# Access Pricing in Telecommunications – Time to Revisit LRIC?

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## Summary

Long Run Incremental Cost (LRIC) models have been applied by regulators in the UK, US and elsewhere in pricing access and interconnection in telecommunications networks since the mid 1990's. Advocacy of LRIC is often based on the assumption that this is the level at which effective competition would drive prices, or more colloquially "mimic competition". In practice the application of the LRIC methodology has been based around hypothetical network models that may depart substantially from the real-world attributes of the actual network in question.

The conditions necessary for LRIC to "mimic competition" and allow a firm to recover exactly its costs over the life of an asset are still a matter of academic research, and failure to take account of known potential sources of bias in modelling can result in large errors. In particular, an efficient competitive firm that believes costs are falling will refrain from investing unless it receives a higher price today to offset, in present value terms, the lower prices that will occur tomorrow.

The LRIC approach differs from that generally applied in other regulated utility sectors where returns are calculated on a regulatory asset base (RAB) which is updated based on actual investment and depreciation. Under a RAB based approach assumptions regarding asset lives and depreciation have no impact on the present value of returns. In contrast, when LRIC prices are recalculated at intervals shorter than asset lives, there is only one unique profile of returns that yields the appropriate return on investment. Returns under LRIC are therefore sensitive to the profile of returns which depends on assumed asset lives and depreciation profiles, both of which are likely to prove contentious.

Even if unbiased estimates of anticipated technical progress, economic asset lives and depreciation are utilised as inputs to a dynamically consistent modelling approach biases may remain. New technologies will periodically arrive on the market and strand old technologies (in a competitive market investors would only invest if they were compensated for potentially lower future investment and/or operating costs via compensating supranormal profits).

The uncertainty, subjectivity, complexity and scope for opportunism inherent under LRIC suggest that LRIC should either be modified to more closely reflect the real-world attributes of networks, or reconsidered in favour of alternatives such as a RAB based approach. While the use of real-world attributes of the actual network in question in modelling would reduce the subjectivity relative to existing practice, it would leave significant sensitivity of returns to subjective parameters including assumed asset lives and depreciation profiles. In contrast, a RAB based approach provides a simple rule which ensures financial capital maintenance irrespective of the assumed time profile of returns (though stranding due to technical progress is still possible if the regulator opens a previous monopoly market to competition when costs have fallen).

Under a RAB based approach recovery of new investment is assured irrespective of the initial level of prices, since prices are updated reflecting additions to the asset base over time. The level of access prices can therefore to some extent be decoupled from debate over whether investors have adequate assurance of cost recovery. However, the initial price level should not be set arbitrarily, consistent with assuring investors that future investments will not be expropriated via a downward price level adjustment alongside (a non credible) assurance that the RAB will in future be respected.

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# 1. Introduction and background

Long Run Incremental Cost (LRIC), as practiced in the telecommunications sector, is a methodology for estimating the cost of a total service increment based on a hypothetical model of the actual network. The methodology differs, therefore, from long run marginal costing methodologies applied in the water and electricity sectors to estimate the cost of a marginal increment of demand.

In addition, LRIC models are often hypothetical rather than reflecting the actual network and actual costs of an operator.[1] The network may be "re-optimised" based on current demand, and "benchmark" capital equipment prices and operating costs may be applied rather than using equipment tender prices and actual operating costs. We abstract from these issues in this paper and consider returns with LRIC assuming actual current costs are used as inputs to modelling.

## 1.1 Developments in the Europe and the US

The LRIC methodology has been used to set access prices in both the US and Europe.[2] The methodology has also been used to cost universal service obligations.

