

Competition, Investment and Regulation in Narrowband Wholesale

Markets in the Netherlands

Martin Cave*

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OPTA has found KPN to exercise SMP on a prospective basis in a number of narrowband (or dual purpose) wholesale markets, including unbundled local loops, wholesale line rental (to the extent that WLR is a product rather than a remedy), call origination, leased lines, call termination and transit.

At the same time it has found the market for standard quality wholesale broadband access to be effectively competitive.

In this paper I explore the degree to which the reasoning underlying the latter decision can be read across into other wholesale markets, concluding that regulation should pay greater heed to the potentially or prospectively competitive nature of many of these markets, either by making a finding of

* Professor, Warwick Business School, University of Warwick, UK. Martin.Cave@wbs.ac.uk

effective competition or by adapting and calibrating regulation to the emerging competition. First, however, I briefly discuss the linkage between competition, investment and regulation.

1. Encouraging competitive investment in infrastructure

OPTA has been in the forefront of the debate about ways of promoting infrastructure competition. The conclusions of its economists, based on the literature and work commissioned by OPTA from a team including the present author and from the consultancy firm Analysys, were captured in a 2003 Economic Policy Note,¹ which acknowledges that infrastructure competition should be the goal, and that where it is possible, access prices should help to achieve it. Moreover, in the case of new infrastructure, a mark-up is appropriate as a reward for investment risk.

¹ OPTA *Economic considerations on balancing infrastructure and services based competition* Economic Policy Note 2003.

Since the publication of the Note in 2003, the discussion of the issue has developed further. Thus the European Regulators Group (ERG) in its 2004 Remedies Paper² noted that

‘...one of the objectives of the regulatory regime set out in the Framework Directive is to *‘promote competition* in the provision of electronic communications services and associated facilities and service facilities.’ When considering remedies, NRAs are responsible for, *inter alia* ‘ensuring that there is no distortion or restriction of competition in the electronic communications sector.’ Thus in the context of remedies for one-way access, the Framework Directive emphasises the objective of *promoting innovation and encouraging efficient investment...*’

The paper then goes on to draw a distinction between cases where consumers have to be protected because the assets providing the services cannot be replicated and hence they are exposed to excessive pricing, and cases where it is feasible to support infrastructure investment by competitors. In the latter case, one of the recitals in the Access Directive states that

‘...the imposition by national regulatory authorities of mandated access that increases competition in the short-term should not reduce incentives for competitors to invest in alternative facilities that will secure more competition in the long term.’

The ERG paper suggests in relation to one-way access that:

‘...new entrants can decide on their investment in a step-by-step way and can establish a customer base (critical mass) before they go to the next step of deploying their own infrastructure. In those areas where infrastructure based competition is feasible, such interventions has as their long-term

² ERG *Common position on the approach to Appropriate remedies in the new regulatory framework* ERG (03) 30 rev 1.

objective the emergence of self-sustaining effective competition and the ultimate withdrawal of regulatory obligations.’

In application to bitstream the ERG noted:

‘As the access to the unbundled local loop, to which it is complementary, [bitstream access] is a means to promote infrastructure, the competitor climbs up the value chain or the ‘ladder of investment’, in other words as he can use more and more of his own infrastructure he is able to add gradually more value to the product offered to the end user. At the same time he reduces the reliance on the wholesale products of the dominant operator. In order to enable a step by step increase of investment, NRAs must regulate prices of the various access products consistently if a price control measure according to Art. 13 AD (ie cost-oriented pricing) is also in place.’

OPTA’s review of wholesale broadband access of standard quality explicitly accepted that broadband competitors had by 2005 made sufficient investments in backhaul, DSLAM etc, such that it was no longer necessary to mandate access to KPN’s wholesale broadband access.³ Some of the relevant data are referred to below.

The ladder of investment approach referred to by the ERG above has two fundamental elements:

- an assessment of replicability of assets producing services

³ The ERG’s own evaluation of experience in the Netherlands and twelve other member states can be found in ERG, *Broadband competition market report*, ERG (05) 23.

- the design of time-specific remedies

In a recent paper⁴, I have argued that the replicability of assets is a concept which can be made operational and subject to evidence, in a two-stage process which considers successively:

- evidence of replication in similar circumstances
- evidence from cost modelling.

