•econ

NETWORK CHARGE CONTROLS AND INFRASTRUCTURE INVESTMENTS

PREPARED ON BEHALF OF BT

6 FEBRUARY 2001

TABLE OF CONTENTS

TABLES AND FIGURES

EXECUTIVE SUMMARY

This report considers the impact of OFTEL's current proposal for future network charge controls on investment and innovation incentives

OFTEL is currently consulting on options for the future of retail price and network charge controls placed on BT. With regard to network charge controls, OFTEL proposes to continue the current regime largely unchanged. Together with a safeguard cap on prospectively competitive services, there would be an RPI-X cap with a value of X between 7.5 and 11.5% (to be determined later) for three baskets of services that OFTEL considers are currently not supplied competitively. OFTEL considers some options that would apply this price cap to services regardless of whether they are provided through an IP-based network or the traditional PSTN, and to apply the price cap to flat rate internet access call origination – a new service introduced by BT which is regarded as being non-competitive. Moreover, OFTEL considers the option of allowing cost-based access to BT's network to a wider range of service providers ('Approach 3') in order to strengthen competitive pressure at the retail level and perhaps substitute for the continuation of a retail price cap. In this context, we have been asked by BT to consider the impact of proposed network charge controls on investment and innovation incentives.

We analyse these effects in a 'build-vs.-buy' framework

With regard to the services subject to network charge controls, competitors to BT have a choice whether to build their own infrastructure or else buy in network services from BT at regulated terms. We consider the impact of network charge controls within the framework of 'build vs. buy' – decisions, which will be strongly influenced by the terms and conditions upon which network services are available.

In practice, the build-buy decision is complex and takes account of flexibility and options

In practice, building infrastructure and buying in network services are not perfect substitutes. Once made, investments are costly and slow to reverse. Therefore, buying in network services offers much greater *flexibility* than building infrastructure. It keeps operators' options open and allows them to respond to changing circumstances, such as uncertainty about future retail demand, technological change and future relative prices of infrastructure and network services.

By buying network services rather than building their own infrastructure, operators retain flexibility which has a considerable economic value

Network services offer operators flexibility that has a measurable economic value (a so-called *option value*). Recent research has shown that these so-called 'real options' are endemic to real world investment decisions made under uncertainty. There is every reason to expect the issue of flexibility to be of great relevance to the build vs. buy decisions of BT's competitors. The more uncertain the environment for operators, the greater will be the value of flexibility provided by bought-in network services relative to investment and the more likely operators are to 'buy' rather than 'build'. As competition progresses, the environment faced by each operator will become more volatile. Where market share could be rapidly lost to rivals, the flexibility that buying in network services offers has considerable economic value relative to committing to investment where capacity may be difficult to adjust.

This option value is not included in network charges that are based on long-run incremental costs (even if they include a mark-up)

Network charges based on long-run incremental costs (LRIC), even if they include a mark-up to recover joint and common costs, do not take account of the much greater flexibility that buying in network services offers over building infrastructure. In practice, users of network services can rapidly increase or decrease the quantities that they purchase and face charges only for the quantities of network services they actually consume. Access regulation provides operators with not just the ability to purchase a certain quantity of network services, but also *options* to vary this quantity. However, LRIC calculates the additional costs that a user of network services would impose on the provider, essentially on the basis that a given quantity of services (the "increment") is purchased indefinitely.

Such network charges potentially distort investment incentives

This means that LRIC-based network charges potentially distort the build vs. buy decision and give sub-optimal incentives to build new infrastructure. They do not consider the issue of associated options that are provided for the user of network services to increase or decrease the quantity of network services used or to stop using them altogether.

This bias is not of concern where there are strong economies of scale in the operation of infrastructure …

Where networks demonstrate strong economies of scale, it will typically be cheaper to carry a given increment of traffic on existing infrastructure (as measured by LRIC) rather than to build new infrastructure. In this case, the primary policy goal may be to achieve static efficiency, in the sense of avoiding inefficient duplication of assets. However, as a result of technological changes, increasing demand and the introduction of local loop unbundling, the relevance of scale economies is diminishing and, therefore, it is necessary to consider with greater care the question of whether such schemes for access charging still give the correct incentives for economically efficient investment decisions.

… but to the extent that technological developments and changes in the regulatory environment make investments more scalable, it needs to be taken into account.

In a situation where technology has only weak increasing returns, LRIC creates a strong bias against infrastructure investment by failing to take account of flexibility and option values. For example, suppose that an operator builds a network with a technology that has no or only weak increasing returns to scale and is then required to make that network open to others at LRIC. Another operator would face the same expected cost from using the available network services or building its own network. However, in this case, it would be strictly preferable to 'buy' rather than 'build', as this would give much greater commercial flexibility than investing, but at no greater cost. Furthermore, market changes are also increasing the magnitude of LRIC's bias against investment infrastructure. Increasing competition places individual operators in a more uncertain environment, increasing the value of the flexibility that buying in network services affords.

Because of economies of scope, the effect of a bias against investment can have considerable spill-over effects

In practice, an infrastructure investment will often enable a range of services to be supplied to final retail customers. Even though network services bought at regulated charges may enable operators to offer only a subset of these services, setting network charges for any service too low may undermine the ability of operators deploying their own infrastructure to recoup their investment by constraining their pricing flexibility. If this discourages investment altogether, there are considerable spill-over effects; if network charges for one service are set too low, this may affect the provision not just that service but others as well.

There are likely to be social benefits from infrastructure investment that are not fully reflected in the build vs. buy decisions of operators, but which should be taken into account when regulating access.

Technological change and the regulatory obligation on BT to offer unbundled local is making network infrastructure more scalable. Increasing demand for telecoms services creates greater opportunity for coexistence of more operators, each at an efficient scale. As the importance of economies of scope decreases, it is increasingly likely that infrastructure investment has social benefits that exceed its private benefits. Where infrastructure investment leads to competing infrastructures rather than regulated access to a single infrastructure, it may be possible to replace regulation by competition. Infrastructure investment is also likely to lead to beneficial 'learning-by-doing' effects, where cumulated experience from one project increases the productivity of later ones. Although operators should factor this in as a benefit of a current investment, there is macroeconomic evidence that such learning-by-doing is not isolated to a single firm, but generates benefits for other firms as knowledge of best practice is shared (deliberately or otherwise). This also suggests that the emphasis should move (back) to providing the right incentives for infrastructure investment.

Empirical evidence supports the theoretical predictions that the regulatory regime has considerable impact upon investment incentives and the build-or-buy decision.

There is ample empirical evidence that the regulatory regime affects infrastructure investment. In general, tougher access regulation displaces investment activities from entrants to incumbents. However, it also replaces inter-modal competition between possibly different technologies with intra-modal competition between operators offering similar services by using access to a common regulated network. Therefore, a tough access regime may weaken incentives for technological innovation. Overall, empirical evidence is consistent with this. In general, more liberal regulatory regimes tend to have faster rates of innovation and deployment of new services. Comparative studies of different regulatory regimes for RBOCs across different US states have found that innovation is significantly greater where incentive regulation is used, rather than a tighter regime of rate of return regulation. There are notable examples, such as Germany, where low access charges available to a wide range of operators (regardless of their own infrastructure investment) very substantially undermined incentives for infrastructure investment. Comparing the US and Canada, there is much more infrastructure investment in the latter where there are few access obligations. There is a widely held view that the 1996 US Telecommunications Act has eroded incentives for new entrants to invest in the US market due to the obligation on RBOCs to unbundled network elements wherever technically feasible and to make such elements available at prices based on total element long run incremental costs (TELRIC).

There is a risk that biased investment incentives could prevent operators from exploiting the opportunities opened up by the move towards local loop unbundling..

These considerations should be taken into account by OFTEL when considering the future of network charge controls. The experience with fixed wireless access for residential customers in the UK suggests that alternative access operators have found (and are finding) it difficult to recover their infrastructure investment, given the level of competition from indirect access operators and price levels. This may have significantly undermined the incentive to deploy wireless local loop technology. Looking forward, we identify one area in which there is a risk that this experience might be repeated and similar problems might prevent operators from exploiting the opportunities opened up by local loop unbundling. Operators investing in xDSL technologies may rely on being able to bundle voice services together with broadband data services. If the availability of such services from indirect access operators purchasing the necessary network services at regulated charges from BT undermines the ability of DSL operators to price service bundles in a way that maximises revenue, this could undermine the incentives to invest in such technologies in the first place. This is one example where crucial investment might be affected by OFTEL's current proposals, and there may be many more.

Overall, we recommend considerable caution is required in order not to discourage infrastructure investment.

Overall, our analysis suggests that considerable caution needs to be taken in order not to discourage future investment in alternative infrastructure. OFTEL ought to continue to encourage infrastructure competition, recognising the enormous contribution of telecommunications investment and innovation to social welfare. Infrastructure policy is as important as competition policy, and regulators need to be fully aware of the way in which regulation changes investment incentives and take this into account in all regulatory determinations

1. INTRODUCTION

The current network charge controls under which BT operates in the UK (in effect since 1 October 1997) are due to expire in September 2001. Currently, OFTEL is consulting on the options for the future of retail price and network charge controls. In its most recent document, OFTEL has proposed to continue the current RPI-X regime of network charge controls for another four years for baskets of services that it believes are not, at present, competitively supplied. Adjustments will be made to the level of X, taking account of the potential for migration of traffic onto IP based networks. Flat rate internet access call origination services (FRIACO) – a new interconnection service introduced in response to the demand from ISPs for a tariff that would allow them to offer unmetered dial-up access more easily to their customers – will be treated in the same way as standard call origination, but be kept in a separate basket. OFTEL considers making cost-oriented access to network services available to a wider range of service providers, increasing the competitive pressure at the retail level and perhaps substituting for a continuation of the retail price cap (Approach 3), but recognises that this would involve significant uncertainty of impact and might therefore not be appropriate at present.[1]

In making these proposals, OFTEL has acknowledged that the regulatory environment can potentially impact on the incentives to invest in alternative infrastructure – too tight a control could damage those incentives.[2] However, there is concern that not enough attention has been given to the extent to which the current proposals might have such a detrimental effect on investment incentives. In this context we have been asked by BT to assess the potential dangers that might result from the specific OFTEL proposals with regard to investment in alternative infrastructure and the optimal deployment of IP-based network architectures.

We find that there are good reasons to expect that the decision to invest in infrastructure, i.e. to 'build' network infrastructure rather than 'buy' network services, depends crucially on the extent to which network elements are available at regulated charges, and the level of these charges. There is a considerable amount of empirical evidence to support this argument.

However, the link between the level of regulated charges and optimal investment decisions is not a simple one. In particular, we find that there is no reason to expect that charges set at, or based closely on, the long run incremental costs of providing a

---

[1] A more detailed description of OFTEL's proposals can be found in the Annex.

[2] See for example OFTEL (2000a) at paragraph 3.45.

particular service provide the right signals for optimal infrastructure investment, as OFTEL appears to believe. For these reasons, we believe that there is a considerable risk that the current OFTEL proposals may have a detrimental impact on investment incentives, possibly running beyond the period of the proposed charge control. For these reasons, we believe that great care is required in devising a system of network charge controls that will allow facilities-based competition to develop appropriately.

Our conclusions are based on:

- a review of the theoretical arguments relating to the 'build or buy' decision (Section 2);
- an application of these arguments to the appropriate setting of network access charges (Section 3)
- a review of evidence for the impact of the regulatory environment on investment decisions (Section 4); and
- identification of specific areas where infrastructure investment is likely to be an important issue over the coming years, and where there are concerns that the current OFTEL proposals might have an adverse impact on investment incentives (Section 5).

Our general conclusion is that great care needs to be applied in order not to discourage investment in facilities that holds the prospect of overcoming the lack of competition in the provision of certain services. The literature on investment incentives is vast and it considers many aspects. Therefore it is difficult to summarise and derive simple consequences. However, the literature makes it clear that regulation matters. Rules influence outcomes and payoffs, thus influencing investment incentives. Therefore regulators should be aware of the great impact the rules make on management practises and should act with more prudence.[3]

[3] Darby and Fuhr (1998).

2. 'BUILD OR BUY' – THE THEORY

For some of the network services that BT is currently required to offer under the network charge control regime there may be few substitutes (e.g. call termination).[4] However, with regard to others, OLOs have a choice between purchasing network services from BT at regulated charges and self-providing these services by investing in their own infrastructure. In this section we consider the key factors that determine whether an operator would want to 'build' or 'buy' a particular network service, and in particular how the charge at which network services are available will affect this decision.