In Europe, the European Commission's recommendations of 8 January 1998 on interconnection in a liberalised telecommunications market (98/195EC) stipulated that LRIC was the most appropriate approach to price interconnection:

> "*the most appropriate approach to interconnection pricing is one based on forward-looking long-run incremental costs since this is most compatible with a competitive market.*"

The more recent European Access and Interconnection Directive of 7 March 2002 (Articles 13(1&2)) does not specify LRIC and simply states that:

> "*National regulatory authorities shall ensure that any cost recovery mechanism or pricing methodology that is mandated serves to promote efficiency and sustainable competition and maximise consumer benefits.*"

The European Independent Regulator's Group (IRG) issued guidance on LRIC on 24 November 2000, and the separate European Regulator's Group (ERG), created by Commission Decision 2002/627/EC adopted on 29 July 2002, consulted on the original guidance with the aim of ensuring a consistent application of the new regulatory framework.[3]

In the US, via the Telecommunications Act 1996 Congress sought to establish a "*pro-competitive, de-regulatory national policy framework*" for the US telecommunications sector. Section 252(d)(1) of the Act provides that state determinations of just and reasonable rates for interconnection and providing network elements shall be:

> "*based on the cost (determined without reference to a rate-of-return or other rate-based proceeding)*", "*non-discriminatory*", and "*may include a reasonable profit*".[4]

The Federal Communications Commission (FCC), in implementing the 1996 Act, stated in the 1996 Notice of Proposed Rulemaking in relation to the 1996 Act that:

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[1] The hypothetical network might involve "scorched earth" whereby only the distribution of customers is taken is given and history is ignored, but more typically involves "scorched node" whereby exchange locations are taken as fixed but the quantity of duct, wire and fibre is "optimised" without account for the historical development of the network.

[2] Note that this is not a long run marginal cost methodology in the conventional sense since a total service increment is typically assumed in calculating LRIC prices.

[3] ERG Consultation Document – Proposed ERG common position regarding FL-LRIC cost modelling. 30 July 2003. The ERGs original aim was to publish a common position in November 2003. Paragraph 123.
http://erg.eu.int/doc/publications/call_input_lric/call_input_lric.doc

[4] 1996 Act, sec 101, 252(d)(1).

> *"...the statute appears to contemplate the use of other forms of cost-based price regulation, such as price cap regulation that is indirectly based on costs, or the setting of prices based on a forward-looking cost methodology that does not involve the use of an embedded rate base, such as long-run incremental cost (LRIC)."* [5]

In the First Report and Order (1996) the FCC noted that:

> *"we establish default proxies that states may elect to use prior to utilizing an economic study and developing prices using the cost-based pricing methodology."* Paragraph 623; and

> *"... we strongly encourage state commissioners, as a general rule, to set arbitrated rates for interconnection and access to unbundled network elements pursuant to the forward-looking, economic cost pricing methodology we adopt in this Order."* Paragraph 767. [6]

While the adoption of LRIC has at times been encouraged, it is not prescribed in Europe or the US. Indeed, European Directives have become less prescriptive in relation to LRIC over time.

## 1.2 LRIC methodology

A number of past critiques of LRIC have focussed on potential biases in the methodology when input capital costs are changing over time. For example, Alfred Kahn (2001):

> *"I never dreamed, however, in proclaiming that efficient prices should be based on incremental costs, that policymakers would then proceed to ignore the actual incremental costs of the incumbent suppliers and instead adopt as the basis for policy the costs of a hypothetical, most efficient new entrant, constructing an entire set of facilities as though writing on a blank slate (with the one qualification that it take as given the existing wire centre locations of the incumbents)."* [7]

On 21 August 2003 the FCC published its review of Section 251 unbundling obligations stating that they would open a proceeding to examine LRIC (TELRIC in the US) noting that:

> *"Among the questions that would have to be addressed by regulators – either the Commission or the states – are how to measure the anticipated decline in value of assets, whether shorter asset lives represent an alternative method of capturing this decline, how UNE [unbundled network element] prices should be structured to reflect decreases in depreciation expense from one period to the next, and whether levelizing rates across periods, as most cost models do, diminishes, or even eliminates the intended effect of the acceleration."* Paragraph 691. [8]

