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SOME ECONOMIC ASPECTS OF ASSET VALUATION

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The views expressed in this paper are those of the author writing in a personal capacity.

"Diverse weights are an abomination unto the Lord; and a false balance is not good" [Proverbs 20:23]

Introduction

An omniscient social planner would not be concerned with asset valuation. Rather, for a given allocation of claims over resources, the planner would look directly to demand and supply curves to determine the set of prices[1] for regulated firms that maximised the sum of consumer and producer surplus. Taxes and subsidies (presumably of a lump sum kind) would then be used to ensure that any break-even constraints were met.

In practice, however, regulators are not omniscient, nor do they have access to non-distorting taxes and subsidies. If particular output prices are to be regulated, and that regulation is to be based on costs, some means must be found of determining the cost base. As regulated industries are typically highly capital intensive, the valuation of the assets used in production will be a central, if not dominant, step in the process of ascertaining costs. If there were complete markets for assets, the problem would be trivial, as external prices could be used to determine the opportunity cost of devoting assets to a particular use. Alternatively, if all regulated activities could efficiently be put out to competitive tender, competition "for the market" would obviate the need for any administrative process of cost determination. In reality, markets are not complete and the scope for tendering out regulated activities is quite limited. As a result, opportunity costs must be imputed rather than observed. The issue then is how this imputation should occur.

In addressing this question, it is useful to note that the regulator is seeking to determine the value of assets as a step in establishing a regulated revenue requirement – that is, an amount the regulated firm can seek to charge. This amount sets a cap on the regulated firm's economic income – that is, the amount that it can distribute without eroding its capital base.[2] The choice of a method for asset valuation therefore frames the expectations the regulated firm's owners will have with respect to the firm's future stream of economic income.

As a general matter, it can be assumed that the regulator will be concerned to ensure that the firm does not secure any economic income in excess of the amount required to provide the service. However, the regulator will have less information about this amount than the regulated firm.[3] In choosing a way of valuing assets, the regulator must therefore take account of the resulting impacts on the firm's incentives to identify and disclose opportunities for cost reduction.

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1 Or *mutatis mutandis*, quantities.

2 This is simply the Hicksian definition of entity income as the change in the entity's capital between two points in time, excluding changes due to distributions to or investments by owners.

3 In practice, it is the firm's managers who hold this information. The regulator is therefore dealing with a situation in which it chooses a way of doing things that affects the firm's *owners*, who in turn must deal with the firm's *managers* in framing and implementing a response.

As for the firm's owners, they can be expected to be mindful of the risk associated with the sunk and long-lived nature of the assets the firm requires. These features of the firm's assets expose the firm to regulatory expropriation – that is, to the regulator determining an income requirement, once the relevant investments have been made, that though sufficient to retain the assets in service, would not have sufficed to attract the investment in the first place.

Seen in this perspective, the most direct test of an asset valuation concept is whether it is consistent with capital maintenance: that is, whether the revenue ceiling it gives rise to allows the firm to maintain intact the capital base required for efficient production. Any valuation concept that, when applied *ex ante*, fails this test could not support the continued financing of the activity, when that financing depends on the free choice of investors.[4]

Additionally, however, attention must also be paid to the credibility of the *ex ante* promise of capital maintenance – that is, to the extent to which the regulator, remaining within the terms of the valuation concept itself, may reduce income once investment has occurred to a level that would not have been acceptable prior to the assets being committed. Investors, to the extent to which they have a choice as to where to invest, will require insurance against promises that are not credible, with that insurance generally taking the form of a higher required rate of return before marginal investments are undertaken.

This paper elaborates on and applies these criteria to alternative valuation approaches. The method it adopts is that of considering the choice of a valuation rule that would be made by investors in the *ex ante* position – that is, prior to the commitment of assets to the regulated firm. The results of this assessment are then used to consider a number of important issues that arise in the practice of asset valuation.

More specifically, the paper starts by considering the choice between historical and current value approaches; then examines the issues involved in choosing a starting position for valuation; moves on to analyse the role of optimisation; and then reviews the issues associated with the treatment of excess capacity. A final section draws some implications for the approaches to valuation adopted by the ACCC.

The choice between historical and current value approaches

In historical cost accounting ("**HCA**") the value of a collection of assets is broadly defined as the sum of the amounts outlayed at various points in time so as to procure those assets.[5] The resulting sum is simply the accumulated record of a sequence of transactions between the owners of the firm and the suppliers of its assets.

