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article:

local loop unbundling: flaws of the cost proxy model

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Regulators everywhere want to see local loops unbundled, but cannot agree a fair and equitable means of doing so. The problem has particularly bedevilled the USA, where five years after the Telecommunications Act, a level playing field is still not in place. So is the FCC using the wrong cost model to try and balance the interests of incumbents with new operators? And what analytical tools should we be using to evaluate alternative models?

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The US Telecommunications Act of 1996[1] sought to replace existing regulatory monopolies with competitive market structures. Like other governments around the world, the USA believed in the ability of those markets to 'promote competition and reduce regulation in order to secure lower prices and higher quality services for... telecommunications consumers', and to 'encourage the rapid deployment of new telecommunications technologies'.[2]

To hasten the development of competition, regulators ordered incumbent local carriers to provide competitors with access to their networks. This access could be in the form of interconnection or unbundled network elements.[3] New entrants could request interconnection at any technically feasible point in an incumbent's network. However, due to its high initial capital outlay, potential competitors are most interested in obtaining access to incumbents' local loop networks.[4]

To facilitate access to the local loop, incumbents are now being forced to 'unbundle' it. With local loop unbundling, incumbents must allow competing providers to connect, on a leased basis, to network elements in their local loop networks. With the availability of these unbundled network elements at regulated lease rates, competitive local exchange carriers are now able to defer most of the capital outlay they would once have had to invest in constructing their own loops. This allows new entrants to enjoy significant capital savings, while deferring their commitment to any particular infrastructure or technology.

The lease rates, or prices, for these unbundled network elements have a dramatic impact on social welfare. As in any economic pricing situation, if prices are set too low, the seller (in this case the incumbent carrier) is deprived of an opportunity to recover its costs. Low prices are also an implicit subsidy to new entrants. This subsidy encourages entry by inefficient firms that could not otherwise survive in a competitive environment.[5] Conversely, if prices are set too high, competitive entry may only occur via facility-based carriers and, thus, will not be as widespread as desired by legislators and regulators. In either of the above scenarios, retail customers (or end users) are adversely affected, for unrealistic lease rates send false signals to the marketplace.

Regulators have a number of pricing options available for setting the lease rates for unbundled network elements. In Europe, EU member countries appear to favour prices based on long-run incremental costs, but have not yet specified a specific methodology, or established default proxy prices.[6] In the USA, the Federal Communications Commission (FCC) opted to establish prices based on its own methodology, known as total element long run incremental cost (TELRIC). The FCC determined that the TELRIC methodology would appropriately recover the forward-looking costs directly attributable to the specified elements.[7] In addition, the FCC encouraged individual states to use an economic cost methodology to set rates for interconnection, unbundled network elements and collocation, but allowed the states to use federal default proxies in setting and reviewing rates.[8]

1. US Congress. Pub. L. No. 104-104, 110 Stat. 56. *The Telecommunications Act of 1996* ('1996 Act') amended the *Communications Act of 1934*, 47 USC. §§ 151 *et seq*.
2. United States Court of Appeals for the Eighth Circuit. No. 96-3321 (and consolidated cases), *Iowa Utilities Board et al, Petitioners v. Federal Communications Commission and the United States of America, Respondents*, Submitted 17 September 1999, filed 18 July 2000, p 2 ('8th Circuit Decision'), citing the Telecommunications Act of 1996, Pub. L. No. 104-104, purpose statement, 110 Stat. 56, 56 (1996).
3. Interconnection is the connection of one telecommunications carrier's network to another, or the connection of a piece of telephone equipment to a nationwide network. Unbundled network elements are portions of an incumbent's network that other service providers may lease, such as loops.
4. The local loop network (eg copper and fibre optic cables, poles, conduits and associated electronics) is the segment of a telecommunications carrier's network that connects the local switching office to the customer's premises.
5. Alfred E. Kahn: *Letting Go: Deregulating the Process of Deregulation, or Temptation of the Kleptocrats and the Political Economy of Regulatory Disingenuousness*, MSU Public Utilities Papers, Institute of Public Utilities and Network Industries, East Lansing, MI, 1998, p 16.
6. *Access Network Facilities: Oftel Draft Guidelines on Condition 83 of BT's Licence*, UK Office of Telecommunications, para 3.6, July 2000.
7. *Implementation of the Local Competition Provisions in the Telecommunications Act of 1996 and Interconnection between Local Exchange Carriers and Commercial Mobile Radio Service Providers*, US Federal Communications Commission, CC Docket Nos. 96-98 and 95-185, First Report and Order, 11 FCC Rcd 15499 (1996), para 682.
8. Interconnection Order, *op cit*, Ref 7, para 787.