2.1. THE KEY DETERMINANTS OF BUILD VS. BUY DECISIONS

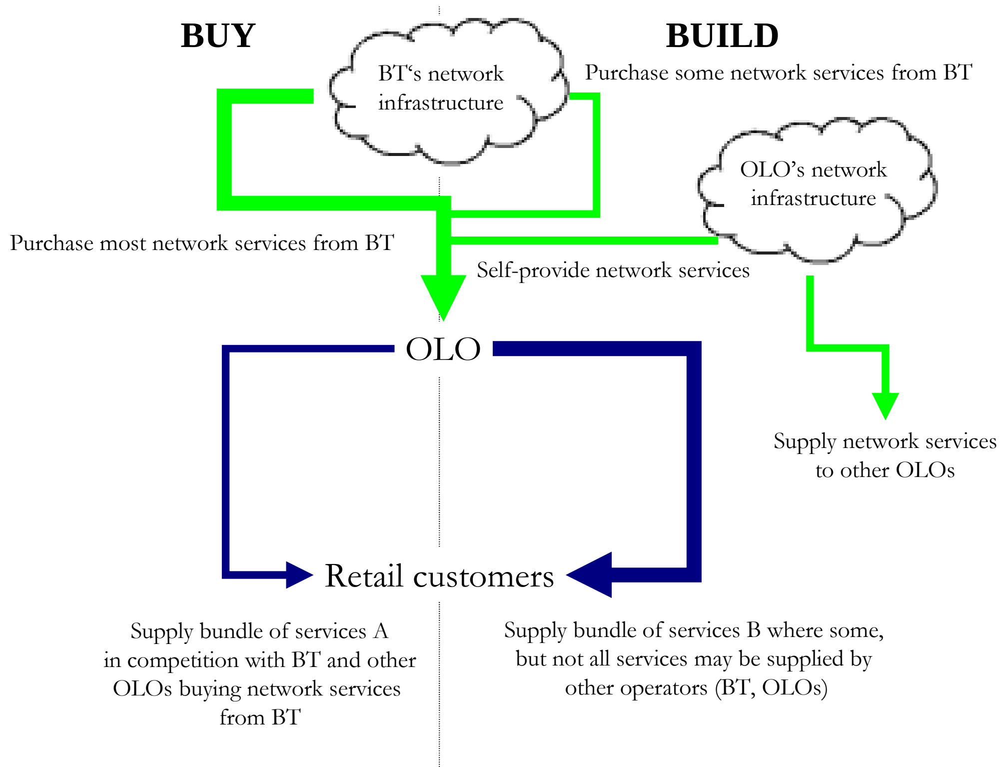
As any investment decision, the decision to invest in infrastructure depends on a comparison of the forward-looking cost of making the investment, and the expected returns flowing from it. Returns on a network infrastructure investment can come from two sources, namely:

- revenues earned from selling services in the provision of which the infrastructure is an input to retail customers; and
- revenues earned from selling network services to other operators requiring such inputs.

The particular case of a 'build vs. buy' decision is characterised by the investor facing the alternative that at least some of the returns can be generated without making the investment, but rather buying the input from a third party, as illustrated in Figure 1.

[4] Note that this statement must not be interpreted as saying that there is no competitive constraint affecting the provision of these services. Assessing the nature of competition between telecommunications operators is far from straightforward, and in particular the extent to which it is sensible to talk about the lack of competitive constraints on the pricing of call termination services has been the subject matter of considerable debate (see the discussion about the termination rates for fixed-mobile calls summarised in the MMC report on Cellnet and Vodafone (Monopolies and Merger Commission, 1998).

Figure 1: 'Build or buy'



In its simplest form, the decision between building and buying depends on two key factors:

- the relative cost of building own infrastructure (including all relevant opportunity costs) and buying the inputs required;
- the difference in returns earned from providing services using one's own infrastructure and buying key inputs from someone else.

As we consider below, fully articulating this principle is highly complex, not least as the opportunity costs of making investments can include a significant loss of commercial flexibility.

2.1.1. THE BENCHMARK CASE

Consider first the hypothetical case of an investment characterised by the following assumptions:

- Any costs incurred in making an investment can be fully recovered later, for example by disposing of assets, by reselling them or finding an alternative use that yields an equal revenue stream.

- There are no costs in re-deploying or transferring ownership of assets.
- The capacity of any infrastructure can be rapidly adjusted to match changing demand for the services that it provides.
- An investment in infrastructure provides the same services as would be provided by a network service and no additional functionality.

In this case, there is a simple rule for making an optimal build/buy decision - comparing the current cost of buying in a given quantity of network service with the current cost of infrastructure to provide sufficient capacity to provide those services. Here, the cost of infrastructure includes:

- the opportunity cost of the funds required to make the investment (i.e. the value of the investment multiplied by the operator's cost of capital); and
- any maintenance or operating costs associated with the investment.

The important feature of this decision rule is that under these conditions it is *not* necessary to consider *future* costs and benefits of investment in infrastructure. Rather, this is a decision that compares only the *contemporaneous* costs of building and buying. In effect, the assumptions imply that

- the expected returns are the same regardless of whether an operator builds its own infrastructure or buys network services from a third party; and that
- infrastructure can be used for a short time and then costlessly discarded, giving complete flexibility to switch back and forth between using network services provided by other operators or one's own infrastructure depending on which might be cheaper or more desirable at any particular time.

However, these assumptions are highly unrealistic for the following reasons:

- Every real-world investment decision is to some degree sunk. It is not possible to unwind an investment decision and re-deploy or dispose of assets without incurring some additional costs. This gives rise to an important difference between building and buying. Building infrastructure generally entails some commitment to that infrastructure, as disposing of it or re-deploying it is costly. In contrast, buying in network services is much more flexible - it is possible to start or stop buying network service at short notice.
- When investing in infrastructure it may only be possible to deploy capacity in indivisible lumps. Subsequently, it may be difficult, time-consuming or costly to increase or reduce capacity. In contrast, buying in network services is much more flexible.
- Own network infrastructure and network services bought in from third parties are not necessarily functionally equivalent. On the contrary, a

given investment may provide a range of functionality that exceeds the functionality that can be replicated by purchasing particular network services (even if it may be replicable by purchasing a range of network services), and making an investment may affect the costs of future related investments.

We consider the implications of these deviations from the benchmark case in turn.

2.1.2. SUNK INVESTMENTS

Let us first consider the implications of infrastructure investments being to some degree sunk. In this case, any build/buy decision is affected not just by the current pricing and demand conditions, but also by the anticipated pricing of network services over a reasonable horizon. This period will be affected by the length of time over which an infrastructure investment is sunk. For example, if assets depreciate very rapidly due to technical change, it may be possible to re-evaluate a build vs. buy decision frequently (say every few years). Other forms of infrastructure (e.g. digging fibre) depreciate only slowly and would therefore suggest a long planning horizon for any investment decision.

In these circumstances, uncertainty may discourage infrastructure investment and encourage the use of bought-in network services. Buying in network services maintains the option to make an infrastructure investment later if relative costs change. This option is valuable, and needs to be taken into account. By contrast, investing in infrastructure entails a commitment and thus a loss of flexibility and options; this is an opportunity cost of making an investment. Where the investment is sunk, it is impossible for an operator at a later stage to switch to buying network services should the cost of doing so fall in the future.

Suppose, for example, that the pricing of future network services was uncertain. To invest in infrastructure in this circumstance would run the risk that the charges for network services could subsequently fall, at which point it might have been preferable to have bought rather than built. However, since the original investment decision was sunk, it would not be possible at this point to go back and revise the build vs. buy decision. In contrast, if the operator initially decided to buy in network services rather than to invest, this would retain considerable flexibility. In particular, it would leave the option open to make an investment at a later date in the event that the cost of building relative to that of buying fell.

Thus, even if *expected* costs of providing the required network services through buying or building were similar, the considerable uncertainty over these costs make it *strictly* preferable to use bought-in network services. Bought-in services clearly provide much greater flexibility to respond to changing circumstances.[5]

2.1.3. INFLEXIBLE TECHNOLOGIES AND INDIVISIBILITY

In practice, capacity cannot be adjusted costlessly and immediately to match uncertain demand, unlike buying mandated services from other operators. This has substantial implications for the relative costs an operator may incur when building infrastructure or buying network services if demand for its retail services is uncertain. In particular, by investing in infrastructure, costs are incurred to provide a certain level of capacity regardless of what level of utilisation is made of that capacity. In contrast, the costs of buying in network services vary with the quantity of such services bought in.

Buying in network services also maintains options for technological flexibility. For example, it is very often possible to provide a given retail service over networks in a variety of different ways. By buying in network services rather than building dedicated infrastructure, it would be possible to change the manner in which a particular retail service might be provided. It also allows operators to defer making investments in infrastructure where technical change is anticipated in the future, lowering costs or making current infrastructure obsolete.

This issue is particularly relevant in any industry with rapid technical change. In these circumstances, any investment in infrastructure may become fossilised. Thus, in these industries there is a substantial option value of buying input services rather than investing in facilities that would allow self-provision of such services, but which could rapidly become obsolete[6]

2.1.4. FUNCTIONAL DIFFERENCES

Where there are functional differences, the expected returns from building own infrastructure and providing services using bought-in network services may differ considerably.

There may be economies of scope both in investment (i.e. an investment that allows an operator to self-provide a particular network service may also provide other network services) and in the provision of retail services (i.e. an investment in infrastructure may allow the operator to provide a wider and different range of retail services). In this case, it may be more appropriate to compare an infrastructure investment with a range of network services. As we discuss below, in this case the pricing of a number of network

[5] Taschdjian (2000) also concludes that the more sunk cost an investment incurs the more delayed the investment will be due to higher option value of buying in network services.

[6] See Gans (2000).

services will affect investment decisions that may go well beyond the self-provision of the network services in question. The presence of economies of scope and learning effects complicates the comparison of build and buy by introducing an additional element of uncertainty with regard to revenues.

2.1.5. THE CONSEQUENCE OF SUNKNESS AND UNCERTAINTY: OPTION VALUES AND THE FLEXIBILITY PREMIUM

The additional flexibility that buying in network services provides has an economic value (a so-called option value). Therefore, in an uncertain world, an operator would be prepared to pay *strictly more* for a network service than it would cost to invest in infrastructure as the former provides more flexibility. This conclusion follows regardless of the source of the uncertainty as long as investment is to some degree sunk.[7]

In practice there are many such sources of uncertainty, including:

- future pricing of future network services (which will be affected by the regulatory framework[8]);
- pricing of infrastructure assets and the impact of possible future technological innovation on the functionality of those assets;
- the future cost of capital;
- retail demand; and
- technological uncertainty (the extent of learning-by-doing, future results of innovation).

Any additional uncertainty increases this flexibility premium and makes buying in network services more attractive relative to building infrastructure as the former are much more flexible than the latter.[9] Expectations about the future regulatory environment (and in particular future policy on network access) are an important source of uncertainty relevant to build vs. buy decisions. Therefore, to the extent that the regulatory system creates uncertainty, even if this does not affect the relative *expected costs* of building vs. buying, it will nevertheless discourage and delay infrastructure investment

[7] See Dixit and Pindyck (1994).

[8] Taschdjian (2000) also concludes that regulatory uncertainty delays the deployment of new infrastructure. Crew and Kleindorfer (1996) emphasise the importance of regulatory commitment in incentivising investment and cost reduction in general.

[9] Decamps and Mariotti (2000) find in a duopoly model of irreversible investment under uncertainty, that if not only the outcome but also the opportunity costs of the investment are unknown then it creates further incentives to delay the investment.

as operators will be prepared to pay a greater premium for the flexibility that buying in network services affords.

2.2. SOCIAL VS. PRIVATE BENEFITS OF INFRASTRUCTURE INVESTMENT

So far we have discussed how individual operators decide whether to build their own infrastructure or buy network services from another operator having already made this investment. Are there reasons to suspect that the criteria that determine the individually optimal build/buy decision do not fully reflect the social costs and benefits of investing in competing infrastructure?

This is essentially the question whether there is insufficient or excess entry in the provision of network infrastructure. There is a large academic literature about the socially desirable rate of entry in markets, which depends both on the nature of competition and cost conditions. In terms purely of cost minimisation, if the cost structure of the industry is sub-additive (there are strong economies of scale or scope) then it is beneficial to limit competition.[10] There are social costs from infrastructure investment if this leads to losses of scale and scope economies. As new entrants into the provision of infrastructure do not take into account the inefficiencies they impose upon other operators in terms of lost scale economies, this is an argument that a private decision based on costs and benefits of infrastructure build-out might result in too much entry from a social welfare perspective.

However, any limitation of the number of competing infrastructure operators in a market would also entail a reduction in competition or require a move to increased regulation, which is generally considered to be an inferior constraint on market power than greater competition. Therefore, there are also social benefits to infrastructure investment.

Whether the net social benefits of infrastructure investment exceed the net private benefits depends on this balance between efficiency gains in retail pricing from increasing the number of competitors with efficiency gains from better exploiting scale economies. However, the clear premise of liberalisation programmes is that the former outweighs the latter.

Furthermore, dynamic efficiency issues give significant further reasons to suppose that the social benefit of infrastructure investment exceeds its private benefit. There are a number of benefits from infrastructure competition that are dynamic in nature and are not, or not completely, taken into account by the investor.

[10] See Sharkey (1982), Faulhaber (1975) or Kahn (1988) for discussion on natural monopolies and their regulation.