From an analytical point of view, there is no reason to expect an income requirement calculated strictly on the basis of historical cost to be consistent with any concept of capital

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[4] In principle, inputs other than equity can contract with the firm for fixed payment schedules (for example, in the case of labour, pre-set wage rates) and hence need not be exposed to residual income risk. However, the credibility of the firm's commitment to pay according to these schedules will depend on the degree to which equity capital acts as a bond against the relevant promise. As a result, changes in the factors affecting the supply of equity also affect the firm's ability to contract for other inputs.

[5] In most if not all historical cost systems there are exceptions to this rule, for example, for the determination of the valuation of gifts, of inventories and of highly marketable assets.

maintenance[6] unless the general price level and relative prices are constant. Thus, adding a sequence of purchases at nominal prices will not measure the cumulated opportunity cost of the funds actually invested in the firm, and hence will not result in an income requirement that allows investors to maintain their financial capital intact ("**financial capital maintenance**"). At the same time, the outlays previously incurred to procure assets need not bear any relation to those that will be required from now on to retain the firm's productive capacity ("**physical capital maintenance**"). The greater the extent of changes in the general price level and in relative prices, the greater will be the likely difference between the income requirement calculated on a historical cost basis and that needed for either financial or physical capital maintenance.

The widespread use of historical cost accounting for financial reporting[7] does not tell against these weaknesses of the HCA approach, nor does the finding that income statements calculated on an HCA basis have information value to investors.[8] In practice, the information value of HCA accounts needs to be viewed in the context of the other information firms make available to investors, including statements of cash flows and of sources and uses of funds, notes to the accounts and discussions of recent developments. Account also needs to be taken of the considerable latitude HCA allows managers to "smooth" or in other ways manage the pattern of reported income over time, in a way that itself conveys information about expected earnings.[9] Seen in this perspective, the information content of HCA income statements may have less to do with the historical cost conventions themselves than with management's use of the discretion the practical implementation of these conventions allows.

Even more importantly, unregulated firms' income options are not constrained by their HCA statements. As a result, the benefits HCA offers for financial reporting in terms of ease of implementation and audit, of comparability with other firms and of accumulated familiarity, may offset any costs it imposes in terms of the direct economic meaning of the accounts to which it gives rise. In management accounting, on the other hand, where accounting information serves to guide decisions and where detailed access to information

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6 Accounting theory distinguishes two concepts of income maintenance. The first, generally referred to as *financial capital maintenance*, defines the activity cycle as "cash to cash", and broadly accounts for changes in the value of the funds owners have made available to the entity. The second, referred to as "*physical*" or "*operating*" *capital maintenance*, views the activity cycle as "physical unit to physical unit", and accounts for changes in the cost of providing a specified level of service potential. The choice between these has important implications for the treatment of changes in asset prices. In particular, in most systems based on financial capital maintenance, these flow into the income statement, and are treated as holding gains and losses. In contrast, under physical capital maintenance, changes in asset prices do not flow into the income statement but rather are treated as solely affecting the balance sheet. The choice between financial and physical capital maintenance is one of the most controversial issues in accounting theory; see generally Sterling and Lemcke Maintenance of Capital: Financial versus Physical (1982).

7 *Financial reporting* is the disclosure of accounting information to parties outside the firm and is conventionally distinguished from (among others) management accounting, which is the collection and use of accounting information as an aid to decision-making within the firm.

8 See especially Beaver Financial Reporting: An Accounting Revolution (2nd edition, 1989) and Scott Financial Accounting Theory (1997).

9 See especially Sunder The Theory of Accounting and Control (1997) 65 and follows.

is available, ever less use is being made of HCA valuation, with increased reliance being placed on such performance measures as "economic value added".[10]

Current cost valuation ("**CCV**") systems are the main alternative to HCA. While HCA focuses on transactions ("accounting events") recorded within the firm, such as asset purchases and disposals, the defining feature of current cost systems is that they take account of events that are not recorded within the firm. In particular, in determining the firm's income statement and balance sheet, current cost systems recognise price changes which affect the current value of external transactions, of internal operations (such as the conversion of inputs into inventories) and of the net worth of the accounting entity.

