concept economics

REPORT

DEPRECIATION

Report by Henry Ergas

Prepared for:
Mallesons Stephen Jaques

Date: August 2008

Concept Economics:
27 Jardine Street,
PO Box 5430 Kingston
ACT 2604 Australia

Disclaimer

Concept Economics and its author(s) make no representation or warranty as to the accuracy or completeness of the material contained in this document and shall have, and accept, no liability for any statements, opinions, information or matters (expressed or implied) arising out of, contained in or derived from this document or any omissions from this document, or any other written or oral communication transmitted or made available to any other party in relation to the subject matter of this document. The views expressed in this report are those of the author(s) and do not necessarily reflect the views of other Concept Economics staff.

Table of contents

1. INTRODUCTION

I am instructed that on 3 March 2008 Telstra submitted to the Australian Competition and Consumer Commission ("ACCC") an ordinary access undertaking for Unconditioned Local Loop Service ("ULLS"). In support of the Undertaking Telstra relies, amongst other things, upon an engineering cost model known as the TEA Model, which it has developed for the purposes of calculating the total service long-run incremental cost ("TSLRIC") of supplying ULLS.

I am instructed that the TEA model calculates the capital cost of deploying a current best practice Customer Access Network ("CAN") and then calculates the required depreciation for that capital base. Depreciation is one component of the building block approach used to calculate the TSLRIC of supplying ULLS. For the purposes of calculating depreciation the TEA Model uses what is commonly referred to as a "straight line" depreciation ("SLD") profile. Other components of the building block approach are added, then the sum of these components is levelised over time using an annuity formula. In contrast, the ACCC has in the past taken the view that a tilted annuity should be used to calculate the annual cost of depreciation for the purposes of calculating the TSLRIC of supplying ULLS.

1.1. TERMS OF REFERENCE

I have been asked by Mallesons Stephen Jacques ("Mallesons") to provide:

1. my views as to whether application of commonly accepted economic theory would reasonably lead to the use of a tilted annuity to calculate depreciation, in the way that the ACCC has done in the past;
2. having regard to (1.) above, my views as to whether the ACCC's use of the tilted annuity formula for depreciation achieves the stated objectives of Part XIC of the Act, in particular the statutory criteria relevant to ordinary access undertakings set out in sections 152AH and 152AB of the Trade Practices Act 1974;
3. in support of my views, a succinct survey of the relevant accepted economic literature in relation to the calculation of depreciation.

My instructions are contained in letters of instructions from Mallesons dated:

1. 5 June 2008; and
2. 26 June 2008.

Copies of these letters are contained in Appendix A of this report.

1.2. SUMMARY OF FINDINGS

In a general sense, depreciation refers to the way in which certain kinds of long-lived assets fall in value (price) over their useful life. Depreciation charges are intended to recover total outlays for the capital equipment required to deliver a product or service. In this statement I am concerned with the structure of depreciation charges for the ULLS service.

The ACCC's tilted annuity formula for depreciation has the effect of postponing – and putting at risk – cost-recovery for regulated assets.

In my opinion, a key element in any durable regulatory contract is *ex ante* or expectational capital maintenance. That is, if investors prudently invest a dollar, they must reasonably expect both a reasonable return on, and the ultimate return of, that dollar. If, in the alternative, investors perceive that there is a significant risk that funds invested, for example, in Telstra, will not be returned to them, they will only make such funds available at a higher cost, if at all. In turn, higher funding costs would reduce the investment that Telstra would choose to undertake, an outcome that would eventually harm consumers.

In some systems of regulation – notably pure "rate of return" regulation – capital maintenance is more or less guaranteed, with investors and regulated firms being assured of cost recovery. These systems do a good job of ensuring investment, though they may not provide incentives for cost-efficiency.

In Australian regulation, there is generally no such guarantee, as regulators base charges on a "forward-looking" concept of efficient costs with costs being periodically re-estimated.

Expectational capital maintenance poses challenges because of the risk of time inconsistency in regulation, a risk which is magnified when costs are periodically redetermined. That is, the regulator (in this case, the ACCC) may adopt conflicting regulatory approaches over time, in particular in relation to how it values Telstra's assets. Time inconsistent policies harm shareholders' interests if their capital is thereby effectively reduced, and will ultimately harm consumers.

Expectational capital maintenance also poses specific challenges when competition or substantial changes in circumstances may undermine cost recovery. For example, some part of Telstra's copper loops and local network may be rendered effectively obsolete by the Government's decision to build a National Broadband Network incorporating Fibre to the Node ("FTTN") architecture. Optus' hybrid fibre coaxial ("HFC") cable network is also a competitive threat in major metropolitan areas. Moreover, developments in HFC technology might lead Telstra itself to shift usage to its own HFC. Finally, there is the prospect of increased competition from wireless services.

The setting of the capital charge is an especially important factor in ensuring expectational capital maintenance in industries with high capital intensity and very long lived assets, such as telecommunications. The return of capital, i.e. depreciation, is a crucial component of the capital charge. Moreover, it is the component where timing of recovery issues looms largest, as different ways of determining the capital charge may have the effect of significantly deferring that return.

The proper approach to depreciation has long been an issue of concern both to economists and to accountants. There are significant differences between the "economic" and "accounting" approach to depreciation:

- The economic approach to depreciation seeks to mimic the pattern of asset prices that would be revealed in well-functioning markets for (aging) second-hand assets, and hence to reflect the opportunity cost of making asset services available.

- The accounting approach seeks to allocate the loss in value of an aging asset to particular periods of time and units of output, with less concern about reflecting notional opportunity costs. It has the advantage of greater verifiability, though at a cost in terms of the extent to which potentially relevant opportunity costs are being measured.

To the extent to which an economic approach is adopted, the time profile of depreciation charges depends on a number of factors, including the time-efficiency profile of the assets (the extent to which the asset's productive capability "decays" as it ages), discount rates, and expectations of future changes in the value of the asset (which are, in turn, determined by demand and supply trends for the output produced by the asset). In some (unusual) instances, these combined factors can lead to a time profile that is effectively "back-loaded", so that depreciation is greater in the later years of the asset's useful life. However, when assets physically deteriorate, where there is a risk of (technical or demand-side) obsolescence, and, in general, when future price trends are uncertain, economic depreciation is "front-loaded", so that depreciation is greater in the earlier years of the asset's useful life.

In a regulatory context, and as demonstrated by Schmalensee in his "Invariance Proposition", there is a family of depreciation profiles that are consistent with expectational capital maintenance (so that shareholders are "indifferent" between them). For any particular regulated asset, these depreciation profiles are determined in such a way that the present value of the future income stream associated with the asset (discounted at the regulated cost of capital) is zero at all points in time over the useful life of the asset. This condition implies that investors are assured of full cost recovery.

However, it is widely recognised in the economic literature that the Invariance Proposition only holds under idealised conditions, and breaks down when assumptions about the regulated firm's future revenues are more realistic: where there is a risk of obsolescence, because (say) existing infrastructure can effectively be "bypassed" as a result of technological innovations, and, more generally where there is uncertainty about future revenues, including regulated revenues. In these circumstances, certain depreciation profiles, in particular back-loaded depreciation profiles are more risky, because they increase the probability that the regulated firm will not be able to recover the cost of its invested capital in some circumstances.

In a regulatory setting, there may also be circumstances where no unique economic depreciation profile (that would match cost causality to particular time periods and units of output) exists. "Ramsey" pricing principles whereby regulated charges (including depreciation) are set to reflect the price sensitivity of consumers of the regulated service can then ensure full cost recovery. However, calculating such regulated charges (including the implicit depreciation component) involves numerous assumptions, many of them difficult to test, and the results can be highly sensitive to these assumptions.

The statutory test in sections 152AH and 152AB of the Trade Practices Act 1974 asks whether an approach is reasonable. This does not mean that it is the only approach that is reasonable, but that it itself is reasonable.

Telstra applies a SLD profile to the asset categories required to produce the ULLS. SLD reduces the written down value of assets by an equal increment in each year of an asset's useful life. As such, SLD can be viewed as a "compromise" between a front-loaded and a back-loaded depreciation profile. There are, however, a number of factors that would make a front-loaded depreciation preferable from an *ex ante* capital maintenance perspective, including risks of competitive bypass. These risks are likely to be rising over time, for instance, as wireless alternatives and HFC become more cost-effective and/or offer equivalent or better service.

In contrast, a tilted annuity approach to depreciation as has been used by the ACCC in the past imposes a high degree of back-loading and exposes investors to greater commercial and regulatory risk. If there is, at the same time, a risk that the future earnings of the relevant assets are reduced, for instance as a result of FTTN or HFC competition, or because the asset is revalued, expectational capital maintenance is no longer assured. As a result, I would expect Telstra's cost of capital to increase, which would likely lead to inefficiently low levels of investment. In principle, the resulting risk could be offset by a higher rate of return, but that would be a departure from the Capital Asset Pricing Model ("CAPM"), which is commonly applied to determine regulated rates of return in Australia, and which only rewards systematic risk. In practice, such an approach has never been taken in a regulatory context in Australia. As a result, I consider that a tilted annuity approach to depreciation is not reasonable.

1.3. STRUCTURE OF THIS REPORT

This report is structured as follows.

Section 2 sets out the central importance of *ex ante* financial capital maintenance in the context of the "regulatory bargain" between a regulated firm and the regulator. The ability of a regulated firm to attract the financing it requires to invest is premised on financial capital maintenance, and the depreciation charge is the mechanism through which this is achieved in all accounting systems. However, in the context of the "forward-looking" accounting system adopted in Australian telecommunications regulation, investors are exposed to significant risks of "time inconsistency" in regulation, particularly since costs are periodically redetermined, so that capital maintenance objectives may not be met. As a result, the time pattern of depreciation (or the depreciation "profile") that is applied to a service provider's regulated assets is of particular significance.

Section 3 examines economic and accounting approaches to depreciation. While economic depreciation is complex to derive in practice, the theory of economic depreciation provides important insights about the circumstances when particular depreciation profiles are likely to emerge. Specifically, risks relating to the future earnings that a firm's assets may generate, including risks arising from technical or demand-side obsolescence (but also other factors) would lead to front-loaded depreciation profiles. Under idealised conditions, investors in a rate-of-return regulated firm would be indifferent between different depreciation profiles. This is because the regulated firm is left financially neutral in net present value ("NPV") terms. However, this "Invariance Proposition" breaks down when there is a risk that, for instance as a result of competitive or technological trends, the regulated firm cannot recover its (historical) investment expenditures (the Invariance Proposition resting, among other things, on the assumption that actual returns equal allowed returns, and that allowed depreciation sums to the asset's original value).

Section 4 sets out my assessment of whether commonly accepted economic theory would reasonably lead to the use of a "tilted annuity" to calculate depreciation in the way that the

ACCC has done, and whether the ACCC's use of a tilted annuity formula for depreciation achieves the stated objectives of Part XIC of the Act. I do not consider this to be the case. The tilted annuity approach to calculating capital charges leads to a significantly back-loaded depreciation profile where asset prices are increasing. Given the "forward-looking" accounting system applied by the ACCC, and given broader competitive trends to which Telstra is exposed, this approach magnifies the risk that Telstra would not be able to recoup the cost of investments prudently undertaken. A regulatory bargain that does not assure investors in the regulated firm of *ex ante* financial capital maintenance is not sustainable, and would prevent Telstra from attracting the funds it requires to invest. Such an outcome is neither in the interests of shareholders, nor of customers, and cannot be consistent with the objectives of the Act. Instead, an approach that locked in Telstra's efficient asset base and relied on a more transparent and less arbitrary (accounting) depreciation approach (such as SLD) for cost recovery is more reasonable and more likely to achieve the objectives of the Act.

1.4. SUPPORTING INFORMATION

I confirm that I have advised Telstra since the early 1990s on regulatory and competition issues, including analysing costing and pricing issues, access charging, and matters related to cost-recovery under the Universal Service Obligation. I have also assisted Telstra in respect of major ACCC inquiries and proceedings. These include advice on a range of services, including ULLS, public switched telephone network (PSTN) originating and terminating access services, local carriage service, line sharing service and wholesale line rental, as well as the proposed fibre-to-the-node National Broadband Network.

I have reviewed the Guidelines for Expert Witnesses in Proceedings in the Federal Court of Australia and I have complied with those Guidelines in preparing this report.

My curriculum vitae is attached in Appendix B.

2. THE REGULATORY BARGAIN

In this section I explain what I consider to be the relevant economic considerations for assessing whether a particular approach to determining depreciation is "reasonable". In short, I find that:

- The most important and overriding policy objective for a regulated firm is that of *ex ante* financial capital maintenance;
- The nature of the regulatory framework applied to telecommunications service providers in Australia is such that *ex ante financial* capital maintenance is not assured; and
- Where capital maintenance is not assured, the risk is that efficient investment by the regulated firm will be compromised.

I come to these conclusions, as will be explained in more detail in the subsections below, as follows. As a general matter, a key element in any sustainable "regulatory contract" between a regulated firm and the regulator is *ex ante* capital maintenance. That is, if investors prudently invest a dollar, they can expect both a reasonable return on, and the ultimate return of, that dollar. To provide capital maintenance, the depreciation charge must first and foremost ensure that every dollar (prudently) invested in capital assets is returned to investors. Depreciation is central to ensuring capital maintenance, and capital maintenance is particularly important in industries with high capital intensity and very long lived assets.

How depreciation is defined in any particular regulatory setting is inextricably linked to the broader accounting system that is adopted, and specifically to how a regulated firm's assets are valued within that accounting system. To the extent that a regulatory accounting system fails to maintain the value of investors' capital, there will be a shortfall in the amount of depreciation that can be recovered. In other words, while it is the case that from an *ex ante* perspective, all accounting systems provide for the full recovery of efficient costs, including depreciation, from an *ex post* perspective, certain accounting systems – in particular those relying on "forward-looking" costs – increase the risk that a regulated firm will not (fully) recover the cost of capital assets that it has invested in.

The forward-looking cost approach that periodically redetermines costs adopted by the ACCC raises the risk of time inconsistency. As a result, there is generally no guarantee of expectational capital maintenance, thereby making efficient investment less likely.

In the following subsections I elaborate on these important concepts, drawing on the relevant economic literature, as well as my own experience and research in the context of the Australian and international telecommunications industries.

2.1. EXPECTATIONAL CAPITAL MAINTENANCE

It is commonly accepted by economists, including by myself, that any system of price regulation, if it is to be sustainable, must take account of the costs suppliers incur in the provision of the regulated service.[1] Moreover, if investment is to be forthcoming, investors must expect that, on average (i.e. in expectation), they will maintain their financial capital intact – they will, in other words, secure both the return of the capital they have invested, and a payment that reflects the opportunity cost of that investment, taking account of its risk. This bedrock condition of "capital maintenance" must be met by any regulatory structure that aims to ensure service provision on a durable basis.

Expected capital maintenance is obviously of the greatest importance when provision of the regulated service relies on voluntary, private investment, rather than "public investment" (i.e. investment by taxpayers, made without any direct choice by the investors as to whether or not to thus invest). Irrespective of the use to which funds will be put,[2] if voluntary, private investment is to be forthcoming, the investors must expect to be no less well off from investing in the regulated entity than they would have been had they instead chosen other investment opportunities. In that sense, every regulated entity, *quite regardless of whether it is or is not a monopolist in its output market* (i.e. in the markets in which it provides services), must – if it is to be financed by private investment – compete for that investment in the capital market.

The regulated entity will only be able to do so if it can assure investors that the system of regulation reflects a "fair bargain".[3] The essence of that fair bargain is simple: investors provide the capital required for the service to be supplied; regulators ensure prices are sufficient to allow investors to reasonably expect the ultimate return of that capital, along with a rate of return that reflects the returns they could have obtained in other investments with similar risks. The prices set by the regulator must therefore allow the regulated firm to recover (or reasonably expect to recover) all of its costs, including a reasonable return to investors.

While this "fair bargain" is readily explained and understood, many complexities are involved in its implementation. Central among these is the actual determination of the quantum of costs that needs to be recovered. In effect, it is a central element in the economics of contracts that if they are to be viable, contracts – actual or implied – must be based on conditions that are *verifiable.* That is, if the terms of a contract impose rewards or penalties contingent on a state of the world occurring, it must be possible to verify whether that state of the world has or has not occurred. If it is not possible to do so, or only possible at great cost, the contract will not provide an effective or efficient way of governing relationships between

[1] Levy and Spiller, for instance, analyse the performance of regulated utilities drawing on case studies from five countries and conclude that without regulatory commitment, including to cost-recovery, long-term investment will not take place. Levy, B. and P. Spiller 1994, "The institutional foundations of regulatory commitment: a comparative analysis of telecommunications regulation", Journal of Law, Economics & Organisation 10: 201-246. Blackmon and Zeckhauser explore the incentives and strategies of investors, consumers, and the regulator in a game-theoretical model of regulation. They find that a regulator, even one whose allegiance lies wholly with consumers, will find it advantageous to commit to repaying investor capital. Blackmon, G. and R. Zeckhauser 1992, 'Fragile Commitments and the Regulatory Process', Yale Journal on Regulation 9(1): 73-105. Gilbert and Newbery model regulation as a repeated game between a utility facing a random sequence of demands and a regulator tempted to under-reward past investment. The model finds that rate-of-return regulation designed with a constitutional commitment to an adequate rate of return on capital prudently invested is able to support an efficient investment program for a larger set of parameter values than rate-of-return regulation without such a commitment. Gilbert, R. and D. Newbery 1994, 'The Dynamic Efficiency of Regulatory Constitutions', RAND Journal of Economics 25(4): 538-54.

[2] That is, irrespective of whether the funds will be invested for purely "commercial" purposes or with some public (social) benefit in mind.

[3] The regulatory bargain or contract commonly described in the economic literature should be thought of as an implicit rather than an explicit (or formal legal) contract. The concept of an implicit regulatory bargain arises because it is not possible to write time-consistent, enforceable long-run contracts that can cover all necessary contingencies. See: Stern, J. and S. Holder 1999, 'Regulatory governance: Criteria for assessing the performance of regulatory systems'.

the parties. It follows that a contract or bargain – actual or implied – between a regulator and a regulated entity for cost recovery will only be credible if it is based on a set of principles and rules for determining the quantum of costs to be recovered. Those principles and rules, which make the quantum of costs more or less verifiable, can be viewed as defining an *accounting system*.

“Accounting systems” are social conventions that structure the collection, analysis and disclosure of cost and revenue information.[4] By so doing, they serve to reduce the transactions costs involved in designing and implementing the explicit and implicit contracts that regulate relations between suppliers and users of resources. Given that this is their purpose, it is not surprising that somewhat differing accounting systems are needed to support differing types of transactions. For example, in most countries, tax accounting differs in important respects from the financial accounting systems used to provide information to the suppliers of firms’ financial resources. Equally, it is common for governments to impose special accounting requirements as part of the public procurement process. In the control of public utilities, *regulatory accounting* serves to support the design and implementation of the regulatory bargain – that is, the complex of more or less formalised understandings between regulatory authorities and regulated entities as to the terms and conditions on which services will be provided.

2.2. ACCOUNTING SYSTEMS AND THE CHOICE OF COST BASE

In principle, any sustainable regulatory bargain, no matter what accounting system it relies on, must provide for financial capital maintenance so that investors are assured that they will recover efficiently incurred costs. In practice, however, certain regulatory accounting systems (or rather, the asset valuation framework they imply) entail different degrees of “asset stranding” risks and corresponding risks to capital maintenance. The cost of such stranded assets must be “written off” and can no longer be recovered from customers via a depreciation charge. With this context in mind, below I briefly describe the main accounting systems, including the “forward-looking cost” system that is applied to Telstra.

The relevance of the accounting system to the depreciation problem is that different asset valuation rules affect the likely “useful life” of the relevant assets and the risk that cost recovery will be impossible over the asset’s useful life. All other things equal, and irrespective of whether an economic or an accounting approach to depreciation is adopted, a (likely) reduction in an asset’s useful life implies that its cost must be recovered over a shorter timeframe so that an asset must be depreciated more rapidly than might otherwise be the case.

2.2.1. Historical cost accounting

It is conventional to view valuation rules as falling into two broad categories. The first involves rules that only recognise historical prices and quantities. These rules, generally referred to as forming part of “Historical Cost Accounting” (“HCA”), are, in theory, only concerned with market prices at the time of asset acquisition or disposal; at all other times, they look only within the firm for information relevant to the accounting process.

4 See especially Sunder, S., 1997, The Theory of Accounting and Control, South Western Publishing, Cincinnati, Ohio.

HCA in a regulatory setting has its origins in the Unites States. The United States has long had a clear formal separation between regulatory entities and telecommunications service providers. Issues of regulatory accounting therefore emerged early on, with complex systems being designed to supply the regulatory authorities with cost and revenue information.[5] These systems formed a natural point of reference when similar needs arose elsewhere.

The systems of regulatory accounting developed in the United States were based on historical costs, which were generally viewed as reflecting:

- The resources investors had, as a matter of fact, devoted to the utilities at issue; and hence,
- The claim these investors had on the revenues the utilities generated.[6]

Within the context of rate of return regulation in which HCA was and is typically applied, the traditional standards applied by regulators to ensure that investment is efficient have been the backward-looking “prudency” test and the forward-looking “used-and-useful” test.[7] If a particular asset is disallowed under the “used-and-useful test”, the utility cannot recover the cost of depreciation on the asset, nor earn a regulated rate of return on the invested capital. The prudent-investment test, in contrast, permits the utility to recover, through its allowed rates, the historical cost of its investments, provided that they were “prudent” when they were made.

While the HCA approach has been criticised on various fronts, the historical cost approach to cost determination has two clear benefits in terms of verifiability:

- First, because historical cost accounts are central to statutory financial reporting, and are required to be comparable between entities, the scope for discretion in the construction of those accounts is relatively limited. As a result, there can be little doubt that contracts based on those accounts will be verifiable: a commitment to reimburse costs as determined by the historical cost accounts has clear meaning.
- Second, the historical cost accounts are, by definition, *ex post*: they relate, especially on the cost side, to transactions that have occurred. As a result, they are readily *audited*, including by independent third parties, which is an essential component of verifiability.

