Brief Response to Questions Raised by the Productivity Commission

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1. Are outcomes under (indexed) DAC significantly different from those under DORC?

With Regard to Existing Assets.

To the extent that indexed DAC is less than DORC, there will be a significant tariff effect. If as observed by Davis (1999) capital costs based on DORC typically make up 70% of the tariff stream, a DAC valuation equal to 75% of DORC will bring about an immediate tariff reduction of 17.5%. More generally, if DAC=DORC×k, the tariff reduction is 100[1–(0.7k+0.3)]%. For example:

DAC as a proportion of DORC	*Tariff Reduction*
0.9	7%
0.8	14%
0.7	21%
0.6	28%
0.5	35%

With Regard to New Assets

The underlying economic rationale of the tariff model is that asset owners earn a "market" rate of return on their investments. This is achieved equally whether new investments are brought onto the regulatory balance sheet (RAB) at DORC or DAC; or more precisely at ORC or AC, since for new assets there is no depreciation. Moreover, for a new asset RC=AC by definition, and assuming the investment is "optimised" (i.e. there is no lower cost way to get the same result), ORC=OAC=AC. Provided that subsequent asset revaluations are precluded under either an ORC or AC approach, it makes no difference practically whether the amount spent on new assets, and added to the RAB, is called RC or AC (ORC or OAC). Either way, the PV of the ensuing tariff stream is equal to the cash amount invested and hence the NPV (at r=WACC) is zero, as expected of an efficient capital market.

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2. Would adopting a DAC approach yield appropriate investment incentives?

Given that for new assets DORC≡DAC, it is curious that a view persists that unless regulators adopt DORC, there will be insufficient incentive for asset owners to invest. It is clearly in the asset owners' interests that regulators work under this presumption. From their standpoint, any use of DAC, even if only for new assets, would leave the gate open for a shift away from DORC for existing assets also, and hence possibly large tariff losses (see above). This would explain why the premise that DORC is a pre-requisite for new investment has been voiced so frequently during the Australian regulatory debate. Less explicably, however, regulators seem to have accepted the investment inducing advantages of DORC on technical grounds.

For there to be any difference between DORC and DAC in regard to new assets, regulators must envisage that DORC and DOAC asset values (and thus periodic tariff flows) will not remain the same over time despite their initial equivalence. This could be for two reasons. The first is that DORC and DAC depreciation patterns may be different. This is a likely explanation given that the ACCC advocates "competition depreciation" as essential to DORC, but not DAC. Of itself, however, a difference in depreciation flows makes no difference to the NPV of the tariff stream (see above) and hence does not explain why DORC rather than DAC is technically necessary to secure new investment. A better explanation is that regulators foresee subsequent asset revaluations (book value increases without new investment) under one approach but not the other, or by different criteria under the two valuation schemes. Indeed, in its *Draft Statement of Principles*, the ACCC clearly acknowledged its anticipation of periodic DORC revaluations:

> The NEC [National Electricity Code] does not preclude the regulator from periodically revaluing the regulatory asset base according to a valuation methodology such as DORC. (ACCC 1999, p.49)

The Admissibility of Future Revaluations. The "no free lunches" principle rules out asset revaluations – that is, increases in RAB by mere book entry – unless these are treated as income, using the extention of the usual tariff equation explained above. There is, however, some confusion surrounding this principle, caused by the regulators' determination of WACC in real (i.e. net of inflation) terms, and the technical mechanism used to achieve this effect.

There are two methods by which to calculate the "return on capital" element of the tariff formula so as to lock in a given real rate of interest. The first is to leave the initial RAB unchanged (except for period depreciation) and multiply this figure by the nominal interest rate equivalent to the given real rate. For example, to achieve a real rate r_r, the RAB is multiplied by the nominal rate

$$r_n = (1 + r_r)(1+i) - 1$$

where i is the rate of inflation.

The second method, thus far generally adopted by regulators, is to first "inflate" (i.e. re-scale) the RAB by multiplying it by $(1+i)$ and then multiply this new RAB figure by the given real interest rate r_r. The result (dollar amount) is obviously the same using either mathematical approach. The disadvantage of the regulators approach is that it gives the impression of breaking the "no revaluations" principle.[1] Whether in fact it does depends on answers to the following two questions:

(i) Is the criterion that new investment earn NPV=0 intended to hold in nominal or real terms? If it is determined that the appropriate ("market equivalent") return to investors is some fixed *real* rate (e.g. 7.75% real), then increasing RAB by the inflation factor $(1+i)$ before multiplying by that interest rate is admissible, and technically does not break the NPV=0 (no revaluations) rule. Whittington (1997, p.6) understood that this is what was intended when he argued that asset users bear all inflation risk.