Current cost systems come in a wide variety of forms, and no purpose would be served by seeking to review these forms here.[11] What is of greater importance is the basis for choosing among the options available.

From an economic point of view, this choice can be analysed in terms of the choice of an income-setting rule to be used in an implicit or explicit contract between the owners of the regulated entity and the regulator. This contract specifies the obligations the owners enter into and the income stream that they will be entitled to seek. *Ex ante*, the owners would not accept any income determination rule that made them worse off from entering into the contract than they would otherwise be. The minimum acceptable income rule is consequently that which makes the owners indifferent between entering and not entering into the obligations at issue.

It is these obligations that distinguish the regulated firm from its unregulated counterpart, so that careful attention to these obligations is required in framing regulatory accounting conventions. In particular, unregulated firms are not subject to obligations to supply at specified prices; they have the option of changing the prices they charge, or reducing production if current prices are not compensatory. However, the price-regulated firm typically cannot unilaterally alter the overall level of its prices (though it may have some discretion over price structure); additionally, the regulated entity is generally required to serve all demand at prices that correspond to the regulated revenue requirement. The owners of the firm are, in other words, committed to providing the service potential needed to meet demand at the regulated level of prices.

This implies that the owners of the firm, in entering into a contract for service provision, would require the firm's income position to be evaluated taking account of **both** financial and physical capital maintenance.[12] More specifically, the firm, if it is to continue its

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[10] Economic Value Added ("**EVA**") is generally defined as the difference between the realised return on assets and the return corresponding to the WACC. In most EVA systems, assets are valued at historical cost – see for example, Rappaport Creating Shareholder Value (1998) or Grant Foundations of Economic Value Added (1997). However, since EVA systems are typically used to measure management performance as between two periods of time, rather than to define a revenue requirement at one point in time, the distortion associated with the choice of an initial valuation base could, but need not, be relatively small.

[11] There are numerous able and exhaustive reviews, including Chambers Price Variation and Inflation Accounting (1980), Edwards, Kay and Mayer The Economic Analysis of Accounting Profitability (1987), Ma and Mathews The Accounting Framework (1979), Whittington Inflation Accounting (1983) and (for those interested in the US debate and terminology) Wolk and Tearney Accounting Theory (1997).

[12] It is worth noting that even in an HCA reporting situation, the existence of obligations to serve will give rise to a contingent liability which ought to be reported in the balance sheet or the notes to the accounts. The

operations, must ensure that owners can maintain intact the purchasing power that corresponds to the funds they have invested in the firm while also providing the firm with the equity it needs to maintain its service potential (over the contract period) to a level that corresponds with price-regulated demand. As a result, in the *ex ante* position, **the firm's owners would seek a revenue ceiling for the regulated entity determined by the greater of the income streams associated with financial and physical capital maintenance**. The income statement that implements such an approach would set out both entity profit (that corresponds to physical capital maintenance) and inflation-adjusted proprietary gain (that corresponds to financial capital maintenance).[13]

The starting position

Consideration of the *ex ante* position may seem of limited relevance when the regulator, rather than dealing with a green-fields operation, comes to an entity whose asset base is largely inherited from the past. Valuing these assets on a green-field basis raises two objections: first, that since they already exist, any payment made for their services is a quasi-rent; and second, that the condition and effective service potential of the existing assets may be inferior to that of new assets, so that the imputing to them of an "as new" value would overstate the price they could command in a competitive market.

Given these objections one, rather drastic, option is to value these assets at their disposal prices, which will often be low or even negative (when decommissioning plant is costly[14]), while allowing new investment to enter the regulated asset base on some other valuation basis. The main attraction of this approach is that it treats by-gones as by-gones, and hence seems minimally distorting of current consumption decisions. In practice, however, this option is more distorting than it seems.

To begin with, if the allowed rate of return is even minimally above the WACC, the firm will have incentives to accelerate the replacement of existing assets. This is merely a form of the Averch-Johnson effect, but preventing it would involve the regulator in close and presumably costly monitoring of the firm's maintenance and investment decisions.[15]

Additionally, and perhaps even more importantly, it is unlikely that investors would view the decision to write assets down to scrap as a once-off occurrence. Rather, anticipating that a similar decision might be taken at some future date – say, on the occasion of a further

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replacement cost valuation of the assets needed to provide the service potential would be the surest guide to the quantitative magnitude of this liability. Following this logic, even HCA reporting should, in the regulated firm situation, lead to financial reports based on replacement cost. In practice, this is not normally done, and indeed sits uncomfortably with some of the other conventions of the HCA model.