As implied by its name, the TELRIC methodology requires an accurate estimate of the cost for each element. Determining these cost estimates, however, is an extremely contentious issue. In the USA, the FCC and state regulatory agencies have been wrestling with the issue since 1996. European regulators will face the same challenge in due course – how to determine accurately the cost of unbundled network elements. In a number of US states, regulators have relied on cost proxy models as estimators of unbundled network element costs.

The purpose of this paper is to investigate the usefulness of cost proxy models in accurately estimating the economic costs of unbundled network elements. It illustrates some of the theoretical and practical shortfalls of cost proxy models and offers some analytical tools that can be used to evaluate them.

Objectives of local loop unbundling

The overall goal of the 1996 Telecommunications Act was to introduce competition in what many refer to as the 'last mile' – that all-important link to the customer's premises. To facilitate entry into the local market, the 1996 Act requires, along with other things, mandatory unbundling. In particular, Section 251(c)(3) mandates:

The duty to provide, to any requesting telecommunications carrier for the provision of a telecommunications service, non-discriminatory access to network elements on an unbundled basis at any technically feasible point, on rates, terms, and conditions that are just, reasonable, and non-discriminatory, in accordance with the terms and conditions of the agreement and the requirements of this section and section 252. An incumbent local exchange carrier shall provide such unbundled network elements in a manner that allows requesting carriers to combine such elements in order to provide such telecommunications service.

To implement local loop unbundling, the 1996 Act also requires that prices be 'based on the cost [determined without reference to a rate of return or other rate-based proceeding] of providing the interconnection or network element [whichever is applicable].'[9] Further, prices must be 'non-discriminatory' and 'may include a reasonable profit'.[10]

The objectives and implementation of local loop unbundling in other countries around the globe strongly resembles the US experience. In April 2000, the European Commission ordered incumbent telecommunications providers to fully unbundle the local loop. To this end, the European Commission charged national regulatory agencies with defining a set of conditions and requirements applying to incumbents' offers of unbundled loop access. Regulators are to make certain that:

- Costing and pricing rules are transparent and objectively based.
- Pricing rules ensure that incumbents recover relevant costs, plus a reasonable return.
- Pricing of local loops is compatible with the aim of fostering fair and sustainable competition and providing efficient investment incentives to alternative providers.
- Pricing rules ensure no market distortion, especially as regards wholesale and retail services offered by incumbents.[11]

9. 1996 Act, Section 252 (d)(1)(A)(i).
10. 1996 Act, Section 252 (d)(1)(A)(ii) and Section 252(d)(1)(B), respectively.
11. Commission of the European Communities, 'Unbundled access to the local loop: enabling the competitive provision of a full range of electronic communications services including broadband multimedia and high-speed internet', Recommendation (C (2000) 1059) and Communication (COM (2000) 237 final) (26 April 2000) specifically Communication, Section 6, pp 12–13.

Several national regulators have acted on this requirement and drafted regulations to implement local loop unbundling. For instance, in the UK, the Office of Telecommunications (Oftel) has issued draft guidelines. Specifically, Oftel mandates that prices be based on an incremental-cost pricing methodology. Furthermore, Oftel requires that prices for unbundled network elements make certain that:

- Long-run incremental costs are recovered, where these costs have been reasonable and necessarily incurred.
- A mark-up for common costs is included.
- A reasonable return on the capital invested is allowed.[12]

In Italy, the former telephone monopoly, Telecom Italia SpA, attempted to set prices for unbundled network elements at 146% of the prevailing retail rate.[13] While regulators have not yet reviewed Telecom Italia SpA's proposal, competitive exchange carriers are already threatening to bring lawsuits if these rates are implemented. Similar developments can be observed in Germany.[14]

As witnessed by the prolonged process in the USA – countless arbitration hearings, lawsuits and appeals – setting economically neutral prices for unbundled network elements is a highly contentious process.