(ii) Is it intended that the Tobin's q argument will be applied continuously over time rather than merely as a way to get an initial RAB? The dynamic rather than static application of q would involve repeated DORC revaluations, applicable whenever the cost of entry (asset replication by a competitor) increases. Revaluation according to this criterion amounts to inflating RAB not by a general price index (such as the CPI) but by an industry (asset) specific index. The scale factor is not $(1+i)$ but something much more narrowly related to the construction costs of the specific infrastructure assets in question (and therefore much more subjective). Changes to RAB made on this basis are likely to break the "no free lunches" (NPV=0) rule. If the replacement cost of infrastructure assets rises by more than the general inflation rate, then the asset owner gains a tariff increase in real terms and thus a real NPV windfall. The reverse is also true, meaning that in theory the owner runs the risk of asset replacement costs, and thus tariffs, not keeping pace with inflation.

Depending on the answers to these questions, the relative effects of DORC versus DAC in regards to new investments can be summarised as follows.

(i) If DAC and DORC are inflated according to the same price index – say the CPI – then the corresponding tariffs flowing from new investments will always be the same (assuming the same depreciation scheme).

(ii) If DORC is inflated according to an industry (asset) specific index and DAC according to a more general price index such as the CPI ("indexed DAC"), the choice in regard to new assets between DAC and DORC is effectively a choice between tariffs anchored to the CPI and tariffs based on industry specific price shifts. This amounts to a choice between two different inflation rates. These rates might differ markedly if for instance new technology was to reduce the price (replacement cost) of energy transmission infrastructure assets while asset prices in the wider economy increased. Generally, however, both sets of prices are likely to increase, in which case the tariff effect of a choice between DAC

[1] Aware of this problem, some regulators have shifted calculations onto an explicitly nominal basis (i.e. dollar return on capital = nominal RAB × nominal WACC); see for example the discussion in ACCC (1999, pp.24, 32) and the calculations of IPART 2000, p.112.

and DORC for new assets will tend to be small compared to its effect in regard to existing assets

The results above indicate that DORC has no theoretical advantage over (indexed) DAC in encouraging new investment. Apart from any differences caused by different depreciation schemes, DAC based tariffs will follow a similar pattern over time as those based on DORC. Both will increase with price increases, DAC with the CPI and DORC with whatever index or revaluations are allowed by regulators. Indeed, an investor who does not want to risk real tariff reductions as a result of technical advancements (reductions in infrastructure costs) will prefer DAC over DORC. If DORC has any advantage as far as encouraging new investment, it is that asset owners will see it as more able than DAC to be manipulated upwards at a rate in excess of general price increases. This is, of course, hardly the kind of advantage that should be welcomed.

3. Will prudence reviews be a cost-effective way of addressing concerns about cost padding under DAC?

The potential for cost padding is no different under DAC than DORC. This presumes that DAC is actually DOAC (depreciated optimised actual cost) for the same reasons of preventing cost padding as DRC is redefined as DOAC. The process of prudence reviews or "optimisation" is not something applicable only to replacement cost (RC) asset valuation. It applies just as effectively (or ineffectively) to actual cost (AC) valuations.

Either way, it is the regulator's job to determine whether new investment is "optimal" or overkill.

If anything, the incentive for gold-plating and cost-padding is greater under DORC than DOAC, because of the potential under DORC for future upward re-valuations. The asset owner will be motivated to get as much new investment as possible onto the RAB (regulatory asset base), with the thought that later this will be revalued upwards and produce an even more inflated tariff stream.

Asset Valuation and Regulation of Energy Infrastructure Tariffs in Australia: The Use and Deficiencies of DORC

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1. Introduction.

In Australia, the owners of energy transmission infrastructure assets (e.g. gas pipelines and electricity grids) are natural monopolists safe from any practical economic risk of private sector investors or governments replicating the main trunks of their transmission networks. Following the principles set down in the *Report on National Competition Policy* (Commonwealth of Australia, 1993), Federal and State governments have established "access regimes" to enable other companies, including downstream users and possible competitors in energy supply markets, to access (i.e. rent) part of the capacity of these otherwise monopolised assets. Arrangements between asset owners and asset users are on an essentially commercial basis, intended to bring about competition in energy supply markets and reduce downstream energy costs. In exchange for access to their networks, asset owners are paid transmission tariffs according to overall amounts and structures determined within the administrative responsibilities of independent regulatory agencies, including primarily the *ACCC* (Australian Competition and Consumer Commission), *ORG* (Office of the Regulator-General, Victoria) and *IPART* (Independent Pricing and Regulatory Tribunal of New South Wales).