2.2.2. Current cost accounting and forward-looking costs

The second set of accounting systems seeks to update asset valuations on the basis of market information, and hence is generally referred to as forming part of “Current Cost Accounting” (“CCA”).

---

5 On the early evolution of regulatory accounting for the telephone system see Danielian (1939), notably p. 334 and following; and Weinhaus and Oettinger (1988). Danielian, N. R. 1939, AT&T, The Vanguard Press, New York. Weinhaus, C. L. and A. G. Oettinger 1988, Behind the Telephone Debates, Ablex, Norwood, N.J.

6 A clear formulation of the philosophy underpinning conventional US regulatory accounting, as well as some of the major criticisms levelled against it, can be found in Bonbright, Danielsen and Kamerschen (1988). Bonbright, J. C., A. L. Danielsen and D. R. Kamerschen 1988, Principles of Public Utility Rates, 2nd ed., Public Utilities Reports, Inc: Arlington, Virginia.

7 Baumol, William J. and Sidak, J. Gregory, "The Pig in the Python: is Lumpy Capacity Investment Used and Useful?". Energy Law Journal, Vol. 23, pp. 383-399, 2002.

Accounts based on “current” valuation approaches are intended to provide information about “current” (rather than historical) costs (which may or may not be opportunity costs).[8] At its simplest, CCA entails revaluing the historical costs of assets to account for inflation or asset-specific price changes.[9] In an imperfect world, however, what constitutes the “current” value of an asset is generally ambiguous, and potentially includes current entry values (purchase prices or replacement costs), current exit values (selling prices less the costs of disposing of an asset), and present values (the discounted net present values of returns expected from use in the ordinary course of the business).[10] Each of these three valuation concepts in turn leads to further variations in how assets are valued in practice, each associated with different interpretations, advantages and drawbacks.[11]

In a regulatory setting, CCA systems sometimes involve the revaluation of the firm’s regulated assets’ service potential using external benchmarks. Australian regulators have generally chosen to value sunk assets on the basis of some form of CCA system. The common feature of these methodologies is that cost estimates are based on current input prices and technologies (and expectations about future input prices and technologies), rather than on the amounts actually outlaid in the past. They are in this sense “forward” rather than “backward” looking.

If assets are valued on a “forward-looking” cost basis, the valuation of the asset base, which is ultimately depreciated and for which the regulated firm receives a rate of return may be determined by periodic re-estimations or “optimisations”. Under most CCA systems, this re-estimation involves determining the “cost” (i.e. the minimum monetary outlays) required to hypothetically secure that service potential in the market as it is at the reporting time. However, as technology moves on and demand conditions and relative prices change, the least-cost way of obtaining “used and useful” service potential will itself change. The optimisation inherent in CCA valuation therefore requires estimating how an existing service potential would be replaced, a task that necessarily involves a considerable exercise of judgement.

While difficulties relating to subjectivity and to do with the extent to which accounting figures can be verified are inherent in forward-looking costings, as describe in the following paragraphs, in my opinion some approaches to forward-looking costing imply a greater risk that the regulated firm will not be able to fully recover its costs than others. This, in turn, has consequences for the type of depreciation profile that is likely to be reasonable.

In my experience, the approaches adopted by telecommunications regulators to implementing forward-looking costing fall into two broad types. The first takes a “top down” perspective. It starts from the firm’s management accounts and revises these on a forward-looking perspective. On the asset side, it does this by estimating for each asset class the cost of replacing that asset class’ outstanding service potential, either through a “modern equivalent asset” approach (which notionally replaces each asset in the class with its most efficient modern equivalent) or by the reproduction cost approach, that is, by repeated

8 Opportunity costs measure the cost of the best foregone alternative.

9 See Whittington, Geoffrey, 1997, Inflation Accounting, An Introduction to the Debate, Cambridge Studies in Management. Pp. 131-136.

10 Whittington, (1997), P.34.

11 Whittington, (1997), P.115 ff.

application of price indices measuring the asset's reproduction cost.[12] At the same time, adjustments are made to current (non-capital) outlays so as to put these on a basis that reflects market prices and available technologies. Finally, a reconciliation is (or can be) effected to the historical cost accounts by creating reserves in the balance sheet for supplementary and backlog depreciation and for holding gains and losses.

The second, "bottom up" approach to costing, centres on developing and estimating an engineering cost model of a hypothetical, "optimised" telecommunications network.[13] These models may reflect some features of a service provider's *existing* network, but essentially measure the costs that a hypothetical efficient supplier would incur in the longer term. As such, they define the relevant costs as those that would be incurred by such a supplier in the provision of a specified increment of output.

TSLRIC (total service long run incremental cost) and TELRIC (total element long run incremental cost) are the main practical forms these "bottom up" costing approaches take in telecommunications. In essence, these concepts involve three elements:

- The relevant increment that is costed is defined as the *total* volume of the service at issue (for instance, the total telephony traffic carried over the network);
- The decision at issue is the supply of the increment over the longer run – so that the capital stock is fully variable, and hence is included in the cost pool; and
- The concern is with the resources that would be needed to provide this service with current technology and management practices, as against those that may have been inherited from earlier periods.

In theory, the top down and bottom up approaches should be equivalent.[14] In practice, however, such reconciliation is never complete, so that the two approaches can (and usually do) yield quite different estimates.

In my opinion, "top down" costing approaches are less subjective and more readily verified than are those based on "bottom up" models. "Top down" costing methodologies have at least some basis in, and continuing role in, conventional financial accounting, because they are "keyed off" the regulated firm's own accounting records. As such, the "top down" costing approach is necessarily capable of being connected back to what the firm actually does and the investments that have actually been made in the firm over time.

This linkage does not exist (or does not exist to the same degree) for "bottom up" costing models. This means that "bottom up" approaches have less of an anchor to the regulated firm's operational environment. Rather, they are inherently hypothetical exercises that

[12] Although the reproduction cost approach is less frequently used, it can be shown that the risk of error is smaller in using reproduction accounting in the face of obsolescence relative to conventional Modern Equivalent Asset valuation. See Revsine, J., 1979, "Technological Change and Replacement Costs", *The Accounting Review,* vol. 54, pp. 306-322.

[13] These models thereby combine the optimisation emphasis that characterises the optimised deprival value (ODV) approach to valuation of the asset base with an emphasis on the relevant output increment, characteristic of economic decision analysis. See, for example, Fabrycky, Thuesen and Verma (1998). Fabrycky, W. J., G. J. Thuesen and D. Verma 1998, Economic Decision Analysis, 3rd ed., Prentice Hall, Upper Saddle River, New Jersey. The ODV valuation approach takes as value the lesser of the replacement cost of an asset, compared with the greater of the present value of net receipts or its net realisable value. Godfrey, J., Hodgson, Al,; Homes, S.; Kam, V., Accounting Theory, John Wiley & Sons, 1994, 407-408.

[14] Indeed, if a "bottom up" costing is properly constructed, it should be capable of being reconciled with the "top down" accounts and hence ultimately traced back to the historical cost accounts.

involve constructing ”optimal” networks. The extent of the resulting cost recovery risk for the regulated firm is further increased by the scope for errors to be made in determining the key parameters on which accounting constructs such as TSLRIC and TELRIC that are built through a “bottom up” costing exercise rely.[15]

2.3. INCENTIVES FOR INVESTMENT

As I describe below, given the “forward-looking” accounting (costing) system adopted in Australian telecommunications regulation, there is generally no guarantee of *ex ante* financial capital maintenance. In combination with the risk of time inconsistency in regulation, this poses specific challenges to ensuring adequate investment. Yet ensuring efficient investment is of far greater consequence from a social welfare perspective than ensuring that short-term pricing outcomes are efficient.

2.3.1. Risk of time inconsistency

In my opinion, and as is generally accepted by economists, some degree of regulatory error is inevitable.[16] Regulators have limited information about costs and demands, and even if they wanted to, could not set fully efficient terms and conditions of access prices.[17] Additionally, in my experience, the greater the discretion vested in a regulator, the greater the risk that the regulator may seek to pursue objectives that are unrelated to economic efficiency.

Regulatory error will distort outcomes both in the short run and in the longer term. In the short run, errors in regulatory price-setting will alter consumers’ choices, both as to how much to consume and as to the allocation of that consumption as between competing suppliers. In the longer term, regulatory discretion and the risk of regulatory error will discourage efficient investment. Thus, investors will fear that once investments are made and their costs are sunk,[18] the regulator – regardless of whatever commitments it may have made – may have incentives to set prices at levels that, had they been known at the outset, would have led to the investment not being made. This is the problem economists refer to as “*time inconsistency*”.[19]

---

15 These assumptions include: the relevant increment of output and the time path of that output; the relevant prices of inputs over time that potentially could be used in producing that output; the technology to be used to supply that increment; the time frame in which a network corresponding to that technology will be built; the base of existing assets and services to which this new network is to be added; provisioning rules with respect to the capacity/demand balance; the appropriate level and time path of operating and maintenance outlays; the level of indirect costs; and the treatment of capital charges, including with respect to depreciation, the opportunity cost of capital and the cost of not deferring investment.

16 For a discussion of the costs of market intervention and regulation, see the Productivity Commission’s review of the Gas Access Regime. Productivity Commission, “Review of the Gas Access Regime, Inquiry Report No. 31”, 11 June 2004, see P. 159.

17 Moreover, outside of a world with complete markets, there are generally more dimensions of efficiency than instruments (especially if prices are constrained to be linear), so the different dimensions of efficiency may conflict and trade-offs must be made between them.

18 Costs are said to be sunk when once committed to a particular use the value in alternative uses of the assets purchased through those costs is low. The costs of a truck purchased to serve a particular freight route are usually not sunk to any material extent, as the truck can be readily redeployed elsewhere. In contrast, once a trench is dug between two places, the costs of that trench are just about completely sunk. Most of the costs associated with building a CAN in telecommunications are sunk once incurred.

19 See Kyland, F. and E. Prescott 1977, “Rules Rather than Discretion: The Inconsistency of Optimal Plans”, Journal of Political Economy, vol. 85, pp 473-92,. and Calvo, G. 1978, “On the Time Inconsistency of Optimal Policy in a Monetary Economy”, Econometrica, vol. 46. pp. 1411-28.

Time-inconsistency arises when a policy that is optimal (from the point of view of the regulator) *ex ante* turns out not to be the optimal policy *ex post*. If a regulator cannot commit to a policy, it may then find itself wanting to change its policy *ex post* (say, after a firm has made its investment decision), regardless of what it said *ex ante*. Such an approach to policy is said to be time-inconsistent.

Unless the regulator takes steps to convince investors it will not engage in time-inconsistent behaviour, investors will rationally expect it to occur.[20] This will lead investors to avoid investing in projects that are subject to time-inconsistent regulation, or at least to require added compensation for the risk of such outcomes. The consequence is that in the long run, the objectives of the regulator may be better served if the regulator can commit *ex ante* to a policy of not engaging in time-inconsistent behaviour.[21] This is true regardless of whether the regulator actually engages (or even plans to engage) in time-inconsistent behaviour.

More generally, where investors expect a likelihood of time-inconsistent regulation, they can be expected to take steps to avoid it.[22] For instance, unless suitably compensated, an access provider can be expected to avoid projects that involve large amounts of sunk capital, even if those projects are expected to be profitable (and hence socially desirable) in the absence of time-inconsistency. Similarly, an access provider can be expected to avoid projects that are very risky even if – absent time-inconsistency – those projects are expected to earn returns more than sufficient to justify the risk involved. An access provider would also likely delay risky investment until major uncertainty is resolved, thereby avoiding the time-inconsistency problem. Finally, investors will tend to avoid projects where high returns are required later in the asset's life to compensate for low returns earlier on, as such projects are particularly susceptible to time-inconsistency. Individually and in combination, these responses are likely to harm consumers, who are likely to end up with fewer and poorer quality services and/or who will have to compensate the access provider more to obtain the same level of investment and service.

In my opinion, the risk of time inconsistency is of particular concern in telecommunications where the relatively open-ended nature of Part XIC makes it possible for the regulator to choose a cost methodology in which costs that have actually been incurred historically play at most a subsidiary role in the valuation of the regulated firm's asset base. Rather, and as I have described in the previous section, all costs are periodically redetermined on a "forward-looking", "bottom up" basis to reflect the costs that a hypothetical efficient network provider would incur.

20 Utility services, such as telecommunications are particularly prone to time-inconsistent regulation: these service require large volumes of investment which, once installed become 'sunk assets' so that they cannot be removed and used elsewhere or sold on second-hand markets at their original cost. Private investors are therefore at risk of opportunistic behaviour by governments or regulators once investments have been made, which in turn drives up the required rate of return and the cost of capital. Levine, P., J. Stern and F. Trillas 2005, 'Utility Price Regulation and Time Inconsistency: Comparisons with Monetary Policy', Oxford Economic Papers 57(4); P. 449.

21 For a discussion of mechanisms to address time-inconsistency in regulation, see Evans, J., P. Levine and F. Trillas 2008, 'Lobbies, Delegation and the Under-Investment Problem in Regulation', International Journal of Industrial Organization 26(1): 17-40.

22 Teisberg (1993), for instance, models investment choice by regulated firms subject to long lead times for capital investment during which the value of the completed project is uncertain. Rational firms are shown to prefer to invest in smaller, shorter lead time plants or delay investment when faced with returns made more uncertain by regulatory profit restrictions. Teisberg, E. 1993, 'Capital investment strategies under uncertain regulation', Rand Journal of Economics 24(4). Guthrie argues that the prospect of regulatory opportunism means that the firm will not fully exploit economies of scale in investment, and will favor reversible rather than irreversible investment since the resulting capital will have a higher salvage value. Guthrie, G. 2006, 'Regulating infrastructure: The impact on risk and investment', Journal of Economic Literature XLIV: 925-972.

Corresponding findings are reported in the economic literature. Guthrie, Small and Wright discuss the additional risk placed on regulated firms as a result of a forward-looking costing framework for a firm undertaking an irreversible investment.[23] Forward-looking costs imply that the access price under the forward-looking rule diverges from its initial value over time and therefore subjects the firm to additional risk. To achieve the same investment decision with forward-looking rules, access prices must be increased to compensate for this additional risk. In particular, where investment costs "drift" downwards, there is a strong incentive to delay investment. Overall, the authors conclude that an accounting system based on conventional "backward looking" costs can result in better outcomes, in social welfare terms, than a forward-looking cost rule.

Pyndyck specifically describes the consequences of adopting a "bottom up" TELRIC type costing model.[24] In effect TELRIC pricing prevents cost recovery, since it is based on the *current* cost of network equipment, rather than cost that have actually been incurred**.** As telecommunications equipment costs tend to fall over time as a result of technological improvements and increasing competition among suppliers, telecommunications firms are generally unable to recover the costs they have actually incurred. When investors know that new capital outlays will not be recouped, they will rationally commit less new capital in anticipation of inadequate returns. Pyndyck concludes:[25]

> *In short, a rule depriving investors of the ability to recoup sunk costs becomes part of the forward-looking analysis for capital not yet sunk. Of course, if there is no concern about creating incentives for new investment, it is reasonable to argue that efficient pricing should be entirely "forward-looking" and sunk costs should indeed be ignored. But creating incentives for new investment is crucial. Capital depreciates and must be maintained or replaced, and efficient new technologies require new investment. The investment needed to adopt new technologies is especially important in local telecommunications networks. If firms considering investing in more modern systems face the constraint that TELRIC pricing will not allow them to recover sunk costs, they simply will not have the incentive to make the investments needed to update and expand telecom networks.*

2.3.2. "Inefficient" prices versus dynamic (investment) inefficiencies

A regulator may take the view that certain accounting systems (such as the forward-looking cost models described above) are preferable because they produce prices that are more "allocatively" efficient (that is, cost-reflective), and that such price effects outweigh the risks to future investment from a failure to permit cost-recovery. But in my opinion, unless prices charged of customers are very highly distorted, the reduction in economic welfare from inefficient production and investment decisions are likely to be relatively greater than the welfare increase from moving prices towards first best allocatively efficient levels.

[23] Guthrie, G., J. Small and J. Wright 2006, 'Pricing Access: Forward-looking versus Backward-looking Cost Rules'.

[24] Pindyck, R. 2007, 'Mandatory Unbundling and Irreversible Investment in Telecom Networks', Review of Network Economics 6(3).

[25] Pindyck, R. 2007, 'Mandatory Unbundling and Irreversible Investment in Telecom Networks', Review of Network Economics 6(3).

In general, a firm's incentive to invest in infrastructure is a function of the returns that it expects from this investment relative to other investments it can undertake. Hence, regulatory constraints that serve to reduce price-cost margins (to improve allocative efficiency) may be expected to reduce the returns that a regulated firm could expect from its infrastructure investment, and thereby weaken incentives to invest.[26] In contrast, the deadweight losses from monopoly pricing are likely limited and are typically outweighed by dynamic efficiency losses that arise as a result of regulation, especially regulation that distorts investment.[27]

2.4. CONCLUSIONS

In this section I have set out the economic framework within which I have considered the ACCC's tilted annuity approach to depreciating Telstra's regulated capital assets.

I have described above that it is a commonly held opinion, and it is also my view, that all industry regulation, if it is to be sustainable, must offer investors in the regulated entity a reasonable prospect of full cost recovery. If voluntary, privately-funded investment is to be forthcoming, investors must be offered a "fair bargain" by the regulator with the prospect of full cost recovery being at the centre of that bargain. In this context, ensuring adequate investment depends heavily on whether the approach adopted to cost determination is consistent with expectational capital maintenance.

In my experience, different regulatory regimes and their corresponding accounting systems place different degrees of financial risk (that is, risk that investors will not be able to maintain the financial capital they have invested in the firm) on regulated firms. Specifically in the context of Australian telecommunications regulation, and given the far-reaching nature of revaluation processes adopted, there is generally no guarantee of financial capital maintenance. In accounting systems that rely on forward-looking costs, the regulatory objective of estimating the gap between a firm's actual costs and the costs that would be incurred by an efficient firm leads to periodic re-optimisations that involve not just individual assets, but wider network configurations. Added to this is the substantial scope for the regulator to adopt policies that are "time inconsistent"; that is, that allow for the (arbitrary) ex post revision of costs. As a result, when assets are "stranded" in this way, the regulated firm's financial capital is not maintained: the cost of the assets may no longer be recovered via depreciation, nor does the firm earn a rate of return on the corresponding capital invested. In general, these types of policies are likely to affect investment negatively, an effect that is likely to outweigh any short-term gains in terms of lower prices.

As I explain in the next section, the potential for regulatory behaviour that is time inconsistent (so that cost recovery may be in doubt) has implications for the depreciation profile that a regulated firm's shareholders would want it to adopt. This is all the more so when cost recovery may be undermined by competition or other substantial changes in

---

26 Bernstein, J. 2007, 'Dynamics, Efficiency and Network Industries: A Special Issue of the Review of Network Economics (Introduction and Overview)', Review of Network Economics 6(3). P.364.

27 Bradburd, R. 1992, 'Privatization of natural monopoly public enterprises: the regulation issue', The World Bank, Policy Research Working Paper Series: 864. Timmins (2002), for instance, measures the deadweight losses resulting from municipal water utility administrators in the western US pricing water significantly below its marginal cost and, in so doing, inefficiently exploiting aquifer stocks and inducing social surplus losses. It is estimated that the deadweight losses amounted to $110.68 per household in 1995 dollars while the benefit to consumers was only 45 cents per household. Timmins, C. 2002, 'Measuring the Dynamic Efficiency Costs of Regulators' Preferences: Municipal Water Utilities in the Arid West', Econometrica 70(2): 603-29.

circumstances. The price of not doing so – that is, the price of requiring shareholders to finance assets that cannot be fully depreciated – is likely to be an increase in the cost of capital of capital of the regulated firm, which will in turn affect investment. The consequences of underinvestment are ultimately borne by consumers – either in the form of higher prices, or of fewer services, or both.

3. DEPRECIATION AND *EX ANTE* CAPITAL MAINTENANCE

In the preceding section I described the importance of *ex ante* capital maintenance and therefore of time-consistent regulatory behaviour in enabling a regulated firm to finance its business activities, including investment. The setting of the capital charge is an especially important factor in ensuring expectational capital maintenance in industries with high capital intensity and very long lived assets. The return of capital, i.e. depreciation, is a crucial component of the capital charge. Moreover, it is the component where timing of recovery issues loom largest, as different ways of determining the capital charge may have the effect of significantly deferring that return.

In this section I explore the general lessons that might be learned from the economic and theoretical accounting literature as regards the depreciation approach that should be adopted for Telstra's ULLS assets.

In a general sense, depreciation refers to the way in which certain kinds of long-lived assets fall in value (price) over their useful life. The economic literature on depreciation is generally concerned with production or "capital" assets whose application results in some type of "output" and whose value then declines. Machines wear out, trucks break down, electronic equipment becomes obsolete, and at some point such assets are withdrawn from service.[28] As assets physically deteriorate or their economic value declines, their productive capacity also falls, and a parallel loss in the assets' financial value occurs.

In the context of a firm, depreciation measures an asset's successive contribution to production in different periods, and the implied (opportunity) cost of that specific input.[29] The problem of how an asset should be depreciated (that is, how the evolution of the value of an asset should be assessed over its productive life) arises because for any asset, objectively verifiable values that are based on external transactions exist at only two points in time: when the asset is first acquired and when it is disposed of at the end of its productive life.[30] If these two events occur within the same accounting period, no depreciation problem arises (although there may still be issues about how the asset's costs should be allocated to individual units of output during that accounting period). But where the acquisition and disposal of an asset are separated in time (as is usually the case with long-lived capital assets), a firm's opportunity costs and profits in each intervening period cannot be determined without also establishing the value of the asset at the end of each period.

The description in the preceding few paragraphs of the problem of depreciation is generic, but as I explain in the following subsections, economists and accountants differ in how they solve this problem:

- The economic approach to depreciation seeks to mimic the pattern of asset prices that would prevail in well-functioning markets for second hand assets, and hence to reflect the opportunity cost of making the services that the asset provides available.