Pricing options

Regulators have a number of options available to them for determining how to establish prices for unbundled network elements. Here are some of the options that have been proposed for setting the prices of interconnection and unbundled network elements:

Fully distributed cost-based pricing

A fully distributed costing methodology is the traditional pricing approach employed by US regulators, in which booked costs,[15] as opposed to forward-looking costs, are used. Under the fully distributed costs method, regulators allocate booked joint and common costs to individual services based on gross revenues, directly attributable costs or relative levels of output. Joint costs are those costs incurred when a firm produces two or more outputs in fixed proportion by the same production process. Common costs are costs incurred by multi-product firms simply as a fact of being in business, and do not vary in proportion to the firm's products or services, eg corporate salaries. Each service is then expected to cover its directly attributable costs and its 'allocated' joint and common costs.[16]

Fully distributed costs were appropriate when telephone companies were regulated monopolies with a guaranteed rate of return. Rates and charges were set subject to strict guidelines and stringent scrutiny by regulatory agencies concerned primarily with affordable basic service rates. The fully distributed costing methodology solved the cost allocation problem inherent in marginal cost approaches – how to allocate joint and common costs to multiple products or services. This problem is particularly severe in natural (and regulated) monopolies where in the presence

12. Oftel Draft Guidelines, para 3.6.
13. Yaroslav Trofimov, 'Rivals Say Telecom Italia plan is meaningless', *Wall Street Journal*, 15 May 2000, p A9.
14. *Ein Analytisches Kostenmodell fuer das Ortsnetz*, Wissenschaftliches Institut fuer Kommunikationsdienste, GmbH, 4 March 1998, http://www.regt.de/reg_tele/start/fs_05.html.
15. Other terms used for booked costs are accounting costs, embedded costs, and historical costs.
16. Ronald R. Braeutigam, 'An analysis of fully distributed cost pricing in regulated industries', *The Bell Journal of Economics*, Spring 1980, pp 182–196.

of economies of scale, the firm necessarily loses money when pricing at marginal cost.[17]

The fully distributed method has been heavily criticized by academics and regulators alike for its apparent lack of economic rationale and for the arbitrary fashion in which joint and common costs are allocated to particular services or products.[18]

Ramsey pricing

A method that has gained increasing attention in economic literature as a potential alternative to fully distributed costing is Ramsey pricing.[19] Ramsey attempted to address the problem inherent in pricing public utilities: where there are different products and different consumers, what is the most efficient set of prices that will allow society to finance the fixed costs of production that are not covered by marginal cost pricing?[20] Ramsey's solution (in the simplest case where cross-elasticities of demand are zero) was a set of prices where the mark-up over marginal cost is highest when demand is inelastic and lowest when demand is elastic, or 'inverse-elasticity pricing'.[21] Under Ramsey pricing, prices exceed marginal costs in inverse proportion to the demand elasticities of the related services.[22]

Supporters of Ramsey pricing argue that it is efficient to produce goods or services when consumers value the good or service more than its marginal cost. Prices above marginal costs are socially inefficient, but the efficiency costs are much less when the level of consumption is not sensitive to changes in prices. That is, with Ramsey pricing, consumers that respond to prices the least are asked to contribute the most to fixed costs.[23]

Although quite popular among economists as an optimal pricing method, Ramsey pricing has drawn criticism for its burdensome implementation. Regulators must be knowledgeable about marginal costs, demand elasticities, and limits to price increases that arise from potential competition. Moreover, when constrained by political limits on basic service prices and competitive entry, Ramsey prices may provide a diminishing amount of revenue to the incumbent that, ultimately, may not be sustainable.[24] In 1985, the US Interstate Commerce Commission stated:

Ramsey pricing is based on a mathematical formula which requires both the marginal cost and the elasticity of demand to be quantified for every movement in the carrier's system. Thus, the amount of data and degree of analysis required seemed to us overwhelming. Our conclusion was that while formula Ramsey pricing is useful as a theoretical guideline, it is too difficult and burdensome for universal application.[25]

Efficient component pricing

The efficient component pricing rule specifies that the price of network access must include all opportunity costs incurred by the supplier in providing the product.[26] Opportunity costs are all the potential earnings a firm forgoes, either by:

17. Kenneth E. Train, *Optimal Regulation, The Economic Theory of Natural Monopoly*, The MIT Press, Cambridge, MA, 1995, pp 12–17.
18. Braeutigam, *op cit*, Ref 16.
19. *See* Frank P. Ramsey, 'A contribution to the theory of taxation', *Economic Journal*, Vol 37, No 1, March 1927, pp 47–61.
20. *See* James Love, 'Pricing government information', *Journal of Government Information*, Vol 22, No 5, 1995, pp 363–387.
21. *Ibid*.
22. For a detailed discussion of Ramsey pricing, see Train, *op cit*, Ref 17, chapter 4. *See also* Baumol, Panzar and Willig, *Contestable Markets and the Theory of Industry Structure*, Revised Edition, HBJ Publishers, Orlando, FL, 1988.
23. Love, *op cit*, Ref 20, p 14.
24. Michael A. Einhorn, 'Recovering network subsidies without distortion', http://www.benton.org/Library/Recovering/wp4.html.
25. US Interstate Commerce Commission, *ex parte* No 347 (Sub-No. 1), Coal Rate Guidelines, Nationwide, decided 3 August 1985.
26. Robert D. Willig, 'The theory of network access pricing', in H.M. Trebing, ed, *Issues in Public Utility Regulation*, MSU Public Utility Papers, 1979; William J. Baumol, 'Some subtle issues in railroad deregulation', *International Journal of Transportation Economics*, Vol 10, 1983, pp 341–355; William J. Baumol and Gregory J. Sidak, *Toward Competition in Local Telephony*, MIT Press and AEI Press, 1994, pp 93–116.

- providing inputs of its own rather than purchasing them; or
- by offering services to competitors that force it to relinquish business to rivals and, thus, to forgo profit on lost business.

The rule requires that the price of a unit of access to an incumbent's network should equal its average incremental cost, including all pertinent opportunity costs.[27] Advocates of this approach tout its economic efficiency under different market structures. Further, they insist that access prices derived using this method allow prices to fall and output to expand for the final product, relative to the price and output obtained under regulation.

Opponents contend that this method holds as a first-best pricing principle only if a stringent set of assumptions is true. For example:

- the incumbent's price for the complementary service is based on a marginal-cost pricing rule;
- components used by incumbent and rival are perfect substitutes and generate returns to scale;
- the rival producer has no market power; and
- the incumbent's marginal cost of production of the component can be observed accurately.[28]

TELRIC – the US regulator's choice

Another pricing option for unbundled network elements is the method selected by the FCC called Total Element Long-Run Incremental Cost (TELRIC) pricing. TELRIC requires that the price of a network element be set at:

> *the forward-looking costs that can be attributed directly to the provision of services using that element, which includes a reasonable return on investment (ie 'profit'), plus a reasonable share of the forward-looking joint and common costs.*[29]

A TELRIC study includes the entire quantity of the network element under study, all costs incurred in the long run for the provision of that network element (eg forward-looking costs of capital, directly attributable costs such as administrative expenses, and certain common costs incurred in the provision of wholesale services), and encompasses a period long enough that all costs are treated as variable and avoidable.[30] The FCC and other parties supporting TELRIC argue that the prices new entrants pay for network elements should reflect forward-looking long-run economic costs, in order to encourage efficient levels of investment and entry. Opponents of the TELRIC methodology argue that it will not recover the total costs of the network and will be more likely to discourage efficient entry and useful investment by incumbents and new entrants alike.[31]

The FCC ordered incumbent providers to base their prices on TELRIC, plus a reasonable allocation of forward-looking common costs.[32] It considered that a forward-looking cost methodology would best replicate the conditions of a competitive market, as well as reducing the ability of incumbent LECs to engage in anti-competitive behaviour.[33] Thus the FCC charged state regulators with determining the cost of unbundled network elements based on the projected future costs of carriers.[34]

27. J. Gregory Sidak and Daniel F. Spulber, *Deregulatory Takings and the Regulatory Contract*, http://www.cup.org/books/sidak/sidakchap.htm, October 1997, Chapter 1, p 5.
28. Nicholas Economides and Lawrence J. White, 'Access and interconnection pricing: how efficient is the 'Efficient Component Pricing Rule'?' *Antitrust Bulletin*, Vol 40, No 3, Autumn 1995, pp 557–579.
29. Interconnection Order, *op cit*, Ref 7, para 673.
30. *Ibid*, paras 690-694.
31. *Ibid*, para 638.
32. *Ibid*, para 682.
33. *Ibid*, para 679.
34. *Ibid*, para 683.

In essence, the TELRIC methodology endorsed by the FCC is based on costs that assume that wire centres will be placed at the incumbent LEC's current wire centre locations, but that the reconstructed local network will employ the most efficient technology, so as to make reasonable allowance for future capacity.[35] That is, only the incumbent's existing wire centre locations are assumed to exist and the rest of the network will be reconstructed using the latest technology available (the 'scorched node' approach, building an entirely new telecommunications network from scratch).