Federal government industry policy on tariff determination written into the national electricity and national gas codes, and reaffimed by the ACCC (1998, pp.6-15; 1999, pp.viii-xiv), requires that tariff settings be "cost-reflective" and generally consistent with prices in efficient and competitive markets (Productivity Commission, 2001 p.198). These overriding but otherwise imprecisely articulated criteria leave regulators with wide discretion but also with the difficult task of contriving market-like outcomes where there are no actual markets. The fundamental problem is one of logical circularity – tariffs cannot be fixed at levels consistent and fair in relation to the market value of the services (energy load transmission) and service infrastructures (pipelines etc.) when in fact those market values are only determined once tariff levels are set. There is no observable market for energy transmission services independent of the regulators own decisions. Nor can regulators look to the capital markets for benchmark asset values and yields, because where observable these depend in turn on the market's observations of the regulators (i.e. on expected tariff outcomes).[1]

Undaunted by this inherent circularity, regulators have developed and relied almost exclusively on a model claimed to emulate market determinations, and described as the "building block approach" (ACCC 1999, p.x; Productivity Commission 2001, p.209). Put simply, this model categorises the period costs of owning (financing) and operating the necessary transmission infrastructure assets and adds these together to give a maximum or upper limit (a "price cap") on allowable period tariff revenue. In general, total period costs are taken as the sum of *operating costs* and *capital costs*, where "capital costs" are defined as (i) depreciation (i.e. loss of asset value) plus (ii) the opportunity cost – that is, foregone return – caused by tying up capital (asset value) in non interest bearing physical (infrastructure) assets.

[1] Walker et al. (2000a) note that this circularity problem has long been recognised within rate-of-return price setting and regulatory regimes; several references are provided, beginning with Bonbright (1937).

Expressed as a formula, the maximum allowable tariff revenue (MAR) in period t is

$$operating\ expense_t + depreciation_t + opportunity\ cost_t \qquad (1)$$

where depreciation_t is the loss in asset value $V_{t-1} - V_t$ over period t (however measured) and *opportunity cost*$_t$ is the dollar return on capital that could have been earned had the period opening asset value V_{t-1} been invested elsewhere for the duration of the period (ACCC 1999, pp.x-xiv). The intuitive justification for this formula is that asset owners are reimbursed for their (efficient) periodic operating costs and for any consequential loss of capital (depreciation), and rewarded at a specified rate of return, determined by the regulator, for their use of capital, as would fairly be expected of a rational and competitive capital market.

The regulators' tariff formula averts any circularity problem by defining entity asset value in an "accounting" rather than "economics" way as a sum of "book values", or in other words, by applying a "balance sheet" approach to the valuation problem. Individual asset book values are measured on a basis independent of the asset's use in regulated energy transmission. Possible valuation bases are current market realisable (scrap) value, "historical" or actual cost, current replacement cost and "deprival value" (a variant of replacement cost). Of these, the later has been actively considered by regulators, but rejected because of its inherent reference to future cash flows (tariffs) and hence the circularity problem (ACCC 1999, pp.x-xi).[2] Each of the other three bases of valuation applies without any circularity – specifically, the amount that an asset (such as say a pump or a pipe) cost when it was acquired, or would cost to replace, or could be removed and sold for, does not depend on how it is currently being used, or moreover on what tariffs it is helping generate.

Having escaped the circularity issue, any of these three possible valuation bases might have been adopted within the "building block approach". However, from the start and with little apparent reservation, there has been consensus between the major regulators, particularly the ACCC and ORG, that the single universally appropriate valuation basis for tariff setting is current replacement cost, or more specifically *depreciated optimised replacement cost*, commonly abbreviated to DORC. By definition, the DORC of an asset is the written down replacement cost of its optimal or most efficient (in an engineering sense) replacement. How (by what rule) it is written down ("depreciated") is another issue and generally open to negotiation, although an algorithm called "competition depreciation" has lately been endorsed by the ACCC (1999, pp.59-61, 65-70).