---

28 Hulten, Charles R., and Frank C. Wykoff, "Issues in the Measurement of Economic Depreciation," Economic Inquiry, Vol. XXXIV, No. 1, January 1996, Pp. 10-23.

29 Baxter, W.T., Depreciation, Sweet & Maxwell, London, 1971. P.25.

30 Towards a General Theory of Depreciation, F. K. Wright, Journal of Accounting Research, Vol. 2, No. 1 (Spring, 1964), Pp. 81.

- The accounting approach seeks to allocate cost recovery to particular periods of time and units of output, with less concern about reflecting notional opportunity costs. It has the advantage of greater verifiability, though at a cost in terms of the extent to which potentially relevant opportunity costs are being measured.

To the extent to which the economic approach to depreciation is adopted, the time profile of charges depends on a number of factors, including the time-efficiency profile of the assets, expectations of future price changes and discount rates. In some instances, these can lead to a time profile that is effectively back-loaded. However, it is widely recognised in the economic literature that where there is a risk of obsolescence through (say) competitive bypass, or where regulatory uncertainty is costly, such back-loading is dangerous, as it may lead to expected losses.

3.1. ECONOMIC DEPRECIATION

Economic depreciation emerges as a residual: it is the difference between the economic value (that is, price) of an asset at different ages. In turn, the economic value of an asset at any point in time is the present value of its discounted future services. In other words, under an economic approach to depreciation, the value of an asset is determined by the future net earnings it embodies, and the depreciation profile is determined by the decline in that earnings potential as the asset ages.[31]

As I explain below, the economic literature suggests that conceptually, various (complex) factors determine the economic depreciation profile of an asset. Measuring economic depreciation is practically difficult, because, for a particular asset, the shape of the depreciation profile can only be determined by ascertaining its price in second-hand markets. Determining the economic depreciation profile for specialised and sunk assets then risks becoming a rather hypothetical exercise, since “market” prices for such assets commonly do not exist.

3.1.1. Economic depreciation and prices

The concept of economic depreciation as a change in asset values is often traced back to Hotelling.[32] Hotelling considered a capital asset, say a machine, that produces some output over its useful life and eventually turns to scrap. Under perfect foresight, the value of a capital asset (such as a machine) is the present value of the future net income accruing to the machine (referred to as “rentals”), and economic depreciation is the change (usually a decrease) in the value of the machine as a result of aging.[33] Since asset values are “forward-looking” (i.e. determined by expectations of future “rentals”), economic depreciation is also a forward-looking concept, being the difference in value (price) of the asset as it ages.

A corollary of the economic depreciation concept is that an asset’s useful life is not a “given”, but is determined jointly with the asset’s value at any point in time by the

[31] At the outset of the asset’s life, the sum of the expected changes will, in present value terms, equal the initial value of the asset and the same will hold ex post so long as all expectations are realised (i.e. in equilibrium).

[32] Harold Hotelling, A General Mathematical Theory of Depreciation, Journal of the American Statistical Association, Vol. 20, No. 151 (Sep., 1925), pp. 340-353.

[33] Hulten, C and F. Wykoff, “The measurement of economic depreciation”, Pp.81-125, in: Hulten, C., (Ed.), Depreciation, inflation, and the taxation of income from capital”, Urban Institute Press Washington, D.C., 1981. P.84.

interaction of demand and supply conditions. This follows from the fact that a profit-maximising firm would wish to maximise the present value of the rentals generated by a productive asset, such as a machine. In a simple, one-machine context, profit maximisation implies that the machine is no longer worth operating if its rentals become zero; that is, if the value of the output the machine produces is equal (or less) than its operating costs.[34]

3.1.2. Depreciation, revaluation, and obsolescence

Many models (including Hotelling's) loosely refer to economic depreciation as the changing of asset values over time,[35] but in a world with changing prices there is a distinction between value changes as a result of aging (i.e. depreciation) and those as a result of changes in relative price levels (referred to as "revaluation").[36] The relevance of this distinction arises because it means that a change in the value of an existing asset (say, an increase in the price of copper wires) does not necessarily imply that the asset's depreciation profile has changed. Rather, as is explained below, it may imply that the holder of the asset has benefited from a revaluation gain (or loss, as the case may be). It is therefore not straightforward to go from relative price changes of assets (such as those that may have occurred in the context of ULLS assets) into changed depreciation profiles.

A change in the price of an asset between *two* points in time can be decomposed into two components. The first component is the decline in price from aging *holding time constant*. This is what is referred to as economic depreciation and is shown in the top half of Figure 1. The top graph in Figure 1 plots the age-price relationship of a group of otherwise identical assets of different ages at *one* point in time, so that the value of a 5-year old asset is represented by point *a* on the curve, and the value of a 6-year old asset by point *b*. Economic depreciation for the 5-year old asset as it ages to a 6-year old asset is the difference on the vertical (price) axis between *a* and *b* (the thick red line).[37]

With few exceptions, and unless the asset has an infinite useful life, the age-price curve for a given class of assets is always downward sloping, for two reasons:

- Any asset that has aged by a year has fewer "productive" years left in its useful life during which it can generate rentals; and
- Additionally, in most cases, the efficiency of the asset is reduced as it ages (say, because it is more prone to break-downs, or because it requires more maintenance or fuel), which further causes the age-price curve to slope downwards.[38]

---

34 Here operating costs are broadly defined to include ongoing costs arising in the course of production (say, labour and materials), but also repairs and overhauls. The fact that asset value and asset life are directly linked creates a circularity in a world where the firm in question is not a strict price taker, but where demand for the firm's output – and how demand evolves over time – varies in response to the firm's pricing decisions. In this case, the depreciation profile determines the price at which the asset's output is sold, which in turn determines demand and therefore asset value and asset life. I return to this point in the context of depreciation in a regulated environment in Section 3.3 below.

35 In this (inter-temporal) formulation, $d_t = v_t – v_{t+1}$, where v_t is the value of the asset at the start of period t.

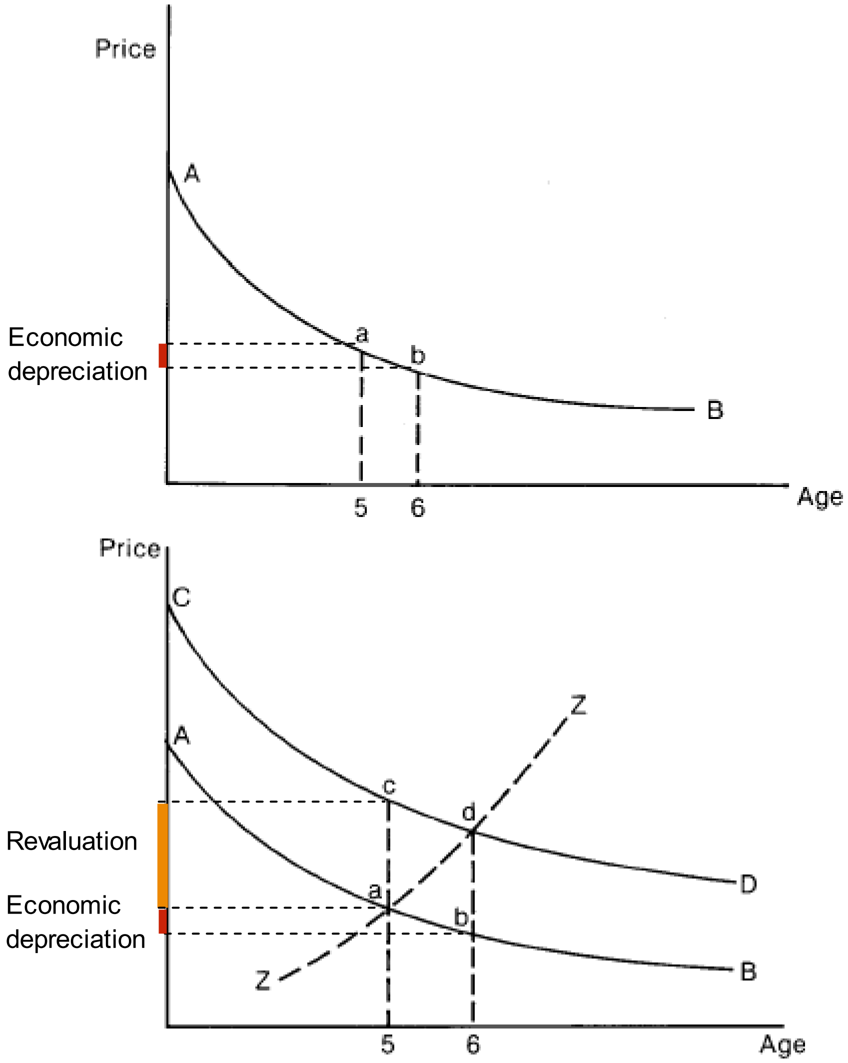
36 The following discussion draws on Wykoff, Frank C., "Obsolescence in Economic Depreciation from the Point of View of the Revaluation Term", February 28, 2003.

37 The rate of depreciation – the speed at which an asset's value declines – is the elasticity of the price (AB) curve between a and b (that is, the percentage decline in asset price between these two points).

38 Of course, an asset may experience favourable or adverse cost shocks as it ages: it may become obsolete, or conversely, new uses for the asset may increase its value. For instance, it might be argued that the development of DSL technology increased the economic value of copper pair networks. But that in no way alters

A key point to understand is that the two assets (the 5-year old and the 6-year old) that are compared to determine economic depreciation must coexist at the same point in time. If one wanted to measure economic depreciation over one year for a 6-year old car in 2006, one would not compare its 2006 price with the same car's 2005 price. Instead, one would compare the price of a 6-year old car in 2006 with that of an (otherwise identical) 5-year old car in 2006. In other words, depreciation measures price differences between assets from different cohorts or "vintages" *at the same point in time*.

Figure 1: Age-price profiles for a homogeneous class of assets



Source: Hulten, C and F. Wykoff, "The measurement of economic depreciation", Pp.81-125, in: Hulten, C., (Ed.), Depreciation, inflation, and the taxation of income from capital", Urban Institute Press Washington, D.C., 1981. P.85, 87..

The second component of a change in an asset's price change over time is the change in price with the passage of time, *holding the age of the asset constant*. This is referred to as "revaluation". In the bottom half of Figure 1, a second age-price relationship has been added for the same class of assets as above, but for a different point in time (say, a year later). It is apparent that the price of all assets has increased relative to Year 1, perhaps

the fact that a 10 year old copper pair is likely to suffer more faults than a 1 year old copper pair, and hence will have a relatively reduced value.

because of general inflation or some price effect that is specific to the asset. A year later, the price of a 5-year old asset is *c* and the price of a 6-year old asset is *d*. A 5-year old asset with a price of *a* in Year 1 now has a price of *d* in Year 2. The price change from *a* to *d* can now be decomposed into two components:

- A pure aging effect (economic depreciation), which corresponds to the price change from *a* to *b*; and
- Superimposed, a pure revaluation effect, which corresponds to the price change from *a* to *c*.

These two price changes work in opposite direction, and since the asset is a year older, its price does not increase by the full effect of the revaluation.

Figure 1 assumes that the loss in the value of the asset as a result of depreciation works in a particular way – the asset loses about half of its value in the first five years; thereafter its value does not change that much. The shape of the price-age curve defines the asset's depreciation profile, that is, how the value of an asset of a certain vintage changes as it ages.

The economic depreciation of an asset as drawn in Figure 1 can be further decomposed into two distinct price effects:[39]

- The first effect on an aging asset is caused by the introduction of new "vintages" of the asset, such as an asset constructed in a later year that embodies superior technology and quality improvements. This effect on the price of an aging asset of the presence of a new vintage is referred to as "obsolescence".
- All other effects that affect the extent to which an asset deteriorates as a result of physical aging are referred to as "deterioration" or sometimes "decay".

To take the example of a computer, the difference in the price of a 1-year old Toshiba laptop computer and a 2-year old Toshiba laptop computer in 2006 can be separated into two effects. First, and all other things equal, the 2-year old computer is more likely to fail; this is the deterioration component of depreciation. Second, the 1-year old Toshiba laptop may have a faster processor and more memory than the 2-year old Toshiba laptop. This is the obsolescence component of depreciation, which may far outweigh the deterioration effect. The relative importance and magnitude of these effects determines an asset's particular age-price profile and therefore its depreciation profile; these can therefore be expected to vary for different types of assets.

Isolating the effect of obsolescence and that of deterioration in the price curves in Figure 1 is not possible, however. Hall's Impossibility Theorem states that one cannot separately identify from price data alone the effects caused by aging (deterioration), passage of time (capital gains or losses), and changes in vintage (obsolescence).[40] What this means in the context of Figure 1 is that the depreciation effect measured by the move from *a* to *b* combines pure depreciation with obsolescence, and that the shape of the age-price curve itself embodies this effect. For example, once one specifies two of the three terms – time,

---

39 The revaluation effect can similarly be decomposed into a time and an obsolescence effect.

40 Hall, Robert E., (1968), "Technical Change and Capital from the Point of View of the Dual." Review of Economics and Statistics. 35, January: pp. 35-46. Wykoff (2003), P.17.

age, and vintage – the third is determined. A three-year-old wine in 2004 must be a vintage 2001 wine. A vintage 2001 wine is, by definition, observed at age three only in 2004. Statistically these effects cannot be separated from price data alone.[41]

3.1.3. Economic depreciation profiles

In this section I explain the economic depreciation profiles that can be expected in different circumstances in more detail. The depreciation *profile* refers to how an asset loses its value over time; for instance, whether an asset's value declines more steeply early on in the asset's useful life (so that depreciation is "front loaded") or whether it loses more value later in its life (so that depreciation is "back-loaded").

Ignoring revaluation (specific or general inflation) effects, older assets are *less* valuable than newer assets for a number of reasons:[42]

- In the first instance, the decline in an asset's value reflects the fact that, with a finite useful life, the present value of an asset's future rentals declines with advancing age. In other words, all else equal, an older asset will generate fewer units of output before retirement and hence have lower economic returns than a younger asset.
- Second, the decline in an asset's value is greater in early years if it is accompanied by a loss of its productive capability or "efficiency". Such a loss in productive capability arises, for instance, if the likelihood of down time and/or the cost of repairs has increased, or if the quality of the service flow has degenerated, or if the cost of operations has increased.
- The third effect relates to obsolescence. Abstracting from general price changes, the values of older assets change over time as a result of technological innovations that are embodied in younger assets, but also because changes in consumer preferences may make some assets obsolete.

This distinction between the underlying causes of economic depreciation – the effects of time, physical decay, and technological obsolescence on asset values – are important, because they illuminate the circumstances in which different economic depreciation profiles are likely to arise.

3.1.3.1 The effects of aging and physical deterioration

Hotelling's theory of depreciation was refined in a number of landmark papers, notably by Jorgenson and Hall.[43] This work illuminates the precise origin and meaning of economic depreciation, but it also makes a number of subtle distinctions between different reasons for why assets' prices change so that terminology is important. Specifically, Jorgenson established that there is a parallel ("duality") between assets' relative rentals and therefore

---

41 I comment on other (hedonic) techniques for estimating the relative importance of these effects below.

42 Baldwin, John, Guy Gellatly, Marc Tanguay, and André Patry, "Estimating Depreciation Rates for the Productivity Accounts", Statistics Canada, September 15, 2005, Pp.6ff. Fraumeni, B.M. 1997. "The Measurement of Depreciation in the U.S. National Income and Product Accounts" Survey of Current Business. July: 7-23.

43 Hall, Robert E., (1968), "Technical Change and Capital from the Point of View of the Dual." Review of Economics and Statistics. 35, January: pp. 35-46. Jorgenson, Dale W., (1974). "The Economic Theory of Replacement and Depreciation." in W. Sellekraets, (ed.) Econometrics and Economic Theory. MacMillan, New York.

value over time, and the same asset's relative productive capability. In other words, all other things equal, a more efficient asset (say, a truck that can drive further on a litre of petrol than another) is worth more than a less efficient version of the same asset.

As an asset experiences wear and tear, its productive efficiency declines. In the neoclassical capital vintage model, the decline of the physical efficiency of an asset as it ages is measured by an index φ.[44] That is, the efficiency or output of an asset of a certain age τ (or "vintage" τ) is assumed to be equivalent to some fraction "φ_τ" of an asset of the newest vintage 0. In other words, the efficiency index φ_τ expresses the productive capacity of a τ year old asset relative to that of a new asset. How an asset's efficiency evolves as it ages is a key determinant of the asset's depreciation profile:

- The efficiency profiles describe how the productive efficiency of an asset deteriorates over time;
- The efficiency profile then translates into a corresponding age-price profile for the asset (since an asset's value at any point in time is just the present value of its future earnings); and
- The asset's age-price profile defines its depreciation profile (since economic depreciation is the difference between an asset's value at two ages).

Figure 2 illustrates this sequence for three types of assets, each with a different (physical) deterioration profile. Figure 2 plots, in the top graph, an efficiency profile for each asset, next, the age-price profile corresponding to that efficiency profile (for each asset), and in the bottom graph, a corresponding depreciation profile (for each asset).

I first consider an asset whose productive capability does *not* physically deteriorate as it ages. This constant efficiency pattern is known as a "one-hoss-shay" pattern; it refers to assets that retain their full efficiency until they suddenly and utterly cease to function.[45] All other things equal, such an asset will, in each of the productive periods over its useful life, generate a rental that is directly proportional to its productive capacity φ.

The top part of Figure 2 plots a constant efficiency (one-hoss shay) profile over the asset's 20-year life, where it is assumed that the asset earns $1 in each year. Assuming unchanged prices, such an asset – say, a light bulb – would generate a constant stream of output and hence revenue until the end of its life. In turn, the asset's (constant) income pattern determines its value (the present value of its future rentals) as it ages.[46] The value is highest at the beginning of Year 1, where it has 20 years of useful life ahead of it and declines thereafter, slowly at first and then more rapidly in later years. Economic depreciation (i.e. the annual depreciation charge) emerges as a residual from this calculation, and the bottom graph plots this. It is apparent that so long as the discount rate is positive (i.e. there is a positive time value of money), the one-hoss shay efficiency pattern gives rise to a back-loaded economic depreciation profile.

In all circumstances where there is some form of physical deterioration of the asset (in addition to the pure aging effect), economic depreciation profiles are front-loaded. Figure 2

44 Formally, the φ_τ is the marginal rate of substitution in production between the τ-year-old asset and the new asset. Hulten Wykoff (1981), P.88.

45 Light bulbs are often cited as exemplifying assets of this type.

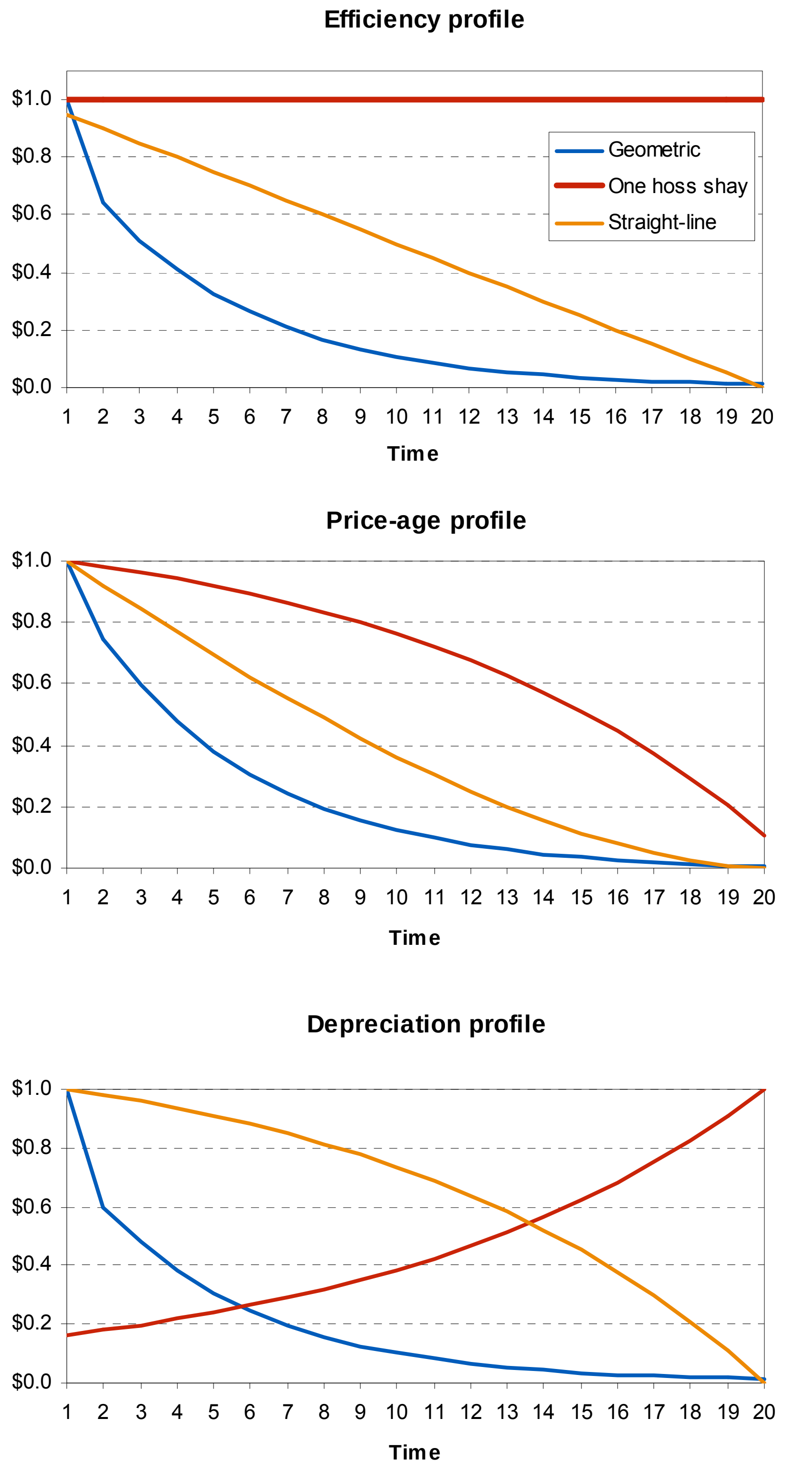
46 These numbers have all been normalised to 1.

repeats the same logic for an asset in which efficiency deteriorates in a straight-line and a geometric manner:

- Under a straight-line efficiency profile, the productive efficiency of the asset declines in equal absolute increments until the asset is retired. All other things equal, the revenues that this type of asset generates similarly decline in linear increments over the asset's useful life. With discounting, the asset's value declines more rapidly in its early years than in later years, and the depreciation charge is correspondingly higher in earlier years (i.e. front loaded) and less in later years.[47]
- Under a geometric efficiency profile the rate at which an asset's efficiency declines is constant over the asset's life. Revenue declines are more pronounced in earlier periods of the asset's service life than in later periods, and depreciation is front-loaded.