Each has its own strengths and weaknesses. In relation to the former, if there are limited examples of replication, they may be the result of special circumstances and/or be unsustainable, although in evaluating the former point evidence from the same country, under nearly identical conditions, will be most convincing.⁵ Conversely, the absence of replication may itself be a consequence of regulation. Such 'false negatives' have to be carefully guarded against. The US experience in local competition is a case in point. The FCC mandated such heavy discounts from the incumbents retail price on wholesale transactions with competitors in local services, that incentives to build competitive infrastructure were weakened or eliminated.

Cost modelling has a bias, based on its neglect of organizational factors and x-inefficiency, towards a finding of non-replicability which can lead to a 'false positive' for regulation, although it may give clearer insights into the *relative* difficulty of replication. Although NRAs will have different data at their disposal in different cases, in my opinion it is safer to rely on the presence or absence of replication in practice than on cost modelling.

⁴ M. Cave, *Encouraging infrastructure competition via the ladder of investment*.

⁵ Thus it would be safer to draw conclusions for the rest of Germany from the success in some areas there of 'city carriers' than to read the experience across, for example, to Italy as discussed above.

As far as the design of remedies is concerned, I argue that it is appropriate to price prospectively non-replicable services on a standard 'efficient LRIC' basis (including an allowance for a mark-up to cover common costs). In the case of replicable assets, however, a different approach may be required. To illustrate this, I draw upon the theory of option pricing; the discussion is on the footing that access still remains mandatory, but not necessarily at conventional LRIC prices.

According to basic investment theory, an asset will be bought when its expected return is at least as great as the activity's cost of capital, where that cost of capital includes in appropriate cases an adjustment for risk.⁶

It may seem that an access charging regime based on long run incremental cost (LRIC) plus common cost, using the appropriate asset-specific cost of capital, would then send the correct 'make or buy' signals to other operators. If they could self-supply at a lower cost, they would 'make'; if not they would 'buy'.

However, this ignores the fact that competitors whose access is mandated always have the option of continuing to buy – unlike the first-mover. Undertaking an investment in conditions of uncertainty and sunk cost carries a risk which makes the option of continuing to buy more attractive. To persuade a competitor to

⁶ It may be appropriate to deal with some risks by other means than an adjustment to the cost of capital.

invest, the access price must cover the competitor's cost of supply and the value of the option. If the option is not priced into the access charge the competitor's incentives will be distorted against investment. I return below to how this can be done in practice

2. Replicability of Assets and Competition in Narrowband Wholesale Markets

The markets to be discussed are:

- 8. call origination
- 10. local transit⁷
- 11. unbundled local loop
- 13. leased lines – terminating segments.⁸

In addition, a wholesale line rental product, underpinning markets 1 and 2 (access to the public telephone network, residential and business) will also be considered. Neither market 12, wholesale broadband access, nor market 9, fixed termination, is considered – the former because it has been declared effectively

⁷ I limit the discussion to local transit because inter-tandem transit is not to be subject to a cost-oriented pricing remedy.

⁸ Trunk segments of leased lines were found not to exhibit SMP.

competitive (in standard form) the latter because of its special features resulting from calling party pays.

Before these markets are discussed in more details, it is worth giving a general overview of network competition, broadband and narrowband, in the Netherlands.

The key factors here are the build out by and take up of competitive offerings in broadband, and investments in cable. In June 2005, 3.6 million customers in the Netherlands had broadband connections. These were supplied on three groups of infrastructure – 40% by cable companies, 44% by KPN's DSL network and 16% by DSL networks of KPN's competitors. In terms of *availability* of network operators, potential broadband customers have a degree of choice on the scale shown in Table 1.

Table 1. Network competition in the Netherlands 2003-5

	% of potential customers with access to the specified number of networks					
	0	1	2	3	4	>5
July 03	3	97	80	63	43	22
Dec 03	1	99	83	65	52	36
May 04	1	99	91	69	59	41
June 05	0	100	99	73	64	52

Source: KPN

This growth of access is reflected in the decline in the degree to which KPN supplies ADSL for resale by competitors such as Tiscali and Versatel. In both cases, the proportion fell by more than half from 2003 to 2005.

These developments in broadband have a wider significance. The development of infrastructure-based broadband competition has a retrospective effect on narrowband voice markets, and a prospective effect on competition in next generation core network and access markets. It makes investment in core and backhaul networks more easily replicable, and potentially make the construction of a new access network – at least as far as the cabinet – potentially contestable.