The Australian regulators' acceptance of DORC has significant economic and political consequences, and has attracted both support and annoyance from within the industries and companies affected. The main issue, immediately obvious to academics who have watched the waxing and waning over three decades of current cost accounting (CCA)

[2] Walker et al. (2000b, p.132) note that in Australia "[t]he deprival value accounting variant of replacement cost has become the dominant public sector accounting method". The institutional history of the emergence this concept is documented in Clarke (1998) and Walker et al. (2000a).

proposals in the private sector, is that DORC valuations tend to inflate asset book values (relative to either historical cost or market realisable value) and hence to increase any related measure of the asset owners' "capital costs", thereby increasing the regulated tariff stream flowing from energy users to transmission asset owners. The ready appeal of DORC-based tariff streams to incoming (and incumbent) asset owners has assisted governments, particularly the State government in Victoria, to maximise the proceeds from infrastructure privatisations. Moreover, the direct connection between prices gained from the sale of infrastructure assets and the basis on which they are valued on paper (on the regulatory balance sheet) has undoubtedly brought much political pressure on regulators to adopt and endorse DORC, and must in part explain why they have generally appeared so committed to its application.[3]

The economic, political and social consequences of regulators' general reliance on DORC asset valuations are clearly very significant. At worst, there is the potential to hamstring present and future Australian industrial development by inflating the costs of energy to downstream producers, thus unnecessarily rationing their use of existing energy transmission networks and known energy reserves. On the other hand, transmission asset owners have argued that an asset valuation base which leads to lower tariffs will jeopardise their profitability and threfore stifle growth and investment in new infrastructure.

Given the import of these considerations, it is essential that there be proper review of the Australian regulators' adoption and advocacy of DORC asset valuations. The purpose of this paper is to contribute towards such a review. In particular, the paper reconstructs the regulators' conceptual framework, including particularly the role of DORC in the tariff formula, and questions the analytical arguments that have been put for DORC and expressly endorsed by regulators in their published proceedings. A secondary objective of the paper is to bring to the notice of regulators and others involved in the tariff setting debate relevant aspects of the established literature on replacement cost valuation in accounting, emphasizing particularly the problems caused by their innate subjectivity.

The most contentious and consequential regulatory asset valuation decisions are to do with "sunk" (already existing) assets. Assets yet to be built (new investments) will come on to the regulatory asset base (RAB) at the same dollar amount irrespective of whether the asset valuation basis is (depreciated) actual cost (known as DAC) or replacement cost (DORC). Although the subsequent treatment of those assets' values may not be the same (see section 7 below), the likely tariff consequences of the regulator's choice between DAC, DORC and other valuation rules are relatively less significant or at least further into the future for new assets than for those already existing. Because of the priority and precedent attached to the issue of valuing the initial asset base (RAB), this paper is primarily about the valuation of existing assets.

[3] See, for example, the Victorian State Treasury submissions, emphasising the validity and importance of DORC, to the ORG/ACCC joint enquiry on the Victorian Gas Distribution Access Arrangements (Final Decision 6 October, 1998; ORG (1998) and ACCC (1998))

2. The Regulators' Tariff Equation

The "building block approach" equation (1) for *MAR* can be written as

$$operating\ expense_t + (V_{t-1} - V_t) + V_{t-1}\, r \qquad (2)$$

where r is the effective rate of return on capital granted to the asset owner by the regulator. In principle, this percentage return is meant to equal the asset owner's *weighted average cost of capital* (WACC), or in other words the risk-related rate of return demanded of such an investment by a competitive and theoretically efficient capital market.

The regulators' discretionary determination of WACC (set at a real rate of return of 7.75% in the ACCC/ORG 1998 determinations) has been as controversial, and subject to the same political lobbying, as their reliance on DORC. Again there is an issue of logical circularity since the market required risk-adjusted return on investment in energy transmission assets hinges on the regulators' choice of, and commitment to, a given figure for WACC, and to the risk of changes to regulatory arrangements in the future ("regulatory risk"). There are however more relevant external benchmarks for WACC than for RAB, such as for example typical market rates of return on "blue chip" assets, and the rates of return earned by similar entities in other countries. Nonetheless, there is no obviously correct or fair answer for WACC and the regulator can only adjudicate between the various affected parties disparate and obviously self-interested views. References on the recent Australian regulatory debate over WACC include Davis (1999a; 1999b).