47 In a regulated setting, this depreciation profile matches that described by Jaffee for a firm that earns a constant amount of revenue from a fixed amount of capital in an environment of certainty. Bruce L. Jaffee, 1973. "Depreciation in a Simple Regulatory Model," Bell Journal of Economics, The RAND Corporation, vol. 4(1), pages 338-342, Spring.

Figure 2: Asset efficiency, asset prices and depreciation



Notes: All values standardised to a maximum of $1. Calculations assume interest rate of 10%, useful asset life of 20 years. For geometric efficiency profile, σ = 0.2. These stylised relationships between asset efficiency and depreciation assume two simplifications: 1. Service lives and efficiency patterns are known with certainty. 2. Asset prices reflect the actualised value of its future stream of revenues where these revenues are a linear function of the capacity of the asset. Baldwin, John, Guy Gellatly, Marc Tanguay, and André Patry, "Estimating Depreciation Rates for the Productivity Accounts", Statistics Canada, September 15, 2005, Pp.6ff. Fraumeni, B.M. 1997. "The Measurement of Depreciation in the U.S. National Income and Product Accounts" Survey of Current Business. July: 7-23. P.6.

3.1.3.2 The effect of obsolescence

Obsolescence is another, separate factor that plays a major role in determining the economic depreciation of an asset.[48] Obsolescence changes asset prices and therefore gives rise to an economic depreciation effect, because when new "vintages" of capital are introduced into the market, they often contain new "state of the art" technology. If this new technology is superior to what exists already, it will ordinarily raise prices of "new" assets over time, but the arrival of new, better vintages may also depress prices of existing "old" vintages of capital, which do not contain the new technology. In that way, prices of new and old assets are equalised when measured in efficiency unit terms (i.e. in terms of service potential). This decline in value of older vintages of an asset class as a result of the introduction of innovations embodied in newer vintages of the asset class is referred to as "embodied obsolescence".

Embodied obsolescence as reflected in the decline in the real price of capital assets described above is caused by new technologies that render the existing capital services obsolete (such as motor vehicles replacing horses as a means of transport). In contrast, "disembodied" obsolescence occurs when the value of the underlying capital asset declines over time due to shifts in demand or other exogenous factors.[49] For instance, as a result of the declining demand for cigarettes, the demand for capital equipment for making cigarettes has also declined. Thus a downward shift in demand for some product will generally lead to a downward shift in the demand for capital assets (and the disposal prices of existing assets) in the industry that produces the declining demand product.

To summarise, while the arrival of the superior competitors does not reduce the efficiency of existing assets, it can reduce their prices when the cost savings realised by the technically superior assets becomes (negatively) capitalised into the prices of the older, (now) obsolescent vintages. In other words, the fact that a newer, "better" version of an asset becomes available in the market has a depressing effect on the ("old") asset's price. In those cases, obsolescence translates into larger price declines (and therefore depreciation) for existing assets.

Assessing the extent to which this (depressing) price effect arises is not straightforward, however, and opinions differ. Griliches has argued that even if an asset becomes relatively obsolete because new technology generates a superior one, the value of the used asset should not be reduced, since the older vintage asset remains as productive as it was before the new one appeared.[50] Hulten, in turn, suggests that whether price shifts from obsolescence occur depends on whether quality improvements are achieved at a cost or not, so that a price reduction from obsolescence is more likely for older assets if quality

---

48 The following discussion draws on: Hulten, Charles R., and Frank C. Wykoff (1996), Issues In The Measurement Of Economic Depreciation, Introductory Remarks, Economic Inquiry 34 (1), P.19ff.

49 This concept goes back to Matheson, Church and Pigou. Diewert, Erwin, and Frank C. Wykoff, "Depreciation, Deterioration and Obsolescence when there is Embodied or Disembodied Technical Change", Revised July 12, 2007. P.11.

50 Wykoff (2003).

improvements are costless.[51] Diewert and Wykoff argue that, irrespective of its origin, rapid *anticipated* obsolescence translates into real declines in the prices of existing capital assets, and can be interpreted as an obsolescence charge on income that is analogous to wear and tear depreciation or deterioration.[52]

More recent empirical studies using “hedonic” estimation techniques that explain asset prices using “objective” factors such as age, as well as “qualitative” characteristics of assets (such as memory or computing power) suggest that, at least for certain types of assets, declines in prices as a result of obsolescence are profound (so that Griliches’ thesis does not seem to be borne out in practice). In a study of laptop computers, for instance, Wykoff found that even if physical deterioration of computers follows a one-hoss-shay pattern, value declines are steep and depreciation is very much front-loaded once obsolescence is taken into account.[53] In other words, in this example obsolescence was sufficiently important to reverse the “standard” one-hoss-shay depreciation profile.

3.1.3.3 Uncertainty and groups of assets

Most research on economic depreciation assumes away uncertainty, so that there is no doubt about future asset prices or about the length of an asset’s useful life. Baldwin et al. suggest that in reality most economic depreciation profiles may in fact be geometric (that is, front-loaded), if the uncertain timing of when assets are discarded is taken into account.[54] In Baldwin et al.’s model, the time when an asset is discarded (“T”) is not known with certainty, because some assets will be retired before T and others will be retired after T. If T is random and skewed (so that more units are discarded before T than after T), the price-age profile resembles that of a geometric asset shown in Figure 2, even when the efficiency profile of an asset is constant (i.e., when the asset has a one hoss shay efficiency profile).[55] Depreciation correspondingly becomes front-loaded.

It is relevant to note that a similar geometric (i.e. front-loaded) depreciation profile appears to arise in practice for *groups of* assets with a one-hoss shay efficiency profile. Hulten and Wykoff point out that while it may be true that every single asset in a group of 1,000 assets depreciates as a one-hoss-shay, the group as a whole experiences near-geometric depreciation.[56] This fallacy of composition arises from the fact that different assets in the group are retired at different dates; some may last a year or two, others ten to fifteen years. Thus the average asset (in the sense of an asset that embodies the experience of 1/1,000 each of 1,000 assets in the group) is not one hoss shay, but something much closer to a geometric pattern.

To summarise, the literature suggests that when useful asset lives are uncertain and when groups of assets are considered, a front-loaded depreciation profile is likely to emerge.

---

51 Hulten, Charles R., “Endogenous Growth and the Cost of Quality Change in Capital Goods”, National Bureau of Economic Research Summer Institute Working Paper, 1995.

52 This concept goes back to Matheson, Church and Pigou. Diewert, Erwin, and Frank C. Wykoff, “Depreciation, Deterioration and Obsolescence when there is Embodied or Disembodied Technical Change”, Revised July 12, 2007. P.12.

53 Wykoff (2003).

54 Baldwin et al (2005), P.11ff.

55 The distribution is taken to be asymmetric—skewed to the left—with more units being discarded before T than after.

56 Hulten Wykoff (1996), P.18.

3.1.4. Measuring economic depreciation

As I explained above, in theory, economic depreciation need not be explicitly calculated: it simply emerges as a residual from a comparison of assets of different ages. But although the factors that are likely to be important in determining an economic depreciation profile – the effects of aging, deterioration, and obsolescence – are reasonably well understood, how these different factors interact is complex. In particular, these factors must be combined with "rentals" or the assets' expected income streams over the expected useful life of the asset in order to, first, derive asset prices, and, second, depreciation profiles. This is a formidable computational exercise and one requiring, particularly for long-lived assets, projections well into an uncertain future.

An additional complication arises from the importance of future asset "rentals" for determining asset prices and, in turn, depreciation profiles. The literature distinguishes between "rentals" (the return obtained by renting the asset to subsequent users), and "quasi-rentals" (if the machine is owner-utilised and the rental is therefore implicit). The quasi-rental or "user cost of capital" concept is notionally equivalent to that of the rental, since the quasi-rental is the opportunity cost that the owner must forego when using a capital asset.

However, determining quasi-rentals (and therefore values of owner-utilised assets) may be problematic.[57] Most owner-utilised capital is fixed in the short run, and the quasi-rental is an *ex post* residual – the amount left over from revenue after current expenses are paid. The rental is instead an *ex ante* concept that refers to an acquired right to use an asset for a stipulated period of time. Under perfect foresight, the two concepts will converge, but with uncertainty they may not.[58] The implication is that even conceptually, determining the prices of aging, *owner-utilised* assets (i.e. assets for which no explicit "rental" is apparent) is difficult, and that hence determining the depreciation profile of such assets is also correspondingly challenging.

It might be thought that, irrespective of these theoretical complications, economic depreciation could simply be measured by observing prices of capital assets in second-hand markets and deriving economic depreciation profiles from these. However, (arguably) most assets, and in particular owner-utilised and specialised assets are never traded once they have been purchased. For the majority of the assets that are at issue in these proceedings, described in Table 1 below, for instance, second hand markets are unlikely to exist. Theoretically, such assets also have a remaining value, namely the remaining expected returns or quasi-rentals, but in practice, uncertainty about future outcomes (including expected demand and supply conditions, technical change and resulting obsolescence) make such valuations tenuous.

Moreover, even when assets are traded in second-hand markets, there are a number of reasons for thinking that the resulting (observed) prices are not representative of the values (in terms of their future rentals) of these assets:

57 Hulten Wykoff (1996), P.12.

58 Even if demand fluctuations are correctly anticipated, the ex ante expected utilisation of a capital asset may differ from its ex post utilisation, which also leads ex ante rentals and ex post quasi-rentals to diverge. See Hulten Wykoff (1996), P.12.

- In practice, market valuations of used assets are hard to come by.[59] Second-hand markets tend to be "thin" or non-existent for specialised (capital) assets. Additionally, firms typically regard their own worn assets as different from (and probably better than) replicas in the market, because their history, condition and foibles are known. As a result, in many cases, there is a perceived "adverse selection" problem in the market for second hand equipment, especially for specialised assets, which limits the "depth" of that market and distorts price formation (as it results in a gap between bid and ask prices).

- Even where market valuations of used assets are available, any simple price sampling procedure suffers from a "censored sample bias" problem.[60] The bias arises because market prices of used assets reflect only the value of assets which have survived long enough to be eligible for sampling. Hence the average market price of 15-year old cars represents the value of cars that have survived 15 years – many other cars of this vintage would have already been retired from service.

Correcting for these difficulties is not straightforward, and a description of the various empirical approaches that have been adopted to estimate economic depreciation profiles for different classes of assets would go beyond the scope of this report. It is nonetheless relevant to observe that recent empirical studies that have been undertaken for the purposes of measuring the value of the capital stock in national accounts point to a pattern of geometric (i.e. front-loaded) depreciation for the overwhelming number of asset classes. For instance, Baldwin et al conclude from their survey of empirical approaches to estimating economic depreciation that:[61]

> *The depreciation profiles generated by the econometric techniques are, on balance, accelerated, producing convex age-price curves. Declines in value early in life are apparent for many assets in the machinery and equipment class, as well as for certain structures. Evidence that rates of depreciation are constant over service life is, on balance, mixed.*

Similarly, a very recent and comprehensive study undertaken by Statistics Canada suggests that geometric depreciation profiles are a good approximation for most manufacturing and engineering (M&E) assets, as well as for manufacturing plants and office buildings.[62]

To summarise the previous discussion, while conceptually appealing, determining economic depreciation profiles in practice is fraught with difficulties. The accounting theory literature, which can be viewed as the interface between the economic theory of depreciation and how this is translated into practice, is therefore concerned with developing accounting rules that, as best as possible, "match" accounting depreciation approaches with economic depreciation. At least in the accounting theory literature, the objective of accounting depreciation is fundamentally the same as for economic depreciation: to derive a measure of the cost of holding and/or using an asset over a particular accounting period.

---

59 Baxter (1971), P.31.

60 Hulten Wykoff (1981),. P.91.

61 Baldwin et al., 2003. P. 53.

62 Patry, André, Statistics Canada, ""Economic Depreciation and Retirement of Canadian Assets: A Comprehensive Empirical Study", Catalogue no. 15-549-XIE, September 2007.

3.2. ACCOUNTING DEPRECIATION

Broadly speaking, what I refer to as the "accounting" approach to depreciation is to accept the initial purchase price of an asset as its value, and to adopt accounting "rules" for "writing down" that asset value over time. That is, the accounting rule determines how much value an asset has lost from one period to the next, and therefore what depreciation should be in each accounting period to account for that value loss. Accounting methods of depreciation then consider how many units of output an asset can still deliver, and distinguish between "time-assets" and "use-assets", corresponding to the causes that may bring an asset's life to an end – the passage of time or "wearing out" by use.

3.2.1. The accounting theory debate

Like the economist, the accountant considers depreciation to be the decline in value of certain capital assets between two accounting dates, but the asset valuation concept that is used differs from that used by economists. Broadly speaking, the traditional accounting approach to depreciation takes the original purchase price of an asset as the asset's "value", and requires that value (less the asset's scrap value, if any) to be distributed over the life of the asset, in accounting terminology, "in a systematic and rational manner."[63]

Traditional accounting and its approach to measuring depreciation has evolved considerably over the years, particularly in the 1970s and 80s, where high inflation undermined the notion that historical prices paid for assets accurately reflected contemporary asset values. The starting point for the theoretical accounting literature from that period was that financial accounts and the information contained therein serve a wide variety of users and uses.[64] Since the information contained in accounts should inform the future decisions that account users would make, less emphasis was placed on historical cost as a basis for valuing assets (other than as an element in reconciling changes in the owners' financial position over time), and the focus turned instead to asset values that reflected current market values or future earnings prospects.

But this changing focus on something more akin to an "economic" approach to depreciation led to a conflict between the objectivity of the information presented in accounts and its relevance. Historical cost data are more easily verified and are relatively objective (in the sense that two independent accountants applying the same rules should arrive at a similar figure), but may be meaningless as far as capturing the actual value or opportunity cost of an asset is concerned. In turn, current values, or "economic" present values obtained by discounting prospective receipts may be more informative about the opportunity cost or future income stream associated with an asset[65], but are clearly less easy to verify and less objective.

Problems with the objectivity or reliability of information presented in accounts prepared on the basis of forward-looking valuation concepts are compounded in a world characterised by

63 F. K. Wright, Towards a General Theory of Depreciation, Journal of Accounting Research, Vol. 2, No. 1 (Spring, 1964), pp. 81.

64 Whittington, (1997), P.24ff.

65 At least for assets traded in secondary markets. Moreover, note that if the services provided by an asset are regulated (in the sense of having regulated prices), there are circularity issues in basing asset valuation on expected income.

uncertainty.[66] Uncertainty implies that ex post income and value outcomes do not necessarily equal ex ante expectations, and that the present economic value of an asset cannot be established objectively in the absence of perfect and complete forward markets. In other words, there is no objective way of determining the current value of a machine that might generate one set of earnings in one set of economic circumstances (or "state of the world"), and another set of earnings in another set of circumstances.[67] A further complication with user-orientated accounts is that there are a variety of users and uses, each of which might have different information requirements. To summarise, "*any attempt to report the 'true' value of the firm's assets or its profit for the period will encounter the problem of uncertainty, and a single choice from among the variety of measures available is unlikely to meet the needs of all potential users*".[68] It is probably fair to say that, overall, and although much effort was expended on developing new, more "realistic" (accounting) valuation concepts, none (with the possible and rather limited exception of top-down current cost valuation approaches that are described below) have gained general acceptance.

A balanced assessment of accounting depreciation would then acknowledge that in an "imperfect" world, deriving depreciation on the basis of the (forward-looking) economic valuations would almost certainly be impossibly costly to undertake and would also be unacceptably subjective. Nonetheless, and as a result of the debate about asset values, more attention has been paid to developing accounts that provide important stakeholders with more meaningful measures of profits and asset valuations, and therefore also of depreciation.

3.2.2. Accounting depreciation profiles

In order to define particular depreciation profiles over time, accounting depreciation relies on (mechanical) depreciation profiles that are thought to appropriately reflect deterioration patterns of different types of assets.[69] These accounting depreciation profiles allocate an asset's price (either in historical or in current cost terms) over its useful life to arrive at the asset's net book value.

The starting point for an accounting depreciation profile is to consider how many units of output an asset can still deliver. Here the distinction is made between "time-assets" and "use-assets", corresponding to the causes that may bring an asset's life to an end – the passage of time or "wearing out" by use.[70] Use-assets are those where there is a cause-and-effect link between an asset's use and the point in time at which it has to be replaced, say, an aircraft engine that must be replaced after it has run for a thousand hours. Time assets include assets whose life will be ended by obsolescence; other time limits arise from patents,

66 Whittington, (1997), Pp.26-27.

67 Moreover, in such a world of incomplete markets, the traditional (Hicksian) economic concept of "income" may not have an unambiguous meaning, so that there is no ready 'anchor' for determining an approach to depreciation. See Beaver W. H. (1997, 3rd ed.) Financial Reporting: An Accounting Revolution, Prentice Hall, Inglewood N.J.

68 Whittington, (1997), P.27.

69 Baxter (1971) provides an excellent overview of how economic depreciation concepts are translated into accounting depreciation approaches.

70 Baxter (1971), P.61ff.

contracts, time-limited franchises or general physical deterioration from causes other than use.[71]

What is relevant for the purposes of deriving an accounting depreciation profile are then the patterns of the relevant activity.[72] With use-assets, a figure for depreciation cost depends on the extent of usage; it is high in years of high use, and low in years of low use. With time-assets, use costs nothing: the depreciation charge measures the passage of time and the approach of the asset's removal from service. In other words, use-depreciation is a function of "service-units" such as miles run, whereas time-depreciation is a function of "time-units" such as years.

Even when asset valuation and depreciation methodology have been determined there are many additional complications that arise from an accounting perspective that I will not go into here. Often a wide range of outlays are connected with an asset, including the initial price paid for it, the cost of operating it (such as operatives' wages and electricity), and the cost of normal and abnormal repairs.[73] There are then a number of questions about how such outlays (but also certain types of revenues) are reflected in depreciation patterns.

What is clear however, is that whether a particular depreciation methodology is appropriate for a particular asset depends on whether it fits in with the asset's pattern of cash flow and activity.[74] These patterns vary greatly for different kinds of assets. Recurring outlays for an asset may increase, decrease or stay constant, and may include one or more regular overhauls. Likewise, the activity pattern of use-assets may increase, decrease, or stay constant. Even though all accounting depreciation methods aim to write off the whole cost of an asset by the end of its life, the spread of this burden between years affects a firm's costs and profits, particularly where depreciation is a big part of a firm's costs.

Figure 3 charts the most commonly used traditional accounting methods for calculating depreciation for time assets. Figure 3 illustrates, for each year of an asset's useful life, first, how depreciation is calculated, second, cumulative depreciation, and third, the depreciated asset value, and it does so for the following depreciation methodologies:

- SLD assumes that the value of the asset declines by a constant and equal percentage in all accounting periods. Although the dollar loss is equal from period-to-period, the rate of depreciation – that is, the percent change in asset value from period-to-period – increases progressively over the course of an asset's service life.

- Fixed percentage of the declining balance depreciation assumes that the diminishing net value of an asset is written down by a constant percentage in each accounting period. This is an accelerated (front-loaded) depreciation method, so that the charges have a high-low pattern and the value curve sags. The factors that would lead to such a depreciation profile are rapid early deterioration, obsolescence, and increasing repair costs.

---

71 In practice, of course, assets may combine both time and use aspects of depreciation, so that the distinction is not necessarily clear.

72 Baxter (1971), P.66ff.

73 Baxter (1971), 41ff.

74 Baxter (1971), P.69ff.

- Sum-of-years'-digits depreciation assumes that the value of the asset declines by a decreasing fraction in each accounting period. Sum-of-years'-digits depreciation results in a more accelerated write-off than SLD, but less than the declining-balance method. Under this method annual depreciation is determined by multiplying the depreciable amount by a schedule of fractions.

With the exception of SLD (which provides for a constant depreciation amount in all years), the depreciation methods pictured in Figure 3 represent "accelerated" or front-loaded forms of depreciation, since dollar depreciation is higher in the earlier periods of an asset's life. All of the methods illustrated here also relate to time assets. In contrast, the "service-unit" method for use-assets begins with an assumption about the number of service units an asset can yield over its lifetime, and simply allocates depreciation accordingly.

3.3. DEPRECIATION IN A REGULATORY SETTING

In a regulatory setting, depreciation profiles are no longer immediately linked to the economic characteristics of the capital assets in question. In certain restrictive circumstances, this leads to a circularity between regulated prices and asset values, so that shareholders of a regulated firms are indifferent which depreciation profile is adopted. This is the essence of the "Invariance Proposition". However, even in circumstances where the Invariance Proposition holds, different depreciation profiles have different social welfare properties, and once more realistic assumptions are adopted about the context in which the regulated firm operates, the proposition breaks down.