The recent announced proposal by Tele2 to acquire Versatel's assets in the Netherlands and Belgium emphasise how competition is extending along the lines set out above. Tele2's press statement of 17 July 2005 states the following:

“Tele2 is pursuing its strategy of backward integration into infrastructure in markets where it has a critical mass of customers. Owning local access infrastructure is increasingly important in the growing ADSL market to ensure higher margins on access, better control of customers and ability to deliver higher margin services. Tele2 fully endorses Versatel's triple play strategy and will aim to leverage this expertise to later introduce these services in other core markets.”

“...The combination of Versatel and Tele2 creates the leading alternative operator in the Netherlands and Belgium, serving both residential, business and carrier customers.

Tele2 will pursue a strategy focused on growth opportunities notably in the fixed broadband market and on improving profitability.

In the residential segment, Tele2 will continue the push in broadband. In the Netherlands in particular, Tele2 will continue to roll-out ADSL2+ and further build the triple play offer with the Eredivisie football and other content as planned by Versatel. At the same time, Tele2 will aim to achieve synergies from the integration of Tele2's operations with Versatel Benelux. These will largely come from migrating Tele2's existing traffic onto Versatel's network but will also come from revenue synergies as well as costs reductions.”

Apart from the development of competitive DSL, the other key consideration is the availability of cable networks with 'state-of-the-art' two-way digital functionality to virtually all households. These will be able to offer digital telephony to about 80% of the population by 2006 in conjunction with analogue television, which is already taken by 90% of households. The opportunity for cable companies to gain telephony customers is, of course, greatly enhanced by the pre-existing commercial relationship.

After this general introduction, I now make some remarks about the scope for competition in the markets listed above.

8. Call origination

The issue here is the degree of competitive constraint placed upon KPN's call origination product (now and until 2007-8 –the period of review) from the following sources:

- VoIP provided by competitive broadband providers mainly renting local loops from KPN

- cable operators providing a digital telephony service⁹
- wireless operators

For the purposes of this discussion, wireless technologies will be ignored, as OPTA has followed the convention of finding that call origination on fixed and mobile networks fall into different markets. This may not, however, be sustainable beyond the current market review. It is clear that some PSTN voice lines are not used for voice but to provide DSL for broadband.

Taking competitive DSL providers first, the availability of multiple providers (see Table 1 above) and the take up of broadband (expected to be 50% by end 2005) make it likely that VoIP offered by these competitive DSL providers will experience significant growth over the next few years. This will provide a major competitive constraint on KPN, even if it too offers VoIP. This is because the additional investment required of a DSL provider to extend its offering to voice over broadband is low. The additional investments required are not large.

Generally, cable operators – which already have more than 90 % of homes as customers- are well placed to cross-sell their digital telephony services, which will be available to 80% of homes in 2006.

⁹ In addition, cable operators are investing in DSL networks outside their franchise areas, expanding their footprints and enhancing their competitive potential.

In short, the assets required to provide call origination are already replicated.

Both telecommunications operators and cable networks are capable of providing the three components of the triple play (or combinations thereof) –voice, broadband and video and are attractive to consumers. This constrains KPN's market power in call origination.

10. Transit

Similar observations to market 8 apply to local transit, from the local to the tandem switch¹⁰. The duplication of networks shown in Table 1 above emphasises the extensive competitive offerings in backhaul, both from competitive DSL providers and from cable.

11. Unbundled loops

In most countries, the unbundled loop is found at the very top of the ladder of investment – and regarded as not practically replicable. However, in the Netherlands, like Belgium, the United States and other countries with universal cable networks, replication has already occurred. Thus the only issue is the

¹⁰ For inter-tandem transit, see fn 7. In fact there is no standalone offer for local transit, which is bundled with origination.

degree to which the local loop is subject to competitive constraint indirectly via telephony and/or broadband services provided by cable networks. However, this case clearly differs from origination, where competition to KPN comes from two quarters – cable networks and DSL competitors, rather than simply (and indirectly) from cable services. In my opinion, it justifies a more cautious approach to pricing local loops (see below)

13. Terminating segments of leased lines

KPN has been found to have no SMP in wholesale trunk markets. In terminating leased lines of 2Mbit/s capacity, competitors meet a substantial minority (40-50%) of their demand through self-supply, when KPN's own self-supply is included. When KPN's self-supply is excluded, and the issue becomes how much do competitors supply themselves, and how much do they rely on KPN, the answer is that they self-supply 50-60% of their needs.