- Build decisions typically increase the diversity of available technologies and result in inter-model rather than intra-modal competition. This in turn could spur innovation and permit "Darwinian selection" of superior technologies for providing specific services to specific customers. The benefits from innovation often cannot be fully appropriated by the innovating firm, and therefore the social benefits from innovation may exceed the private benefits.[11]

- Build decisions may spur further innovation by generating 'learning-by-doing' effects. In a world of complementary and incremental innovations, there may be long term benefits from investment in alternative infrastructure that exceed those taken into account by the investor.

- Finally, only where there is potential for competition in the provision of facilities will the perceived need for regulatory intervention be reduced over time. Where infrastructure monopolies remain, there will always be a need to oversee the terms and conditions upon which access to this infrastructure is available. Given that competition is generally presumed to be more effective than regulation, there is a benefit from winding back regulation and replacing it with competition that is not at all reflected in the individual operator's investment decision.[12]

Thus, the overall effect depends on the presence and size of economies of scale and scope that would be sacrificed on the one hand, and benefits from innovation and an increase in the variety of available technologies as well as the long-term reduction of regulatory involvement on the other hand. Therefore, it is impossible to establish in general whether this overall suggests that there is too much or too little infrastructure competition.

However, if infrastructure investment can be channelled into areas where the loss of scale economies is minimal, then it seems likely that individually optimal investment decisions lead to too little entry. In this context, it is important to look at precisely where infrastructure investment would occur, and where economies of scale and scope are strongest. For example, it may be possible that infrastructure investment is focused around the use of unbundled local loops rather than their duplication. In this case,

[11] For a simple model see Tirole (1988), page 391 ff for a simple model in which firms may have insufficient incentives to innovate relative to the social optimum. Of course, there may also be a problem of excessive innovation triggered by so-called patent races (ibid., page 394 ff.).

[12] Kahn (1988) argues that the fundamental problem between regulation and competition lies in the fact that competition is measured by many performance criteria (prices, innovation, profits etc) while regulation may only focus on one of these (prices or profit levels). Tardiff & Taylor (1996) reason that in a competitive environment prices reflect **both** demand and cost, thus there are no guaranteed dividends for particular services and consumers. Thus, if regulation gives such guarantees in the face of competition then it can do considerable harm.

investments complementary to the use of unbundled local loops (i.e. equipment to terminate loops at the consumer and exchange ends and associated backhaul networks) are likely to be subject to few scale economies in the long run.

3. THE IMPLICATIONS OF OPTIMAL BUILD/BUY DECISIONS FOR THE SETTING OF NETWORK CHARGES

In this section, we draw some conclusions from the theoretical analysis with regard to the optimal setting of network access charges by a regulatory authority. In particular, we argue that using long-run incremental costs (LRIC) of those services provided under a regulatory obligation as a basis for setting network charges is likely to create a bias against infrastructure investment and in favour of purchasing network services. Yet, OFTEL's current proposals (which are summarised in more detail in the Annex) appear to be aimed at ensuring that access to network services OFTEL believes to be non-competitive is available to a wide range of operators at charges as close as possible to LRIC (or LRIC plus a mark-up for the recovery of fixed and common costs).

3.1. OPTION VALUES

In the event that network services are available on a regulated basis from an operator such as BT, the regulatory environment has a critical role in setting incentives and sending price signals for this build vs. buy decision. As we have discussed a build vs. buy decision is much more complex that simply a comparison of expected costs over some planning horizon. In particular, buying in network services tends to provide operators with much more flexibility to respond to changing circumstances than does building their own infrastructure. This flexibility has significant economic value, as the simple stylised example in Annex B demonstrates.

Therefore, even if an investment in infrastructure assets provides a service that is technically equivalent to buying a network service from another operator, build and buying are *not economically equivalent*. Buying a network service provides additional flexibility that has significant economic value. This suggests that, if functionally equivalent network services are available at the same expected cost as an operator would have to incur in building its own infrastructure, then the operator is likely to prefer buying the network services over making its own infrastructure investment. As a consequence, incentives to build rather than buy exist only where the charges for network services are somewhat higher than the expected cost associated with making a functionally equivalent investment in infrastructure. In this regard, network charges set at the level of long run incremental costs of providing the services in question (even if they include a mark-up to recover joint and common costs) are unlikely to provide an incentive to build infrastructure.

Consider the following hypothetical situation. Operator A has just built a network and is subject to an access obligation. Operator B is considering whether to build its own network using the same technology as operator A or else to buy in network services from A. Suppose that access charges are determined by LRIC. For the sake of simplicity, suppose that the network technology is not subject to economies of scale in the long run (i.e. the network technology scales with required capacity). Then with LRIC based access charges the *expected cost* of self-provision by operator B should equal the *expected cost* of buying in network services from operator A. However, faced with this choice, if there is any degree of "sunkness" in investment, operator *B* will strictly prefer to buy in network services rather than build its own network, as this provides greater flexibility.

By ignoring the value of flexibility that is associated with network services, the use of LRIC-based access charges (whether or not mark-up are applied to recover other joint or common costs) systematically biases the build vs. buy decision. It can lead to operators choosing to buy in network services when it would be social optimal for them to build their own infrastructure, as this would reduce total deployment costs.

Recent research on the importance of so-called "real options" on investment decisions has shown that the effects of uncertainty and 'sunkness' are not negligible.[13] In particular, it has been shown that even small costs of reversing investment decisions can give rise to disproportionate large impacts on investment decisions of option values. In this context, this means that even if investments are only partially sunk (e.g. they are fungible to other purposes), nevertheless there can be a very considerable value to the flexibility provided by using network services instead. Although option values are clearly difficult to quantify, there are no grounds at all to believe that these effects are negligible so that they can be ignored when setting access charges.

3.2. ECONOMIES OF SCOPE AND CHERRY-PICKING

In the case of economies of scope across a number of services provided by a single investment, the network charges set for individual services may have a spill-over effect on the incentives to build alternative infrastructure due to 'cherry-picking' behaviour. In essence, using network services may allow an operator to pick and choose the retail services it offers in a manner that infrastructure investment may not. If individual network service are mispriced, the desire to 'cherry-pick' may be a disincentive to investing.

An infrastructure investor may compete at the retail level with other operators who purchase network services. Retail prices of particular services are thus determined by the level of network charges. Underpricing some network services might undermine the ability of infrastructure investors to recoup their investment by restricting their flexibility to offer service bundles and prices these in a way that maximises revenues. Even if other network services were overpriced, there would not necessarily be any significant countervailing effect. Put differently, competitors may exploit the opportunity offered by some network services being too cheap and cherry-pick those customers who place a relatively high value on the retail services that can be provided by using the under-priced network services.

[13] For example, see Dixit and Pindyck (1994).

Consider a simple example of an investment that jointly provides two services, call them *S* and *T*. These services are used both individually and together to provide a variety of retail services. An alternative would be to buy *S* and *T* separately as network services from another operator. In this case, an operator may compare the cost buying in a bundle of *S* and *T* with providing those services jointly by investing.

If the prices of *S* and *T* are set by regulation, this raises the question of what happens if they are mispriced. Would underpricing one network service be compensated for by overpricing the other network service? Suppose that although a bundle of network services *S* and *T* was 'optimally' priced on average, the price of *S* was set too low and that of *T* too high. Therefore, although the general level of prices might be reasonable, there was a relative pricing distortion.

When making an investment the operator considers the *total* returns that flow from all new activities that the investment enables. As a result of this pricing distortion, the returns that can be earned from retail services involving activity *S* will be reduced due to competition from non-facilities based operators making use of network service S being available at sub-optimal prices. The overall return on investments in infrastructure will fall.

Whether the investment is commercially attractive depends on the expected return over this entire range of services. This is complicated as it requires us to gauge the impact that setting the charge for a particular network service might have on the ability of an operator investing in its own infrastructure to recover investment costs by offering bundled services in an optimal fashion. This may perhaps best be illustrated with a simple stylised example:

Assume that an operator wishes to exploit the opportunity offered by LLU and provide a bundle of broadband data and voice over DSL services. Assume further that customers differ with regard to their relative valuation of voice and broadband services. More specifically, assume that there are three distinct types of customers (I, II and III) whose valuation is given in Table 1. Assume that there are *x* customers of each type.

Table 1: Economies of scope and bundling – a stylised example

	Type I	Type II	Type III
Broadband	11	6	2
Voice	2	6	10
Bundle	13	12	12
Bundle if voice were available at 3 from other operators	13	9	5

Assume that the incremental cost of serving a customer is 8, but that the incremental cost of providing voice or broadband services given the other service is being provided is zero. In this case, the optimal pricing strategy for the operator is to offer the services only as a bundle at a price of 12. At this price, all customers would wish to purchase the bundle; the operator would incur a cost of $3 \times x \times 8$, and would earn revenues of $3 \times x \times 12$. Profit (including any contribution towards the recovery of common and fixed costs) in this case would be equal to $12 \times x$.[14]

Now consider that the voice element were to be available separately at a price of 3 if the customer did choose to use indirect access operators over a BT connection. In this case, the total value placed on the bundle is given by the sum of the valuation of broadband services and the lower of the value placed on voice services and the price of obtaining voice services from elsewhere (resulting in the numbers given in the last row of Table 1 above). In this case, the operator has the choice between offering the bundle at a price of 13 only to customers of type I (resulting in a contribution of $4 \times x$), or at a price of 9 to both type I and type II customers (resulting in a contribution of $2 \times x$).

Obviously, the availability of voice services from other sources at such a low price greatly reduces the incentives to deploy DSL services, and may even make it impossible for the operator profitably to undertake such an investment if common and fixed costs were in excess of $4 \times x$, the maximum gross profit achievable in this case.

[14] Note that the alternative would be to set a price of 11 for broadband services, and a price of 10 for voice services, at which customers of type I would purchase only broadband, customers of type III would purchase only voice and customers of type II would purchase neither. The overall revenues would be equal to $10 \times x + 11 \times x = 22 \times x$, and costs would be equal to $2 \times x \times 8$. This would result in a contribution towards the recovery of fixed and common costs of $x \times (22-16) = 6 \times x$.

The implication of this example is that where investments jointly provide a range of services, there is little sense in which underpricing one of these network services can be compensated for by overpricing another. This means that where a number of network services are regulated and might be jointly provided by infrastructure investment, underpricing *any* of these network services could depress investment incentives.

3.3. SOCIAL BENEFITS OF INVESTMENT

To the extent that there are reasons to expect that the social benefits from infrastructure investment exceed those taken into account by individual operators, it may be overall beneficial to set regulated charges for inputs that could substitute for deployment of infrastructure with a bias towards incentivising investment. This would suggest a deviation from LRIC even in the absence of issues related to option values and economies of scope.

3.4. A FIRST SUMMARY

The question whether an operator wishes to purchase network services at regulated charges from BT or invest in its own infrastructure is complicated and depends on a number of crucial factors. We have argued that the presence of sunk costs and uncertainty there is a considerable option value in buying rather than building, and that with the expected cost of the two alternatives being equal, it is strictly preferable to buy rather than to build.

This suggests that a purely cost-based benchmark which does not take account of this option value is likely to generate a potentially significant bias against investment, and distort the build-vs.-buy decision. This is the danger inherent in the current proposal that would continue to peg network charges at levels that have been based on the long run incremental cost of the services that BT has to provide. The current regime started with charges being set equal to LRIC plus a mark-up to recover fixed and common costs, and the level of X was set to guarantee that cost reductions would be reflected in these charges.

It might be argued that with the emergence of new services (in particular broadband services based on DSL technology) the relative importance of charges for network services that are required mainly in the provision of voice telephony services will decline, and therefore the impact of the network charge control will disappear over time. However, as we have argued above, this conclusion is mistaken if infrastructure investments are subject to economies of scope. In this case, an investor will take into account all revenue streams flowing from the investment, and an impact on only one of them will change the relative attractiveness of the investment. Even if regulation covers only some parts of the services that can be provided over new infrastructure, it may have a significant impact on investment incentives.

In particular innovative investments are likely to be strongly affected by a regulatory regime that does not acknowledge the role of option values. The survey of Hall (1994), amongst others, concludes that some of the main characteristics of innovation are that it involves significant sunk costs; innovation influences costs and revenues in vastly different ways; that its effects are highly uncertain and that firms vary widely but not predictably in their innovativeness. This would suggest that innovative investments with potentially large social benefits are particularly prone to be discouraged by a purely cost-based benchmark for network services.

4. THE IMPACT OF REGULATION ON INVESTMENT DECISIONS

There is evidence of the impact the regulatory environment can have on the incentives of both the regulated firm and prospective competitors to invest in the build-out of additional or alternative infrastructure. In this section, we provide some simple and high-level statistical analysis of aggregate data and a number of selected case studies that illustrate the need for regulators to be aware of the effects of their policies on investment incentives.

4.1. GENERAL EVIDENCE

Some general results about the link between regulation and investment and innovation can be obtained from analysing aggregate data on investment and the percentage of digital access lines available from the OECD. We have undertaken a statistical analysis of the relationship between the degree of regulatory leniency and:

- the level of investment undertaken by telecoms operators;
- the degree of network modernisation as measured by the percentage of digital access lines.