[13] See, for an example of the specification of such an income statement, Kennedy "Inflation Accounting" 4 Cambridge Economic Policy Review (1978) 58-64.

[14] If there is an option value to being in the market, say because demand may exceed current expectations, firms will remain in the market even if the income that can be obtained from assets falls below the salvage value of those assets. As a result, whenever there are sunk costs to investment, and uncertainty is of the kind that will be reduced by subsequent realisations, the "floor price" a firm will require to retain assets in use may be below the scrap valuation. This is generally overlooked in discussions of ODV, where it is assumed that the floor price is set by the possibility of selling the asset for scrap.

[15] Since there is generally considerable ambiguity as to what is meant by "new investment" as compared to "major maintenance", such a rule would seem to invite substantial cost shifting by the firm, with a requirement for offsetting monitoring and enforcement outlays by the regulator.

change in the regulatory regime, or in its key personnel – investors, much like creditors responding to alleged "once and for all" debt rescheduling[16], would increase the required rate of return on investment. To the extent to which investors are risk-averse and cannot diversify the risk of expropriation (see below), the long term costs of supply must rise. Since this is a productive inefficiency, its welfare costs are likely to outweigh any welfare gains that could come from temporarily reducing the regulated firm's prices.

Alternatively, the regulator could simply disregard the objections set out above and value the asset base "as if" operations were being conducted on a green-fields basis. This is less extreme than it sounds.

To begin with, when the obligation to provide service is perpetual, or at least extends over several asset renewal cycles, the value of inherited assets will likely be a relatively small part of the net present value of the outlays the owners will need to incur.[17] The "over-estimate" made by treating existing assets as new will not be substantial in the scheme of things, and may in any case be offset by the terminal value of assets when the obligation comes to an end.

Moreover, where changes in asset values are entirely due to obsolescence[18], an "as new" valuation is strictly equivalent to valuing the assets as they would have been valued today had they been depreciated on an economic basis **regardless of their actual date of construction**.

To see this, assume that the cost K of constructing a network falls at the constant rate α per annum and that the rate[19] of depreciation (that is, the rate at which the total valuation of the asset's current service potential erodes) is also constant at δ. The relationship between the cost of constructing a network in 1988 and 1998 is therefore given by $K_{98} = K_{88}(1-\alpha)^{10}$. Given a construction date, the connection between written down values in various years is simply $w_t = w_0(1-\delta)^t$. It can be seen that the 1998 capital charge for a network constructed in 1988 is:

$$C_{98,88} = (\delta + r)K_{88}(1-\delta)^{10}$$

where r is the cost of capital, whereas the corresponding charge for a network constructed in 1998 is:

$$C_{98,98} = (\delta + r)K_{98}$$

$$= (\delta + r)K_{88}(1-\alpha)^{10}$$

Thus, so long as the rate of decline in construction costs α is exactly equal to the depreciation rate δ, the capital charge in the current period will be the same for networks of different ages.

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16 See for example, Aggarwal Debt Games (1996).

17 This will not be the case if assets that are perpetual, or so long lived as to be virtually so, account for a substantial part of the asset mix. Airports would seem a case in point.

18 That is, service potential remains constant, but the price of assets changes over time.

19 Note that the implied connection between d_t and δ is simply $d_t = \delta w_t$.

This implies that the bias involved in applying an "as new" valuation to existing assets is solely a function of the extent of the deterioration in physical service potential (as against of changes in the value of service potential). For utility networks in which maintenance is used to keep the serviceability of in-use assets at a roughly constant level over time, which have a wide mix of asset vintages, and where there is *de facto* a perpetual obligation to provide service, the bias is likely to be small.[20] With relatively inelastic demand, and scope for sophisticated pricing of output, the welfare loss associated with the bias will be even smaller.

To the extent to which the regulator must choose between valuation on a salvage basis on the one hand and on an "as new" basis on the other, a simple consideration of welfare consequences therefore seems to point to the latter. However, in some instances a wider range of options may be open.