Recent academic literature has focussed on the implications of changing capital input prices, and how LRIC might be modified to offset any bias introduced by the methodology as practiced. For example, the FCC published a working paper in September 2003 that set out the approach to LRIC consistent with cost recovery over an asset's life. [9] However, the timing of the FCC working paper indicates that

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[5] FCC 96-182. 19 April 1996. Notice of proposed rulemaking. CC Docket No. 96-98. Page 43. http://raven.stern.nyu.edu/networks/fcc96182.pdf
[6] FCC. August 1996. First Report and Order. In the matter of implementation of the local competition provisions in the Telecommunications Act 1996. CC Docket No 96-98 and CC Docket No 95-185.
[7] Alfred E. Kahn. 2001. "Whom the Gods Would Destroy, or How Not to Deregulate". AEI-Brookings Joint Centre for Regulatory Studies.
[8] FCC. 21 August 2003. Report and Order and Order of Remand and Further Notice of proposed Rulemaking. In the matter of: Review of Section 251 Unbundling Obligations of Incumbent Local Exchange Carriers (CC Docket No. 01-338), Implementation of the Local Competition Provisions of the Telecommunications Act of 1996 (CC Docket No. 96-98), and Deployment of Wireline Services Offering Advanced Telecommunications Capability (CC Docket No. 98-147). FCC 03-36. http://www.fcc.gov/Daily_Releases/Daily_Business/2003/db0821/FCC-03-36A1.pdf
[9] Mandy, D and Sharkey, W. September 2003. "Dynamic Pricing and Investment from Static Proxy Models". FCC Working Paper 40. http://hraunfoss.fcc.gov/edocs_public/attachmatch/DOC-238934A2.pdf

applied theory has lagged practice in relation to LRIC following the passage of the 1996 Act. The FCC issued a Notice of Proposed Rulemaking on the pricing of unbundled network elements in September 2003 which noted that:

> "One of the central internal tensions in the application of the TELRIC methodology is that it purports to replicate the conditions of a competitive market by assuming that the latest technology is deployed throughout the hypothetical network, while at the same time assuming that this hypothetical network benefits from the economies of scale associated with serving all of the limes in a study area. In the real world, however even in extremely competitive markets, firms do not instantaneously replace all of their facilities with every improvement in technology. Thus, even the most efficient carrier's network will reflect a mix of new and older technology at any given time." Paragraph 50.[10]

> "Simultaneously assuming a market inhabited b y multiple competitors and one with a ubiquitous carrier with a very large market share may work to reduce estimates of forward-looking costs below the costs that would actually be found even in an extremely competitive market. It may therefore undermine the incentive for either competitive LECs or incumbent LECs to build new facilities, even when it is efficient for them to do so." Paragraph 51.

The FCC note that they:

> "tentatively conclude that our TELRIC rules should more closely account for the real-world attributes of the routing and topography of an incumbent's network in the development of forward-looking costs." Paragraph 52

## 1.3 This paper

In this paper I review the arguments regarding potential bias under LRIC (leaving aside the use of hypothetical network structures and benchmark costs), and then examine the uncertainty over cost recovery inherent to the LRIC method and its economic and policy implications. An alternative approach based on a Regulatory Asset Base (RAB) is considered.

# 2. Expected returns may be biased under LRIC

Under a LRIC based pricing methodology networks are typically re-valued periodically based on the replacement cost of a hypothetically "efficient" network. Here we are concerned with the impact of periodic revaluation based on replacement costs on expected returns and ignore the possible impact of modelling a hypothetical "efficient" network. As David Mandy (2002) noted:

> "it is erroneous to think of a competitive equilibrium price as the minimum of some long-run average cost curve, because the cost curve will shift before the capital costs are fully recovered. In such a dynamic environment, the concept of competitive equilibrium prices must be modified to the notion of a dynamic price sequence with the property that a price-taking firm exactly recovers its costs over the life of the asset."[11]

In practice LRIC has been applied in ways that are not dynamically consistent. The difference between static estimates and dynamically consistent estimates can also be large in practice; for example, David Mandy has estimated that the use of TELRIC prices for end-office switches, for which