A detailed description of this analysis can be found in Annex C. The results confirm our prediction that both investment and the degree of network modernisation are likely to be higher in lightly regulated countries.

4.2. THE US EXPERIENCE

A considerable number of empirical studies have analysed the effects of different regulatory regimes on price, productivity and to some extent investment in the United States, not least because differences in regulation of the RBOCs provide a sufficient amount of detailed data to enable the deployment of econometric methods. The focus of these studies is on the impact of differences in the regulatory regime and the extent of competition on investment incentives and modernisation[15] and/or determinants of investment (such as the costs of capital).[16] However, there is little or no work assessing directly the extent to which the regulatory environment has encouraged or discouraged investment by competitors to the regulated firm, and thus promoted facilities-based competition.[17]

The US approach to telecommunications regulation has been noted for its *'complexity, its political compromises, and its reluctance to trust market forces'*.[18] In particular, the Telecommunications Act of 1996, widely regarded as intended to promote the

[15] Greenstein et al. (1995) use data of the deployment of new local telephone exchange technology at firm level across the USA between 1987 and 1991 to study the influence of regulatory rules on investment in modern infrastructure. They find that "*both demographic and regulatory factors influenced observed deployment patterns*". Moreover, further tests lead them to conclude that "*more liberal regulatory environments lead to greater incentives to deploy modern equipment*". Similarly, a study conducted earlier by Taylor et al (1992) using industry-wide data for local exchange companies reported that deployment of new infrastructure is enhanced by incentive regulation (as opposed to rate of return regulation). Montgomery (1994), on the other hand, concluded that incentive plans have no impact on investment. However, the independent variable he used (investment per access line) is known to be a very unreliable measure of investment (see Darby and Fuhr, 1998). Ai and Sappington (1998), using data on regional Bell Operating Companies in the US analyse the link between investment for the period 1990-1999 and competition as well as demographic and political influences. They find that *aggregate* investment and operating costs of the regulated firm do not vary across regulatory regimes. However, they also show that there is "*more pronounced network modernisation* [deployment of fibre optic networks] *under incentive regulation*".

[16] Archer (1981) showed that for the US "*capital costs of electric utilities were strongly related to ratings that reflect stringency with which individual states regulate rates*". This shows that under more stringent regulatory regimes firms marginal investment cost rise, hence they will be less likely to begin projects with low return. However, it has to be noted that this result is derived using very basic econometric methods and may possibly be biased by the lack of alternative explanatory variables. Nwaeze (1997) examines the response of stock market returns to changes in investment in the US electricity industry, using a sample of traditional rate of return regulated firms and a corresponding group of incentive regulated firms. This response is interpreted as the information content of investment decisions, which reflects the level of confidence shareholders have in the quality of investments made by companies. The higher the level of information captured the lower will be the cost of capital for a project, all other things being equal, as investors are exposed to less 'measurement' risk. The study finds that firms subject to IR are regarded by investors as making better investment decisions than firms subject to TROR.

[17] The study with the topic of analysis closest to this is conducted by Ros and McDermott (2000). They analyse the relationship between the level of local exchange prices and competition in the local exchange market. They use dependent variables that proxy for facilities based competition. They find that in areas where tariffs are less rebalanced, less residential customers are served by switching centres where new entrants have collocation arrangements. Although their findings cannot be used directly to evaluate the effect of different regulatory regimes on investment incentives it indicates that prices set by the regulator effect the incentives to innovate, in particular that too low prices discourage investment by new entrants.

[18] Green and Teece (1999), page 23.

development of facilities based competition,[19] has been criticised as being far too complex and interventionist, and hence stifling rather than promoting competition.[20]

The primary goal of the 1996 Act was to foster competition in all telecommunications market segments.[21] In addition, the 1996 Act had further objectives such as:

- to ensure the timely deployment of advanced services and the underlying infrastructure necessary to achieve such competition;
- to safeguard the provision of universal service; and
- to remove the legal barriers hindering the convergence of telecommunications and TV, mobile and fixed, local and long-distance services. [22]

However, despite its primary focus on the development of competition, overall very little facilities-based competition has developed. A number of explanations have been suggested for this.

Unbundling requirements and the level of charges for unbundled network elements. The FCC's 1996 Local Competition Order revealed the FCC's belief that incumbent local carriers would enjoy some form of natural monopoly and that as a result new entrants would not initially build extensive competing facilities. Instead, new entrants were believed to follow a multi-stage strategy, starting as pure resellers and proceeding towards infrastructure investment. A natural consequence of this view was to require incumbents to provide network services that were to be unbundled *'at any technically feasible point'*,[23] in the belief that the market would decide with regard to which components competition was feasible and which were indeed natural monopolies.

The FCC determined that charges for interconnection and unbundled elements would be set at total element long-run incremental cost (TELRIC). Such cost setting has been criticised, as a facilities based operator thus would have to beat a conceptually idealised

[19] The Telecommunications Act in Section 706 suggests tools the regulator might use to achieve this goal. These are price cap regulation, regulatory forbearance, measures that promote competition in the local telecommunications market and other regulating methods that remove barriers to infrastructure investment (Darby and Fuhr 1998).

[20] Farrell and Katz, (1998).

[21] Ware et al (2000).

[22] Farrell and Katz (1998).

[23] Crandall (1999).

mark, rather than the incumbent's actual forward looking cost.[24] In addition, local charges were historically kept low relative to the cost of service provision, and subsidised with revenue from long distance carriers. This caused residential local markets to be a difficult area for a competitor wishing to build its own infrastructure. However the TELRIC based pricing made it cheap and easy for competitors to enter into the provision of local services.

An indication of the failure of this approach to promote the development of facilities based competition is provided by the fact that only very limited use is being made of the requirement on the incumbent operators to unbundle their facilities at any technically feasible point. This option would be particularly relevant for operators having invested in some of their own infrastructure, but needing some unbundled network elements in order to complement their own facilities. However, despite the availability of unbundled network elements, their leasing uptake at the local level is not widespread. An FCC 1999 Local Competition report states that UNE loops were being used to serve only 0.2% of access lines by the end of 1998.[25] This suggests that operators are not using the ability to access unbundled network elements as a stepping stone towards their own infrastructure.

Legal uncertainty. A January 2000 General Accounting Office Report recognised that over four years, controversies over the Act were not yet resolved .[26] Implementation of the new interconnection and pricing policies proved to be time consuming and the detailed regulation had led to lengthy and expensive disputes between incumbents and entrants. It may be argued that uncertainty regarding the outcome of lengthy litigation procedures has dampened long-term investment plans, both for incumbents and new operators. This is consistent with the modern options-based view of investment.

Competitive local markets as a trigger for the removal of line-of-business restrictions on the Regional Bell Operating Companies (RBOCs). Following the break-up of AT&T, a line-of-business restriction was placed on the RBOCs, barring them from the provision of long distance services. The 1996 Act lifted this restriction *provided that* the regulator had certified that the RBOCs' local markets were competitive. Until an RBOC could receive regulatory certification that its local market was competitive, it was not permitted to enter into the potentially lucrative long-distance markets.[27]

[24] Haring and Shooshan (1998).

[25] Ware et al (2000).

[26] Ware et al (2000).

[27] Ware et al (2000).

This may have provided a disincentive for long distance carriers to extend their operations into the local markets. By helping to develop competition in local markets, they would have contributed towards the release of the RBOCs from their restrictions and the increase in the number of competitors in the long-distance markets. To the extent that established long-distance operators were in a good position to expand into local access markets, this would have had a negative impact on the development of local competition.

The US experience provides support for the view that regulation that is based on the view that certain services are very likely to be non-competitive and therefore need to be regulated very tightly is likely to contribute to the very absence of competition. In other words, a tightly regulatory view of the world has a tendency become a self-fulfilling prophecy. The importance of profit margins created by the absence of regulation can be seen with regard to the US long-distance market.

The disappointing development of facilities-based competition at the local level can be contrasted to the long-distance market where facilities-based competition has taken hold. Long distance competition was introduced during the 1970's in the US, and as operators were required to subsidise local services, the regulator allowed charges in these markets to be in excess of costs. However, the FCC introduced access charges to try to distribute the burden of subsidising the cost of the local network equally only in 1984, and even then AT&T was still treated as dominant provider and was subject to price regulation. This price regulation created opportunity for new entrants on low-cost, high-revenue routes. New entrants were able to enter this market and operate at a profit, but they had to deploy their own infrastructure to do so.[28]

To summarise, there is a widely shared view that the 1996 US Telecommunications Act has complicated the workings of the market and delayed facilities-based competition. The incentives for new entrants to invest at the local level in the US are minimal. Unbundling at cost was mandated, hence an entrant's incentive to build that element or a substitute was removed, and an entrant's incentive to build a complement to that element was increased. Wholesale prices available to resellers – set at a discount to retail prices - are below cost, and hence competition has developed mainly in the resale market.

4.3. THE CANADIAN EXPERIENCE

By comparison with the US, the Canadian regulators opened up their local telecommunications market with a far greater emphasis than their US counterparts on supporting the entry of facilities based competitors.

---

[28] Green and Teece (1999).

Long-distance competition has been in place in Canada since 1990 for long-distance resellers,[29] since 1992 for facilities based competition (following a decision by the Canadian Radio-television and Telecommunications Commission, CRTC, to allow such competition).[30] Even though alternative facilities have been developed, the majority of long-distance competitors are resellers.[31] New entrants, in particular resale competitors, gained substantial market shares from the incumbent telecommunications companies.[32] From 1994 to 1999, the incumbent exchange carriers are estimated to have lost almost 35% of the total long-distance voice market.[33]

When opening local markets to competition (CLECs were allowed from May 1997, and the target date for completion of tariff approvals and the resolution of technical issues was set at 1 January 1998) the CRTC was intent not to repeat this experience and to support facilities based new entrants. The measures taken by the Canadian regulator in order to achieve this goal are set out very clearly in a letter written by the Chairman and the President of the Alliance for Public Technology to Reed Hundt, then Chairman of the US Federal Communications Commission, in August 1997:[34]

> *[First, Canada] didn't mandate local resale discounts; competitors must pay retail prices for the underlying services.*
>
> *Second, in Canada only 'essential facilities' – those that can't be provided economically in any other fashion – must be provided. In practical terms, only three network elements must be unbundled: access to telephone number, access to directory listings, and local loops in high-cost areas. In a concession to facilitate early market entry, however, the CRTC decided to mandate unbundling of all local loops for the first five years. Prices for unbundled elements will be based on long-run incremental costs, plus 25% for joint and common costs. Competitors in Canada weren't given access to incumbent's back office operation support systems.*

This pricing structure and the limited period for which unbundled local loops were available other than in high-cost areas provided considerable incentives for the roll-out of alternative infrastructure.[35] In fact, Canadian CLEC's are judged to have had very few

---

29 CRTC Decision 90-3 'Resale and Sharing of Private Line Services'.

30 See "Primus Canada Acquires London Telecom", http://www.wintel.ca/news, 31 March 1999.

31 Gibert and Tobin- International Trends in Telecommunications Regulation. January 1997.

32 OECD (1996)

33 Grant (1999)

34 See http://www.apt.org/policy/797hundt.html

35 See http:// www.crtc.gc.ca/eng/BACKGRND/acc20000e.htm

options but to build directly to end user locations.[36] Whilst this may result in delays to the introduction of competition in suburban and rural areas, it has been regarded as being likely to prompt more rapid development of alternative infrastructure, particularly wireless technologies.[37]

Despite these 'harsh' conditions for new entrants, by 1999, some 30 companies had announced plans to meet the CRTC's list of requirements for CLEC status and thus signalled their intention to enter the local market. New entrants include wireless service providers, cable companies and long-distance carriers.[38] AT&T Canada and Optel Communications had been operating in local market as resellers, and thus has substantial customer bases with whom they could attempt to switch into the facilities based market.[39] By the end of 1999 'real' competition became evident when new local entrants were ready to roll-out their networks.[40]

In an effort to promote convergence in telecommunications and broadcasting distribution industries, in 1998 the CRTC also ruled that cable companies were to be able to enter the local telephone market, and telecoms companies are allowed to apply for broadcasting licences. Cable television was launched in Canada in the 1940's, but cable voice telephony is still in its infancy. However, the residential broadband Internet solutions market is currently dominated by the cable operators, who hold a 70% share. This dominance will continue, as 70% of all Canadian households are passed by the three major cable companies, Shaw, Rogers and Vidéotron who offer broadband-ready connections.[41]

The progress of facilities based competition may have been gradual, with real local competition being felt some 20 months after the CTRC's decision.[42] However, facilities based competitors are now a viable alternative to the incumbent carriers in both long-distance and local markets.

---

36 See Kiessling and Blondeel (1999).

37 Ibid.

38 OECD (1996).

39 See Grant (1999)

40 Ibid.

41 Ibid. In 1999, cable companies were ordered to make available for resale these connections at wholesale charges 25% below retail rates (Telecom Decision CRTC 99-11, 14 September 1999). However the effectiveness of this obligation may be limited by a get-out clause that restricts the requirement to where it is 'technically feasible'.