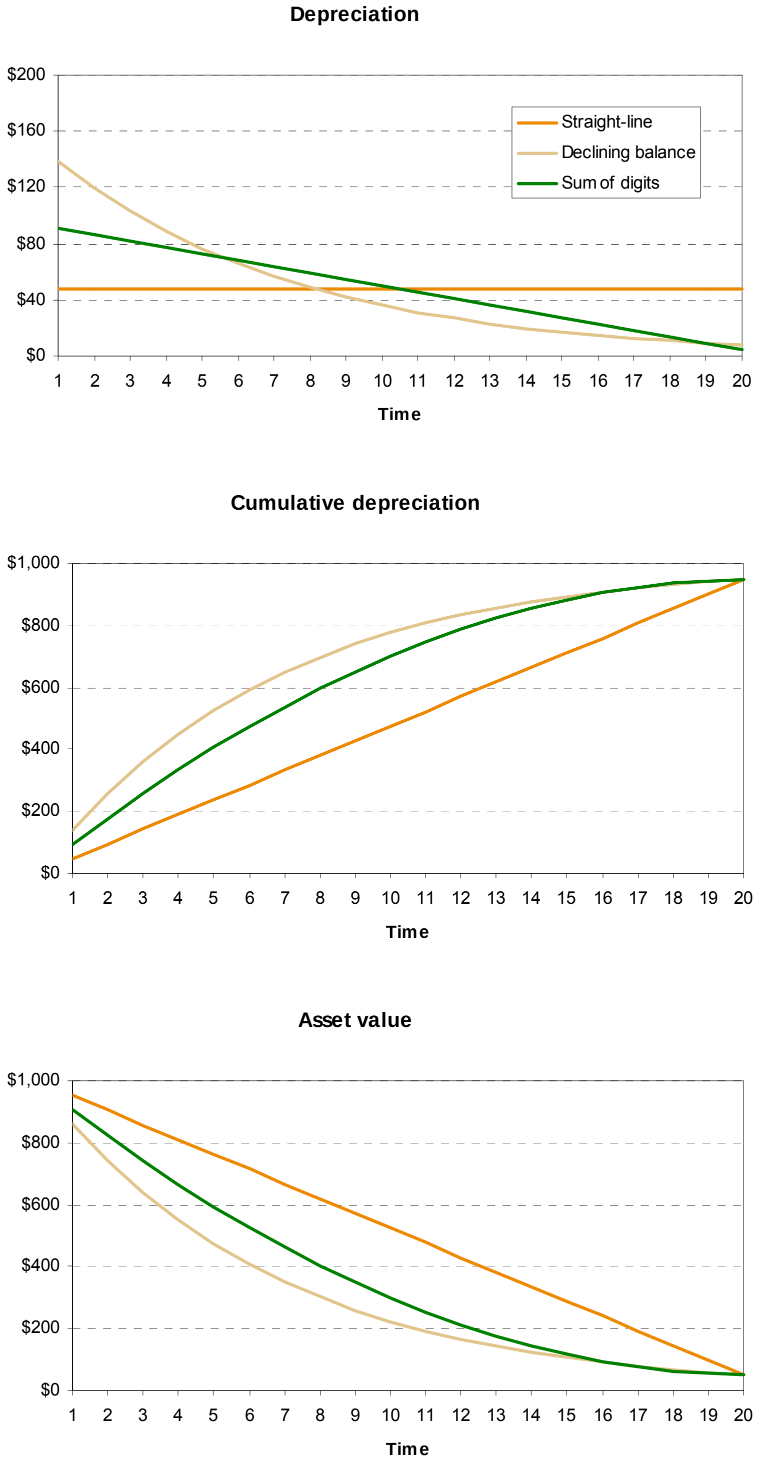
3.3.1. The Invariance Proposition

In a regulatory setting where regulated prices are calculated on the basis of "forward-looking" costs, the link between an asset's future earnings, its value and its economic depreciation profile is a circular one, and economic depreciation cannot, in general, be interpreted as an opportunity cost.[75] That is, once the regulator has determined future prices that may be charged for the regulated service (and therefore allowed revenues), asset values and therefore depreciation profiles over time follow. In this sense, the choice on the part of the regulator of one of any number of future regulated price paths corresponds to a choice of a depreciation profile, since each regulated price path corresponds implicitly to an asset value. As long as the depreciation profile is such that a forward-looking appraisal of the asset (that is, the present value of its future earnings) at any point in time yields an internal rate of return equal to the cost of capital, it can be described as economic depreciation.[76]

[75] Salinger, Michael Al, "Regulating Prices to Equal Forward-Looking Costs: Cost-Based Prices or Price-Based Costs?" Journal of Regulatory Economics; 14: 149-163 (1998).

[76] This concept of depreciation is referred to as "Hotelling depreciation": the allocation of the cost of a durable asset over its life so that the expected profit in each period divided by the expected net asset value equals the internal rate of return.

Figure 3: Common accounting depreciation methods



Notes: Figures assume an initial outlay of $1,000, an asset life of 20 years, and a scrap value of $50.

It could be argued that, as long as a regulated firm's shareholders are fully compensated for the cost of the asset the firm invests in (including the cost of capital), the precise form of depreciation (that is, which depreciation profile is adopted) should not concern them too much. Schmalensee's "Invariance Proposition" defines the circumstances where a regulated firm[77] is indifferent between alternative depreciation profiles.[78] The Invariance Proposition states that if a regulated firm is allowed to earn its cost of capital on the depreciated original cost of its investments, and if actual revenues equal allowed revenues, then the NPV of all investments is zero for any method of computing depreciation (so that shareholders neither make a net loss nor earn extra profits).

The Invariance Proposition arises because under rate-of-return regulation, the choice of depreciation profile determines the stream of prices that the firm may charge to recover the cost of the investment in the asset. The proposition implies that "perfect" regulation adjusts prices and therefore allowed revenues so that asset prices always equal their discounted future earnings, and depreciation schedules always equal the differences in these assets' prices. Depreciation then becomes a balancing item for the economic value of an asset between two accounting periods, and as long as the sum of depreciation precisely recovers the cost of the original investment, shareholders are indifferent between depreciation schedules: the internal rate of return on the cash flows of any particular asset will equal its allowed rate of return.

However, as I explain in the next sections, the Invariance Proposition does not consider broader, social welfare objectives, and only holds in a highly stylised environment under which cost recovery by the regulated firm is guaranteed. In other words, it is not generally the case that a regulated firm is indifferent between different depreciation profiles.

3.3.2. Optimal depreciation policy

Even in a "perfect" regulatory world where shareholders can be assured that they will recoup the value of their investment and a corresponding return, it is not the case that all depreciation profiles are equally socially desirable.[79] An inappropriate choice of depreciation policy can lead to an intertemporal pattern of regulated prices that bears no relation to the corresponding intertemporal pattern of the opportunity cost of capital. Moreover, and even in the absence of competition, the choice of a depreciation profile may mean that shareholders do not recover the cost of their investment, and more generally lead to suboptimal investment.

In the Schmalensee world, the choice of depreciation policy is equivalent to selecting one of many intertemporal patterns of regulated prices, all of which will yield a revenue stream adequate to compensate investors. Given an asset's costs there may be many alternative streams of regulated prices (containing a depreciation component), each of which can deliver investors their required returns. The choice of depreciation policy may then be defined as the selection of one of these intertemporal patterns of prices, which will yield one of the revenue streams adequate to compensate investors.

[77] Of course, references to a "regulated firm" having preferences in this context refer to its shareholders.

[78] Schmalensee, Richard, 1989. "An Expository Note on Depreciation and Profitability under Rate-of-Return Regulation," Journal of Regulatory Economics, Springer, vol. 1(3), pages 293-98, September.

[79] William J. Baumol, 1971. "Optimal Depreciation Policy: Pricing the Products of Durable Assets," Bell Journal of Economics, vol. 2(2), pages 638-656, Autumn.

However, one depreciation profile may then be better than another if one set of intertemporal (regulated) prices results in a better allocation of resources than another. In this sense, an optimal depreciation profile is one that results in the most efficient use of resources. At the same time, the depreciation profile becomes key to whether an investment is efficient in the first place. Unless demand is fixed, whether or not an investment in a particular asset will turn out to be profitable depends on the time pattern of prices selected.[80] One pattern of prices (corresponding to one depreciation profile) may mean that the investment is profitable, while another may mean that the same asset may not be worth its cost. In other words, if consumers are at all price responsive, some depreciation profiles will produce regulated prices at which the asset becomes an uneconomic investment and shareholders do not recover the cost of their investment.

Baumol develops a simple investment model to identify depreciation profiles that permit the regulated firm to recover the cost of an investment in a way that equates supply and demand, and results in an optimal intertemporal pattern of investment in capital assets and the use of those capital assets.[81] From the point of investors, an initial investment decision will only be worthwhile if they are returned the cost of the original investment and a rate of return on that investment. Furthermore, from the point of view of society an investment should be undertaken only if it is expected to offer at least this return. If consumers of the goods or services to be produced with the aid of the investment are unwilling to pay the opportunity cost of the asset in question, then the investment is, by definition, wasteful. Baumol examines the case of an (incremental) investment in an asset with a fixed life and the one-hoss shay efficiency profile described in Section 3.1.3. If general price levels are constant and there is no uncertainty, the following depreciation policy is optimal:

- In years in which the asset is not fully used, regulated prices should reflect only short run marginal costs and should not contain a depreciation component; while
- In those years in which the asset is used to capacity, consumers should be charged a price which just induces them to purchase the output of the investment. In other words, regulated prices should be set with reference to the elasticity of demand, and any difference between regulated prices and marginal costs makes up the depreciation payment for that period.

In effect, Baumol describes an intertemporal peak-load pricing problem. In “off-peak” years (when the asset is not fully used) it is always desirable to increase the use of the asset by lowering regulated prices, provided that marginal costs are recovered. Once demand reaches capacity, price becomes the rationing device to equalise demand with supply and the regulated firm recovers (some or all of) the cost of the investment. Baumol’s scenario can also be expanded to take into account the physical deterioration of an asset. If it is assumed that the asset in question physically deteriorates over time (so that it becomes less productive), the optimal regulated price must contain a payment for the marginal cost of this deterioration, which is essentially a payment for future output losses.

80 In other words, there is a duality relationship between the optimal investment program and the optimal pricing (depreciation) policy. William J. Baumol, 1971. "Optimal Depreciation Policy: Pricing the Products of Durable Assets," Bell Journal of Economics, vol. 2(2), pages 638-656, Autumn.

81 William J. Baumol, 1971. "Optimal Depreciation Policy: Pricing the Products of Durable Assets," Bell Journal of Economics, vol. 2(2), pages 638-656, Autumn. P.642ff.

Baumol's results relate to an investment that is perfectly divisible, so that a marginal cost pricing rule will recover the cost of the investment. If this is not the case, a revenue constraint has to be added to the optimisation problem to ensure that sufficient depreciation is collected to recover the original cost of the investment, which will in turn determine deviations of prices from marginal costs. In this sense, Baumol's approach reverts to the rules for maximising welfare (or rather, minimising efficiency losses) subject to a revenue constraint, and therefore the "Ramsey-Boiteux" theorems for optimal departures from marginal cost pricing.[82] In other words, to recover the cost of the asset, regulated prices should be set in inverse proportion to the price sensitivity of consumers' demand, so as to ensure that demand is "distorted" (that is, changed from what it otherwise would have been had all prices been set at marginal cost) as little as possible.

Baumol and Sidak comment in more detail on cost recovery for "lumpy" investment in regulated industries, such as the electricity industry.[83] Here it is the case that timely investment is typically undertaken in step increments, so that there will always be some "excess" capacity in the system. In that context, Baumol and Sidak argue that in recovering the cost of a lumpy plant over its lifetime, the payments should be timed as they are in any competitive market. Thus, the sum of the revenues over the lifetime of the investment should be sufficient to cover all costs, including replacement of the investment (as well as the cost of the capital tied up in the investment during its lifetime). The timing of these revenues, however, cannot be determined definitively by the regulator, but is ultimately affected (if not entirely determined) by the state of the market at different periods during the lifetime of the investment.

In Baumol's analysis, the firm's profit maximisation objective and the regulator's social welfare objectives generally coincide. Burness and Patrick investigate a similar model of a firm that is operating under a rate of return constraint and invests in a single asset.[84] In this case, the firm's objective may diverge from that of the regulator, depending on the relationship between the allowed rate of return and its cost of capital: if the allowed rate of return exceeds the regulated firm's cost of capital, the firm will prefer a back-loaded depreciation profile (since it can increase its profits by depreciating the asset as slowly as possible); the firm will prefer a front-loaded depreciation profile if the allowed rate of return is less than its cost of capital. In that sense, a preference for a front-loaded profile will tend to be stronger, the greater the probability investors attach to the risk that the regulator will set the allowed rate of return below the cost of capital.

3.3.3. Competition and technical progress

Schmalensee's model (and the regulatory literature of depreciation in general) assumes *ex ante* capital maintenance, that is, the regulatory bargain provides for full cost recovery of any investment. Even if this assumption is maintained, once competition and technological

[82] Frank Ramsey, "A Contribution to the Theory of Taxation, Economic Journal, Vol. XXXVII (March 1927), and M. Boiteux, "Sur la gestion de Monopoles Publics astreints à l'équilibre budgétaire," Econometrica, Vol. 24 (April 1956). Baumol paper is itself an extension of: S. C. Littlechild, "Marginal-Cost Pricing with Joint Costs", The Economic Journal, Vol. 80, No. 318 (Jun., 1970), pp. 323-335; and Ralph Turvey, "Marginal Cost", The Economic Journal, Vol. 79, No. 314 (Jun., 1969), pp. 282-299.

[83] William J. Baumol & J. Gregory Sidak, The Pig in the Python: Is Lumpy Capacity Investment Used and Useful?, 23 Energy Law Journal. 383, 390 (2002).

[84] Burness, H Stuart & Patrick, Robert H, 1992. "Optimal Depreciation, Payments to Capital, and Natural Monopoly Regulation," Journal of Regulatory Economics, Springer, vol. 4(1), pages 35-50, March.

change are introduced into Schmalensee's model, the Invariance Proposition no longer holds.

Crew and Kleindorfer consider a regulated firm that is confronted with technological progress (so that existing assets become technically obsolescent) and competition in some of its product lines.[85] Under these circumstances, the threat of competitive entry restricts the price of the output produced by an asset and therefore the timing of regulated revenues generated by the asset. Crew and Kleindorfer show that then the ability of the regulated firm to recover its investment is affected both under rate of return and price cap regulation: if there is competition and technological progress, accelerated (front-loaded) depreciation is essential if the regulated firm is to remain viable. Technological change essentially implies that the same output can be produced in future periods more cheaply than in current periods, so that, in the absence of barriers to entry, new entrants can produce the same output more cheaply than incumbents.

If, in addition, accelerated depreciation is delayed by the regulator (for instance, if regulated prices do not permit for cost recovery early on in the asset's life), this effectively eliminates any "window of opportunity" for the regulated firm to recover its investment outlays, so that past mistakes can no longer be rectified. Once costs have fallen sufficiently, the regulated firm must charge a "competitive" price, so that it can no longer recover the cost of historical investment. This window of opportunity becomes shorter, the more rapid is technological change and the stronger is competition facing the firm, and therefore requires that depreciation is set optimally.

3.3.4. Uncertainty and regulatory error

Salinger considers in more detail the challenges to implementing a forward-looking cost standard in an industry such as telecommunications that is exposed to competition and technical change.[86] Salinger notes that, in contrast to "traditional" regulatory practice, the threat of competition to (some aspects of) regulated firms' activities substantially weakens or eliminates the ability of regulators to:

- Delay the introduction of new technology (so that the regulated businesses could recover the cost of old assets);
- Insulate regulated businesses from competition from old and new technologies; and
- Allow a regulated business to recover part of the cost of an asset after it is no longer in use.

Implementing a forward-looking cost model whereby the implied depreciation rate recovers the cost of the initial investment requires forecasts, inter alia, of future price trends, price changes of cost of new equipment, discount rates, and future asset utilisations, as well as asset lives and demand growth. Specifically Salinger notes that:

---

85 Crew, Michael A & Kleindorfer, Paul R, 1992. "Economic Depreciation and the Regulated Firm under Competition and Technological Change," Journal of Regulatory Economics, Springer, vol. 4(1), pages 51-61, March.

86 Salinger, Michael Al, "Regulating Prices to Equal Forward-Looking Costs: Cost-Based Prices or Price-Based Costs?" Journal of Regulatory Economics; 14: 149-163 (1998).

- The possibility of competition decreases the length of time over which the cost of the asset can be recovered and therefore results in "front-loaded" depreciation when a firm must undertake sunk investments to provide a good or service; and
- Uncertainty about asset lives similarly increases forward-looking costs, potentially substantially so.

It is worth finally briefly mentioning Awerbuch, whose focus in analysing the Invariance Proposition is more on uncertainty and regulatory error.[87] Awerbuch does not develop a formal model of the regulated firm, but nonetheless points to a number of other practical factors that would also render the Invariance Proposition invalid. These include differences between actual and allowed revenues, arising, for instance, as a result of forecasting errors, differences in timing between when the asset is installed and when regulated prices come into effect, and a number of others.

3.4. CONCLUSIONS

In this section I have described the factors that are identified in the economic and accounting theoretical literature as determining different depreciation profiles, the distinction and rationale for accounting depreciation profiles, and the specific considerations that apply for depreciation in a regulatory setting.

Economic depreciation only leads to back-loaded depreciation profile in unusual instances – namely when assets generate constant or increasing rentals into the future and when obsolescence plays no role. More generally, deriving an economic depreciation profile over time requires a detailed understanding of and foresight about the future evolution of the prices of the assets that must be depreciated. In practice, observing and sampling asset prices to measure economic depreciation is fraught with difficulties since markets for used assets tend to be "thin" or non-existent, and may suffer from adverse selection problems, and because those asset prices that are observed inherently reflect a sampling bias. Moreover, it is important to avoid "fallacies of composition" in determining depreciation profiles, as the patterns that may seem justified for a single asset can fail to hold even for collections of assets that are seemingly identical.

Instead of attempting to infer the price patterns that would be generated by "complete" markets for used assets, accounting depreciation instead relies on "rules" that allocate an asset's price over its useful life to arrive at the asset's net book value in each accounting period. There is a wide range of choices of accounting profiles that seek to mimic economic depreciation profiles, but that avoid the conceptual and practical complexities that are inherent in economic depreciation approaches.

The regulatory depreciation literature focuses specifically on how the capital assets of regulated firms should be depreciated. In an "ideal" system of regulation in which "*regulators are assumed to follow basic textbooks and thus to allow the firm to recover depreciation expense .. plus the allowed rate of return on the depreciated original cost of the investment*", regulated firms are indifferent between depreciation profiles.[88] Within the context of this

---

87 Awerbuch, Shimon, "Depreciation and profitability under rate of return regulation", Journal of Regulatory Economics, Issue Volume 4, Number 1 / March, 1992, Pages 63-70.

88 Schmalensee (1989), P.294.

"Invariance Proposition", questions about whether or not the depreciation profile applied to Telstra's ULLS assets is "reasonable" should therefore (theoretically) not arise.

I conclude from the economic literature that I have reviewed that there are at least two reasons why it would *not* be the case that Telstra (and indeed, society) would be indifferent between different depreciation profiles for its ULLS assets.

First, even if financial capital maintenance is assured (as is assumed by the Invariance Proposition), different depreciation schedules are not equally desirable from an economic welfare perspective: an arbitrary depreciation profile can lead to a pattern of regulated prices over time that bears little resemblance to the opportunity cost of capital. Having said that, in the presence of fixed and sunk capital assets, attributing costs to different time periods for the purpose of recovering costs tends to be complex. In those circumstances, "Ramsey" pricing principles are applied, which place the bulk of charges on customers who are the least price sensitive. Ramsey pricing, however, involves numerous assumptions that tend to be difficult to test, and the results can be highly sensitive to the assumptions.

Second, and irrespective of these general welfare implications, the Invariance Proposition breaks down when financial capital maintenance is not assured. The literature points to a range of circumstances when this is the case, most importantly if the regulated firm is exposed to competition and technological change that reduce asset prices. In particular these last two factors, which potentially threaten the ability of the regulated firm to recover the cost of its investment would reasonably lead the firm to adopt front-loaded depreciation profiles. The preference for such front-loaded depreciation profiles would be accentuated by any risk that the regulator would act in a time-inconsistent manner, as that risk reduces the credibility of promises by the regulator to ensure future recovery of amounts deferred to future periods.

4. WHETHER THE DEPRECIATION APPROACHES ADOPTED BY TELSTRA AND THE ACCC ARE "REASONABLE"

In the previous sections of this report I described the economic framework I have adopted for assessing whether a particular approach to depreciation is "reasonable". In my opinion, any depreciation approach applied to a regulated firm must first and foremost ensure that the firm recovers efficiently incurred costs.

I have reviewed the relevant economic and theoretical accounting literature on depreciation, including the research on depreciation in a regulatory setting. The general conclusions I draw from that literature in the context of this report are that:

- Economic depreciation profiles, while economically "correct", are complex to derive, particularly in an uncertain world. They also cannot be observed easily, and this is in particular the case for certain types of fixed and sunk assets for which there are no second-hand markets as is the case here.
- While it may be the case that in some stylised circumstances any depreciation profile – provided it meets the financial capital maintenance criterion – can be applied in a regulatory setting, in practice that is not the case. More specifically, when the regulated firm's future revenues are at risk, for instance, because of the risk of technological bypass, depreciation profiles should be front-loaded.

In this section I describe my corresponding interpretation of the statutory criterion that must be applied to the terms and conditions of Telstra's undertaking, Telstra's approach to depreciation, and the (alternative) depreciation approach that has in the past been applied by the ACCC. In my opinion, the central policy objective that I described above – that of *ex ante* (expectational) capital maintenance for a regulated firm – is consistent with the statutory criterion. To the extent that the ACCC's tilted annuity approach implies that investors' financial capital is *not* maintained, I consider that this approach is *not* reasonable.

4.1. THE STATUTORY CRITERION

I have been asked to consider whether the ACCC's depreciation approach achieve the stated objectives of Part XIC of the Trade Practices Act 1974 ("the Act").