Cost proxy models

Since TELRICs are not directly observable, the FCC and US state regulators have relied on cost proxy models to estimate them. The ultimate objective of these cost proxy models is to estimate the TELRIC for each unbundled network element 'using the least cost, most efficient, and reasonable technology currently available for purchase, with all inputs valued at current prices'.[36]

The cost proxy models being submitted most frequently in current regulatory proceedings in the USA are the HAI Model prepared by HAI Consulting Inc. on behalf of AT&T and MCI WorldCom, and the FCC Synthesis Model, developed by staff at the FCC. Other commonly proposed models are the Benchmark Cost Proxy Model, developed by Sprint, US WEST and BellSouth, and the Integrated Cost Model, developed by GTE. A lesser-known alternative is the Telecom Economic Cost Model, developed by Ben Johnson and Associates, Inc.

On the international front, German regulators seem to be travelling down the same road as their counterparts in the USA. They have also proposed the use of cost proxy models to estimate the costs of the local network. A proposal offered to regulators in Germany is the 'Ein Analytisches Kostenmodell fuer das Ortsnetz' by the Wissenschaftliches Institut fuer Kommunikationsdienste GmbH ('WIK').

Given the FCC's reliance on cost proxy models, these models play a pivotal role in the deregulation effort in the USA. I will therefore focus solely on the usefulness and accuracy of these models for the remainder of this paper.

Theoretical limitations of cost proxy models

The primary goal of a cost proxy model must be accuracy. In the USA, the developers and proponents of the various cost proxy models all claim their models to be the most accurate.

Yet, ironically, the cost estimates produced by these models vary dramatically and the output, if used, will affect not only telecoms operators, but also subscribers. For instance, cost estimates for unbundled network elements differ on average by 50% between the two most popular models. In particular, one of the cost proxy models proposed estimates

35. *Ibid*, para 685.
36. US Federal Communications Commission, *Federal-State Joint Board on Universal Service*, CC Docket No 96-45, Report and Order, 12 FCC Rcd 8776 (1997) para. 224, n. 573.

a monthly average loop cost of approximately $23, while the other puts it closer to $16 per month.[37] With about 200 million loops in the USA, the difference would amount to $1.4 billion monthly.[38]

The large discrepancy in the estimates of the models is due in part to the FCC's interpretation of the 1996 Act and to the simplified assumptions used in the models. Some of the more serious drivers of this difference are discussed below.

Hypothetical network standards

In an apparent effort to eliminate embedded costs from forward-looking cost estimates, US regulators have endorsed the 'scorched node' method.[39] Combined with the forward-looking concept, the developers of the cost proxy models have interpreted this to mean that a model has to create a brand new, hypothetical network that does not represent any real incumbent provider's network. The creators of the HAI Model, for example, repeatedly characterize theirs as a 'scorched node' model.

These structural and operating assumptions completely ignore incumbents' *actual* costs and existing physical plant. In fact, most cost proxy models proceed on the assumption that all of the incumbent's existing facilities and assets are abandoned. In their place, a totally new telecommunications network is constructed that uses:

- the most streamlined distribution routes, ignoring geographic obstacles and right-of-way issues;
- the most advanced technology; and
- the lowest possible costs.

For instance, the HAI Model purposefully designs a network unrelated to the network of any incumbent, and of a type which no operator would be likely to build. It is not rational to suggest that any firm would continuously replace its network in order constantly to employ the most recent, least-cost technology. From an economic and engineering perspective, these assumptions are unrealistic. As Kahn states, firms in the real world typically incur such heavy sunk costs 'only if prevailing market prices are high enough to provide rapid depreciation of those costs, and rates of return that [Jerry Hausman has estimated] would have to be two or three times current costs of capital'.[40]

Proponents of the cost proxy model acknowledge that rebuilding incumbents' networks would not occur in a real-world situation and that certain assumed efficiency gains would take a number of years to manifest.[41] Yet they stand by the model as a measure of the actual costs of carriers – if it is seen as predictive and forward-looking, and assuming a reasonable level of efficiency.