42 See Grant (1999)

4.4. THE GERMAN EXPERIENCE

In line with the European liberalisation process, the German telecommunications market was fully liberalised in January 1998, with reforms encompassing local, long distance and international services. These reforms are widely viewed as successful; the German market transformed swiftly eroding Deutsche Telekom (DT) position to produce a market also containing numerous smaller competitors. By 1999 DT's share of the domestic fixed line market had fallen to 61%.[43] By July 2000 over 400 licences for fixed network voice telephony and transmission lines had been issued by the German regulator, RegTP.[44]

However, the transition may be considered as somewhat unsatisfactory, as the envisioned competition to DT from alternative facilities providers has not developed to the extent hoped for. Competition to DT currently comes primarily from resellers providing services on leased DT lines. Both before and after liberalisation, lengthy disputes ensued involving the appropriate costs and conditions for new entrants' interconnection to DT's network and access to the local loop.

Initially all new entrants lobbied for low charges. However, as service providers succeeded and put considerable downward pressure on retail prices, those who had and continued to invest in new infrastructure experienced large losses. Competitors actually wishing to roll out their own infrastructure found it to be commercially unviable.

The main reason for this was that network services at low costs were available to all operators, regardless of how much they had invested in infrastructure. DT argued for eight points of interconnection, preferably meshed switches, to be the minimum infrastructure requirement on the grounds that DT's capacity was limited and alternative operators routing their calls over long distances to their one switch were clogging up DT's network.[45] However in March 1999 the German regulator, RegTP, defined a telecommunications network as being at least one switch and three transmission lines.[46] Hence an operator with minimal own-infrastructure investment could gain access to DT's network and operate a competing service.

---

[43] CIT, Datafile of European Telecommunications.

[44] InterConnect, The European Interconnection Manual.

[45] Gerd Tenzer, Telekom Board member cited in Total Telecom, 5 May 1998.

[46] European Commission (1999).

This, together with the very low level of charges set by RegTP[47] and what many perceive as a flawed strategy of DT in responding to competition, has helped quickly to erode DT's market position at the retail level. By the end of 1998 MobilCom held a 10% market share, and both it and Talkline had been able to generate millions of minutes of traffic with minimal infrastructure investment. The Financial Times reported that "*MobilCom, the small German operator, grew dramatically last year by exploiting a regulatory regime which enabled it to undercut Deutsche Telekom handsomely*".[48]

Facing cut-throat competition from service providers, Mannesmann Arcor sided with DT on the interconnection issue - the new entrant had invested billions in new infrastructure, yet the low-cost re-sellers threatened its success. Mannesmann board member Peter Mihatsch said operators with no infrastructure should pay different network usage fees from those operators who build infrastructure, otherwise "*there is little incentive to invest*".[49] By the end of 1998 o.tel.o recorded lower than expected sales, and posted losses of DM 2.2 billion, partly caused by its failure to anticipate the popularity of call-by-call services and relying on customers pre-selecting their carrier. The Chief Executive resigned in July 1998.[50]

By 1999 tensions were evident in the professional association of telecoms providers, VATM, which experienced an internal conflict of interest within the group over whether the association should lobby for high or low interconnection fees. Infrastructure owners Mannesmann Arcor, o.tel.o, Viag Interkom and others including city network operators such as NetCologne were badly hit by large infrastructure investment and heavy losses in the face of new entrant service providers. After losses of DM 2.2 million in 1998, o.tel.o revised its rollout plans downwards. o.tel.o was later acquired by Mannesmann Arcor after its original shareholders (REW and VEBA) decided to withdraw from the fixed line telecommunications business.[51]

---

[47] Prior to liberalisation, DT announced relatively high interconnection charge of 6 pfennnigs a minute to its network. New entrants (including the facilities-based carriers Mannesman Arcor and o.tel.o) were initially vocal opponents to these proposals, supported by the EU Commissioner for Competition Karel van Miert, who demanded that DT reduce its rates or face legal action from Brussels. Criticism regarding Governmental interference was levied at the Economics Minister Werner Mueller after he stated that he would protect DT shareholders (which included the German government) from harmful regulatory decisions, even though the Ministry had no power to make or change regulatory decisions. However, it was believed that the Minister's comments precipitated DT's withdrawal of its third charge proposal, and hence delayed the final fixing of charges. The German Post and Telecommunications Ministry eventually set an average rate of 2.7 pfennings a minute (see Bloomberg News, 12 September 1997).

[48] Financial Times, 8 December, 1999.

[49] Peter Mihatsch, Mannesman AG board member quoted in Total Telecom, 5 May 1998.

[50] Total Telecom, 20 October 1998.

[51] www.teletarif.de, 1 April 1999.

Charges for access to DT's local loop also proved to be problematic. DT initially proposed local loop access charges of almost DM 50 per month, which it eventually decreased to DM 28.80 per month. New entrants requested that access charges be set at DM 15 per month. Both sides repeatedly appealed to the regulator, who announced temporary local access charges of DM 20.65 per month.[52] However a lengthy period ensued with no clear long-term prices. New entrants have complained that RegTP's delays in overall decision making lead to a lack of a stable basis for market entry-especially in the case of RegTP's postponement of more than one year regarding the authorisation of tariffs for local loop unbundling. In addition, the uncertainty hindered infrastructure investment. As o.tel.o's Chief Executive Thomas Geitner complained, it "*effectively turns investment plans into speculation*", and, "*postponing this decision means pushing back these investments*". In February 1999 the local access charge was finalised at DM 25.40, to hold until 31/03/01. However, this rate is 20% higher than DT's residential line rental, and hence provoked criticism as rivals would not be able to compete with DT[53].

The German experience clearly shows that liberalisation can be made to have a quick and almost immediate impact at the retail level, but that this comes at the price of discouraging infrastructure investments. It also shows that investment decisions are very sensitive to uncertainty. By contrast, service providers and resellers are able to enter and exit the market also immediately, and can exploit any opportunity that is created by pricing access to network services at a very low level.

[52] Total Telecom, 10 March 1998.

[53] Bloomberg News, 8 Feb 1999.

5. AREAS OF CONCERN

In this section, we discuss in more detail why any bias against the incentives to invest in alternative infrastructure inherent in OFTEL's proposal may be of considerable concern in the current environment.

The major change in the regulatory environment since the introduction of the current regime of network charge controls has been the introduction of an obligation on BT to make available unbundled local loops to operators wishing to provide DSL services using their own DSLAMs located at BT's local exchanges. This is regarded as a measure that facilitates the investment in alternative infrastructure. Competitors wishing to deploy new technology to serve subscribers directly are able to do so by obtaining the copper loop from BT. Both industry participants and experts consider this to be a vital step towards the deployment of alternative infrastructure.[54]

Overall, this opens up the potential for facilities-based competition in any part of the network apart from the physical piece of copper wire connecting customer premises to the local exchanges. However, in order to exploit this opportunity, other operators need to have an incentive to undertake the investment required to provide the necessary equipment both at the customer premises and at the local exchange. Whilst this investment is considerably smaller than rolling out an alternative infrastructure, it is nevertheless significant.

The success of LLU depends on both the willingness of alternative operators to undertake potentially considerable investments in their own infrastructure and the effective enforcement of the LLU obligation. Effective enforcement of LLU without sufficient demand for unbundled loops does not lead to the facilities-based competition LLU is expected to generate.

The history of fixed wireless access demonstrates that the success of promising technologies may be rather limited if investors face a competitive environment supported by regulation in which it is difficult to recover their investments and earn a sufficient return. Therefore, we briefly review the examples of Ionica and Atlantic Telecom. We then discuss where similar problems might surface in the incentives to

---

[54] Mark Armstrong, one of OFTEL's external economic advisers and a former member of its Fair Trading Advisory Board, is quoted as saying that "LLU allows new entrants to test the water before engaging in full-blown competition." They can build a customer base and test their services before investing in their own facilities (see "Keeping Broadband in the Loop", *Telecommunications International,* September 1999, available at http://www.telecoms-mag.com/issues/199909/tci/llu.html. Similarly, Redstone Telecom sees LLU as a chance to implement a 'smart build' strategy, investing in additional capacity as traffic volumes grow and avoiding the speculative investment characteristic for traditional telecommunication build models (see Redstone Telecom Annual Report and Accounts 2000, at page 3).

exploit the opportunity offered by LLU, in particular with regard to symmetric digital subscriber lines (SDSL).

5.1. THE FIXED WIRELESS ACCESS EXPERIENCE

Apart from cable operators rolling out their networks in their franchise areas and offering subscribers a bundle of television and telephony services, wireless local loop (WLL) operators were the only alternative providers of access for residential customers. The UK's two most notable WLL ventures (namely Ionica and Atlantic Telecom) provide suggestive evidence of the impact of regulated network charges on the extent to which alternative infrastructure investment is commercially viable.

The main factor that differentiates these two companies from OLOs' providing their services to customers using indirect access is that the latter are required to purchase network services from BT - mainly call origination services and local-tandem conveyance.[55] In other words, the main difference between WLL operators and indirect access operators lies in the fact that the former self-provide the access portion of the network (build) whereas the latter buy network services from BT. As both WLL and indirect access operators can in principle provide the same range of services, the success of WLL operators is to a large extent determined by any cost advantage they might have as a result of self-providing the access portion of the network rather than having to obtain it from BT.

Ionica was founded in 1991 and launched its services in 1996.[56] Ionica's product was designed to compete head-on with BT's PSTN and voice services provided by indirect access operators. Although Ionica offered one or two extra services, and it had a similar ability to support data services (via voice-band modems) and its main proposition was very similar to that available from other. This left Ionica competing with other operators primarily on price. Ionica's promise was to supply PSTN services at a price that was 15% less than BT's – a small margin, in particular if compared to the offers available from indirect access operators which reduce charges for UK national calls typically by about 50%.

Given these offers, Ionica's success in attracting customers was limited, and its penetration levelled off at about 3% - a very small market share. Moreover, Ionica's customer base appears to have been heavily biased towards customers with lower incomes, which is reflected in a very high rate of forced disconnections due to credit problems. For example, in September 1997 Ionica had 31,399 customers, with 2,705 of

---

[55] Note that WLL operators will also need to purchase network services from BT (e.g. call termination) and may purchase others (conveyance and transit), but that there may still be a difference with regard to the amount of network services they require BT to provide.

[56] For a more detailed description of the company's history see Epsicom Business Intelligence (1998).

these disconnected in that single quarter. Ionica stated that 50.6% of these disconnections were related to customer credit problems, which means that they forcibly disconnected 4.4% of their customer-base in that quarter – corresponding to an annual rate of around 17%.[57]

This poor performance was reflected in Ionica's stock market performance. From a peak of 399p per share in September 1997 (9p above the floatation price of July 1997), Ionica's shares had fallen to around 110p per share by the middle of November 1997, and have never recovered from this slump. In mid-1998, Ionica announced it was seeking a strategic investor after failing to agree terms with its banks over a £300 million lending facility. No investor came forward and, as a result Ionica went into administration in October 1998.

Industry insiders were in little doubt as to where the blame lay for Ionica's failure[58]:

> *It has been widely reported that its expansion plans were scuppered by glitches in its computer network, which in turn hit sales. But analysts rejected this claim, arguing that computer systems were being used as the fall guy. 'There were computer problems early on but these are being blamed to a much greater extent than is merited. You cannot blame equipment for a shortfall in sales,' said John Matthews, principal consultant at Ovum. 'There were over ambitious financial forecasts at the time of flotation that were hard to justify. The management and financial advisors have to take responsibility', he added."*

Atlantic Telecom – the other provider of fixed wireless access in the UK (with a customer base concentrated in Scotland) – has avoided Ionica's fate, but has experienced limited success in the provision of access to residential customers and has recently re-focused on broadband services and indirect access. The main difference between Atlantic Telecom and Ionica does not lie in the type of service provided – a voice-centric package with limited support for data (i.e. voice modem rates)[59] – but rather in their pricing and marketing strategy.

Atlantic's line rental is higher than BT's (at £10 per month, although this includes a second voice line), and customers have in addition to subscribe to a call package costing at least £5 per month giving them 333 free call minutes. Call charges are in general

---

[57] Epsicom Business Intelligence (1998).

[58] http://www.zdnet.co.uk/news/1998/43/ns-5902.html

[59] The following description has been taken from Atlantic Telecom's website (http://www.atlantic-telecom.com: *"Using fully digital FRA technology Atlantic provide a tailored package to suit you and your families needs. A feature rich service that will change the way you and your family use the telephone. Customers can add to this with a range of options, including advanceClass (Caller line identity and advanced feature phone services), Advance 4× (3 sub numbers against a main line number each with its own distinctive ringing tone). Also available are advanceplus (call pick-up, call transfer), and advancedata (for modem/internet use)."*

lower than those available from BT, but the minimum spend for on line rental/call package per quarter is £45 compared to BT's £27.77.[60] As a result, the Atlantic service is attractive only for higher-spending high-use customers.