At first sight, on the basis of market shares only, this appears to fall in 'borderline' territory for a finding of SMP, and it seems likely that the rigorous application of a harsh price control is inappropriate.

3. Remedies

On OPTA's findings of SMP, it is required to impose remedies in each of the markets discussed above. OPTA also proposes an intervention via mandatory availability of a wholesale line rental (WLR) product. In each case, this involves – amongst other things – mandatory access and setting a price for it.

OPTA's proposals for remedies consist of two major components:

- use of a price control mechanism based on incentive regulation (a price cap)
- differentiation of the implementation of the price cap based upon differences in replicability (as Section 1 of this paper has recommended).

This section concentrates on the second point, although some comments on the first are included in Annex A.

A. How should the markets be classified in terms of replicability?

OPTA proposes a four-way classification-

1. no prospect of competition

2. competition to develop in the review period, becoming sustainable thereafter
3. competition becoming sustainable in the review period
4. competition has developed.

The markets listed above (and discussed here) all are all placed in category 2.

In my opinion, this is a pessimistic view of competitive opportunities, with the risk that the pessimistic view may be a self-fulfilling prophecy through excessively tight regulation. Within the four OPTA categories, I would place call origination, local transit and leased lines as capable of developing sustainable competition by 2008. For reasons given above the local loop market is subject to greater uncertainty. I return to WLR below.

B. How does OPTA propose to differentiate its approach to regulation on the basis of replicability?

OPTA's proposals for the four categories are embedded with a system of comparative competition, based upon analysis of KPN and US LEC data. OPTA proposes the following remedies for the categories listed above:

1. start and end of period price to be based on observed and projected costs of the most efficient US operators
2. start and end of period price to be based on averagely efficient US operators
3. safeguard (CPI-O) cap over period
4. price floor only.

Further side conditions are imposed to prevent prices rising, and KPN's reported costs will be used to set prices if those costs are lower than the comparator.

The most obvious question this raises is why OPTA's choice of relative prices for categories of access products classified by different degrees of replicability should be determined by the distribution of efficiency among US local exchange carriers. The question can be illustrated as follows:

Consider two access products (A and B) in category 1 and category 2 respectively. In one state of the world, the difference in efficiency between the most efficient and the average US operator is 40%; in the other state of the world, it is 10%.

In the former case the relative price difference between the products is 10%, in the latter, 40%. This has been based not on any consideration of investment incentives in the Netherlands but on the characteristics of a US data set. What has governed it is a consideration which has the merit of being exogenous but the disadvantage of being wholly arbitrary and extraneous.

C. Is there a better alternative, conceptually or practically?

I argued above that a conceptual way forward in setting access prices when replication is feasible is provided by option pricing theory, which is designed to encourage infrastructure building earlier rather than later. In essence, the access price is raised to counteract the access seeker's preference for delaying investment until uncertainties are resolved. Annex 2 sets out this intuition in greater detail.

Precise estimates of the option value of delaying investment until uncertainties have been resolved can be made, using a variant of the model for valuing financial options developed initially by Black and Scholes. and applied to 'real options' initially by Dixit and Pindyck(1994).¹¹ The key factors for applying the approach to telecommunications include the degree of demand uncertainty and

¹¹ A. Dixit and R Pindyck, *Investment under Uncertainty*, Princeton University Press, 1994.

the expected change in input and output prices (see Annex B). It is possible, making assumptions about these factors (and others) to calculate the option value of access. The product of the calculation is the 'mark-up' on long run incremental cost associated with pricing the option. Dixit and Pindyck estimated it as 100%, but a recent paper by Dobbs (2004), taking account of other factors influencing output prices, suggests that a mark-up of 5-50% is more likely.¹² Moreover, this mark-up only applied to the sunk cost component of an access product, which is unlikely to exceed 50%.

This estimate can then be built into a dynamic access pricing regime consistent with incentives to invest. In Figure 1, the solid line shows prices rising over a period of T years from the LRIC value to the 'option' value.