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[10] FCC. 15 September 2003. "Review of the Commission's Rules Regarding the Pricing of Unbundled Network Elements and the Resale of Service by Incumbent Local Exchange Carriers." Notice of Proposed Rulemaking. FCC 03-224. http://hraunfoss.fcc.gov/edocs_public/attachmatch/FCC-03-224A1.pdf

[11] David Mandy. March 2002. "Pricing network elements when costs are changing". *Telecommunications Policy* 26. This paper was made available to Professor Melody on 13 December 2002. Page 60.

the estimated rate of technical progress is 11%, would understate the cost of switching services by 24%.[12]

The intuition behind the potential bias is illustrated in Figure 2.1.

**Figure 2.1: Prices exceed costs with technical progress**
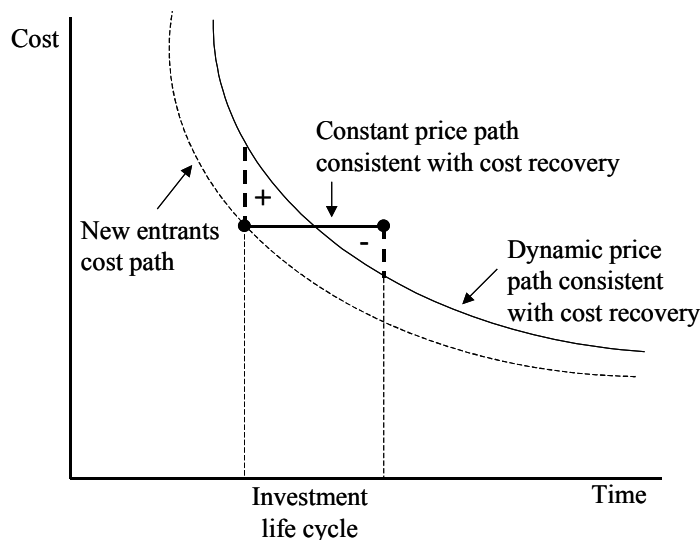


The horizontal line spans the asset life for a new asset and illustrates the cost on an averaged basis. Relative to an historic cost based estimate of what returns ought to be, a competitive equilibrium would initially involve returns above the estimate (the +ve region) and later below the estimate (the –ve region).

Relative to a replacement cost based estimate of what returns ought to be (the new entrants' cost path), competitive equilibrium would always involve returns above the estimate (the upper dynamic price path). Thorough consideration of this issue is contained in an FCC Working paper published in September 2003. It is therefore perhaps not surprising that the actual application of LRIC in policy settings has in the past not always set these issues out clearly. For example, the Competition Commission noted in relation to call termination charges to mobile phones:

> "the economic depreciation method used by the DGT differs from the historic cost straight-line accounting depreciation method used by the MNOs, and as a result the timing of cost recovery under economic depreciation is likely to vary from that under accounting depreciation." Paragraph 7.109.[13]

It is implied that what is at stake is the "timing of cost recovery", rather than cost recovery itself. This might be relatively unimportant if the correct methodology were adopted and the relevant parameters were known with confidence. However, as the Competition Commission notes, one of the key assumptions, the rate of change in asset prices, was inherently subjective and uncertain:

> "The outputs of the Oftel LRIC model from 2002 onwards depend, therefore, on the assumptions about decreasing prices of equipment in the future. This forecast is particularly difficult, as it involves forecasting costs of 2G equipment." Paragraph 7.136.

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[12] David Mandy. November 2002. TELRIC Pricing with Vintage Capital. Journal of Regulatory Economics; 22:3 215-249; and David Mandy. February-March 2002. "Pricing network elements when costs are changing". *Telecommunications Policy* 26: 53-67.

[13] Competition Commission. 18 February 2003. "Vodafone, O2, Orange and T-Mobile: Reports on references under section 13 of the Telecommunications Act 1984 on the charges made by Vodafone, O2, Orange and T-Mobile for terminating calls from fixed and mobile networks."