Despite very positive assessments by analysts,[61] the performance of Atlantic's shares in the last few months indicates that many within the investment community have started to question Atlantic's prospects. If the analysts were correct in their assertion that Atlantic had everything right, this rapid decline in fortune suggests that it is the general concept of residential fixed wireless access in the UK that is losing favour.

Indeed, recently, the company has announced a series of acquisitions and deals that indicate that it is rapidly trying to "diversify", thereby greatly reducing its emphasis on residential fixed wireless access. In particular, Atlantic Telecom has re-focused on the provision of DSL services across Europe[62] and on indirect access.[63]

Recent company statements have acknowledged this obvious de-emphasis on UK residential fixed wireless, For example, Gordon Sleight, the managing director of Atlantic Telecom, pointed out that "*[t]hrough our recent acquisition of First Telecom, the group is building up a portfolio of technologies and services which are ideally suited to our target market: small to medium sized enterprises throughout Europe.*"[64] Atlantic Telecom's Annual Report for 1999-2000 refers to the "*intention to build SME focused networks across all our licensed areas while reducing, at least in the medium term, the amount of capital that we commit to accessing the residential market,*" and a focus on serving "*SME [Small Medium Enterprises] customer base over a wide*

---

[60] Charges for the Atlantic Telecom services have been taken from Atlantic Telecom's website.

[61] See for example SG Equity Research, 16 February 2000: "Atlantic Telecom: FRA comes of Age": *UK investors' only previous contact with Fixed Radio Access was via the ill-fated Ionica. Atlantic is a very different business. Atlantic's management is far more prudent, it has ensured that licences do not contain restrictive coverage clauses and the FRA product is far more reliable, faster and technically advanced. Marconi has taken a 27% stake in the company.* Similarly Warburg Dillon Reed, 29 March 2000: "Atlantic Telecom Group plc": "*We understand investors' natural reservation towards this type of technology, particularly since Ionica's failure using a fixed wireless network. There are a number of strategic and operational reasons why Atlantic is not another Ionica..*"

[62] In April 2000 Atlantic "*reached an in-principle agreement with Metromedia Fibre Networks BV ("MFN") and AboveNet UK Ltd under which we will receive dark fibre throughout the 16 European city networks currently planned or under construction by MFN…. The ability to gain access to metropolitan fibre, particularly in Germany, will greatly assist our ability to roll-out our DSL plans*" (Atlantic Telecom Group PLC, Chairman's Report, 1999-2000). In June Atlantic Telecom Group Plc announced the launch of its DSL service in Frankfurt, saying that this would make it "*one of the first companies to install SDSL (Symmetrical Digital Subscriber Line) broadband technology in Germany*" (see Reuters News, 20 October 2000: "UK: Atlantic Telecom buys French Internet firm") Later in the year, Atlantic Telecom launched SDSL services in France (Scotsman, 1 August 2000: "Atlantic Telecom launching French SDSL services").

[63] During October 2000, Atlantic Telecom unveiled a deal to operate a new fixed line Indirect Access service to be offered by Vodafone (see Scotsman, 20 October 2000: "Vodafone deal sees Atlantic shares jump").

[64] Scotsman, 01 August 2000: "Atlantic Telecom launching French SDSL services".

geographic area using state-of-the-art technologies… This is a fundamentally changed position compared to last year and one which gives us an excellent platform to take the Group further".

This shift in focus has been identified and commented on by the press and a number of analysts:

> *From being focused entirely on domestic operations 12 months ago, Atlantic has made a number of additional European acquisitions, such as taking a controlling stake in Dutch DSL operator, Telepartner Plus, and the ISE Gulliver Internet service provider in France. And last month, Atlantic won a UK contract to carry branded, traditional fixed-line phone services for mobile phone giant Vodafone - a deal which analysts consider will "dramatically improve" Atlantic's profitability and may even bring forward the break-even date."* [65]

> *HSBC Securities said on Monday it started coverage of Atlantic Telecom Plc with a "buy" rating and a price target of 350 pence. In a research note, analysts at the investment bank noted Atlantic's move from specialising in wireless local loop services to a focus on digital subscriber line services across Europe.*[66]

The experience with fixed wireless access in the UK suggests that given the level of prices and competition from indirect access operators (using network services available under the network charge controls at prices based on their long run incremental cost) operators who have invested in alternative local access infrastructure with similar functionality to the PSTN have a difficult time recovering their investments. Both the failure of Ionica and the strategic shift of Atlantic Telecom from residential fixed wireless access to broadband services and SMEs shows that investment incentives for local access infrastructure are at best weak.

Whilst this is not be an issue of concern in areas where facilities-based competition is socially undesirable because it results in considerable losses of scale economies, the risk of undermining investment incentives needs to be taken seriously where the deployment of alternative infrastructure is expected to be overall beneficial.

5.2. IMPLICATIONS FOR THE USE OF LLU AND VODSL

Industry commentators regard the provision of voice services over DSL infrastructure as an important element of the commercial proposition underlying the deployment of DSL equipment. A report by the Gartner Group states that:

---

[65] The Herald, 28 November 2000: "Atlantic Telecom gets £10m booster"

[66] Reuters News, 6 November 2000: "UK: Research alert – HSBC starts Atlantic Telecom as buy".

> *Until the middle of 1999, high-speed Internet access was viewed as the "killer application" driving xDSL demand. At Supercomm 1999, exhibitors introduced the notion that voice coupled with high-speed Internet access might be an even bigger killer application and proceeded to demonstrate Voice over DSL (VoDSL). … To many industry observers, this is the next logical step in the progression of xDSL applications.*[67]

Unsurprisingly, operators everywhere are considering this opportunity. Verizon Communications in the US has begun trialling VoDSL services earlier this year[68] in its attempt to become the market leader on DSL: "*As we layer on advanced services, realising that the underlying platform is really the DSL-enabled loop, the next layer of services will become the margins game for us as we start bringing voice over DSL and other services*".[69]

According to Probe Research, the main reason for this is "*the need for additional revenue. …Customers reluctant to install broadband lines solely for data and Internet access may be persuaded if they could use the line for voice services as well, thus bringing down customer cost per service while simultaneously increasing carrier revenue per line.*"[70]

Moreover, bundling of services and innovative pricing should enable DSL providers to exploit the opportunity of "*increasing revenue without adding new customers*". Bundling leads to "*reduced churn and reduced operating costs of billing.*"[71] Overall, the "*value proposition is simple: Capture more revenue on a one pair of copper wire.*"[72]

However, in order to provide VoDSL services, operators need to make additional investments. Figure 2 illustrates the typical architecture required for VoDSL, using current proven technology and assuming that they wish to deploy a service that is directly competitive with the incumbent's voice offerings. This shows that DSL

[67] Gartner Group (2000).

[68] "USA: Verizon conducts voice over DSL technical trial", PR Newswire, 1 August 2000.

[69] "USA: Verizon Online cuts DSL rates for residential users and small businesses", Telecoms Pricing Bulletin, 20 September 2000.

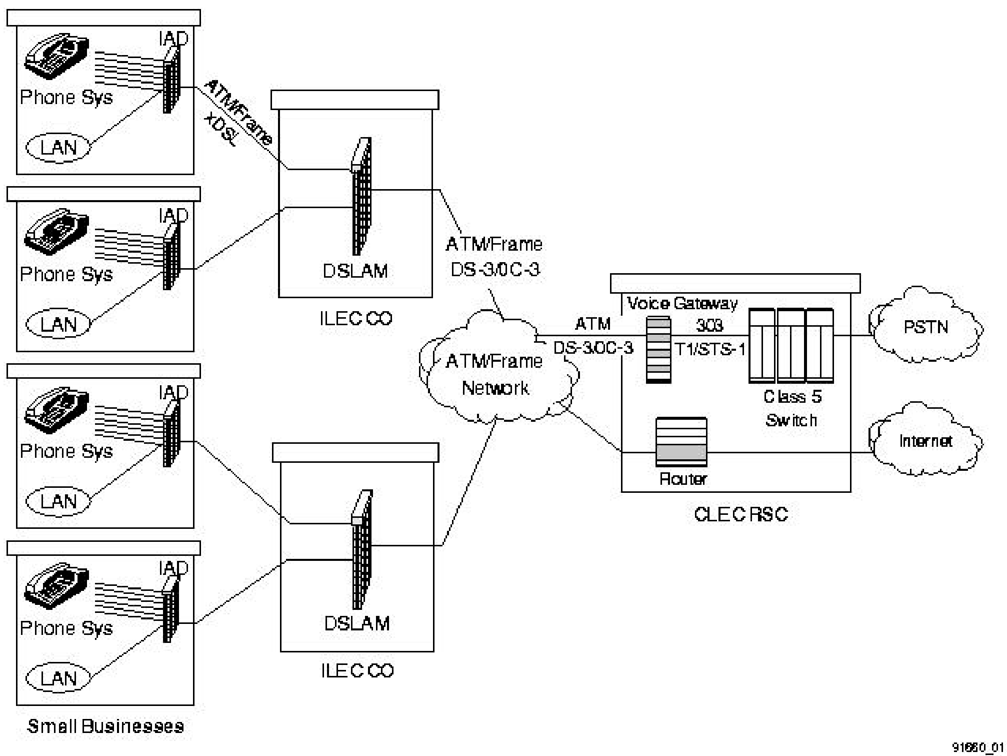
[70] Probe Research (2000).

[71] Probe Research (2000).

[72] Gartner Group (2000).

operators wishing to offer VoDSL need to invest in additional and costly switching equipment.[73]

Figure 2: Voice over DSL architecture



Source: Gartner Dataquest (August 2000), taken from Gartner Group (2000)

In addition, the operator needs to put in place a billing system that can track the individual usage. "*Even if carriers offer their customers flat-rate pricing, they still need to account for minutes handed off to other carriers.*"[74] Again, the deployment of a suitable billing system can imply a considerable additional cost.[75]

---

[73] According to Probe Research (2000), the cost of a Class 5 switch supporting tens of thousands of lines can cost up to $5 million. Event though the cost of switching voice traffic can be reduced by deploying voice over IP systems and using softswitches, this technology is not yet available on a commercial basis and is not expected to take off until 2001. Another alternative is the use of ATM switches, which could lead to a cost reduction.

[74] Probe Research (2000).

[75] Probe Research (2000) quotes costs for billing software in the range of $450,000 to $1 million, with annual charges for maintenance at about 10% of the software price.

One crucial question for operators considering the deployment of VoDSL services is "*how to bundle services to make them more attractive to customers and at the same time to increase the revenue yield.*"[76]

Even though the return on investment required to offer VoDSL can be as high as 60-70%, assuming that the operator will be able to use the cheapest (and as of yet not widely available) technical implementation,[77] the investment decision is far from obvious. Probe Research (2000) estimates that an ISP can "*reach break-even point in 24-36 months, depending on revenue per subscriber, which can range from $70-150 per month.*" Assuming that in line with the current split[78] the majority of this revenue would have to come from voice services, for "*an ISP with little infrastructure, the decision to offer voice services is a major strategic undertaking. It is a big risk for operator and customers, although once the voice solution is in place, it is expected that it will be a significant factor in reducing churn.*" Similarly, Gartner Group (2000) states that for "*an ISP tottering on the edge of profitability (in combination with the capital market's current pullback from telecom), it may be difficult to obtain the funding for routing and switching equipment required to offer telephony services, especially if the carrier makes a decision to own infrastructure.*"

As we have illustrated above[79], operators offering service bundles of voice and broadband data services may be constrained in their ability to extract revenues and earn profits that can contribute to the recover of fixed and common investment costs by competition in the provision of individual elements. Indeed, operators currently offering VoDSL services are offering prices that are "*discounted from 15% to 50% of traditional telephone service rates.*"[80] In such an environment, it is quite conceivable that the prices of POTS, which in turn are affected by the terms and conditions upon which operators and service providers can make use of BT's network, may have an impact on the overall expected return available on the investment required for VoDSL and may delay the deployment of DSL technology. This is one, but by no means the only example where the way in which OFTEL decides to go forward on network charge controls is likely to impact upon infrastructure investment incentives.

---

[76] "Voice evolving as a 'killer app' in DSL portfolio", Telecoms Markets, 16 January 2000.

[77] Probe Research (2000).

[78] For example, in the US "*the typical small business spends on average $800 per month on voice and some US$100 per month on data.*" ("Voice evolving as a 'killer app' in DSL portfolio", Telecoms Markets, 16 January 2000.)

[79] See the stylised example on page 15 passim.

[80] Probe Research (2000).

5.3. CONCLUSIONS

OFTEL is generally considered to be very much aware of the investment incentives created by regulatory intervention and well regarded for the emphasis it puts on facilities-based competition.[81] There is no reason to abandon this focus.[82] In particular at a time when the issue of a potential natural monopoly in the local loop has been resolved by imposing an obligation on BT to provide unbundled loops to competing broadband providers, there is a considerable risk that the simple continuation of a network charge control regime that was introduced in a rather different technological and regulatory environment could seriously undermine investment incentives for alternative infrastructure operators.