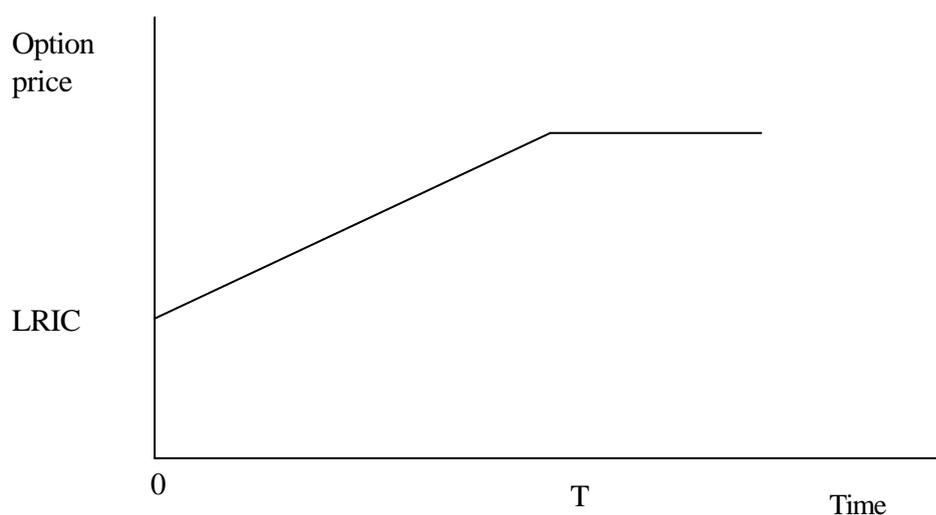


Figure 3: The trajectory of access prices

¹² I. Dobbs, 'Intercorporal price cap regulation under uncertainty', *Economic Journal*, 2004, pp. 421-448.

The timing of the price change is key, and we can distinguish two cases. In the first, replication is already feasible, and prices should after a brief transition period, take account of existing obligations go up to the option price level shown in the figure (or access should cease to be mandatory). In the second, replicability is foreseeable in the near future and prices (or other access conditions) should start to adapt to it over the longer period between market reviews.

However, it is not easy to carry out such calculations in practice. A possible short cut is to utilise the approach proposed by OPTA for category 3 markets – namely a CPI-0 price control. This would create a wedge above LRIC dependent on the expected productivity gain, in excess of the average productivity gain in the Netherlands economy as a whole¹³. For example if X in the CPI-X formula would otherwise be 4% p.a., then after 3 years, using a cap of CPI-0, the increase and price (compared with LRIC) would be about 12%.

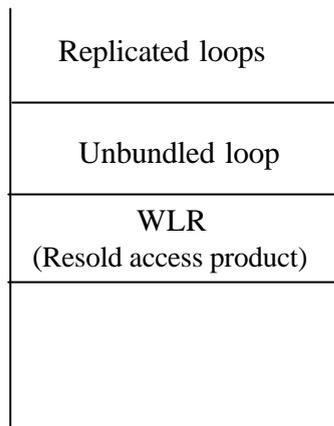
D. How should wholesale line rental be treated?

WLR is analysed by OPTA as a remedy for SMP in markets 1 and 2 (retail access by residential and business customers). As it is a newly resold retail product, the

¹³ This qualification is necessary as the average productivity gain in the economy will broadly pass through into a lower CPI.

pricing rule has to be chosen from scratch. This process can be assisted by locating WLR in a 'ladder' with other access products, see figure 2.

Figure 2: The WLR 'ladder'



According to the analysis in Section 1 above, the key question relevant to pricing WLR is how it should be seen in relation to other products. According to OPTA's Economic Policy Note and other reasoning, this should depend upon i) the benefit from having competitors selling WLR, rather than the incumbent providing access, and ii) the competitive benefit from transition to unbundled or replicated loops.

OPTA has resolved the issue in favour of a rigorous implementation of forward-looking EDC costing. In this respect it is following the lead of OFTEL, which in

January 2002 first set out the logic of its choice of pricing methodology for WLR, subsequently implemented in 2003:

“... 3.13. Oftel believes that the price of this product should be based on BT’s costs in providing the service, including the contribution to common costs deemed to be recovered from the access service in the setting of interconnection charges under the Network Charge Control. At present BT’s residential PSTN line rental is set below this level, and the common costs deemed to be recovered from access are in fact recovered through profits on calls. As calls markets become more competitive, it will be increasingly difficult for BT to recover costs in this way. In addition, in respect of customers taking calls and access from a reseller, BT would receive no retail revenue. A wholesale charge based on BT’s retail line rental could therefore be unsustainable against a background of increasing competition in calls markets, unless BT were to raise the line rental at an unacceptably rapid rate.