In particular, where physical service potential is observable, say through the measurement of an asset condition index, the "as new" valuation can be discounted by that index, corrected for the cost elasticity of serviceability.[21] If there are substantial scale economies to serviceability (for example, because assets are shared across users and are subject to random arrivals risk of failure), relatively small reductions in the physical asset stock will generate significant reductions in service potential. In these cases, the difference between the entirely "as new" value of assets and that corresponding to any given level of the asset condition index may be small.

Such an approach corresponds to an *ex ante* rule in which the collection of assets is depreciated in such a way as to ensure that two conditions are met:

1. When the assets are new, they are not valued in excess of the stand-alone cost (at current replacement costs) of the service potential made available in that time period, and

2. The change in valuation during any subsequent time period is exactly compensated by depreciation and major maintenance charges which the owner is entitled to recover from customers during that period.

This rule is readily consistent with the requirement, set out above, for revenue over the life of the service obligation to be sufficient to cover the greater of financial or physical capital maintenance.

More *ad hoc* approaches – such as discounting the "as new" valuation by the ratio of the HCA written down value of assets to their cost of original acquisition – are not readily reconciled with any *ex ante* rule based on capital maintenance. These rules are essentially arbitrary income adjustments, made so as to select a point between salvage and "as new" valuation, but which could not be applied consistently without violating the capital maintenance constraint.

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[20] As noted already by Domar "Depreciation, Replacement and Growth" 63 Economic Journal (1953) 1-32.

[21] That is, the proportionate reduction in the value of the stock of assets required to obtain a given reduction in physical service potential. For example, a relatively small reduction in the switching plant in service in a telephone network will lead to a substantial reduction in service potential, defined as the volume of traffic that can be handled at peak.

The role of optimisation

While financial capital maintenance does not strictly require any regard to be paid to the cost of replacing current service potential, virtually all forms of accounting based on physical capital maintenance do. As a result, they all involve some degree of optimisation.

This is even the case when assets are valued on a reproduction, as against replacement, basis – that is, when existing assets are valued on the basis of the "as new" prices of those assets, as against being valued on the basis of the entry price for modern equivalent assets. In effect, if the current assets are still being traded (so that reproduction prices can be used for valuation purposes), the prices at which those assets are being traded will reflect the efficiency differential between those assets and their modern equivalents. As a result, the sequence of valuations derived from repeated application of reproduction costing should provide no worse a measure of that component of economic depreciation due to obsolescence than the sequence of valuations obtained from the modern equivalent pricing of service replacement.[22]

However, while all forms of accounting based on physical capital maintenance involve some optimisation, optimisation is more aggressively pursued in some approaches than in others. Moreover, for any given degree of optimisation, a central issue is that of the income consequences to the regulated entity of that optimisation, and in particular, the extent of the stranding risk to which the entity is exposed.

Exposing the regulated entity to stranding risk is conventionally justified in terms of the desirability of ensuring a sequence of outcomes that could prevail were the market contestable. This argument is unconvincing, in that it abstracts from the defining feature of a contestable market – namely, the absence of sunk costs, and hence the lack of any *ex ante* exposure to asset stranding. No valid inferences can be drawn, at least in any simple way, from the workings of contestable markets to those of markets in which sunk investments must be made. A more plausible account of the argument for exposing the regulated entity to stranding risk is that -- phrased in crudely populist terms – it is intended to prevent consumers for paying costs associated with monopoly inefficiencies.

In considering this argument, it is useful to start by noting that an unregulated monopolist need not be technically inefficient. While complex arguments can be mounted as to why a monopolist might be less efficient than a competitive firm,[23] powerful counter-arguments can be put pointing the other way. Nor is there any *a priori* reason to believe that a firm exposed to competition will innovate at a more socially efficient rate than one that is not so exposed.[24] It is surely striking that in all the major anti-trust cases that have concerned firms

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[22] Indeed, 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 "Technological Change and Replacement Costs" 54 The Accounting Review (1979) 306-322.

[23] The most convincing of these arguments have to do with the ability of the owners of a competitive firm to rely on industry benchmarks in contracting with managers, thus reducing agency costs.

[24] Compared to a monopolist, a competitive firm may innovate either too little (if it cannot as fully appropriate the social value of its innovation) or too much (if it is more exposed to a patent race type phenomenon, additionally motivated by the hope of securing monopoly rents that the monopolist in any event enjoys). More generally, a monopolist, in considering when to replace an old asset by a new one, will use the same

close to being monopolies – Standard Oil, Alcoa, United Shoe Machinery, du Pont (for cellophane and titanium dioxide), IBM and most recently Microsoft – the complaint has been not of too little innovation, but rather of innovation so sustained and targeted as to exclude potential rivals.