Difficulty in forecasting future costs and economic asset lives is an inherent problem with LRIC, and raises the question of how sensitive overall returns are to such assumptions.

Figure 2.2 presents a simple numerical example to illustrate the error in assuming that depreciation only affects the profile of returns under LRIC. In Figure 2.2 the NPV under LRIC is shown for straight line and titled annuity depreciation with annual revaluation.

**Figure 2.2: NPV of returns with straight line and tilted annuity depreciation under LRIC**
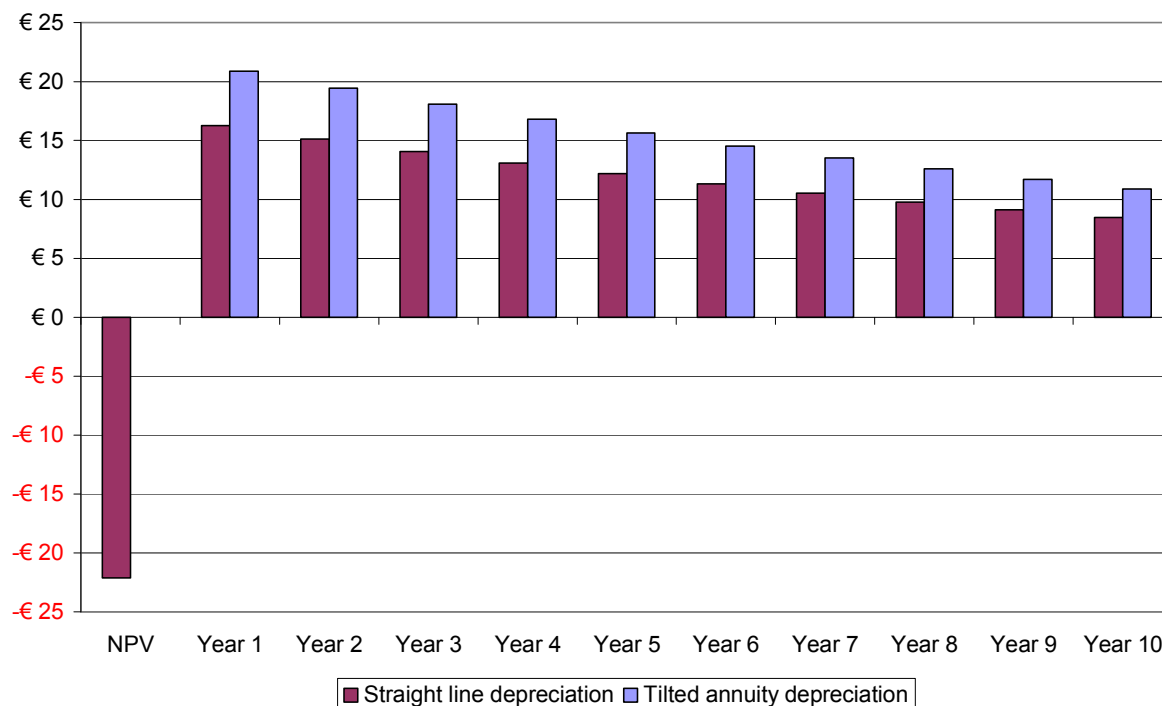


Straight line depreciation yields an NPV of -€22 when asset prices fall at seven per cent per annum and assets are re-valued annually (for an initial investment of €100), while tilted annuity depreciation corrects the bias – provided the assumed *ex ante* change in capital costs over time is identical to the actual rate at which assets are re-valued *ex post*.

In fact, only one unique depreciation profile yields an NPV of exactly zero when assets are periodically re-valued. William Baumol (1971) proved this result, noting:

> *"we show that… is the only depreciation rule that (a) permits payments to decrease in proportion with the rate of fall of the replacement cost of the asset, and (b) permits the original cost of the asset to be recouped by depreciation payments over its n-year life."* [14]

## 3. A RAB based approach would eliminate the risk of bias

Outside the telecommunications sector variants on LRIC have only rarely been applied, and the norm is to calculate returns on the basis of a regulatory asset base (RAB) without periodic revaluation of assets.