The Australian Competition and Consumer Commission must not accept an undertaking unless it is satisfied that, *inter alia*, the terms and conditions specified in the undertaking are *reasonable* (s 152BV(2)(d)). Section 152AH(1) sets out the matters that are relevant (without limitation) to determining whether particular terms and conditions of an access undertaking are reasonable:

> (a) *whether the terms and conditions promote the long-term interests of end users of carriage services or of services supplied by means of carriage services;*
>
> (b) *the legitimate business interests of the carrier or carriage service provider concerned, and the carrier's or provider's investment in facilities used to supply the declared service concerned;*

> (c) *the interests of persons who have rights to use the declared service concerned;*
>
> (d) *the direct costs of providing access to the declared service concerned;*
>
> (e) *the operational and technical requirements necessary for the safe and reliable operation of a carriage service, a telecommunications network or a facility;*
>
> (f) *the economically efficient operation of a carriage service, a telecommunications network or a facility."*

Section 152AB(2) furthermore provides that in determining whether the terms and conditions of an undertaking promote the long-term interests of end users of carriage services or services supplied by means of carriage services ("listed services"), regard must be had to the extent to which the terms and conditions are likely to achieve the following (limited) objectives:

> (c) *the objective of promoting competition in markets for listed services;*
>
> (d) *the objective of achieving any to any connectivity in relation to carriage services that involve communication between end users;*
>
> (e) *the objective of encouraging the economically efficient use of, and the economically efficient investment in:*
>
> > (i) *the infrastructure by which listed services are supplied; and*
> >
> > (ii) *any other infrastructure by which listed services are, or are likely to become, capable of being supplied."*

In Section 2 of this report I have referred to the central economic objective of expectational capital maintenance and time-consistency of regulatory policies. In the present context I interpret the term "reasonable" as being consistent with general economic principles. Specifically, and from an economic perspective, I interpret the term "reasonable" to imply an approach that is consistent with a sustainable regulatory bargain, and specifically that is consistent with financial capital maintenance and time consistency objectives.

The essence of the ACCC's chosen approach to modelling costs – the TSLRIC approach – is to evaluate the costs that would be incurred were an entirely new, hypothetically fully efficient, network constructed. That evaluation will result in a quantum of capital costs (the costs of the assets required for the network) and of O&M costs. In principle, the return of the sum of these capital costs in the form of depreciation is then "promised" to the investor, and it is that "promise" that constitutes the "fair bargain" required for the investment to take place. Given that promise, an investor starting from scratch in a hypothetical, fully contestable, market would be willing to enter into a long-term contract with the regulator for the supply of that network and its services. A depreciation regime that meets that "promise" is time consistent and "reasonable". In contrast, varying the depreciation regime once it is made – in a way which reneges on the return of the promised amount – is the essence of time inconsistency.

In my opinion, this interpretation is consistent with the formulation of Section 152AH(1) and Section 152AB(2).

From an economic perspective, the requirement for expectational capital maintenance is reflected in clauses (a) (b), and (c) of Section 152AH(1), which refer to the long-term interests of end users, the legitimate business interests of the carrier or carriage service provider, and the interests of persons who have rights to use the relevant service. Quite simply, and as I have explained in Section 2, any approach to depreciation that does not assure cost recovery of efficiently incurred investment is not sustainable in the sense that such an approach would fail to attract the investment required to maintain and augment an infrastructure network. Such an outcome would serve neither the interests of the carrier (or rather its shareholders), nor those of end users or any other party with a right to use the relevant service.

In my opinion, such an interpretation is also consistent with the objectives formulated in Section 152AB(2). Specifically:

- In relation to clause (c), although a depreciation approach that fails to recover the provider's investment costs may, in the short term, generate additional demand for the service (since prices would have been set "too low"), and thereby encourage additional entry, over the longer term, patterns of output and competition predicated on prices that are not viable for the access provider are not sustainable.
- In relation to clause (e), to the extent that depreciation failed to recover the costs of efficient investment, prices charged to consumers would incorporate a subsidy with no apparent and offsetting social benefit and would therefore not be consistent with the economically efficient use of the asset. Additionally, inefficiently low prices that failed to recover the full costs of an investment would reduce the ability and incentive of competing service providers to enter the market with lower cost facilities.

4.2. DEPRECIATION IN THE TEA MODEL

Below I first describe the approach that Telstra has adopted for determining depreciation for the various assets required to provide the ULLS. I then set out how this has been modified by the ACCC.

4.2.1. Telstra approach

I am instructed that Telstra's TEA Model calculates the capital cost of deploying a current best practice Customer Access Network ("CAN") using a "building block" approach.[89] This approach separately calculates depreciation and the opportunity cost of capital. Specifically, the TEA Model calculates "capital cost factors" for each year of the assets' lives, which comprise depreciation and the opportunity cost of capital:

- Depreciation is calculated using the SLD method;
- The opportunity cost of capital is calculated by applying the vanilla post-tax WACC to the written down value of the asset.

89 Telstra, Telstra's Efficient Access Model, Model Documentation, 3 March 2008, P.51ff.

The capital cost factors are calculated for each asset category and vary over the assets' lives. The TEA Model assumes a range of asset lives for different capital asset categories (Table 1).

Table 1: TEA Model default asset lives

Life	Capital asset
5 or less	Information Technology
	Software
	IEN Software
	Switching Software
10 - 20	
	Local Switching
	Misc. Transmission
	Other Indirect (Fleet, etc.)
	Building Fitouts
	Multiplexing Systems
	Copper Cables-Main
	Copper Cables-Distribution
	Radio Equipment-CAN
	Network Management
	Power Systems
	SDH Transmission Equipment
	Radio Transmission
	Radio Spectrum
21 - 30	Ducts & Pipes-Distribution
	Lead-Ins
	Support Structures
	Buildings
	Optical Fibre Cables
31-40	
	Ducts and Pipes-Main
	Network Buildings

Source: ACCC Discussion Paper, P.41.

Each of the annual capital cost factors, which are calculated for each year of an asset's life, are converted into an annuity over the relevant asset's life. The effect of this calculation is to deliver a payment stream that delivers the same NPV, but evens out regulated prices over the life of the asset. At the same time, it has the effect of converting a SLD (accounting) depreciation profile into a back-loaded depreciation profile.

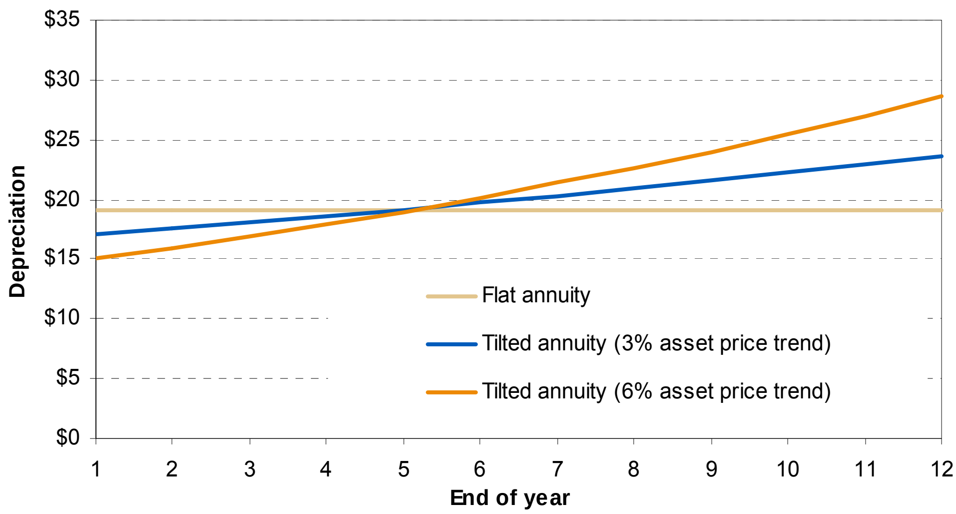
4.2.2. ACCC approach

The ACCC has and Telstra have, since its first PSTN Undertaking assessment, relied on a tilted annuity for estimating the TSLRIC of both PSTN OTA and ULLS.[90]

[90] The ACCC's tilted annuity, TX_t, is given by $TX_t = (1+g)^{t-1} \cdot V \cdot (r-g) / \{1-((1+g)/(1+r))^N\}$ t = 1, 2, …N, where V is the cost of the asset, r is the rate of return, g is the tilt factor and N is the asset life. See Australian Competition and Consumer Commission, 2000, A Report on the Assessment of Telstra's Undertaking for Domestic PSTN Originating and Terminating Access Services, July. P. 102.

For example, in its draft decision on ULLS pricing principles and indicative prices, the ACCC states that it has used Telstra's calculated price trends and has applied a "tilt" to the annuitised capital charge derived by Telstra.[91] Figure 4 illustrates this approach. By inserting a "tilt factor" (corresponding to the expected price trend for regulated assets) into the formula used to annuitise an income stream (in this case, the sum of the cost of capital and depreciation), the annuity is transformed from a "flat" function into a function that slopes upward.[92]

Figure 4: Flat versus tilted annuity



Notes: Calculations assume the initial cost of the asset to be $100, the discount rate is 15.89%, the life of the asset is 12 years.

The effect of the tilted annuity approach is to superimpose a further element of back-loading on the depreciation profile applied to the relevant assets, postponing the time when the historical cost of these assets can be recovered.

All things equal, a delay in the time when Telstra is able to recover the costs of historical investment increases commercial and regulatory risks for Telstra. Figure 5 illustrates this effect. It compares different depreciation profiles, namely:

- A SLD profile;
- The depreciation profile implicit in a (flat) annuity;
- The depreciation profile implicit in a tilted annuity that has been constructed assuming that the price of the relevant asset increases by 3 per cent each year; and
- The depreciation profile implicit in a tilted annuity that has been constructed assuming that the price of the relevant asset increases by 6 per cent each year.

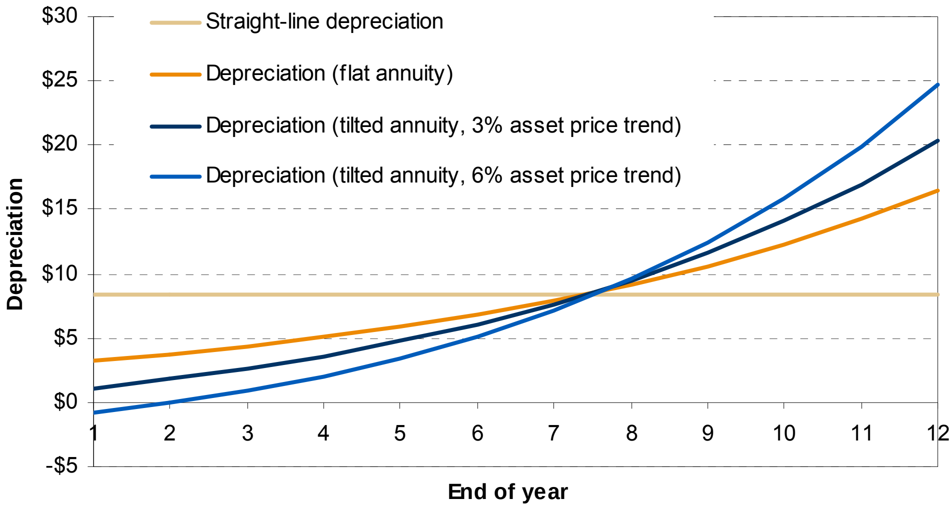
It is apparent that the effect of annuitising the capital charge is to back-load depreciation, and that this effect is more pronounced if a tilted annuity is used. If the (assumed) trend in asset

91 ACCC, DRAFT Unconditioned Local Loop Service Pricing Principles and Indicative Prices, April 2008. P.9.

92 Conversely, a negative tilt factor results in a downward sloping function.

price increases is large enough, it implies that depreciation in the first few years of the asset's life is negative, since the resulting tilted annuity would not (in those first years) suffice to cover the cost of capital.

Figure 5: Depreciation – straight-line vs. annuity



Notes: Calculations assume the initial cost of the asset to be $100, WACC is 15.89%, the life of the asset is 12 years. The depreciation profile has been calculated as the residual by first subtracting from the annuity the (written down) value of the asset multiplied by the cost of capital.

4.3. ASSSESSMENT OF THE CHOICE OF DEPRECIATION PROFILE

In the following subsections I first assess Telstra's approach to depreciating ULLS assets and then that of the ACCC.

4.3.1. Whether straight-line depreciation is reasonable

In the TEA Model Telstra applies an SLD profile to depreciate its capital assets, such that it exactly recovers the costs of the investment required to provide the ULLS service from its (hypothetical) optimised network.

SLD reduces the written down value of assets by an equal increment in each year of an asset's useful life.[93] As such it represents an intermediate position between a frontloaded and a back-loaded profile, which provide for higher/lower dollar amounts of depreciation in the beginning/at the end of an asset's useful life, respectively.

In my opinion, there are a number of factors that would lead to a front-loaded depreciation profile from an ex ante capital maintenance perspective, and as I have explained in earlier sections of this report. These include:

93 Although the dollar amount of depreciation is the same in each period over the asset's useful life under SLD, the rate of depreciation—that is, the percent change in asset value in each period - increases progressively over the course of an asset's useful life as the underlying asset base is written off.

- Risks associated with regulatory discretion and error, in particular in relation to the periodic revaluation of Telstra's capital base, which threaten the ability of the firm to recover legitimately incurred costs; and
- Risks of technological obsolescence and competitive bypass, which would tend to reduce the future revenues that Telstra can earn from the use of its network. These risks are likely to be rising over time, as wireless alternatives and HFC improve.

Arguably these risks and their timing are uncertain, and how these would translate into a valuation of asset prices is unknown. Put in another way, the objective of deriving, from scratch, something akin to an economic depreciation profile would, in my opinion, not only be practically very difficult, but in all likelihood extremely contentious. Specifically, given the factors that would be relevant in the regulatory context in which Telstra operates, deriving such a profile would require forecasts of the combined effect of:

- Future regulatory determinations in relation to regulated prices over the useful life of the relevant assets; and
- Information about future market trends, both in terms of customer demand for the service and for other, substitute or otherwise competing services; and
- Specific information about the assets in question, including their future efficiency profiles and susceptibility to (embodied or disembodied) obsolescence.

Such economic depreciation profiles, if they could be derived at all, would reflect the opportunity cost of holding the relevant assets over time, assuming second-hand markets existed for the assets (and combinations of assets) at issue. In contrast, the SLD approach adopted by Telstra is one of a family of simple depreciation profiles that is both easily understood and widely used, including in a regulatory context.[94] SLD makes no particularly sophisticated assumptions about regulated prices, future market trends or efficiency trends and simply assumes that these factors combine to reduce the value of the underlying asset by an equal increment in each year.

Given the undoubted complexities in deriving economic depreciation profiles that I have explained in earlier sections of this report, and the correspondingly likely scope for regulatory error and dispute, I consider that the SLD approach adopted by Telstra is reasonable, and is consistent with the formulation of Section 152AH(1) and Section 152AB(2). Specifically, the SLD approach provides for financial capital maintenance, and is therefore consistent with the long-term interests of end users and the legitimate business interests of Telstra.

SLD is transparent and widely applied in private and regulated industries, and takes a neutral stance on the depreciation profile of assets, since it simply assumes that the value of the relevant asset is reduced in equal increments in each year of an asset's useful life. This does not mean that SLD is the *only* depreciation approach that is reasonable, but in my opinion it is reasonable.

---

[94] For instance, the survey of depreciation approaches applied in other regulated Australian industry sectors suggests that SLD is the most common approach adopted. See, "ACCC Industry Depreciation Survey", Report by Paul Paterson, August 2008.

4.3.2. Whether the tilted annuity approach is reasonable

As is explain in more detail below, the most recent description of the ACCC's rationale for applying a tilted annuity with a positive tilt factor to the ULLS capital charge suggests that the ACCC assumes that the prices of ULLS assets (that is, the inputs to provide the ULLS) are rising. I begin, by describing the implications of the ACCC's tilted annuity approach and then comment on the ACCC's justification for its approach.

4.3.2.1 Back-loaded depreciation and ex ante financial capital maintenance

In these circumstances, a tilted annuity imposes a high degree of back-loading on cost recovery, and as such exposes investors to a high degree of commercial and regulatory risk. This effect is compounded by the ACCC's policy of successive asset revaluations.

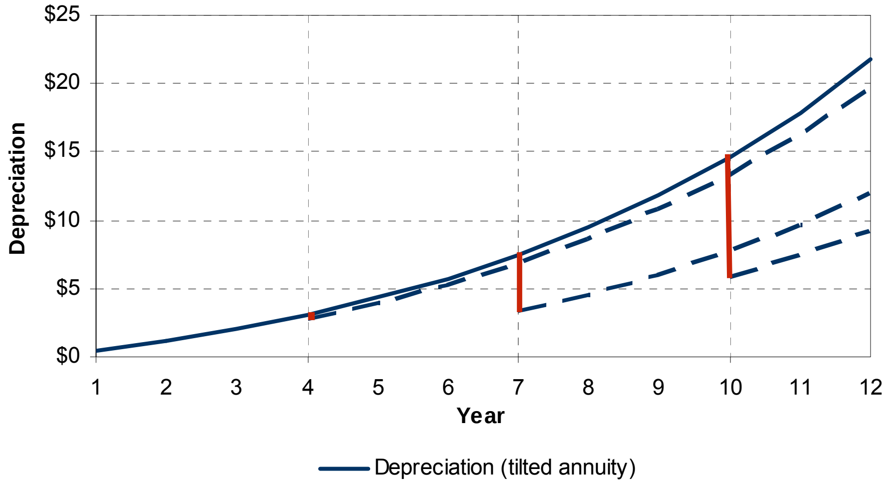
The maximum term of an undertaking under Part XIC is three years. Once an undertaking has expired, the relevant assets are "optimised", that is, revalued by the ACCC. To my knowledge, these successive asset revaluations have, to date, resulted in large *reductions* in asset values, compared to earlier valuations.[95] Once the relevant assets have been written down, their remaining value can no longer be recovered via the depreciation charge, and Telstra (or rather its investors) suffers a financial loss. This financial loss is magnified because the tilted annuity implicitly defers depreciation to later periods of the asset's useful life. In other words, the outcome of the approach that has historically been adopted by the ACCC is to first postpone cost recovery to the future, and then to retrospectively (after the assets have been put in place) reduce the quantum of costs that may be recovered.

Figure 6 below illustrates this effect for a hypothetical asset with a life of 12 years and an initial cost of $100 that is successively revalued by (-)10 per cent every three years (i.e. at the beginning of Year 4, Year 7, and Year 10). The effect of the revaluations is to successively reduce the undepreciated value of the asset, in effect "resetting" the tilted annuity that corresponds to the capital charge to a lower level. This, in turn, implies an increasing "wedge" between the dollar amount that investors would have received in the absence of the asset revaluations (the dashed lines in Figure 6). For instance, the effect of the Year 10 revaluation is to immediately reduce depreciation for the remaining life of the asset by about one third. The fact that depreciation is substantially back-loaded (so that most of the asset's value is recovered in later years of its life) implies that the overall loss suffered by an investor, compared to the amount initially outlaid, is all the greater. The effect of the tilted annuity approach is then to further undermine *ex ante* financial capital maintenance for Telstra's shareholders.

I note that the opposite effect would be achieved if a back-loaded depreciation profile were combined with periodic *upward* asset revaluations. In other words, if the regulator were to adopt such an approach, the application of a back-loaded depreciation profile to increasing asset values would allow the regulated business to earn a pure economic profit in addition to its regulated rate of return.

[95] Thus, I calculate that in real (inflation-adjusted) terms, regulated access charges for the ULLS declined at an annual rate of 12.7 per cent over the period from April 2002 to September 2007.

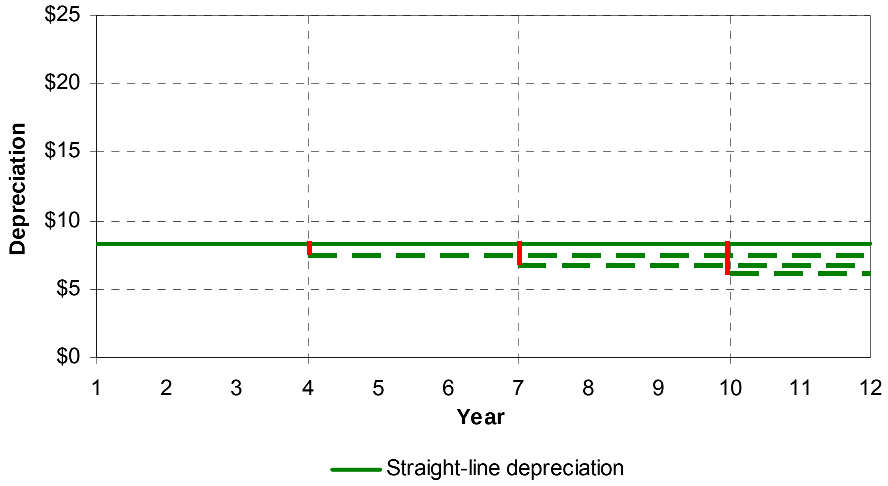
Figure 6: Combination of depreciation from a tilted annuity with successive asset revaluations



Notes: Asset has an initial cost of $100 and a useful life of 12 years. Tilt factor assumes year-on-year asset price increase of 4%. Assets are revalued by -10% at years 4, 7, and 10. Depreciation is calculated as the difference between the tilted annuity amount and the cost of capital.

It is important to note that, while still material, the effect of the asset revaluations on financial capital maintenance is far less pronounced if depreciation is calculated on a straight-line basis (Figure 7). For instance, for the same asset, depreciation following several successive asset revaluations reduces from $8.33 (to recover the original $100 value of the asset) to $6.08. In other words, while in the above example and over the life of the asset, the overall shortfall under SLD is $14.03, under tilted annuity depreciation, the overall shortfall is $47.81.

Figure 7: Combination of straight-line depreciation with successive asset revaluations



Notes: Asset has an initial cost of $100 and a useful life of 12 years. Assets are revalued by -10% at years 4, 7, and 10. Depreciation is calculated using the straight-line formula.

In summary, and on the basis of the above analysis, in combination with the ACCC's policy of successive asset revaluations, the highly back-loaded depreciation profile implied by the ACCC's tilted annuity approach is fundamentally in tension with a financial capital maintenance objective, imposing on investors a substantial risk that capital prudently invested will not be recovered. Given that risk, a rational investor would not proceed with the investment absent an additional risk premium, which must increase costs to end-users and society. As there is no obvious efficiency gain that offsets this cost, in my opinion, the ACCC's approach is not reasonable.

Additionally, and as I have explained earlier, the tilted annuity approach with its reliance on back-loaded depreciation would, in my opinion, seem to contradict a number of trends that, if anything, would lead to more front-loaded depreciation profiles. These are uncertainty about future regulated revenues and regulatory error, and the risk of competitive bypass.