As a result, the greatest productive and/or dynamic inefficiency associated with monopoly is likely to arise from regulation, rather than from the fact of monopoly *per se*. This effect is most obvious when cost-of-service regulation effectively removes the incentive the firm would otherwise have had to increase productivity, by eliminating the economic profit that those increases in productivity would otherwise have given rise to.[25] Indeed, to the extent to which Averch-Johnson effects are at work, the regulated monopolist will have incentives to pad its cost base.

In principle, there are two ways in which these inefficiencies could be dealt with. The first of these relies on **punishing** the firm for excess costs through periodic exposure to asset stranding; the second on **rewarding** the firm when it seeks out and implements measures that reduce costs.

From an economic point of view, the punishment model has little to recommend it. Virtually by definition, the regulator is less well informed about opportunities to reduce costs than the regulated firm; as a result, the regulator will err more frequently in determining whether costs could or could not be reduced. In turn, a higher incidence and extent of error will have at least two effects: for a given expected penalty, it will reduce the incentive to be efficient (as some part of the penalty will be suffered even if the firm is not inefficient); and to achieve a given level of efficiency (or more properly, to deter any given level of inefficiency), a higher penalty will be required.[26]

These penalties are not costless in social terms. To begin with, investors cannot fully insure against these risks. This can be seen by noting that an investor could so insure if the penalty to the regulated firm were fully offset by gains to other firms captured in the market portfolio – if for example, the losses imposed on Telstra were fully offset in gains to Optus. However, to the extent to which the gains flow to final consumers, insurance against stranding through portfolio diversification will be incomplete. As a result, barring third-party insurance (which is not likely to be available because of moral hazard problems) the firm will need to self-insure. Given investor risk-aversion, and losses to the regulated entity that are large (both absolutely and relative to the gains to any individual consumer)[27], the

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rule as any other firm, that rule being most simply expressed as: purchase the new asset once the anticipated average total cost of the new asset is below the anticipated variable cost of the existing asset.

[25] As a general matter, an unregulated monopolist whose costs decrease will reduce its prices, but its profits will increase. Conversely, when the unregulated monopolist's costs rise, its prices will rise, but not by enough to prevent profits from falling. As a result, an unregulated monopolist faces incentives that point in the right direction – that is, to seek cost reductions and avoid cost increases. In contrast, a firm subject to pure cost-of-service regulation will be insured against cost increases, and will receive no additional profits from cost decreases. Indeed, if Averch-Johnson effects are at work, a reduction in its asset base will deprive the firm of economic profits.

[26] Kaplow "The Value of Accuracy in Adjudication: An Economic Analysis" 23 Journal of Legal Studies (1994) 307-401. Note that the deterrent value of a sanction depends not on the extent of that sanction, but on the expected value of the difference between the sanction imposed on innocent relative to non-innocent conduct.

[27] The extent of stranded asset risk to which regulatory decisions expose firms can be gauged from the fact that the allowed cost base for Telstra's recovery of universal service costs was reduced, as a proportion of revenues obtained in universal service areas, by 20 per cent as between 1997/98 and 1998/99.

cost of that insurance could be high. Under any rule that allows capital maintenance, that cost must ultimately be passed on to consumers.

Second, even if investors could insure against stranding risk, it is not obvious that managers (whose human capital is tied up in the firm, and whose renumeration is likely to depend on the firm's performance) could.

Third, the combination of investor and management exposure to stranding risk could readily result in incentives which defeat the very purpose of exposing the firm to the risk in the first place. More specifically, investment in innovative projects will be deterred, if these are especially likely to be subsequently stranded. Additionally, to the extent to which the firm itself signals, through its decision to adopt new technologies, the range of cost-reducing choices available to it, adoption decisions will be affected by the impact they have on the valuation of the firm's outstanding assets.[28] As a result, cost-reducing innovations will be introduced later than they otherwise would. Finally, to the extent to which the firm has any control over depreciation schedules, it will have incentives to depreciate assets too quickly, thus distorting the pattern of demand. The net effect will therefore be to increase supply costs and shift demand in ways that have no economic justification.