Depreciation is subtracted from the RAB, and returns are calculated on the RAB. Under this approach the time profile of returns is <u>irrelevant</u> to the NPV of returns, provided the correct cost of capital is utilised.[15]

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[14] William J. Baumol. 1971. "Optimal depreciation policy: pricing the products of durable assets." *The Bell Journal of Economics and Management Science* Vol 2(2). Page 651.

Figure 3.1 illustrates two different depreciation profiles which both yield an NPV of returns of zero on an investment of €100 using a RAB approach.[16]

**Figure 3.1: NPV of returns with straight line and tilted annuity depreciation under a RAB**
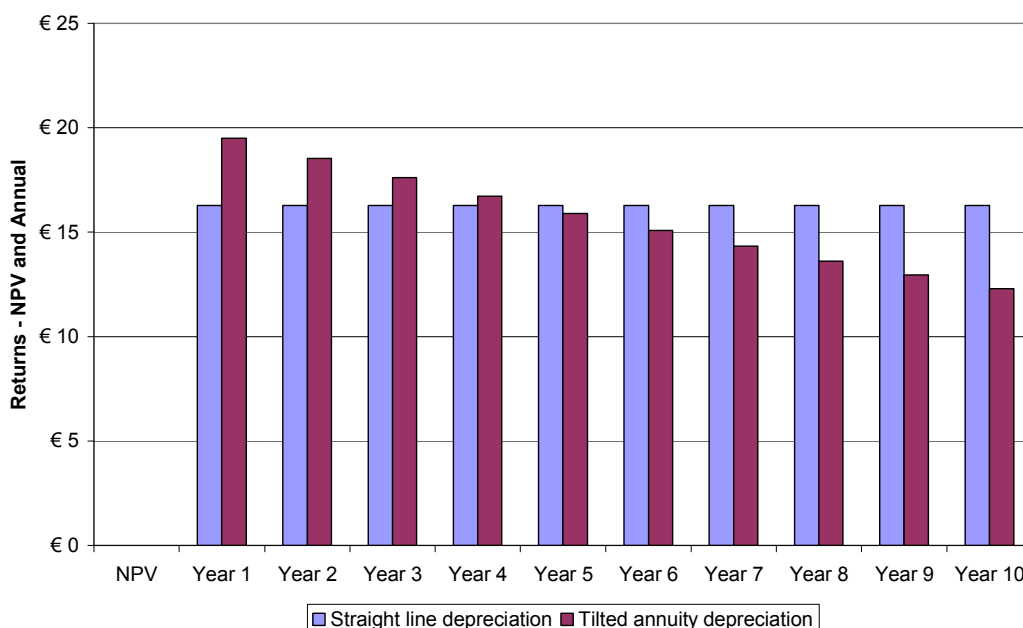


Annual returns are constant under straight line depreciation and yield an NPV of zero. Under tilted annuity depreciation, assuming an expected decline in asset prices of seven per cent per annum, annual returns are initially higher, but fall below those for straight line depreciation by year 5. The constancy of the NPV of returns under a RAB approach is general - <u>any</u> returns profile will yield the same NPV.

# 4. Sensitivity of returns with periodic revaluation

Assuming LRIC is adjusted to remove any bias due to <u>anticipated</u> asset price changes, errors may still arise if actual asset price changes – and revaluations under LRIC - deviate from those forecast. Such errors can be expected as asset price movements can be both large, and difficult to forecast. In addition, periodically a new technology may replace existing technology producing a downward jump in asset prices. In practice the likelihood of discontinuous change is seldom if ever considered in calculating LRIC prices.[17]

Figure 4.1 illustrates the sensitivity of the NPV of returns to errors in forecast rates of changes in asset prices when actual replacement asset prices are used for valuation under LRIC.

