competition for (temporary) monopoly franchises for solid waste collection.

- There may be an unsustainable or suboptimal outcome from the competition for a natural monopoly under a policy of free entry. Suppose a single efficient firm is the cheapest solution to supply the whole market, e.g. a water company that is constrained to charge uniform single price tariffs in the service area. Suppose further that production technology is such that average costs are minimized when two-thirds of customers are supplied, but are rising again when more customers are to be connected. A new entrant could then offer to supply two-thirds of the customers at a lower price than the incumbent and would drive him out of business. In this case one third of the market would remain unsupplied.[30] Foreman-Peck and Millward (1994) use this argument to explain why service provision in 19th century water and gas systems was often limited.

- Regulation may provide incentives for excessive bypass (Laffont and Tirole 1990). Vertically integrated incumbents would tend to try charging excessive access/interconnection fees, which will by the same token provide excessive incentives to bypass the system.

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[29] In cases like trash collection, where sunk investments are minimal, a reasonably effective alternative to free entry is to auction off monopoly franchises in short intervals on the basis of the lowest price offered (Demsetz-Chadwick auction).

[30] This could be avoided in case price discrimination is allowed, because the incumbent could charge two thirds of the customers the minimum average costs and more to the rest so that the new entrant cannot offer better terms.

- Network externalities may create either excess inertia (too little investment while everybody waits for others to invest in the expansion of the network, which becomes more valuable the more it connects users to others) or excess momentum (too much investment as firms try to establish a first-mover advantage) (Tirole 1988, Economides 1994, Katz and Shapiro 1994)

The basic tradeoffs. Altogether the arguments for erecting policy barriers for entry into natural monopolies point to excessive costs of service delivery under free entry regimes or undersupply. To evaluate such arguments ex-ante one would need to have a view on the magnitude of such costs and compare them to the likely losses of efficiency resulting from restraints on competition. Such a tradeoff is by definition impossible to quantify ex ante, but the following general considerations may hold.

- **Costs of establishing networks.** Competition between networks may be desirable if the sunk costs of establishing those networks are "small" relative to the cost of the ultimate service, e.g. lines in telecommunication networks.

- **Government capability.** In cases where government capacity to benevolently and efficiently recognize natural monopoly and establish barriers to entry is weak it is more likely that entry should not be limited by policy (award of monopoly franchises or exclusivity periods etc.). Likewise when monopoly firms are either owned or regulated by a "weak" state the case for allowing competition is strengthened.

- **Technical change.** When technical change is rapid it will be more difficult to circumscribe the domain of natural monopoly and the dynamic benefits of competition will be large.

- **Complexity of networks.** As argued above in the discussion of scheduling there is likely to be more value in competing networks the more complex the network is, e.g. logistics networks. This is simply a case where the costs and benefits of maintaining a monopoly are little known and where competition is most needed to find innovative solutions.

4.3 The Political Economy of Natural Monopoly

Unavoidable political decisions. Most of these arguments are difficult to translate into practical measures that allow governments to assess the likelihood of wasteful duplication. It is harder still to assess the magnitude of dynamic benefits that need to be weighed against the costs of duplication. The easiest may still be cost function studies as suggested by the contestability literature. But this says nothing about how to factor in dynamic benefits from competition. Arguments about network externalities and games among a small number of players can go both ways — in favor or against entry barriers — depending how the games are specified. The foregoing arguments thus mainly characterize the logic of some arguments. At the end of the day — politically established biases will be the decisive factor. Good policy should ideally take such

biases into account guarding against arguments to restrict entry that do little more than protect special interests.

Government subsidized duplication. The same governments that advocate entry restrictions ostensibly to reduce wasteful duplication tend to tolerate and subsidize duplicate networks of major proportions — witness transport networks for example rail and road. In the 19th century competition from rail led to a decline of the private road industry in the United Kingdom. On the continent, France for example, the government maintained the roads with subsidies in the face of competition from rail. Today the reverse holds and many governments heavily subsidize rail. Governments also tolerate highly inefficient price structures and usage of infrastructure. For example, inefficiencies in road and airport usage pricing have been estimated to amount to around US$15 billion each in prices of 1995 (Small, Winston, and Evans 1989 and Morrison and Winston 1989).