In contrast to the punishment model, an approach based on rewarding the firm for cost reduction requires that the firm be allowed to retain the income that cost reduction permits for some specified period of time. While determination of the optimal form and duration of such a reward is obviously a complex matter, it is clear that the main cost of such an approach is the fact that it allows the regulated firm to earn economic profits.[29] These correspond to a rent the firm secures on its superior information relative to the regulator.

It is questionable whether the economic costs of these rents could be high, especially when compared to the costs of the punishment model. The rents are only earned because the firm has freed resources for other uses. Moreover, with demand relatively inelastic, and the firm free to price discriminate among consumers, any allocative efficiency distortions are likely to be small.

This suggests that valuation approaches in which optimisation and the writing down or out of designated assets play an important part are not likely to be selected in any *ex ante* choice oriented to economic efficiency. Nonetheless, if such approaches are selected, it is important that they be implemented properly. Two errors are very frequently made in this respect.

The first arises from the failure to take proper account of adding up constraints, especially in applying "value to the owner" approaches or ODV. The difficulty here is that these approaches calculate the value of each segment (where segments correspond to distinct elements of service potential) as the lesser of replacement cost or economic value. The value of the combination is then defined as the sum of the segment estimates. The "replacement

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[28] In valuation on a Total Service Long Run Incremental Cost basis, for example, the technologies used in asset valuation are determined through a "best in use" test. This implies that the firm, in introducing a new technology, makes it available to the regulator as a valuation base. As a result, in calculating the cost of introducing a new technology, the regulated firm will take account of the income loss associated with any reduction in the valuation of existing assets.

[29] There can also be economic costs when say a price cap replaces pure rate-of-return regulation with no asset stranding. These arise because the cap exposes the firm to the risk associated with input price shocks, which it is insured from in pure rate of return regulation.

cost" of a segment for these purposes is defined as the difference between (1) the cost of replacing the combination of segments and (2) the cost of replacing all segments except that at issue. Equally, the "economic value" of a segment is defined as the difference between (1) the economic value of the combination of segments and (2) the economic value all segments except that at issue. Now, it is apparent that where there are economies of scale and/or scope, any sum constructed from the sequence of these valuations will not result in capital maintenance.[30]

Second and no less important, careful attention needs to be paid to the calculation of operating and maintenance outlays in implementing replacement cost accounting. In particular, there is a tendency to adjust allowed operating and maintenance outlays to the levels they would attain were old assets actually replaced by their modern equivalents. However, this is only correct if the depreciation provision is calculated in a special way. More specifically, the depreciation provision needs to account for the net present value of the difference between operating and maintenance outlays under the equipment actually in use and that associated with its replacement.[31] Whenever the depreciation provision is not calculated in this way, but O&M costs are determined by reference to hypothetical assets, capital maintenance can only be achieved by accident.

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[30] To see this, let

$$RC(j) = \sum_{i=1}^{N} RC(i) - \sum_{i \neq j} RC(i) \cdot$$

Then, with economies of scale and/or scope

$$\sum RC(i) < RC\sum(i),$$

where it is the latter term that is relevant for capital maintenance. Equally, define the economic value of a segment such that:

$$EV(j) = EV\sum_{i \in j}(i) - EV\sum_{i \neq j}(i).$$

Then again with economies of scale and/or scope,

$$\sum EV(i) < EV\sum(i).$$

Moreover, as a general proposition: $sum(\min(rc, ev)_i : i = 1,..., N) \neq \min(sum(rc, ev)_i : i = 1,..., N)$.

[31] To see this, consider the depreciation in period 1 of a car whose allowed operating expenses will be calculated for period 2 according to the operating expenses associated with a hypothetical modern equivalent alternative. Moreover, assume the modern equivalent has lower fuel consumption. At the time the existing car is purchased, the owner must be assured that all the costs associated with running the car will be recovered. This is only possible if the depreciation provision for period 1 includes the net present value of the difference between the car's actual fuel expenses over its life and those allowed to it under the modern equivalent put in place at the period's end.

Treatment of capacity costs

An issue closely associated with optimisation is that of the treatment of capacity costs when capacity comes in lumpy increments. In these cases, efficient provision of service potential will generally require some pre-provisioning, in which the capacity provided exceeds instantaneous demand.