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[15] The intuition for this result is that all the money invested is eventually returned via depreciation (the return of capital), while the return on capital compensates for the holding cost irrespective of how long it is before the value of the RAB is returned.

[16] Calculated using the annuity $C = I_{t=0} \cdot \dfrac{r}{1-(1+r)^{-n}}$ and tilted annuity formulas $C_t = I_{t=0} \cdot \dfrac{(r-i)}{1-\left(\dfrac{1+i}{1+r}\right)^n} \cdot (1+i)^{t-1}$ where

$C$ is the annual capital charge, $I$ is the replacement value of the assets at the start, $r$ is the discount rate and $i$ is the annual change of the assets value.

[17] In addition, to the extent that an instantaneously optimised network model is applied in LRIC modelling the progressive change in the optimal configuration over time is analogous to a reduction in asset values due to changing replacement prices. This is also unlikely to be factored into LRIC modelling in practice.

**Figure 4.1: Sensitivity of NPV of returns to "errors" in assumed rate of change in asset prices**
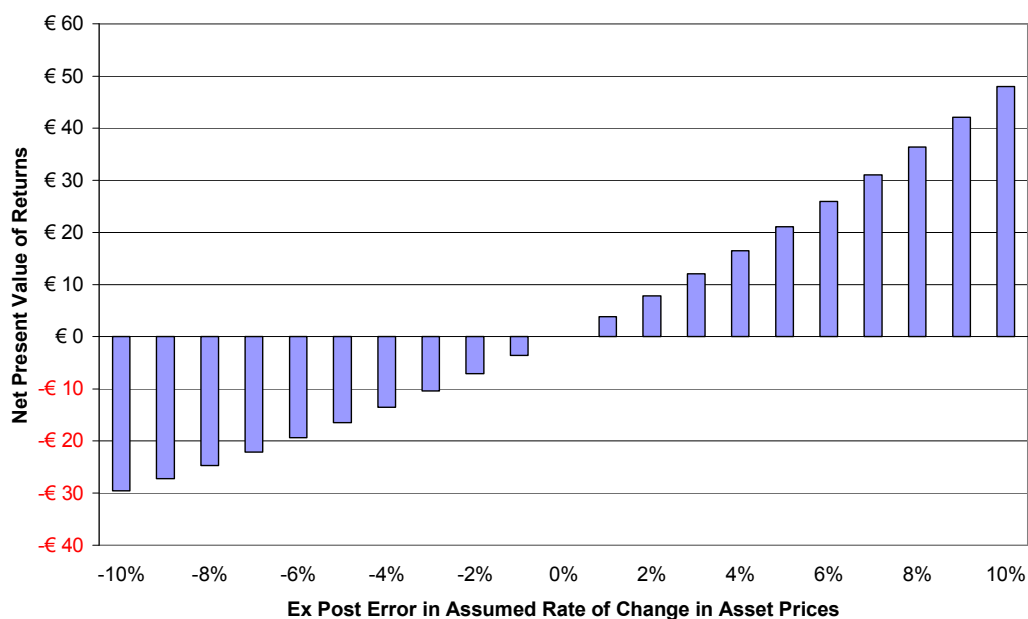


Large variations in the NPV of returns, over a range of –€29.60 to +€48 for an investment of €100, are apparent from Figure 4.1. The extent of over or under recovery is approximately three times greater than the percentage error in forecasting the rate of change in replacement asset prices.

While it might be argued that such sensitivity is unimportant to investors, provided calculated returns are based on unbiased estimates of asset price changes and asset lives, and any accompanying uncertainty is either diversifiable or factored into the assessed cost of capital, in reality there are reasons why uncertainty *per se* is costly.

## 5. Uncertainty *per se* is costly

Even if all of the problems of potential bias in LRIC estimation could be overcome by factoring in and allowing for expected changes in asset prices, including possible "jumps", the method would still produce uncertain estimates of the prices required for cost recovery ex post. One response to this concern might be to argue that in a competitive market the same uncertainties arise. However, as this section argues, such uncertainty involves costs under regulation that do not arise in a market context.