Entry restrictions motivated by the private and political search for rents. Entry restrictions on the other hand have often been set at the behest of incumbents and to keep out new technologies. A case in point is the fight of gas companies against power companies around the turn of the century. Entry restrictions are particularly hard to undo when the boundary of a protected company coincides with the political jurisdiction that grants the protection. There are obvious benefits from collusion between the political powers and the firm, which would be reduced if the firm operated across jurisdictions and several political entities had to collude to extract monopoly rents. Municipal monopoly franchises may be particularly difficult to undo as history seems to suggest.

A variation of the theme are arguments in favor of entry barriers that are based on the need to maintain cross-subsidies. Certainly cross-subsidies can only be sustained if competition is somehow limited and so-called cherry-picking restricted. But the same subsidy can be provided explicitly and based on competition-neutral funding sources. Monopoly profits in one part of the network are not the only source of "tax" revenues.

Another argument for entry barriers is based on attempts to lower the ostensible cost of capital for network service providers. The natural incentive for investors, investment bankers and short-term revenue-maximizes in Government is to argue for entry barriers when privatizing infrastructure firms or issuing concessions to build new facilities. Thus the call for exclusivity periods, long-lasting concession terms etc. Indeed, monopoly rights will lower the ostensible cost of capital and render financing "easier." But they do so by shifting risks to the customers not by reducing risk overall, unless the entry barriers help avoid a social cost of the type outlined above, in which case the ease of finance and the cost of capital is not the critical argument.

Experience from the last century shows that investments not protected by entry barriers were in fact funded. Today we also see that new investments in competitive segments of network industries will be financed, e.g. power plants in competitive markets in Argentina, Chile, and the United Kingdom. What is no longer possible though is project finance based on long-term power purchase agreements with the ability to attract long-term debt in for highly leveraged projects. Rather financing patterns resemble more normal corporate finance patterns with low leverage, short

maturities and on-balance sheet financing by the sponsor. A recent case which suggests that competition may effectively stimulate investment and lower prices compared to a monopoly franchise solution is found in Chile, where the government allowed two rather than one gas transmission line to be built to supply gas from abroad. The decision to allow a competitor brought contract gas prices to final users tumbling down by some 20 to 30 percent.

4.4 Basic Policy Rule

As there are so many questions about whether monopoly should prevail and whether government is capable of identifying such situations ex ante, maybe the basic policy rule should be: in case of doubt do not restrict entry and, if you do, subject the entry restrictions to an automatic test after a set period of time and require a cost-benefit review to argue for prolonging entry barriers.

5. A SKETCH OF SECTORAL IMPLICATIONS

Depending on the physical characteristics of each "network" industry ways to introduce competition will vary in nature and effectiveness and differ in ease of implementation. Broadly speaking competition is of course easiest to introduce in industry segments, where sunk costs are unimportant e.g. in the case of many transport vehicles such as ships, airplanes, trucks, taxis etc. The basic policy solution here is free entry without economic regulation. Matters become more complex when economies of scale due to scheduling are important. In those cases it may be efficient to award monopoly franchises competitively e.g. for urban bus transport or solid waste collection services. As long as sunk costs are not important as in the case of buses and garbage trucks repeated franchise bidding can provide a good level of competition without the need for extensive regulation. To date positive experience has been gained with competition in all the above transport industry segments.

Where sunk costs are important, matters are more complex. For electricity and natural gas systems, which produce and carry fairly homogeneous products the best conceivable solution would appear to lie in "smart" competitive pools, wherever a sufficiently large market can be created to sustain workable competition. This argues, of course, very heavily for fostering international trade in energy services wherever possible. Competitive pools are still in an experimental stage, but with demonstrated effectiveness and clear promise. The greatest current challenge is whether fully flexible congestion price systems can be made to work and allow effective deregulation of investment decisions in the transmission and distribution networks. Water pipeline systems might also benefit from competitive pool solutions, if and when markets in tradable water rights in areas where the price of water is high are allowed to function. However, the politics of water may impede progress. Competition in water is also made difficult, because water sources can be quite heterogeneous and economies of scale in water treatment may render effective competition difficult in many cases.