4.3.2.2 *ACCC rationale for "tilted annuity" approach*

The ACCC does not comment on the rationale for a tilted annuity approach in its most recent ULLS Discussion Paper. While the ACCC occasionally refers to its preference for a tilted annuity approach in the context of other decisions,[96] to my knowledge, the most recent description for the ACCC's preference for this approach is set out in its Statement of Reasons for its final determination in the ULLS access dispute between Telstra and Primus Telecommunications, dated December 2007.

In that decision, the ACCC extensively cites Optus' submission to the effect that the use of a tilted annuity would allow "regulators to replicate the cost recovery conditions that would be faced by a firm in a competitive market":[97]

> *(a) when input prices are falling, the incumbent operators will know that a new entrant in the future will have a lower cost base. As a result, incumbent operators will only invest in the market today if they recover more of their capital in the early periods, because they know they will face a lower cost entrant in the future; or alternatively*
>
> *(b) when input prices are rising, the incumbent operators will know that a new entrant in the future will have a high cost base, therefore their future return will be 'protected', they are [sic] can therefore afford to invest and compete price down today in the knowledge they will not face a new entrant with a lower cost base in the future.*

Accordingly, and in relation to the statutory criteria, the ACCC claims that access charges that reflect "forward-looking efficient costs" will better promote competition, as they will allow the access provider and access seeker to compete in downstream markets on their

96 In its Final Determination in relation to the access dispute between Telstra and Optus for the ULLS, the ACCC similarly argues in support of a tilted annuity. In that determination. ACCC, Unconditioned Local Loop Service Access Dispute Between Telstra Corporation Limited (access provider) and Primus Telecommunications Pty Ltd (access seeker) (monthly charges), Statement of Reasons for Final Determination Version published under section 152CRA of the Trade Practices Act 1974, December 2007. ¶424.

97 Australian Competition and Consumer Commission, "Unconditioned Local Loop Service Access Dispute Between Telstra Corporation Limited (access provider) and Primus Telecommunications Pty Ltd (access seeker) (monthly charges), Statement of Reasons for Final Determination", Version published under section 152CRA of the Trade Practices Act 1974, December 2007. ¶416.

relative merits.[98] This approach would be more consistent with outcomes in a competitive market.[99]

In relation to the objective of encouraging economic efficiency in use or investment (152AB(2)(e)), the ACCC states that the tilted annuity approach would better encourage efficiencies, since:[100]

- A "cost-reflective" price would encourage competition in downstream services and encourage efficiencies in markets for these services; and
- ULLS prices that reflected the efficient cost of the CAN would lead to more efficient build/buy decisions.

The ACCC furthermore argued in relation to the factors identified in section 152CR(1)(b) that its tilted annuity approach would lead to Telstra recovering an amount commensurate with its legitimate commercial or business interests, including its recovery of direct costs.[101] This would be the case, since the increased asset base in each subsequent period would lead to a cost profile that reflected the cost to Telstra of its network assets. In relation to 152CR(1)(d), the ACCC argued that Telstra would be able to recover its network costs inclusive of a normal risk-adjusted return on its capital employed.

In summary, as I understand it, the ACCC appears to advocate the use of a tilted annuity approach for determining the capital charge (thereby implicitly imposing a significantly back-loaded depreciation profile) for ULLS assets, because it assumes that the prices of these assets are rising. The consequence of applying a tilted annuity to the capital charge for ULLS assets would then be to impose a correspondingly rising cost trend for ULLS.

I note that the ACCC does not appear to discuss those factors that would, *prima facie,* indicate that a back-loaded depreciation profile would not be reasonable, namely, the risk of competitive bypass. However, irrespective of whether it is the case or not that the costs of ULLS assets are rising, for the reasons set out below, I do not believe that the ACCC's rationale for its approach is correct.

First, to my knowledge it is not the case that successive revaluations have led to *increased* valuations of ULLS assets. While some part of the reduction in charges is due to falls in ULLS-specific costs,[102] a substantial share of the reduction arises from successive re-optimisations. Therefore, as an empirical matter, the assumption that this is an asset that is increasing in value over time does not appear consistent with the experience to date.

Second, it is difficult to understand the argument that the tilted annuity leads to "better" signals for competing entry than would occur under alternative approaches to depreciation. From society's perspective, entry is efficient if it leads to lower costs than would otherwise be incurred. In my opinion, this does not depend on the costs that would be incurred in a hypothetical replication of the existing network on a fully efficient basis, but on the costs

98 Ibid. ¶424.

99 Ibid. ¶425.

100 Ibid. ¶427.

101 Ibid. ¶428.

102 That is, the costs associated with the systems and other assets specifically required to provide service to access seekers.

that are actually going to be incurred.[103] As a result, in my opinion, purely hypothetical costs (such as those generated by a TSLRIC model), regardless of the depreciation profile adopted, will not provide the socially correct signal for competing entry to the extent that they do not reflect the costs society actually incurs when service is provided by the access provider rather than by the access seeker.[104] Even setting that aside, from an analytical perspective, it is contentious whether the choice of cost standard has an effect on entry decisions.[105] Finally, it seems highly unlikely that any actual entry would take the form of replicating Telstra's copper pair network, regardless of how depreciation for that network was calculated.

Third, in my opinion, the claim that a tilted annuity reflects what would occur in a textbook competitive market misses the point. In such a market, firms do not incur substantial sunk costs and are not vulnerable to regulatory time-inconsistency. There are workably competitive markets in which firms do incur substantial sunk costs, and it is conceivable that they might do so in a market where there was effectively a single buyer (thus replicating at least in part the situation of a price-regulated firm). However, under those circumstances, one would expect the supplier and the buyer to enter into a "whole of life" contract, which would protect the supplier from ex post opportunism by the buyer. The limited term of Undertakings rules out such a "whole of life" agreement in this context. Moreover, the ACCC is unable to bind its future decisions outside of the Undertaking mechanism. As a result, it lacks the ability to replicate the long-term contract outcome one would expect to see in a workably competitive market.

Fourth, in my opinion, there is no obvious sense in which the tilted annuity better reflects opportunity costs than alternative depreciation profiles. In effect, it is not clear what the relevant foregone opportunity is that the tilted annuity better reflects. As a practical matter, the opportunity of deferring construction and operation of the network is not available.

Given these considerations, it seems that the primary benefit of the tilted annuity is that it leads to lower prices in the short-term. However, if one accepts the implied promise that amounts deferred to future periods will be recovered, this benefit is obtained at the expense of what must be higher prices in future (if Telstra is to recover the costs it has incurred); conversely, if that promise is not capable of being made fully credible, deferral of cost recovery implies greater regulatory risk for the access provider. From an efficiency perspective, there is no particular gain to be made from securing lower prices today, if the trade-off is simply correspondingly higher prices tomorrow.[106] However, the greater uncertainty about ultimate recovery is definitely socially costly, especially when experience

---

103 In fact, society can be worse off if the use of optimised costs for pricing access services deters entry by an access seeker whose actual costs are lower than those of the access provider.

104 For example, assume the access provider's actual costs are 100 but optimised costs (and hence prices as set by a TSLRIC model) are 50. If the access seeker's actual costs are 60, and those costs lead the access provider to avoid costs of 100, efficiency requires a price signal of 100.

105 See Sappington D. (2005), "On the Irrelevance of Input Prices for Make or Buy Decisions," American Economic Review, 95, 1631-1638.

106 As noted above, there can be a welfare gain from altering the time pattern of prices when willingness to pay is expected to rise over time. However, there is no reason to think this is relevant in the case at hand. Moreover, even if there were such a trend, it is well-known that the gains associated with a move from fully distributed cost prices (as would occur under time-invariant cost allocation) to Ramsey prices are generally small to very small. See for example Brown, S. J. and D. S. Sibley (1986). The Theory of Public Utility Pricing. Cambridge, UK, Cambridge University Press, at page 193.

shows that regulated costs for the service tend mainly to decline over time.[107] As a result, in my opinion, any gain from the low/high pattern of prices is likely to be more than offset by the increased regulatory risk.[108]

It is of course possible for the greater regulatory risk to be offset by a higher allowed WACC (weighted average cost of capital). However, there is no particular merit in so proceeding. Moreover, such an approach would be inconsistent with the capital asset pricing model (CAPM)-based WACC, on which the ACCC has relied to date, which only compensates investors for systematic risk. Additionally, it is far from obvious how the required adjustment could be properly determined. Finally, and importantly, there is no evidence to date of the ACCC making any such offsetting adjustment to the WACC.

I note that if it were the case that ULLS assets are certain to be increasing in price *and* that the ACCC intended to periodically revalue assets accordingly (that is, upwards) then SLD applied to the revalued asset base would breach the “zero NPV ” condition I described in Section 3.3.[109] In other words, under such an approach (in which positive revaluation was periodically built into the asset base), Telstra would “over-recover” the cost of historic investments.

There are two mechanisms to address a potential for over-recovery of costs. The first would be to define a “revaluation” item in the balance sheet, and write that gain off against current income, consistent with a financial capital maintenance accounting approach. In my opinion, such an approach extends the complexities I have described in the context of the ACCC’s “forward-looking” valuation framework, in that it locks in a process of continuous (upward and downward) revaluations, most likely with little or no reference to economic asset values. Moreover, to be applied consistently, such an approach would require the maintenance of a balance sheet, in which a revaluation item would occur. Additionally, to the best of my knowledge, the ACCC has not, to date, adopted a fully articulated balance sheet/income statement approach to regulation in any of the areas it regulates.[110]

The second would be to follow regulatory precedent in relation to the accounting system (and therefore depreciation) in other regulated industries in Australia by “locking in” the initial asset base. This would imply setting aside the “forward-looking” cost and revaluation framework currently applied by the ACCC, and moving instead to the “roll-forward” approach that has also been adopted in other regulated industries in Australia. The “roll-forward” approach is consistent with the ACCC’s own finding (in the context of electricity regulation) that periodic revaluation of assets could result in transmission providers “*facing an unpredictable revenue stream which could deter investment”* through the potential for *“periodic revaluation to result in a significant variation in the regulated asset base from one*

[107] See See Guthrie, G., J. Small, and J. Wright (2005). "Pricing access: Forward-looking versus backward-looking cost rules." European Economic Review 50(7): 1767-1789.

[108] Indeed, as I describe below, the ACCC has elsewhere recognised that periodic revaluation of assets places significant risks on regulated businesses. For this reason, the ACCC stated its preference, under the regulatory regime for transmission then in place, for locking in the regulated asset base and its main parameters. Presumably, the greater the revenue at risk, the greater this deterring effect will be. A tilted annuity defers a greater share of capital recovery to future periods, so it is reasonable to assume it increases the risk the ACCC notes.

[109] Discounted at the (regulated) rate of return, the NPV of a regulated entity’s outlays and revenues must always equal zero.

[110] An accounting system is said to be fully articulated where there is comprehensive reconciliation of the balance sheet and the income statement. That reconciliation is at the heart of the various price change adjustment mechanisms that are used in current cost accounting and that ensure consistent treatment of revaluations.

period to the next".[111] It was precisely on the basis of that finding – which is no less applicable in the context of telecommunications – that the ACCC decided to forbear from ongoing asset revaluation in electricity transmission, after the initial regulatory valuation of the same assets.

Under the roll-forward approach to asset valuation, the initial capital base, once estimated, is treated as a given, and net increments are added as incurred. If this model were adopted, no further revaluations of a TSLRIC kind would be required, and at the end of the undertaking period, the initial asset base, as adjusted for additions and depreciation, would simply be rolled forward. Telstra's current policy of estimating depreciation on a straight-line basis would be entirely consistent with this approach and would not lead to any breach of the zero NPV condition.

It may be argued that the roll-forward approach to asset valuation entails some allocative inefficiencies, in the sense that prices that are based on historical costs are not necessarily reflective of the current opportunity cost of these assets. However, as I have set out in earlier sections of this report, the ACCC's current process of asset "optimisation" to arrive at what it considers to be the "true" opportunity cost of Telstra's assets applies a hypothetical model to an established network, and is therefore fraught with scope for regulatory discretion and error. Second, even if it were the case that the roll-forward approach to asset valuation resulted in some allocative inefficiencies, these would likely be far outweighed by the risks to future efficient investment that is a direct result of the ACCC's current "optimisation" approach (and would be further magnified by the application of a tilted annuity formula).

4.4. CONCLUSIONS

In the preceding sections I explained that, in my opinion, a financial capital maintenance objective, and the corresponding requirement on the regulator to adopt time-consistent policies are not only consistent with, but central to the objectives of the Act. Simply put, no regulatory bargain is sustainable without the accompanying "promise" that efficient costs that must be incurred to deliver the relevant regulated service will be returned to investors. At the same time, the ACCC has, in past decisions, consistently revised its interpretation of efficient costs, so that the regulatory valuation of Telstra's CAN has been consecutively reduced. The extent of value reduction as a result of this process of "optimisation" directly translates into a financial loss to Telstra's shareholders, relative to the income stream these shareholders would otherwise have obtained from the assets.

In my opinion, the tilted annuity approach used previously by the ACCC for Telstra's ULLS assets would further compound this effect. That approach further back-loads the depreciation profile for Telstra's ULLS assets, so that the process of asset "optimisation" would likely ensure that a substantial portion of the costs of these assets could never be recovered. Additionally, and even in the absence of the ACCC's periodic asset revaluation process, back-loaded depreciation increases the risk that Telstra will not be able to recover the cost of its assets. The ACCC's approach therefore implies a significant financial risk for Telstra's shareholders, and would deter rational investors from funding Telstra's future

[111] ACCC, Decision: Statement of Principles for the Regulation of Electricity Transmission Revenues —background paper, December 2004. P. 39. I note that the Australian Energy Regulator (AER) has recently confirmed the "roll forward" approach to asset valuation for transmission. AER, "Final decision, Electricity transmission network service providers, Roll forward model", September 2007.

investment, unless the allowed rate of return were increased accordingly (which to date it has not been).

Additionally, there are some reasons to suppose that the depreciation profile that is inherent in the ACCC's tilted annuity approach is not an "economic" one. Asset price changes such as those implied by the tilted annuity could only be justified on the expectation of a significant rise in the future earnings associated with the asset. In my experience, this has not occurred in relation to the relevant service to date. However, even if it were, such price changes would need to then be decomposed into a revaluation component and a depreciation component. The revaluation component should then be dealt with separately. Indeed, given the costs to society of deterring efficient investment, the best way of dealing with that component without creating added regulatory risk would be to lock in the initial valuation, as the ACCC has itself recommended in other contexts, and consistently apply a conventional depreciation approach (such as SLD).

I conclude that commonly accepted economic theory would not reasonably lead to the use of a tilted annuity to calculate depreciation in the way that the ACCC has done. More importantly, the ACCC's tilted annuity approach does not, in my opinion, achieve the stated objectives of Part XIC of the Act.

In principle, an alternative approach to compensating financial risks to shareholders arising from the back-loading of capital recovery would be to offset these risks by a higher allowed rate of return. However, this approach would represent a departure from the Capital Asset Pricing Model (CAPM) approach that is consistently used in Australia in a regulated setting. The CAPM only rewards systematic risk, that is, the extent to which the underlying risk is correlated with that of the "market". Specific risks that are unique to the asset or firm in question (such as the risk of expropriation from regulatory intervention) are not rewarded. Furthermore, in practice, to the best of my knowledge an approach that compensates investors for anticipated asset write-downs has never been applied in Australia.

I have made all the inquiries that I believe are desirable and appropriate and no matters of significance that I regard as relevant have, to my knowledge, been withheld.

Henry Ergas Date

APPENDIX A: TERMS OF REFERENCE

APPENDIX B: CURRICULUM VITAE FOR HENRY ERGAS

Contact Details

Henry Ergas
Chairman
Concept Economics

Phone:	+61 2 61265002
Fax	+61 2 62326188
Email:	henryergas@concepteconomics.com.au

Nationality:	Australian
Country of Residence:	Australia

Professional Qualifications

M.Ec.Stud. (High Distinction)
University of Queensland

B.A. (Econ) First-Class Honours
Sussex University

Henry Ergas spent a decade as a micro economist at the OECD in the 1980's, focusing on the analysis of issues affecting efficient resource allocation. At the OECD, he headed the Secretary-General's Task Force on Structural Adjustment, which concentrated on improving the efficiency of government policies in a wide range of areas. As part of this work, and subsequently, he has examined the design of systems for allocating scarce resources over a range of issues from the allocation of R&D funds through to the design of congestion charging. His work on innovation policies, originally carried out at the OECD, has been influential in the design of R&D policies in a wide range of countries.

Since leaving the OECD, Henry's work has focused on competition policy and regulatory economics. He has been closely involved in dealing with regulatory issues in a range of industries, including telecommunications, electricity, aviation, surface transport, and financial services. He chaired the Intellectual Property and Competition Policy Review Committee for the Australian Government in 1999-2000, and was a member of the Prime Minister's Export Infrastructure Task Force in 2005 and of the Defence Industry Consultative Group in 2006.

Henry was the founder and Managing Director of the Network Economics Consulting Group (NECG) Pty Ltd, which became part of CRA in November 2004.

Henry Ergas is currently the Chairman of Concept Economics, an economics consultancy firm with offices in Canberra and Sydney. He is also a Professor in the Faculty of Economics at Monash University in Melbourne, and a Lay Member of the New Zealand High Court.

External Appointments

2007	*Professor*, Department of Economics, Monash University
2006	*Member,* Defence Industry Consultative Group reporting to the Australian Minister for Defence
2005	*Member*, Prime Minister's Taskforce on Exports and Infrastructure
2004–	*Adjunct Professor*, School of Economics, National University of Singapore
2004–	*Member*, Australian Centre of Regulatory Economics (ACORE) Advisory Board
2004-	*Member,* French Ordre Nationale du Merite
2002–	*Editorial Board*, *The Review of Network Economics* at www.rnejournal.com
2001-	*Lay Member, New Zealand High Court* in cases involving appeals from decisions of the Commerce Commission and other matters under the Commerce Act
1999-2000	*Chairman*, Intellectual Property and Competition Review Committee, Attorney-General's Department, Australia
1998-2004	*Member*, Commissione Scientifica, Telecom Italia, Rome, Italy
1997	*Member*, Advisory Panel on Telecommunications Reform to the Minister for Communications and the Arts, Australia

Employment History

2008-	*Chairman,* Concept Economics
2004-2007	*Vice President and Regional Head, Asia Pacific,* CRA International
1996–2004	*Managing Director,* Network Economics Consulting Group (NECG), Australia
1995–1997	*BellSouth NZ Visiting Professor of Network Economics and Communications,* The University of Auckland, New Zealand
1994–1995	*Visiting Professor,* Kennedy School of Government, Harvard University
1993–1997	*Advisor,* Trade Practices Commission, Canberra, Australia
1991–1993	*Counsellor for Structural Policy,* Economics Department, OECD, Paris
1987–1991	*Professor,* Graduate School of Management, Monash University, Melbourne
1978–1987	*Administrator,* Principal Administrator, and subsequently Counsellor, OECD, Paris

Academic

Henry Ergas has held teaching positions at a number of leading institutions. He has taught at the Kennedy School of Government at Harvard University and been a consultant to the

RAND Corporation in Santa Monica, California; an adviser to the Australian Trade Practices Commission (now the ACCC); and a visiting professor at the Centre for Research in Network Economics and Communications at the University of Auckland. He was a Professor in the Graduate School of Management at Monash University and taught at the Ecole Nationale de la Statistique et de l'Administration Economique in Paris. He is also an external Professor in the Faculty of Economics at Monash University, Melbourne and an Adjunct Professor in the Department of Economics at the National University of Singapore.

Journal Articles

2008, 'Shelter from the Storm: Reflections on "The Risk Society"'', *Quadrant Magazine*, vol 52, no 1- 2, available at http://quadrant.org.au/php/article_view.php?article_id=3749.

2007, 'The Owl of Minerva', *The Review (a supplement to the Australian Financial Review)*, 30 November 2007, p. 1.

2007, 'Reflections on Expert Economic Evidence', *Bar News*, *The Journal of the New South Wales Bar Association,* Summer 2006-2007, available at http://www.nswbar.asn.au/docs/resources/publications/bn/bn_summer0607.pdf

2007, 'Pillars of Sand', *The Review (a supplement to the Australian Financial Review)*, 18 May 2007, p. 1.

2007, 'In the Dark: Defence Spending', *The Review (a supplement to the Australian Financial Review)*, 9 February, p. 1.

2006, 'Carbon Trading is Smoke and Mirrors', (with Anna Matysek), *The Review (a supplement to the Australian Financial Review)*, 18 May 2006.

2005, 'Panel on Competition Policy in Card-Based Payment Systems: Commentary', *Review of Network Economics*, vol. 4, issue 4, pp. 415-419.

2004, 'Exclusive Licensing in Harbour Towage', (with Teresa Fels and Jason Soon), *Review of Network Economics*, vol. 3, issue 2, pp. 145-167.

2004, 'Not another article about Section 46 of the Trade Practices Act', (with Mitchell Landrigan), *Australian Business Law Review*, vol. 32, no. 6, pp. 415 -435.

2004, 'The Economics of Buying Complex Weapons', (with Flavio Menezes), *Agenda* vol. 11, no. 3, pp. 247-64.

2003, 'New Directions in Australian Air Transport', (with Christopher Findlay), *Agenda*, vol. 10, no. 1, pp. 27-41 available at http://epress.anu.edu.au/agenda/010/01/10-1-A-4.pdf

2002, 'Public Liability : An Economists Perspective', *Bar News*, *The Journal of the New South Wales Bar Association,* Winter 2002, available at http://www.nswbar.asn.au/docs/resources/publications/bn/bn_winter2002.pdf

1998, 'Are the ACCC's Merger Guidelines too Strict?', *Competition and Consumer Law Journal*, vol. 6, p. 171.

1998, 'Telecommunications Issues in Market Definition', (with Deena Shiff and Mitchell Landrigan), *Competition and Consumer Law Journal*, vol. 6, p. 32.

1995, ' Competition Policy in Deregulated Industries', *International Business Lawyer,* vol. 23, no. 7, p. 305.