Subjective elements of regulatory price setting methodology may allow the regulator to deny cost recovery for sunk assets. Regulators may be under pressure to obtain lower prices, and regulation in the presence of irreversible investment introduces a classic "time inconsistency" problem whereby the socially optimal approach must involve a credible commitment not to revisit prices once investment is made.[18] LRIC introduces the need to forecast future asset prices changes, thereby introducing greater scope for opportunism.

Pure uncertainty can also interact with other elements of regulatory methodology to bias expected returns. For example, any asymmetry in the treatment of under or over performance under a price cap when returns are uncertain will impact expected revenues. The greater the uncertainty the more pronounced the bias will be.

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[18] David Currie, Paul Levine and Neil Rickman. October 1999. "Delegation and the ratchet effect: should regulators be pro-industry?". Centre for Economic Policy Research Discussion Paper 2274.

A further reason for wishing to limit regulatory uncertainty is that the social costs of over versus under provision of allowed revenues may be asymmetric i.e. a small loss of consumer surplus when prices are a little too high, versus a large loss of surplus if non-supply or deteriorating quality of supply results from prices that are a little too low. The efficient response to this is to "bias" allowed revenues taking account of both the level of uncertainty and the social "loss function" associated with upside and downside errors. Unnecessary uncertainty may therefore result in consumers paying an excess margin, or risking the consequences of having an under-funded network.

Uncertainty can also reduce the power of incentive contracts within firms since it becomes more difficult for owners (and the senior executive) to monitor and provide incentives for profit maximising behaviour.[19] Lower powered incentive contracts and the self selection of less capable management are the predicted outcomes, and both would result in poorer productivity performance.[20]

Finally, subjective methods promote costly disputes. As Kahn ((2001) noted in relation to LRIC:

> *"...its open invitation to combat-by-engineering-and-econometric-models was eerily reminiscent of the constipation of the public utility regulatory process in the early decades of the past century…."* [21]

## 6. Policy implications

The uncertainty, subjectivity, complexity and scope for opportunism inherent under a LRIC based costing suggest that either the methodology should more closely reflect the real world attributers of actual networks, and/or alternative methodologies should be considered. A "conventional" RAB based methodology whereby new investment is added to the existing RAB without periodic revaluation is a potential alternative. In the US and Australia, and over time the UK, the RAB has formed a cornerstone of a credible commitment to assuring cost recovery for investments in sectors other than telecommunications.[22]

Under a RAB based approach recovery of new investment is assured irrespective of the initial level of prices, since prices are updated reflecting additions to the asset base over time. The level of access prices can therefore to some extent be decoupled from debate over whether investors in the network have adequate assurance of cost recovery.

However, the initial price level could not be set arbitrarily, consistent with assuring investors that future investments will not be expropriated via a downward price level adjustment alongside (a non credible) assurance that the RAB will in future be respected. One approach to setting the initial level of prices in a transition from LRIC to a RAB approach would be to ensure price level continuity at the point of transition.

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[19] Brian Williamson. October 2000. "Competition, Policy Stability and Growth" - October 2000. Seminar on Economic Growth and Government Policy at No 11 Downing Street. http://www.hm-treasury.gov.uk/mediastore/otherfiles/256.pdf

[20] There is some evidence that less capable management work in the utility sector in the US. Darius Palia. Spring 2000. "The impact of regulation on CEO labor markets." *RAND Journal of Economics*, Vol 31(1).

[21] Alfred E. Kahn. 2001. "Whom the Gods Would Destroy, or How Not to Deregulate". AEI-Brookings Joint Centre for Regulatory Studies. Pages 4 and 6.

[22] Brian Williamson. January 2002. "UK incentive regulation - international best practice?" CRI Millennium edition 2000/2001. http://www.indepen.co.uk/panda/docs/CRI.pdf