Smart markets have yet to provide practical solutions to introduce competition in networks where goods and services are not homogeneous and where starting and end points of network flows matter. Attempts at solutions are being debated in the context of the Swedish and U.K. railway

reforms. But basically the preferred option of the day is some form of open access or common carriage system with regulation of interconnection rules. This is particularly important in telecommunications, but also used in various other networks such as railroads, airports, and natural gas.

To some extent the search for competitive, unregulated solutions can be facilitated if one simply relies on competition between "networks," otherwise described as intermodal or substitute competition. Typically that is an option for railways, which face competition from trucks in many cases. One can also rely on competition from petroleum product market to discipline pricing behavior e.g. in the natural gas market. Thus is the case for natural gas in Finland, Germany, and Hong Kong (for large users). Large electricity contracts in Germany are also unregulated. Indeed, international comparison of regulatory regimes shows that the rail and natural gas sectors are most likely to remain unregulated tend to rely most on substitute competition to provide pricing discipline.

Telecommunications services are more and more exposed to competing wireless services and in many cases competing line-based networks are being established as the cost of such infrastructure falls. Further technical progress may thus obviate the need for regulation. Countries with limited government capability to regulate can already rely on competition form wireless services to provide basic consumer protection.

The toughest regulatory challenges remain in electricity, water, airports and roads. In electricity the solution may lie in the above mentioned competitive power pools. In water the effective introduction of competitive forces is a fair way off, although conceptually similar to power pools. Road management may be revolutionized as electronic traffic management in conjunction with road (congestion) pricing becomes more widespread as a result of current tests in countries such as Italy, Norway, Singapore, and the United States. Airport landing rights auctions are still awaiting the arrival of appropriate smart markets, which would also be required to efficiently manage road networks and decentralize investment decisions in these networks.

The key to the introduction of new solutions will remain technical progress in telecommunications and telemetry. In the telecommunications industry itself technical change holds out the hope for workable competition among networks. In other industries such as transport and energy telemetry and telecommunication advances combined with computer-based smart markets are crucial for new solutions.

REFERENCES

"Australia: Telecoms Liberalisation." *Oxford Analytica Asia Pacific Daily Brief*, 2 August 1995.

Bacon, R. 1995. "Competitive Contracting for Privately General Power: What to Do in the Absence of Competition in the Market." Viewpoint Note 47. Washington, DC: World Bank, May.

Baumol, W.J., and G. Sidak. 1994. *Toward Competition in Local Telephony.* Cambridge: MIT Press and the American Enterprise Institute for Studies in Telecom Deregulation.

Bingaman, A.K. 1995. "Injecting Competition into Regulated Industries and Utilities." Address before the Public Utility Communications and Transportation Law Section, American Bar Association, April.

Cave, M., and C. Doyle. 1994. "Access Pricing in Network Utilities in Theory and Practice." *Utilities Policy* 4(3):181–89.

Comnes, G.A., E.P. Kahn, and T.N. Belden. 1995. "The Performance of the U.S. Market for Independent Electricity Generation." Advance Workshop in Regulation and Public Utility Economics, Eighth Annual Western Conference, San Diego, California, May.

Coopers & Lybrand. 1994. "Methods of Capacity Allocation." Mimeo.

Demsetz. 1968 "Why Regulate Utilities?" *Journal of Law and Economics* 11:55–66.

Economides, N. 1994. "The Economics of Networks." New York University, Leonard N. Stern School of Business, Department of Economics, November.

Economides, N., and L.J. Lawrence. 1993. *One-Way Networks, Two-Way Networks, Compatibility, and Antitrust*. New York University, Leonard N. Stern School of Business, Department of Economics, Working Paper Series EC-93-14:1–25.

Einhorn, M.A., ed. 1994. *From Regulation to Competition: New Frontiers in Electricity Market.* Boston: Kluwer Academic Publishers.

Ergas, H. 1993. *Investing in Infrastructure,* February.

Ergas, H., and E. Ralph. 1994. "The Baumol-Willig Rule: The Answer to the Pricing of Interconnection?" Trade Practices Commission, Canberra, mimeo.