3.14 Oftel therefore proposes that the charge for this service should be based on BT’s costs rather than its retail price.....’

Oftel Protecting consumers by promoting competition, p.24

In other words Oftel’s concern was that the price of WLR should not be too low, given the imbalance in the tariff. However that is not a problem in the Netherlands as these tariffs have already been rebalanced, and by adopting a cost-plus approach to the pricing of WLR, OPTA is focussing more on the link with retail prices (ie on detaching customers from KPN’s retail base) than on encouraging a transition to unbundled loops. In my opinion, a more ambitious

approach to infrastructure competition would suggest a retail minus approach.¹⁴

This would leave WLR as a stepping stone on the way to unbundled loops, but give competitors an incentive to move, as by doing so they would only pay the LRIC price of the service they buy. It is noteworthy that the retail minus approach to WLR pricing has been adopted by eight of the nine regulators which have proposed it as a remedy. Oftel/Ofcom is the only exception to date, for reasons noted above.

It can thus be argued that, if OPTA is focussing upon infrastructure competition it should be encouraging operators to rent local loops, not resell a KPN retail product. Such a product plays at best an interim role, and the pricing rule should reflect this.

E. Dealing with new technologies

OPTA is fully aware of the forthcoming switch to new IP technologies. It recognises in its Annex C that a transition period will be required in which both conventional PSTN and IP networks will be employed, but is determined that KPN's wholesale customers should not pay for investments related to services which they do not take.

¹⁴ Recall that under retail minus, the access seeker pays the incremental costs of the services it purchases plus the full contribution to common costs embedded in the price of the retail product.

If the transition were optimally forecast, new technology would replace old assets at a moment when they had been fully depreciated.¹⁵ Optimal replacement decisions would thus create a seamless (downward) price trajectory.

In practice, things will be messier. Standard methods of calculating depreciation will not be used. Duplication and excess capacity will be observed. Costs are likely to rise temporarily. The situation will be exacerbated if overall traffic on the network is decreasing as a result of the diversion of calls, for example, to mobile.

OPTA can cope with this in a number of ways: it could allow full cost recovery; it could influence the transition by setting differential costs of capital for new and old assets; or it could impose all the costs and risks of transition on KPN.

OPTA's Annex C, as summarised above, suggests that OPTA's policy has the following elements:

¹⁵ Such annual depreciation charges would also reflect declining use of the obsolescent network.

- buyers of wholesale services should not incur extraneous costs; this is an attractive principle, but it is silent on whether they should incur the actual costs, over a period in which unavoidable duplication is observed
- OPTA should not rely on KPN's transition forecasts, as these may be biased
- the above two problems can be resolved via comparative competition – ie by relying on cost levels observed in the United States.

The problem with this approach is that it assumes that decisions about the timings of investments and other costs which are rational in the US should be adopted in the Netherlands. It also seems likely that the procedure will deal with the problem of declining traffic by seeking efficient comparators from the US data which become smaller and smaller over time. In other words, instead of tracking the path-dependent costs of a given operator, KPN will be expected to match the performance of a sequence of operators chosen from the panel of LECs. The effect of this is to impose all the costs of transition on KPN

In my opinion, such a policy has long term disadvantages for consumers in the Netherlands, since it signals a willingness by OPTA not to remunerate KPN – and by extension any competitor whose prices are influenced by KPN's

regulated prices – for costs necessarily associated with a transition to a new cost-saving technology. Such conduct may have a long term effect on incentives to invest.

It is also true, however, that a tight price control does not accelerate the process of innovation. It sets a revenue stream, which itself varies with the level of competition. The firm then minimises forward-looking costs. This latter task will be largely unaffected by unit revenues (except by a volume effect).

By contrast, the relative price of old and new access products can affect the rate of innovation. KPN's incentive to invest in IP networks to replace earlier ones is influenced by the rate of return on capital employed it can earn on access service provided by innovative technologies, or by the blended return it earns on combinations of old and new technologies.