A recent decision by the US Court of Appeals for the Eighth Circuit agreed that the hypothetical network standard was unrealistic and stated that Congress 'did not expect a new competitor to pay rates for a reconstructed local network… but for the existing [network] it would be using in an attempt to compete'.[42] Furthermore, the court stated that: 'Congress has made it clear that it is the cost of providing the actual facilities and equipment that will be used by the competitor (and not some 'state of the art' technology ideally configured but deployed by neither the ILEC nor its competitors), which must be ascertained and determined.'[43]

37. Average loop costs were derived from a sample of 12 incumbent local carriers in the USA.
38. 'Total USF loops for all local exchange companies as of 31 December 1997', *Preliminary Statistics of Communications Common Carriers*, US Federal Communications Commission, 1998, table 2.3. This number was extrapolated to the year 2000 by assuming an annual growth factor of 5%.
39. Embedded costs (often called historic, booked or accounting costs) are costs incurred by a firm in the past for providing service. Although they were most likely prudently incurred, either because of prevailing economics or by regulatory mandate, they should be ignored and replaced with new costs representing the most recent technology.
40. Kahn, *op cit*, Ref 5, p 92.
41. *Testimony of AT&T Witness Dr Nina Cornell*, US State of Washington Utilities and Transportation Commission, Docket No UT-960369, 70, 71, Tr. at 753-55, 10 July 1997
42. 8th Circuit Decision, *op cit*, Ref 2, p 8.
43. *Ibid*.

In making this decision, the court essentially overturned the use of the TELRIC methodology in favour of the long-run incremental cost approach (LRIC). The TELRIC methodology estimates the cost of a network element by constructing a completely new hypothetical network and calculating the cost of provisioning that element. The LRIC approach estimates the additional cost of providing network elements with the incumbent's existing network. This is a fundamentally different approach and renders current cost proxy models useless for estimating the real costs to incumbents for interconnection and unbundled network elements.

Forward-looking methodology

Another area that caused wide debate in the USA was the definition of 'forward-looking'. Loosely defined by Congress, the forward-looking methodology simply requires that rates 'shall be based on the cost… of providing the interconnection or network element…'[44] The term 'cost' as used by Congress is certainly ambiguous, and most competitive carriers have assumed that forward-looking means 'futuristic'. As a result, the networks conceptualized by cost proxy models embrace a wide range of expert opinion.

Since Congress never specifically defined a cost standard, the FCC imposed its 'forward-looking' interpretation on the ambiguous language in the 1996 Act, ruling out the use of historical or embedded costs. Since historical or embedded costs are considered sunk costs, the use of forward-looking costs appeared to be an economically sound concept, which it is. It is the manner in which cost proxy models *implement* the concept that is flawed. Most competitive carriers assume that forward-looking costs will be lower than historical costs. This is a fallacious assumption that is perpetuated in the proposed cost proxy models. In particular, the HAI Model, which often employs 'expert opinions', assumes that future costs will be a fraction of today's.

It is true that some telecommunications costs have been declining, especially those associated with digital switching equipment and fibre optic transmission facilities. However, the lion's share of an incumbent's costs is associated with its loop network, and most of these costs are escalating, not declining. For example, forward-looking structure costs can be expected to exceed embedded costs due to the increased urbanization that has occurred since the loop network was initially built. Future forward-looking placement will be necessary in paved and heavily populated areas, and the associated costs will go up accordingly. In addition, a forward-looking structure mix should be weighted more heavily toward underground and buried placement as opposed to aerial structures, due to municipal zoning restrictions.

Right-of-way costs have also risen since the embedded plant was designed. A number of municipalities have begun to impose high fees, sometimes up to 5% of gross revenues, to build and maintain telecommunications facilities. It is likely that the incumbents' right-of-way fees have been fully amortized in their embedded rate base. Finally, labour and material costs necessary to construct the loop network have increased and will continue to increase. The Turner Price Index clearly demonstrates that the cost of copper wire has increased consistently over time.[45] Consequently, depending on the particular vintage of an incumbent's distribution plant, forward-looking loop costs can be expected to be significantly higher than the historic cost of construction.

44. 1996 Act, Section 252 (d)(1)(A)(i).
45. The Turner Price Index is a commonly used inflation adjustment guide used by telephone companies in the USA.

A simple way for regulators to evaluate the estimates of any model is to perform external validity tests. External validity tests verify whether the cost estimates of the model can be confirmed by comparison to external measures of the same costs. For instance, one can compare the current expenses for digital switching to the forward-looking estimate for this account. While a dollar-to-dollar match is not necessary, current expenses and model estimates should align, or a model has little or no forecasting power. For instance, as detailed below, the HAI Model usually forecasts forward-looking switching expenses to be approximately 10% of current switching expenses. Models that fail such simple 'back-of-the-envelope' tests should not be considered in setting rates for interconnection or unbundled network elements.