Evans, C.A., K.A. Small, and C. Winston. 1989. *Roadwork: A New Highway Pricing and Investment Policy*. Washington, DC: Brookings Institution.

Foreman-Peck, J., and R. Millward. 1994. *Public and Private Ownership of British Industry, 1820 - 1990*. Oxford: Clarendon Press.

Friedland, J. 1995. "Free Market Wins in Chile's Pipeline War." *Wall Street Journal*, 1 August.

Funk, C. 1992. "How can Natural Gas Markets be Competitively Organized?", *Économides et Sociétés,* Série Économie de l'Énergie - EN, 5: 239-261.

Gray, P., D. Helm, and A. Powell. 1995. "The Experiment of Competition in British Electricity Generation: An Interim Appraisal." Oxford, mimeo.

Hajny, M.R. 1995. "Inter-Company Control, Metering, and Billing in Interconnected Electric Power Systems." World Bank Group, Energy Seminars, Washington, DC, June.

Katz, M.L., and C. Shapiro. 1994. "Systems Competition and Network Effects." *Journal of Economic Perspectives* 8(2):93–115.

Kay, J. 1995. "Discussant's Comments in Beesley Med Utility Regulation: Challenge and Response." IEA Readings 42. London.

Laffont, J.J., and J. Tirole. 1993. *A Theory of Incentives in Procurement and Regulation*. Cambridge: MIT Press.

_____. 1994. "Access Pricing and Competition." *European Economic Review* 38(9):1673–1710.

_____. 1990. "Optimal Bypass and Cream Skimming." *American Economic Review* 80:1042–1061.

McCabe, K.A., S.J. Rassenti, and V.L. Smith. 1990. "Auction Design for Composite Goods: The Natural Gas Industry." *Journal of Economic Behavior and Organization* 14:127–49.

_____. 1989 "Designing 'Smart' Computer-Assisted Markets: An Experimental Auction for Gas Networks." *European Journal of Political Economy* 5(2/3):259–83.

Morrison, S., and C. Winston. 1989. *Enhancing the Performance of the Deregulated Air Transportation System*. Brookings Papers on Economic Activity, Special Issue, 1–123.

Newbery, D. 1995. *Competition and Regulation in the Electricity Industry*. Proceedings of the OECD/World Bank Conference on Competition and Regulation in Network Infrastructure Industries, Paris.

Nilsson, J.E. 1995. *Allocation of Track Capacity: Experimental Evidence on the Use of Vickrey Auctioning in the Railway Industry*. Sweden: Centre for Research in Transportation and Society, mimeo.

Phillips, Jr., Charles F. 1993. "The Regulation of Public Utilities: Theory and Practice." *Public Utilities Reports, Inc.*: 127–159.

Ruff, L. 1994. "Real Competition." *The Electricity Journal* 7(5): 24–43.

Scheppe, F., C. Caramanis, R.D. Tabors, and R.E. Bohn. 1988. *Spot Pricing of Electricity.* Kluwer Academic Publishers.

Smith, P.L. .1995. "Technology, Competition, and Investment in Telecommunications Networks." World Bank, Washington, DC, August.

Smith, V.L. 1987. "Currents of Competition in Electricity Markets." *Regulation* 2:23–29.

Swartwout, R.L. "Current Utility Regulatory Practice from a Historical Perspective." *Natural Resources Journal* 32(2):289.

Tirole J. 1988. *The Theory of Industrial Organization.* Cambridge: MIT Press.

Train, K.E. 1991. *Optimal Regulation: The Economic Theory of Natural Monopoly.* Cambridge: MIT Press.

Vickers, J. 1994. *Concepts of Competition.* Oxford: Clarendon Press.

von Weizsäcker, C.C. 1980. "A Welfare Analysis of Barriers to Entry." *Bell Journal of Economics* II.2.

Williamson, O. 1976. "Franchise Bidding for Natural Monopoly—In General and With Respect to CATV." *Bell Journal of Economics* 7:73–107.

Winston, C. 1993. "Economic Deregulation: Days of Reckoning for Microeconomists." *Journal of Economic Literature* 31:1263–89.

Zupan, M. 1989. "The Efficiency of Franchise Bidding Schemes in the Case of Cable Television." *Journal of Law and Economics* 32.