The need for such returns to cover costs of risk was acknowledged in the OPTA Economic Policy Note, discussed in Section 1 above. Moreover, the argument referred to above about option prices is relevant here. The option of waiting

until uncertainties have diminished has to be priced into KPN's returns, if investment in new networks is to materialise speedily¹⁶

¹⁶ Ofcom's recent paper on remunerating risky investments invites firms to make submissions to it seeking to justify taking account of real risk options in access prices. Ofcom, *Ofcom's approach to risk in the assessment of the cost of capital*: final statement, 18 August 2005.

Annex A. Price caps

This Annex contains some additional observations on various aspects of OPTA's proposed wholesale price caps.

A. Price Caps

Although incentive regulation or price caps have been used largely in relation to retail prices, as the focus of regulation switches to wholesale, it is natural to seek the same demonstrable benefits of incentive regulation from wholesale services. It is also, of course, possible to combine wholesale and retail services in a single (so-called global) price cap.

B. The choice of starting prices

OPTA proposes to set the starting price for the cap at (some definition of) costs eliminating any excess or deficient returns at the start of the period. This has certain advantages in terms of allocative efficiency, but it should be recognised that it undermines the incentive properties of the cap, especially in its later years.

The point is the simple one that any cost saving innovation introduced in the last years of the control, rather than deferred until the first year of the next control

period, will accrue overwhelmingly to consumers rather than investors, eliminating the incentive to make the investments and thus depriving consumers of their benefit as well. To fix ideas, consider an innovation saving £100 annually for ever. Its value in perpetuity at a discount rate of 10% is £1000. If implemented in the middle of the final year of a price control period, only 5% (£50) of the benefit will go to investors. If implemented in the middle of a three-year price cap, less than 15% (£150) will go to investors. This reflects the general proposition that a short price control period approximates to cost-plus regulation, and lacks desirable incentive properties.

A way of improving the situation is to adopt a progressive convergence of regulated prices to expected costs over the following control period, using a 'glide path'. In the example above, such an approach will allocate nearly 20% of the benefits of a final year cost saving to investors, which may be enough to make it worthwhile.¹⁷ Given the three-year period proposed by OPTA, this should be considered.

¹⁷ Calculated as a return to investors of the sum of £50 in the final year when the cost-saving innovation is made plus £100 (discounted) in the first year of the next control period, £50 (discounted) in the second year, and zero thereafter.

C. Flexibility in the cap

In the interests of predictability, OPTA proposes to impose a cap on the price of each controlled service, rather than on a 'tariff basket'. This denies the sector one of the potential benefits of a cap, that the supplier can vary mark-ups on individual products in accordance with demand conditions, thus enhancing economic efficiency. Decentralising relative pricing decisions to the regulated firm carries the risk of anti-competitive conduct, but this must be guarded against by appropriate side constraints and the construction of appropriate baskets containing services with similar competitive conditions. OPTA should consider relaxing its grip on individual prices.

Annex B. Option pricing¹⁸

Where investments involve sunk costs and uncertainty, there is a 'reward for waiting', because the effluxion of time typically eliminates some uncertainty. For example, an entrant in the broadband market will be able, after a period, to derive more accurate market demand forecasts and, probably, cost forecasts too. The same applies to an incumbent making a postponable investment in new and sunk assets.

Following Hausman, in a very simple model with no uncertainty, investment in an infinitely long-lived asset will occur provided that P (the price of output net of labour and material –ie non-capital -inputs) exceeds the cost of investment $[I]$ suitable annualised; ie the investment will be made if

$$P > (c+d)I \quad 1)$$

Where c is the cost of capital and d is the rate of decline of capital goods prices.

¹⁸ This account closely follows J. Hausman *The effect of sunk costs in telecommunications regulation*. Mimeo 1998.

Now introduce uncertainty about i) demand, ii) output price, iii) technological progress, iv) the interest rate – ie. all the variables in 1). It can be shown that the revised rule for investment is to do so where

$$P > m(c+d)I \quad 2)$$

Where $m > 1$ and depends upon the level and the underlying random structure of each of the variables. It can be conceived as a mark-up on the sunk component of costs.

Early estimates put m at two. A recent study by Dobbs has used simulation to derive estimates of m in between 1.05 and 1.5 (ie. a mark-up of 5-50% on sunk costs). Dobbs' work is of interest as it models a world in which an incumbent faces an investment decision. Dobbs shows that a firm facing a price cap when subject to uncertainty will delay investments and ration customers (as the price cap bites), rather than invest as a capped firm would in a certain environment. In other words, the uncertainty has a major effect on an incumbent's investment decisions.