1994, ‘The Interconnection Problem with a Focus on Telecommunications’, (with Eric Ralph), *Communications & Strategies*, no 16, 4th quarter, 1994, pp. 9-24.

1994, ‘Oftel: A Tragic Libretto ‘,*CommunicationsWeek International*, 21 February, Issue 119, p. 8.

1994, ‘MCI's $20B Posturing’, *CommunicationsWeek International*, 17 January, Issue 117, p. 12.

1991, ‘International Telecommunications Settlement Arrangements: An Unsustainable Inheritance?’ (with Dr Paul Paterson),*Telecommunication Policy*, vol. 15, pp. 29-48.

1991, ‘Implications of Positive Adaptation as a Strategy for Government’, (with Frank Castles, Discussant), *Australian Journal of Management*, vol. 16 (Special Issue): pp. 50-52, 54-55.

1984, ‘Le Determinanti Della Capacita’ Innovativa: Perche’ Alcuni Paesi Innovano Piu’ Di Altri?’, *Economia e politica industriale*, fasc. 43, p. 45.

Papers, Books, Chapters in Books

2008, *Wrong Number: Australia's Telecommunications Mess and How to Fix It*, Allen & Unwin, in press.

2008, ‘Telecommunications Access Pricing: the Australian Experience’, available at http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1086856

2005, ‘Regulatory Approaches to Mobile Virtual Network Operators (MVNOs)’, in *Regulating access to networks, Vodafone Policy Paper No. 3*, London, 10-15.

2005, *Establishing an Efficient Regulatory Regime for Telecommunications in Canada*, (with Frank Mathewson), a CRA International Submission on behalf of Bell Canada to the Telecommunications Policy Review Panel, available at http://www.telecomreview.ca/epic/site/tprp-gecrt.nsf/vwapj/Appendix_D6_Annex_A.pdf/$FILE/Appendix_D6_Annex_A.pdf

2003, ‘Quantifying Differences between Broadband Penetration rates for Australia and Other Countries’, (with John Fallon, Olivier Renard and Iain Little), September, available at http://www.aph.gov.au/Senate/Committee/ecita_ctte/completed_inquiries/2002-04/broadband_competition/submissions/sub21att.pdf

2003, ‘Doubts About Dawson’, available at http://www.crai.com/pubs/pub_4676.pdf

2003, ‘Some Economic Aspects of the Weapons Systems Acquisition Process’, available at http://www.crai.com/pubs/pub_4717.pdf

2003, ‘The Economics of Exclusive Distribution’, available at http://www.crai.com/pubs/pub_4728.pdf

2003, ‘Australian Competition Tribunal Condemns ACCC Approach to Setting Allowed Returns for Regulated Firms’, available at http://www.crai.com/pubs/pub_4674.pdf

2003, ‘Epic in Retrospect and Prospect’, available at http://www.crai.com/pubs/pub_4678.pdf

2002, ‘Intellectual Property Rights and Competition’, available at http://www.crai.com/pubs/pub_4683.pdf

2002, ‘Technological Change and Regulatory Approaches to an Australia-United States Free Trade Agreement’, available at http://www.crai.com/pubs/pub_4722.pdf

2002, 'The (Uneasy and Somewhat Messy) Interaction of the IP Laws and the Competition laws', available at http://www.crai.com/pubs/pub_4726.pdf

2002, 'Treatment of Unilateral Refusals to License and Compulsory Licensing in Australia', available at http://www.crai.com/pubs/pub_4729.pdf

2002, 'Fair Dealing, Libraries, and Competition in the Digital Era', (with Sarah Strasser), available at http://www.crai.com/pubs/pub_4670.pdf

2002, 'Regularities and Essential Facilities: Some Key Issues,' Network Economics Consulting Group, Rome.

2001, 'Productivity Commission Draft Report: Telecommunications Competition Regulation', (with Tim Kuypers), available at http://www.crai.com/pubs/pub_4701.pdf

2001, 'Price Caps and Rate-of-Return Regulation', (with John Small), available at http://64.233.179.104/scholar?num=100&hl=en&lr=&q=cache:R0glFaBCksQJ:www.necg.com.au/pappub/papers-ergas-org-may01.pdf+author:h-ergas

2001, 'Parallel Imports: The Australian Experience', Room document for May 30th discussion,by

OECD Joint Group on Trade and Competition for the Synthesis Report on Parallel Imports

2001, 'Regulatory Risk', (with Jeremy Hornby, Iain Little and Ian Small), a paper prepared for the ACCC Regulation and Investment Conference, March 2001, available at http://www.crai.com/pubs/pub_4708.pdf

2001, 'Stirling Harbour Services v. Bunbury Port Authority: A Review of Some Economic Issues', http://www.crai.com/pubs/pub_4718.pdf

2001, 'The "Uneconomic to Develop" Criterion after Duke', available at http://www.pc.gov.au/inquiry/access/subs/subdr116.pdf

2000, 'Land Valuation at Sydney Airport', http://www.crai.com/pubs/pub_4689.pdf

2000, 'Some Economic Aspects of Asset Valuation', available at http://www.crai.com/pubs/pub_4713.pdf

2000, 'Real Options and Economic Depreciation', (with John Small), NECG Pty Ltd and CRNEC, University of Auckland, March, http://www.business.auckland.ac.nz/comwebContent/docs/Economics/opt_depn.pdf

2000, 'Land and Easement Valuation in Pricing for Networked Businesses – a Critical Appraisal', (with Mike Smart), Network Economics Consulting Group.

1999, Chairman of the Australian Federal Government Review of Intellectual Property Legislation under the Competition Principles Agreement (also known as the Ergas Committee), Recommendations and report available at http://www.ag.gov.au/www/agd/agd.nsf/Page/Copyright_IssuesandReviews_IPandcompetition

1999, 'What is Regulatory Best Practice?', available at http://www.crai.com/pubs/pub_4731.pdf

1999, 'Economic Depreciation in Telecommunications Cost Models', (with Alexis Hardin and John Small), available at http://www.crai.com/pubs/pub_4677.pdf

1999, ‘Internet Peering: A Case Study of the ACCC's Use of its Powers Under Part XIB of the Trade Practices Act, 1974’, available at http://www.crai.com/pubs/pub_4687.pdf

1999, ‘The Rental Cost of Sunk and Regulated Capital’, (with John Small), Working Paper, University of Auckland, Business School, http://www.business.auckland.ac.nz/comwebContent/docs/Economics/wp17.pdf

1998, ‘Valuation and Costing Issues in Access Pricing with Specific Applications to Telecommunications’, in *Infrastructure Regulation and Market Reform: Principles and Practice*, Margaret Arblaster and Mark Jamison. (eds.), Canberra, Australia: ACCC and PURC, pp. 91-112, available at http://bear.cba.ufl.edu/centers/purc/publications/accc/09.pdf

1998, ‘Telecommunications Services in the Bush: Are Rural Consumers Getting a Raw Deal?’, (with H., T Warren and J Thorn), Network Economics Consulting Group.

1998, ‘Access and Interconnection in Network Industries’, in Hope, E. and Maeleng, P. (eds) *Competition and Trade Policies: Coherence or Conflict?,* Studies in the Modern World Economy, Vol. 13. London and New York: Routledge, pp. 81-114. Also in *Economia e politica industriale*, 1997, vol. 24, fasc. 95, pp. 53-88. Also at http://www.crai.com/pubs/pub_4671.pdf

1998, ‘The Todd Report on Competition in New Zealand Telecommunications: A critique’, 23 November.

1998, ‘Declaration of GSM Roaming: An Economic Analysis’, (with Eric Ralph and John Small), http://www.crai.com/pubs/pub_4675.pdf

1998, ’New Models of Foreclosure: Should Antitrust Authorities Be Concerned?’, (with Eric Kodjo Ralph), available at http://papers.ssrn.com/sol3/papers.cfm?abstract_id=55775.

1998, ‘L'economia delle Autorità Indipendenti: Alcune Riflessioni Sui Criteri di Scelta Degli Assetti Istituzionali’, (with Alberto Heimler), available at http://www.crai.com/pubs/pub_4690.pdf

1998, ‘International Trade in Telecommunications Services: An Economic Perspective’ in Hufbauer, G. C. and Wada, E. (eds), *Unfinished Business: Telecommunications after the Uruguay Round,* Washington DC: Institute for International Economics (IIE), pp. 89-106.

1998, ‘Should s.36 of the Commerce Act be Amended to Include an Effects Test?’, available at http://www.crai.com/pubs/pub_4712.pdf

1997, ‘Cluster Markets: What They Are and How to Test For Them’. Working Paper, The Centre for Research in Network Economics and Communications, School of Business and Economics, The University of Auckland.

1997, ‘Technology Institutions and Policies. Their Role in Developing Technological Capability in Industry’, (with M. Goldman, Eric Kodjo Ralph and G. Felker), Working Paper No 383, World Bank - Technical Papers.

1996, ‘Telecommunications Across the Tasman : A Comparison of Regulatory Approaches and Economic Outcomes in Australia and New Zealand’, in Richardson, Megan (ed) *Deregulation of Public Utilities: Current Issues and Perspectives*, Centre for Corporate Law and Securities Regulation.

1996, ‘New Zealand’s National Grid : Transmission Pricing and Ownership Issues’, (with John Small), Centre for Research in Network Economics and Communications, Auckland Business School, The University of Auckland, Working paper no. 6.

1996, ‘Pricing Network Interconnection: Is the Baumol-Willig Rule the Answer’, (with Eric Kodjo Ralph), Prepared for Trade Practices Commission (Australia), available at http://www.ekonomicsllc.com/Ergas&Ralph1993Ix&ECPR.pdf

1995, ‘Structure and Change in Distribution System: An Analysis of Seven OECD Member Countries’, Felli, Ernesto; Furio C. Rosati and Giovanni Tria (eds.), in *The service sector: Productivity and growth,* Proceedings of the international conference held in Rome, Italy, May 27-28, 1993, pp. 177-242, Contributions to Economics series. Heidelberg: Physica, 1995.

1995, ‘Internal and External Sources of Information in the Innovation Process: The Results of a six Country Survey’.

1995, ’A New Access Regime for New Zealand‘ University of Auckland, September.

1995,’The Control of Price Discrimination in Australian Telecommunications: A Critical Review‘ prepared in role of Visiting Adviser, Trade Practices Commission.

1995, ‘Prices, Costs and Subsidies in a Telecommunications Network - the Australian Experience’. in *Universal Service Obligations in a Competitive Telecommunications Environment*, Analysys Publications.

1995, ‘Discussion of 'Productivity Change in the Australian Steel Industry: BHP Steel 1982-1995', 'The Performance of the NSW Electricity Supply Industry', 'Measuring Productivity in the Australian Banking Sector' and 'Micro Reform in the Australian Labour Market: Implications for Productivity and Growth'', (with Barry Hughes), *Reserve Bank of Australia 1995 Conference, Productivity and Growth*, 10-11 July available at http://www.rba.gov.au/PublicationsAndResearch/Conferences/1995/ErgasHughesDisc.pdf

1994, ‘An Alternative View of Australian Telecommunications Reforms’, Wellenius, Bjorn and Peter A. Stern (eds.), in *Implementing reforms in the telecommunications sector: Lessons from experience,* pp. 247-60, Regional and Sectoral Studies. Washington, D.C.: World Bank.

1994, ‘Internationalisation, Firm Conduct and Productivity’, (with Mark Wright), *Reserve Bank of Australia 1994 Conference, International integration of the Australian economy,* 11-12 July.

1994, ‘The Failures of Mission-Oriented Technology Policies’, in P. Bianchi and M. Quere, (eds.), *Systems of Innovation: the International and Local Levels*, Kluwer, Amsterdam.

1994, ‘Comment on 'Appropriate Regulatory Technology'', Bruno, Michael; Pleskovic, Boris, (eds), *Proceedings of the World Bank Annual Conference on Development Economics*, 1993, Supplement to The World Bank Economic Review and The World Bank Research Observer, Washington, D.C.: World Bank, pp. 205-10.

1993, *Industrial Policy in Europe, Industrial policy for agriculture in the global economy*. CARD Publications. Ames: Iowa State University Press for the Center for Agricultural and Rural Development, pp. 149-68.

1993, ‘Resale of International Service: How Big an Impact?’ Working Paper, Columbia University, available at http://www.columbia.edu/dlc/wp/citi/citi522.html.

1993, ‘Europe’s Policy for High Technology: Has Anything Been Learnt?’, Paris, OECD.

1990, ‘Reforming Australian Telecommunications: A Review of Issues and Options’, A research paper prepared for the Business Council of Australia Reference Group on Telecommunications, (with Eric Ralph and Siva Sivakumar), 9 July.

1989, 'Liberalisation of Cellular Mobile Telephone Service' (with Eric Ralph, Sophie Cobee and Siva Sivakumar), Monash Information and Technology Centre, Graduate School of Management, Monash University.

1989, 'Global Technology and National Politics', for the Council of Foreign Relations, New York.

1988, 'Countervailing Duty Laws and Subsidies to Imperfectly Competitive Industries: Comment', Baldwin, Robert E.; Carl B Hamilton and Andre Sapir, (eds), in *Issues in U.S.-EC trade relations*, pp. 334-41, National Bureau of Economic Research Conference Report series, Chicago and London: University of Chicago Press.

1988, 'Deregulating International Telecommunication: Costs and Benefits', Current Economic Issues Forum on Structural Adjustment, Economic Society of Australia (Vic), 22 June.

1988, 'A Survey of the Role of Entry Barriers', in Ergas, H. et al *Firm-Environment Interaction in a changing Productive System*, Milano, Italy, Franco Angeli.

1987, 'The Importance of Technology Policy' in *Economic Policy and Technological Performance,* Dasgupta, P. and P. Stoneman, (eds.), Cambridge University Press.

1987 'Does Technology Policy Matter?' in *Technology and Global Industry : Companies and Nations in the World Economy*, National Academy of Engineering of the United States, National Academies Press, Washington DC. Reprinted in Stephan, Paula E.and David B. Audretsch, (eds.), in *The economics of science and innovation,* vol. 2, pp. 438-492, Elgar Reference Collection, International Library of Critical Writings in Economics, vol. 117, Cheltenham, U.K. and Northampton, Mass. 2000.

1987, 'Regulation, Monopoly and Competition in Telecommunications', OECD.

1986, 'Information Technology Standards: The Issues.' Special Report in *Telecommunications*, September 1986, pp 127-133.

1984, 'Corporate Strategies in Transition', Jacquemin, Alexis, (ed), in *European Industry: Public Policy and Corporate Strategy*, Oxford; New York; Toronto and Delhi: Oxford University Press, Clarendon Press, pp. 327-42.

1984, 'Monopoly and Competition in the Provision of Telecommunication Services', Henry Ergas and Jun Okayama (eds) in *Changing Market Structures in Telecommunications : Proceedings of an OECD Conference*, North Holland.

1984, 'International Aspects of Telecommunications Regulation', Henry Ergas and Jun Okayama (eds) in *Changing Market Structures in Telecommunications : Proceedings of an OECD Conference*, North Holland.

1984, 'Why Do Some Countries Innovate More than Others?', Centre for European Policy Studies, CEPS Papers No. 5.

1984 'Servizi pubblici e politica industriale : il caso della politica francese delle telecomunicazioni', in *La Politica Industriale In Europa E Negli Stati Uniti*, Alfredo Del Monte & Salvatore Vinci (eds), Liguori.

1983, *The Inter-Industry Flow of Technology: Some Explanatory Hypotheses*, Paris, OECD.

1975, *The Confederazione generale italiana del lavoro and the evolution of the system of industrial relations in Italy, 1945-1963*.

Presentations

2008, Discussant, Commercial Implications of the Birdsville Amendments - Issues for Clients and Practitioners, *2008 Competition Law Conference*, 24 May.

2008, Presentation, Dealing with the Regulatory Burden, *Economic and Social Outlook Conference*, Melbourne Institute of Applied Economics and Social Research, The University of Melbourne, 28 March.

2008, Panel Discussion, Ageing and the Intergenerational Report: A policy perspective, *ACERH Policy Forum 2008*, 22 February.

2007, Future Funds and Infrastructure Investments: What Role, If Any?, Comments at the *ANU/Lowy Institute Conference on and Intergenerational Financial Funds*, Sydney, August 24th, 2007.

2007, Discussant, Behavioral economics and consumer policy, *Productivity Commission Roundtable on Behavioral Economics and Public Policy*, 9 August.

2007, 'Presentation, The Economics of Alternative Infrastructure Funding Arrangements', *2007 Residential Development Leaders Summit,* 18 June.

2007, Keynote address, 'The Competition Policy Experiment', *Australian Law and Economics Conference*, 2 June.

2007, Paper on 'State of the States', Presentation to *Menzies Research Centre State Policy Conference*, available at http://www.statewatch.com.au/state_of_the_states_HenryErgas.pdf, 1 June.

2007, Presentation, 'Strategies for the Future', *Aged Care Queensland State Conference*, 22 March.

2006, Presentation, 'Tanks versus Helicopters: Defence Decision-Making: The Conceptual Approach', *CRA/ASPI Defence Economics Short Course*, 2 November.

2006, Presentation, 'Should Trucks Pay More?', *CRA Seminar on Implications of the Productivity Commission's preliminary findings on road and rail freight*, 29 September.

2006, 'Achieving Market Oriented Outcomes in Aged Care', Presentation to *CRA Seminar on The Economics of Aged Care*, 31 October.

2006, 'Regulating with a lighter touch: reality or mirage?', Presentation to *Bureau of Transport & Regional Economics' Annual Colloquium*, May 14 available at http://www.bte.gov.au/presentations.aspx

2006, 'Road pricing and modal choice', Presentation to *CRA Seminar on Freight Infrastructure: What are the Challenges in Achieving Efficient Pricing?*, 28 April.

2006, 'Identifying the areas where the current regulatory framework needs reform and where improvements can be made', Presentation to *DCN Summit on Transport and Infrastructure Regulation*, 8 March.

2005, 'Is Competition Feasible in Defense Procurement?' Presentation (with Flavio Menezes) to *CRA Asia Pacific Summit*, 10 December, available at http://www.crai.com/pubs/pub_5045.pdf

2005, 'Implementing the Recommendations of the Prime Ministerial Taskforce on Export Infrastructure - 6 months on', Presentation to *Transport Victoria Conference*, 29 November.

2005, 'The Transition to an IP World: Key Commercial and Regulatory Issues', Presentation to *Australian Telecommunications Conference*, 21 November.

2005, 'Level Playing Fields and Competition', Presentation to *National Insurance Outlook Conference*, 11 November.

2005, 'Mapping the Future of Transport Infrastructure Investment', Presentation to *Investment for Transport Infrastructure Conference*, 31 October.

2005, *Productivity Commission - Roundtable on Productive Reform in a Federal System*, 28 October, Discussant comments available at http://www.pc.gov.au/research/confproc/productivereform/productivereform.pdf.

2005, 'Economic Issues in Telstra's Privatisation', *Industry Economics Conference, La Trobe University*, 29 September.

2005, Discussant, *Federal Reserve Bank of New York - Antitrust Activity in Card-Based Payment Systems: Causes & Consequences*, New York, 15 September. http://www.rnejournal.net/articles/ergas_RNE_dec05.pdf

2005, 'Tort Reform', Presentation to NSW Bar Association Conference, 30 August.

2005, 'Prime Minister's Infrastructure Taskforce Report', Presentation to *National Australia Bank - Infrastructure Forum*, Canberra, 24 August.

2005, 'Translating Forecast Demand into Growth Strategies for Australian Ports and Rail', Presentation to *Transport Infrastructure for Export Commodities Conference*, 22 August.

2005, 'Investment in Bulk Transport Infrastructure: Regulatory Hurdles and Competition', *Ausintermodal Conference*, 26 July.

2005, 'Delivering a Competitive and Robust Electricity and Gas Sector', *5th Annual Western Australian Energy Outlook Conference*, 23 June.

2004, 'Telecommunications: Competition Regulation and Communication via the Internet', *ACCC Regulation Conference – Evaluating the effectiveness of Regulation*, July, available at http://www.crai.com/pubs/pub_4724.pdf

2004, 'Price Caps — How Useful Are They?', presentation to the *Forum on Price Cap Regulation in Australia*, Australian Centre of Regulatory Economics, The Australian National University, Canberra, 27 August.

2002, Discussant Remarks on 'Competitive Neutrality: Regulating Interconnection Disputes in the transition to competition' *ACCC Regulation & Competition Conference*, July 2

http://www.accc.gov.au/content/item.phtml?itemId=259730&nodeId=2c5b219151e6cf1f0a18407676fae22d&fn=Session+2+-+Mr+Henry+Ergas.pdf

1999, 'Annuity and Levelisation Issues in Forward-looking Cost Models: the Case of Telecommunications', paper presented for the *ACCC Depreciation Forum*, 30 September (with Alexis Hardin).

1999, 'Economic Depreciation in Telecommunications Cost Models', paper presented to the *1999 Industry Economics Conference on Regulation, Competition and Industry Structure*, 12-13 July (with Alexis Hardin and John Small), available at http://www.necg.com.au/papers.shtml

1999, 'Providing a Right of Access to Essential Facilities:The Australian Experience', (with Linda Evans), paper presented at the CRNEC Policy Conference, Auckland 1999.

1998, 'TSLRIC, TELRIC and other Forms of Forward-Looking Cost Models in Telecommunications: a Curmudgeon's Guide', paper to the *EU Competition Workshop*, available at http://www.crai.com/pubs/pub_4730.pdf

1995, 'Managing Interconnection: Issues of Institutional Design', delivered to the *ITS Conference on Interconnect*, Wellington, New Zealand, April 10-12.

1994, H. Ergas, Comment on "Appropriate Regulatory Technology: The Interplay of Economics and Institutional Conditions," by L. Jones in *Proceedings of the World Bank Annual Conference on Development Economics* 1993 (Washington, D.C.: World Bank, 1994).

1992, 'France Telecommunication: Has the Model Worked?' Paper for the workshop on *International Experiences in Telecommunications Reform and its Relevance to India,* New Delhi.

1983, 'Transborder Data Flows and the International Firm', Paper presented at OECD Conference, December.