In principle, the costs of this capacity are essentially a joint and common costs to the periods which the assets at issue will serve. As with other common costs, a variety of allocation approaches exist, including some specifically designed for the inter-temporal sharing of costs. Those based on economic analysis generally relate the costs being allocated to each period to that period's willingness to pay, subject to the constraints (1) that no period or combination of periods bears a revenue burden in excess of the stand alone cost of serving demand in that period and (2) that each period or combination of periods recovers at least the incremental costs associated with its demand. Specific methods that can be employed include smoothed Ramsey-Boiteux allocations[32], the "rational customer" rule (which allocates to each period an amount based on the willingness of a customer to *ex ante* contract for the cost allocated to that period[33]) and the "golden rule" used in fiscal theory to allocate the tax burdens among over-lapping generations[34].

Regardless of which of these approaches is used, consistency of application requires that costs deferred to future periods ultimately be brought to account. These costs will consist of the deferred rental and depreciation charges associated with the capacity that is treated as excess to current needs, to which must be added the future value (that is, the value at the time when these charges are brought to book) of any maintenance outlays expended on that capacity. It is only if costs will ultimately be thus recovered that investors would, ex ante, accept a rule that involved cost deferral.

As a result, the use of any valuation approach that distinguishes as between "necessary" and "excess" capacity must be accompanied by the construction of a balance sheet item to which the costs of "excess" capacity are posted and from which they are ultimately brought to account. Again, if the valuation approach adopted departs from this principle, consistency with a freely chosen *ex ante* income rule can be achieved only by chance.

Conclusions

This paper starts from the presumption that asset valuation rules, to be acceptable to investors on an *ex ante* basis, would have to make investors no worse off from investing in the regulated firm than they would otherwise be. In any firm, regulated or not, investors will only invest in an asset if the expected revenue stream corresponding to that asset will allow them to maintain their financial capital intact. Where the investment is in a regulated firm that has an obligation to meet demand at regulated prices, the revenue stream must

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[32] See Rolla Park Incremental Costs and Efficient Prices With Lumpy Capacity (1993).

[33] Kaplan and Cooper Cost & Effect (1998) at 131 and follows.

[34] See Musgrave "Public Debt and Inter-generation Equity" in Arrow and Boskins (ed.s) The Economics of Public Debt (1988) 49; and Robinson "Measuring Compliance With the Golden Rule" 19 Fiscal Studies (1998) 447-462.

also be sufficient to maintain intact the service potential needed to discharge the regulatory obligation. It follows that the ex ante income bargain must provide for the revenue stream corresponding to the **greater** of financial and physical capital maintenance. This principle is then used to consider a number of difficult issues that arise in asset valuation, including the choice of starting position (essentially, the treatment of sunk assets), the role of optimisation and the recovery of the costs of capacity that is not needed in the current period. In each case, an approach is proposed that is consistent with ensuring capital maintenance.

In examining each of these issues it is apparent that the regulator cannot hope to assess the adequacy of the revenue stream accruing to the regulated firm without a consideration not only of an income statement but also of a balance sheet. Issues such as the adequacy of depreciation provisions, the incidence of asset stranding or write downs, the extent of capacity cost deferrals and recoveries, cannot be gauged in terms of flows alone – rather, they require careful accounting for stocks. As a result, a well-articulated linkage between the income statement in each period and the entity's balance sheet needs to be specified and implemented. Ideally, this should include consideration of transitional issues, when accounting changes are implemented – such as the shift from one valuation basis to another.

In practice, the ACCC seems to place very little weight on ensuring consistency between the process of determining allowed revenue in any period and the entity's overall balance sheet. In telecommunications, for example, the Commission has deferred capacity costs as between periods without any consideration of how the costs thus being deferred will ever be recouped. Seen more generally, this lack of attention to investors' balance sheet position seems to reflect a degree of disregard for the constraint of capital maintenance.

This is not to say that the valuation approaches adopted by the ACCC are necessarily inconsistent with capital maintenance. At least in principle, it is possible to reconcile DORC and even TSLRIC with capital maintenance; but this requires great care in their implementation – for example, in the treatment of the issues considered above. Moreover, it requires a set of control tools – in terms of maintaining an income statement that measures both entity and proprietary profit, and a balance sheet articulated with that income statement – that the ACCC has not as of yet sought to construct. As a result, an outcome consistent with capital maintenance cannot be assured.