This in turn could significantly delay the deployment of alternative infrastructure and the development of innovative technologies to the detriment of customers. By erring on the side of caution and imposing a tight regulatory regime on services that may *at present* not be subject to sufficient competitive pressure, OFTEL might hold back the very development of facilities-based competition that it appears to require before it could lift the price cap. By contrast, loosening the network charge control regime (but maintaining a safeguard against the exploitation of market power) might help to bring about the competitive pressure that is currently lacking.

A regulator needs to recognise the enormous contribution of telecommunications investment and innovation to social welfare and that infrastructure policy is as important as competition policy, and be aware that regulation changes investment incentives and take this into account in all regulatory determinations.[83]

[81] See, for example, Haring and Shooshan (1998).

[82] There are some indications that OFTEL might have shifted its priorities from encouraging facilities-based competition to ensuring that existing infrastructure is utilised to the maximum extent and a focus on service competition. For example, in its recent consultation on the merits of shared access to the local loop, OFTEL emphasises the role of shared access in promoting "*a more efficient use of existing resources and greater competition in the provision of higher bandwidth services.*" (OFTEL, 2000b, at paragraph S.6). It is perhaps worth pointing out that Energis, in its reply to the first price control review consultation document, also raises concerns about OFTEL's regulatory focus, stating that "*the proposal to state Annex II status to further parties is at odds with the OFTEL strategy statement where the regulatory principle II states that 'where competition is increasing but not yet effective, promotion of competition is acceptable as long as … it does not create disincentives for new entrants or incumbents to invest in infrastructure of innovate in the provision of new services.*"
(see http://195.92.252.136/about_us/cd2dft1.htm)

[83]See, for example, Darby and Fuhr (1998).

ANNEX A: A SUMMARY OF OFTEL'S PROPOSALS

Historically, network charges were determined by the Director General annually and based on fully allocated costs. In order to sharpen BT's incentives to achieve productive efficiency, this was replaced by the current system of network charge controls, which have been in effect since 1 January 1998. It is this regime that OFTEL proposes to continue for another four years. The essential features of the current regime of network charge controls are as follows:

(1) Network charge controls are applied only to services that are not competitively supplied because "*[w]ithout charge controls … BT might abuse its market power or dominance in the relevant market by setting excessive charges for interconnection services. This could be harmful for the long-term sustainability of competition in UK telecommunications markets.*"[84]

(2) Rather than re-setting network charges annually, they are based on an RPI-X formula in order to provide incentives for achieving efficiency because under this regime "*the party subject to control obtains the benefit of efficiency gains that it achieves over and above the control.*"[85]

(3) Network charges are based on long-run incremental cost (LRIC) rather than fully allocated cost because, according to OFTEL, "*[c]harges based on LRIC better reflect the basis on which businesses in competitive markets make investment decisions.*"[86]

(4) Network services are grouped into three categories – competitive, prospectively competitive and uncompetitive. No controls apply to competitively supplied services and new services that BT introduces, unless these services are found to be non-competitive. Prospectively competitive services are subject to safeguard controls (RPI – 0), and only non-competitive services are subject to stricter controls (RPI-8).[87]

(5) With regard to non-competitive services, the controls are implemented in the form of price caps on call termination, a range of interconnection services grouped together in a general network basked (call origination, local-tandem conveyance and

[84] OFTEL (2000a), paragraph 3.5.

[85] OFTEL (2000a), paragraph 3.6.

[86] OFTEL (2000a), paragraph 3.7.

[87] OFTEL (1997).

single transit), and a range of services grouped together in the a interconnect-specific basket (essentially services required for physical interconnection between networks).

(6) Starting from the level of charges agreed for the year ending 31 March 1998, which were based on LRIC and, except for the services in the interconnection-specific basket, included a mark-up to recover fixed and common costs, BT should be free to set charges for services within each basket subject to compliance with the overall price cap. The weighted average charges for services within a basket are calculated using the revenue shares in the previous year as weights. Moreover, charges will be averaged over the year in order to prevent BT from implementing permissible charge increases early in the year, and delaying required charge reductions until the end of each charge control period.[88]

(7) The price cap controls apply over and above any constraints on pricing of network services that might arise out of BT's licence or general competition law. This implies that the charge for each individual service must be between its incremental cost floor and a ceiling determined by the stand-alone costs of this service.[89]

OFTEL proposes to continue this regime without any changes in the assessment of the competitiveness (or otherwise) of individual network services. Thus, both the safeguard cap on prospectively competitive services and the stricter cap on uncompetitive services will be retained. OFTEL will adjust the level of X, and expects this to be in the range of 7.5% to 11.5% following further consultation.

Moreover, OFTEL considers making cost-oriented access to network services available to a wider range of operators including service providers (who currently can obtain bulk capacity at BT's 'Calls and Access" tariffs).[90]

However, a number of modifications are required in order to take account of the changes in the telecommunications industry that have taken place since the previous charge control regime was put in place. These relate to the increased deployment and use of IP-based networks, and the introduction of new network services required by ISPs in the provision of flat-rate Internet access to their subscribers.

Migration of traffic onto IP-based networks: Given the developments that have taken place since the first consultation document was issued in March 2000, one of

[88] Similarly, network charges subject to the safeguard cap must not be increased by more (reduced by less) relative to the charges at the beginning of the Charge Control Year than the proportionate increase (decrease) in RPI, where the proportion is determined by the proportion of the Charge Control Year that has passed so far. See OFTEL (1997), paragraph 3.9.

[89] OFTEL (1997), paragraph 3.5.

[90] OFTEL (2000a), Approach 3 in paragraphs S4 and 2.29.

OFTEL's implementation concerns is the uncertainty resulting from the rate of growth of data traffic and BT's plans to construct an IP-based network to handle this traffic. As a result, traffic forecasts required in order to determine the value of X so that gains from exploiting economies of scale and scope are included are difficult to make, and subject to considerable amounts of uncertainty. Whilst this could in principle be addressed by shortening the period for which X is set (introducing a mid-term review of the network charge controls), according to OFTEL such a decision would have the undesirable consequences of (a) undermining the incentive properties of the price cap and (b) creating an incentive for BT to migrate traffic onto its IP-based network regardless of whether or not it is efficient to do so.

For this reason, OFTEL proposes *inter alia* an alternative approach that would (a) the network charge price cap would apply to services regardless of whether they are offered using the PSTN or the IP network and (b) in the determination of X treat all traffic as if it were carried on the PSTN

FRIACO: Since June 2000, BT has been offering an unmetered call origination interconnection service in order to make it easier for ISPs to offer their subscribers flat rate dial-up access to the internet. This so-called Flat Rate Internet Access Call Origination (FRIACO) service is a new interconnection service that was not available at the time the charge control regime became effective. Because the competitive conditions with regard to the provision of this service are no different from the competitive position in the provision of 'normal' call origination, OFTEL proposes to treat FRIACO services in a similar way. More specifically, OFTEL proposes to impose a price cap on the proportion of FRIACO charges that relates to the provision of the call origination circuit.

However, OFTEL proposes to subject FRIACO to a separate cap rather than including this service in the general network basket. The reason for this is that OFTEL is concerned about potentially anti-competitive behaviour by BT, distorting the relative charges for metered and unmetered call origination. One concern, for example, is that "*the use of prior year revenue weights could give BT an excessive incentive to increase the charge for FRIACO, whose volume is likely to be increasing quickly, relative to the charge for other slower-growing services in the general network basket.*"[91]

In order to ensure consistency in the charges for metered and unmetered call origination and not to distort the incentives for using one or the other, OFTEL would ideally want to determine the starting charge for FRIACO services based on BT's actual return on capital (which is what BT currently earns on the provision of metered call origination) rather than its cost of capital. However, if this resulted in a considerable difference to the existing FRIACO charges, OFTEL would wish to use these as starting charges and

[91] OFTEL (2000a), paragraph 3.71.

bring charges for metered and unmetered call origination in line over the duration of the charge control period by using additional factors that would be reflected in the value of X.

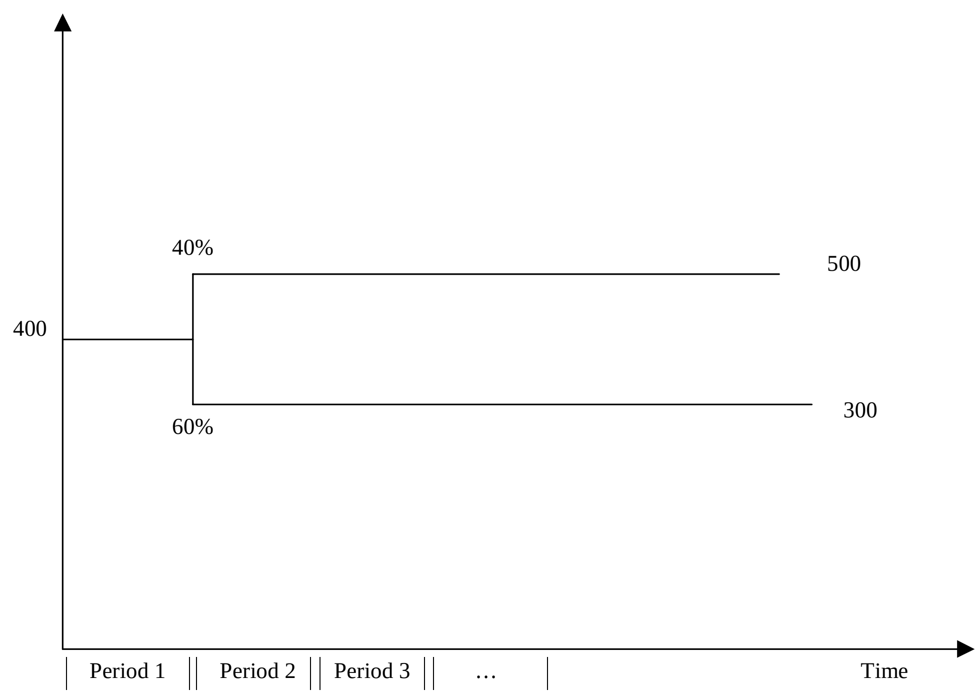
ANNEX B: A SIMPLE EXAMPLE OF OPTION VALUE

The following simple example demonstrates the effect of uncertainty and sunkness on investment decision.

Suppose that an operator can decide between investing in a network asset that would allow it to supply its retail customers or alternatively buying network services from another operator. For simplicity, assume that the asset has an infinite life.

Assume further future demand is uncertain, which will be resolved in period two. More specifically, assume that from period two onwards demand may go up or down by 100 units from its present level of 400 per period, i.e. it may be 500 per period or 300 per period for the entire future. The network asset would provide sufficient capacity to serve demand in either case. Let the price per unit by equal to one for all periods.

Figure 3: Uncertainty about demand



Assume that the investment has a cost of 2,000, and that the cost of capital faced by the operator is 15%. Thus, the annual capital charge for the asset is 300, and the per-unit capital charge in period one (as well as the expected average per-unit capital charge for future periods) is equal to 0.75. Assume that network services are available at a charge of 0.8 per unit, which is in excess of the expected average per-unit capital charge.

The key assumptions are summarised in Table 2.

Table 2: Option values – a stylised example: key assumptions

Cost of capital	15%
High demand (probability 40%)	500 units per period
Low demand (probability 60%)	300 units per period
Present demand [units]	400 per period
Cost of undertaking the investment	2000
Retail price per unit	1 per unit
Charge for network services	0.8 per unit
Margin on resale	0.2 per unit
Profit on resale	
High demand	100 per period
Low demand	60 per period
Present demand	80 per period
Net present value (NPV) of infinite stream of resale profit	
High demand	766.7
Low demand	460
Expected NPV	582.7
NPV of infinite stream of revenues	
High demand	3,833.3
Low demand	2,300
Expected NPV	2,913.3

This suggests that the operator would prefer to invest in a situation of high demand, but prefer to resell if demand were low. However, based on a comparison of expected NPVs, the decision would be made in favour of investing as the upside from investing in the case of high demand is so large that it outweighs the downside if demand turned out to be low. Moreover, as at the present level of demand the cost of obtaining network services from another operator are well in excess of the per-unit capital charge, one might get the impression that the operator would have an incentive to invest now rather than to wait and see.

However, this simplistic view ignores the option value inherent in a wait-and-see strategy, which becomes obvious once we look explicitly at the *timing* involved in making the investment. Rather than investing in period 1, when demand is unknown, it is possible to wait until period 2 and invest only in the high demand state. The benefit from being able to choose whether to invest once the uncertainty has been resolved outweighs the cost incurred in the first period as a result of purchasing network services at charges in excess of the per-unit capital charge. The difference in expected NPVs captures the option value of delaying the investment until the uncertainty that is crucial for the optimal investment decision has been resolved.

Of course, the operator would be best off if it could take advantage of the investment benefits in the present period whilst retaining the flexibility to undo the investment if it would be strictly better off reselling. However, this is not possible if the investment is sunk, and therefore the 'undo investment' alternative is unavailable.