Customer location

Much of the debate about the use of cost proxy models focuses on how these models locate an incumbent's customers in order to model the costs of the local loop. Specifically, determining where customers are located in the hypothetical network created by these models is of the utmost importance, because it has a major impact on the cost estimates.

To properly model customer locations, a cost proxy model needs a complete and accurate customer location database that contains the longitude and latitude of each local telephone customer in the study area. Unfortunately, many local telephone companies do not have an accurate database of where their customers are located. Billing addresses are often not representative of a customer's actual location and, therefore, provide very limited information. Moreover, the databases that do exist usually do not list the latitude and longitude of customer locations; ie they are not in a geocoded format. A geocoded database containing the precise coordinates, both latitude and longitude, for all customer locations would provide the most accurate customer location data. This, in turn, would enable cost proxy models to select the least-cost, most efficient design for a local distribution network, thus making the distribution network more accurate than the ones currently being modelled.[46]

The lack of a complete and accurate database of customer locations has sparked a lot of debate in the USA. Many solutions have been proposed to this problem, but with limited success.[47]

Omitted variables

While all the cost proxy models proposed to regulatory agencies in the USA claim to accurately estimate the cost of unbundled network elements, many overlook a number of fundamental variables that contribute significantly to costs. First, none take into consideration 'make ready' costs. These are expenses that the incumbent incurs when reconfiguring its network. For example, if an incumbent decides to install a digital switch to replace an analogue switch, the old switch needs to be removed and the building space made ready for the new installation.[48] These are actual expenses that a model should take into consideration when it 'reconstructs' an incumbent's entire network.

Second, with the exception of a few models, most cost proxy models fail to account for right-of-way costs. Again,

46. Although making a cost proxy model's distribution network more accurate, geocoding alone cannot correct other problems inherent with this type of model, such as real-world constraints associated with geographic barriers and legal and political constraints that incumbents encounter when laying cable.

47. Christian Dippon, 'Estimating the cost of local telephone service: where are the customers?', presented at the Rutgers Conference, Lake George, Bolton Landing, NY, 24 May 2000.

48. Cost of removal must be included in the cost estimates of any model. Often these costs are significant and far exceed the salvage value of an outdated piece of equipment. Occasionally walls have to be destroyed and replaced in the removal process, or new walls erected to accommodate smaller switches in order to free up the space no longer needed for a switch for other use. Also, flooring generally needs to be repaired, cable runs and distributing frames reworked, and sometimes air conditioning and power need to be upgraded.

this is an integral component of an incumbent's local loop costs and must be included. Finally, instead of replacing perfectly serviceable equipment each time there is a newer, cheaper or more technologically advanced product, a proper model takes into account the costs of network upgrades. This is of particular importance on a forward-looking basis, as networks increasingly rely on computer hardware and software that require constant upgrades.

Diagnostic tools

There are a number of diagnostic tools available to regulators and other reviewers. Rather than pinpointing specific problems within a model, these tools are used to evaluate the results of a cost proxy model to determine if they are reasonable. Two tests that have proven to be very powerful and simple to apply are the external validity test and the minimum spanning tree test.

External validity test

This is a basic test where a cost proxy model's estimates are compared to an actual incumbent's data. In the following analysis, I use booked costs as a basis for my comparison. Table 1 compares the costs produced by one of the cost proxy models proposed in the USA with the booked costs of an incumbent provider. For illustrative purposes, I performed this analysis for an actual US incumbent's operating area in one state.[49]

Table 1: Cost proxy/booked comparison (in thousands).

		Booked	*Cost Proxy Estimates*	*Cost Proxy/ Booked*
Investment	Network	$316,138	$117,664	56%
	Switching	$64,841	$22,240	34%
	Support	$43,241	$20,012	46%
	Total	$359,379	$197,676	55%
Expenses	Network	$8,995	$3,325	37%
	Switching	$3,775	$0	0%
	Support	$11,169	$2,801	25%
	Corporate	$7,411	$3,902	53%
	Total	$27,575	$10,027	36%

Table 1 clearly illustrates the fundamental flaws of this cost proxy model. The top part of Table 1 compares the incumbent's booked capital investment with the corresponding amounts estimated by the cost proxy model. For example, the table shows that the cost proxy model produces only 56% of the investment in network components that the incumbent currently has on its books. For end office switching, the cost proxy model performs even worse,

49. The values for booked and cost proxy model investment and expenses are taken from a default run of the HAI Model, Version 5.2 ('HM 5.2') for GTE Northwest Incorporated's operating area in the state of Idaho. Booked values represent 1998 FCC Automated Records Management Information System ('ARMIS') figures as calculated and used by the HAI Model. Model values represent default outputs.

producing only 34% of booked investment. Similarly, the cost proxy model produces only 46% of the support investment (vehicles, office equipment and the like) that the incumbent is currently using.