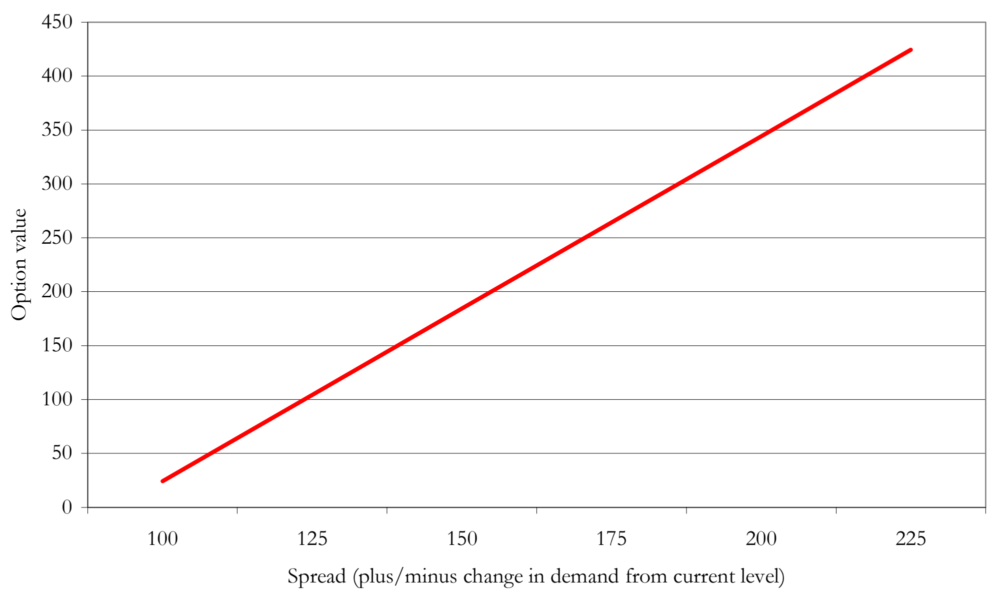
Table 3: Option values – a stylised example: results

Strategy	***NPV of Strategy***[92]	***Period 1 cash flows***	***Period 2 expected NPV of cash flows from period 2 onwards***
Resale	***586.7***	80 Resale revenues in period 1 with demand equal to 400	582.7 Expected NPV of infinite stream of resale profits (see Table 2)
Immediate Investment	***933.3***	-1600 Revenues of 400 minus investment cost	2,913.3 Expected NPV of infinite stream of revenues (see Table 2)
Wait and see	***957.7***	80 As with resale	1,009.3 Undertake investment if demand is high, continue to resell otherwise (0.4×1,888.3 + 0.6 × 460)

[92] Sum of period 1 cash flow and the NPV of revenue streams from period 2 onwards discounted at the cost of capital, e.g. 587.6 = 80 + 582.7/1.15

As the option value of delaying an investment depends on the extent to which the value of the investment is affected by uncertainty, we would expect the option value to increase with the degree of uncertainty. The above example can be used to demonstrate this effect, and to show that it can be quite dramatic. Leaving everything else equal, but increasing the amount by which demand can exceed or fall short of the present level, we can calculate option value, i.e. the difference between the value of immediate investment and the wait-and-see strategy. The relationship between the option value and the spread (measured by the amount by which demand from period two onwards may exceed or fall short of the present level) is shown in Figure 4. This shows that the option value increase significantly with the increase in the extent of uncertainty.

Figure 4: Uncertainty and option value



ANNEX C: STATISTICAL ANALYSIS OF THE RELATIONSHIP BETWEEN INVESTMENT, MODERNISATION AND REGULATION

We obtained data for infrastructure development from the OECD Communications Outlook Database.[93] We used two measures for investment and network modernisation. The first measure is the level of public telecommunications investment by country, scaled by revenue (to compensate for varying size in the countries' telecommunications industries). The second measure is the percentage of digital access lines as a proxy for the level of deployment of modern infrastructure.

The measurement of regulatory liberalisation was taken from Boylaud and Nicoletti (2000) who use cluster analysis to show that, *"two groups of countries can be identified: the "liberal" ….and the "middle-of-the-road""* for the period 1993-1997. Using their analysis, we group our sample into the subsets of more liberal[94] and less liberal[95] regulatory regimes.

The time span of the analysis and the number of countries was constrained by the data about regulatory regimes. Therefore, we conducted our analysis for the years (1993-1997) and the countries analysed by Boylaud and Nicoletti.

Table 4 presents the results of the regression analysis on the effect of regulatory regime on investment. Even though investment was scaled by revenue it was found to be non-stationary, hence the percentage change in investment over revenue has been used as the dependent variable ($\Delta Inv := (I_t/R_t - I_{t-1}/R_{t-1})/I_{t-1}/R_{t-1}$). Lagged values of the dependent variable were included up until the point at which a t-test showed no further explanatory power. This is in part to offset problems of serial correlation, but is also to control for previous investment decisions. The percentage change in number of access lines (Alines) is included as one may suspect that greater investment may be a result of expansion and not development. Finally a dummy RegType which takes on the value one if in the country is in the more liberal group and zero otherwise is included. Robust t-statistics using White's variance matrix are presented in parentheses.

[93] OECD Telecommunications Database 1999, ISBN 92-64-06769-8.

[94] Australia, Canada, Denmark, Finland, Japan, New Zealand, Sweden, the United Kingdom and the United States of America.

[95] Austria, Belgium, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, the Netherlands, Norway, Portugal, Switzerland, Turkey.

Table 4: Regression of investment on regulatory type

Dependent variable	ΔInv
Explanatory variable	Coefficient
Constant	-0.20 (-4.06)
RegType	0.11 (2.37)
ΔInv_{t-1}	-0.29 (-2.96)
ΔInv_{t-2}	-0.10 (-0.90)
ΔInv_{t-3}	-0.32 (-3.02)
ΔAlines	3.83 (3.29)
R^2	0.28

The results presented in Table 4 show that the RegType dummy is positively associated with a change in investment. Thus, a more lenient regulatory regime is associated with higher investment growth (or slower investment decline).

With regard to the second variable, the proportion of digital access lines, a different approach had to be taken. This is because a number of countries reached 100% of digital access lines during the sample period, thus we could not measure further modernisation with the change in the percentage of digital lines. To test the relationship between regulatory behaviour and modernisation we therefore compare the mean of digitalisation between countries with more and less liberal regulatory regimes.

More specifically, to test the relationship between regulatory behaviour and modernisation we compare the mean of digitalisation between countries with more and less liberal regulatory regimes. Technically, we invoke a simple unpaired t-test for the mean levels of percentage of digital access lines of the two groups of countries. We test the hypothesis that the means are the same against the alternative hypothesis that the mean is greater for the more lightly regulated sample. The t-statistics show the mean of the percentage of digital lines is greater for the less regulated countries on the 1% significance level[96]. Therefore, we accept the alternative hypothesis that digital access lines are more developed under the more lenient regulatory regimes.

[96] The t-values are the following: 2.36 under the assumption of equal variances and 2.49 for samples with unequal variances.

REFERENCES

Archer, S. H. (1981), 'The Regulatory Effects on Cost of Capital in Electric Utilities', *Public Utilities Fortnightly*, February 26 1981, 36-39.

Boylaud O. and G, Nicoletti (2000), 'Regulation, Market Structure and Performance in Telecommunications', *OECD Economics Department Working Papers* No 237, ECO/WKP(2000)10.

European Commission (1999), *Fifth Report on the Implementation of the Telecommunications Regulatory Package, Annex 3: Effective application- Analysis by Member State,* Communication from the Commission to the European Parliament, the Council, the Economic and Social Committee and the Committee of the Regions, 11 November 1999.

Crew, M. A. and P. R. Kleindorfer (1996), 'Incentive regulation in the United Kingdom and the United States: Some lessons', *Journal of Regulatory Economics*, 9, 211-225.

Darby, F. L. and J. P. Fuhr (1998), 'Regulatory perspectives on investment and innovation in U.S. telecommunications', *New Telecom Quarterly*, Issue 2.

Decamps, J. P. and T. Mariotti (2000), 'Irreversible investment and learning externalities', *IDEI (L'Institut d'Economie Industrielle) Working Paper*.

Dixit, A. and R. S. Pindyck (1994), *Investment under uncertainty*, Princeton: Princeton University Press.

Espicom Business Intelligence (1998), *Emerging Network Operators, Ionica*, 25 April 1998.

Farrell J. and M. L. Katz (1998), *Public Policy and Private Investment in Advanced Telecommunications Infrastructure*, University of California at Berkley, *mimeo*.

Faulhaber, G. R. (1975), 'Cross-subsidization: Pricing in public enterprises', *American Economic Review*, 65, 966-977.

Gans, J. S. (2000), *Regulating private infrastructure investment: Optimal pricing for access to essential facilities*, Melbourne Business School, *mimeo*.

Gartner Group (2000), *Same Voice … and High-Speed Data, Too: Voice Over DSL*, published by e-Remote Access Europe, 16 October 2000.

Green J. R. and D. J. Teece (1999), *Four Approaches to Telecommunications Deregulation and Competition: the U.S., U.K., Australia and New Zealand*, *mimeo*.

Greenstein, S., S. McMaster and P. T. Spiller (1995), 'The Effect of Incentive Regulation on Infrastructure Modernization: Local Exchange Companies' Deployment of Digital Technology', *Journal of Economics and Management Strategy*, Volume 4, Number 2, 187-236.

Grant, I. G. B. (1999) 'Competition in the Local Market Heats Up', http://www.telecoms-mag.com/issues/199910/tcs/copm.html, October 1999.

Hall, P. (1994), *Innovation, economics and evolution: Theoretical perspectives on changing technology in economic systems*, New York: Harvester Wheatsheaf.

Haring, J. and H. M. Shooshan III (1998), *Local Telecommunications Competition and Deregulation: Assessing the U.S. Model,* Presented to the 30th Annual Conference of the Institute of Public Utilities, Williamsburg, Virginia. 10 December 1998.

Kahn, A. E. (1988), *The economics of regulation*, Cambridge, Massachusetts and London: MIT Press.

Kiessling T. and Y. Blondeel (1999), *The Impact of Regulation on Facilities Based Competition in Telecommunications; a comparative analysis of recent developments in North America and the European Union, mimeo.*

Monopolies and Merger Commission (1998), '*Reports on references under Section 13 of the Telecommunications Act 1984 on the charges made by Cellnet and Vodafone for terminating calls from fixed-line networks*', December 1998.

Montgomery, W. P. (1994), *Promise versus reality: Telecommunications infrastructure, LEC investment and regulatory reforms*, Research Paper, MCI Communications Corporation.

Nwaeze (1997), 'Incentive regulation, investment decisions, and stock returns', *Journal of Accounting, Auditing and Finance*, Volume 12, Issue 3, 285-307.

OECD (1996), *Competition in Telecommunications*, OECD/GD(96)114, Competiton Policy Roundtables. No. 6, Canada, 1996.

OFTEL (1997), *Guidelines on the operation of Network Charge Controls,* October 1997.

OFTEL (2000a), *Price Control Review – A consultative document issued by the Director General of Telecommunications setting out proposals for future retail price and network charge controls*, October 2000.

OFTEL (2000b), *Access to bandwidth: Shared access to the local loop: Consultation Document on the implementation of shared access to the local loop in the UK*, October 2000.

Probe Research (2000), 'Giving Data a Voice: ISPs and Data Carriers Entering the Voice Market', *US Competitive Service Markets: Emerging Operators,* Vol. 3, No 9, September 2000.

Ros, A. J. and K. McDermott (2000), 'Are residential local exchange prices too low? Drivers to competition in the local exchange market and the impact of inefficient prices', *in: M. A. Crew (ed.): Expanding competition in regulated industries*, Boston, Dordrecht, London: Kluwer Academic Publishers.

Sappington D. E. M. and C. Ai (1998), 'The Impact of State Incentive Regulation on the U.S. Telecommunications Industry', *Department of Economics University of Florida Working Papers*.

Sappington, D. E. M. and D. L. Weisman (1996), *Designing incentive regulation for the telecommunications industry*, The MIT Press and The AEI Press.

Sharkey, W. W. (1982), *The theory of natural monopoly*, Cambridge University Press.

Tardiff,, T. J. and W. E. Taylor (1996), 'Revising price caps: The next generation of incentive regulation plans', *in: M. A. Crew (ed.): Pricing and regulatory innovations under increasing competition*, Kluwer Academic Publishers.

Taschdjian, M. (2000), *From Open Networks to Open Markets: How public Policy Affects Infrastructure Investment Decisions*, Cambridge (Mass), Harvard University, Center for Information Policy Research, Program on Information Resources Policy.

Taylor, W., C. Zarkadas and J. D. Zona (1992), *Incentive Regulation and the Diffusion of New Technology in Telecommunications*, National Economic Research Associates.

Tirole, J. (1988), *The Theory of Industrial Organization*, Cambridge (Mass.), MIT Press.

Ware, H., T. Tardiff, A. Ros and N. Attenborough (2000), *Costs of Telecommunications Competition Policies.* Report prepared by NERA for Telecom New Zealand, 9 May 2000.

Woroch, G. A. (1998), *Facilities Competition and Local Network Investment: Theory, Evidence and Policy Implications*, University of California at Berkeley, *mimeo*.