Turning to expenses, the cost proxy model estimates only 36% of the total expenses that the incumbent currently incurs. The comparison is especially stark for end office switching, where the cost proxy model estimates that the incumbent could maintain its switches at no cost.[50] Since almost 100% of the incumbent's switching investment is already digital, the idea that these switches can be maintained for nothing is ludicrous. In addition, the incumbent's network consists to a high degree of 'current' equipment. That is, the same equipment that a cost proxy model would select for an 'efficient' carrier (eg digital loop carriers, fibre optic inter-office facilities and digital switches). Thus, the discrepancy between the output of the model and the incumbent's booked costs is even more disturbing.

Before spending valuable time examining the structure of a cost proxy model, I recommend that European regulators first perform an external validity test to assess the reasonableness of the estimates of the proposed model.

Minimum spanning tree test

A second test that is quite powerful and convincing is the minimum spanning tree test. This type of test compares the cable length estimated by the cost proxy models to connect customers to the wire centre to a minimum spanning tree (MST). An MST is a mathematical graph theory construct used to connect a set of points with the least possible length of total connecting lines.[51] As such, the MST provides a lower limit for the amount of distribution cable needed to serve a group of customers.

A colleague and I performed an analysis of the cable length estimates produced for an incumbent's operating area by one of the cost proxy models proposed for use in the USA.[52] We found that the cost proxy model identified over 1000 groups of customers in the incumbent's operating area. For each group, we calculated the total cable length implied by the MST method and compared these lengths with those estimated by the cost proxy model. We found that the lengths estimated by the cost proxy model were considerably less than those produced by the MST method.[53] This result leads us to believe that the cost proxy model's methodology for calculating cable is not designed properly. This is an extremely important point as the less cable estimated, the lower the associated costs. A cost proxy model that estimates less cable than is actually required results in distorted costs and, ultimately, prices that are set below cost.

I strongly suggest that any firm or regulatory agency considering a cost proxy model for internal or regulatory purposes perform some basic validation tests on the model before making a final decision to use it.

50. If the user-defined factors discussed above are set to equal the expense-to-investment ratio, then the total switching expense calculated by the HAI Model is $1.3 million, or 34% of the GTE Northwest Incorporated's actual switching expense in Idaho.
51. See eg J. E. Flood, ed, *Telecommunications Networks*, IEEE Telecommunications Series 1, London, UK, 1977, Section 13.4; N.L. Biggs, *Discrete Mathematics*, Clarendon Press, London, 1994.
52. Christian M. Dippon and Kenneth E. Train, 'The cost of the local telecommunication network: a comparison of minimum spanning trees and the HAI Model', *Telecommunications Policy*, Vol 24, No 3, April 2000, pp 253–262.
53. Although we conducted this test on an older version of the HAI Model, the same type test produced similar findings when using the most recent versions of the HAI Model and the FCC Synthesis Model.

Conclusion

In this paper, I have examined the usefulness of cost proxy models for local loop unbundling. Welcome as these models have been in sparking interest in the future economic costs of supplying telecommunications services, their accuracy remains highly questionable. Most suffer from a number of theoretical and practical drawbacks, based as they are on over-simplified or incorrect assumptions about the economic environment of incumbent carriers. Most do not pass basic external validity tests, never mind simple common sense issues.

Consequently, at this stage, the use of cost proxy models for setting prices cannot be recommended. Their use would be profoundly anti-competitive and thwart the very objective of local loop unbundling. It would retard the development of facilities-based competition, because more efficient facilities-based competitors would be unable to price 'below-cost'. If as a result of such inefficient pricing, the local exchange market were left with only resale competition, customers would fail to enjoy many of the benefits intended by the unbundling legislation. Thus, I strongly suggest that regulators around the world learn from the US experience and avoid the use of cost proxy models in setting the prices of interconnection and unbundled network elements.