Replacing the corresponding terms in (2) with the acronyms RAB and WACC, the regulator's tariff equation is written in its now familiar form as

$$operating\ expense_t + (RAB_{t-1} - RAB_t) + RAB_{t-1}\ WACC. \qquad (3)$$

3. Theoretical Foundations of the Tariff Equation.

The tariff formula can be rationalised in terms of NPV, using the mathematical reconciliation between cash and "accruals" measures of capital costs proved by Peasnell (1981, pp.53-4) and Edwards et al. (1987, pp.12-31), and elaborated upon in the literature on "clean surplus" accounting (e.g. Peasnell 199?) and "economic value added" or EVA©.

Specifically, after being re-imbursed for their periodic operating expenditures (e.g. wages etc.) asset owners receive net cash (tariff) flows in period t equal to

$$(RAB_{t-1} - RAB_t) + RAB_{t-1}\, WACC.$$

Discounting this cash flow sequence at rate r=WACC, the discounted net present value (NPV) of the tariff stream to asset owners is

$$NPV = \sum_{t=1}^{T} \frac{(RAB_{t-1} - RAB_t) + RAB_{t-1} WACC}{(1 + WACC)^t}$$

where $t=T$ represents the time at which the regulatory asset base is fully depreciated ($RAB_{t=T} = 0$).

Simplifying this equation as follows

$$NPV = \frac{(RAB_0 - RAB_1) + RAB_0\, WACC}{(1 + WACC)^1} + \frac{(RAB_1 - RAB_2) + RAB_1\, WACC}{(1 + WACC)^2} + ...$$

$$..... + \frac{(RAB_{T-1} - RAB_T) + RAB_{T-1}\, WACC}{(1 + WACC)^T}$$

$$= \frac{RAB_0(1 + WACC)}{(1 + WACC)} + \frac{RAB_1(1 + WACC) - RAB_1(1 + WACC)}{(1 + WACC)^2} + ...$$

$$..... + \frac{RAB_{T-1}(1 + WACC) - RAB_{T-1}(1 + WACC)}{(1 + WACC)^T} - \frac{RAB_T}{(1 + WACC)^T}$$

$$= RAB_0 \qquad (4)$$

reveals that the NPV of the regulated tariff stream, calculated at discount rate equal to the regulated WACC, is equal to the amount of the initial (t=0) RAB. This result makes obvious the asset owner's economic imperative for negotiating the highest possible initial RAB. If the regulated WACC is in fact the true cost of capital, then the NPV of the ensuing tariff stream is exactly equal to the RAB granted by the regulator.

Three further results follow immediately:

(a) any asset revaluation agreed to by the regulator amounts to an NPV "gift" to asset owners equal to the amount of the (upward) revaluation. To prevent this "free lunch" the regulator must either prohibit asset revaluations or treat them explicitly as income in the tariff equation, thus reducing period tariffs in the period of the

revaluation by the amount of that revaluation. The expanded tariff equation satisfying this requirement is

$$operating\ expense_t + depreciation_t + opportunity\ cost_t - revaluations_t.$$

(b) any new investment in infrastructure assets by asset owners offers NPV equal to the difference between the corresponding increase in the RAB and the actual cash amount invested. To fix this incremental NPV equal to zero, as is characteristic of an efficient capital market, expenditure on new assets must be brought onto the regulatory balance sheet at actual cost (which is, of course, also the then replacement cost of the new asset).

(c) NPV is a constant regardless of the time pattern of depreciation. It makes no difference over what interval assets are written down, or how aggregate depreciation expense is distributed within this interval – that is, NPV=RAB_0 whatever the depreciation scheme. This observation traces to Preinreich (1938); cf. Schmalanesee (1989), Whittington (1997, pp.9,11) and Davis (1999a, pp.7-8; 1999b, p.2).

Analogy with a Bank Account. The financial effect of the regulators' tariff equation can be described intuitively as follows. In essence, the regulator creates a "bank account" in the name of asset owners of initial amount RAB_0. Against this account, owners are paid periodic interest at effective interest rate WACC (as granted by the regulator). Interest is calculated on the period opening RAB value. Each period the RAB or account balance falls by the amount of depreciation in that period. This sum is paid to the asset owner, and equates to a cash withdrawal from the asset owner's interest bearing account. In aggregate, the period tariff includes both a sum of interest ("return on capital") and a withdrawal ("return of capital"). When at $t=T$ all capital is withdrawn (RAB=0), cash flows (tariffs) cease. In practice RAB will likely never approach zero, because the asset owner will over time make further investments in its infrastructure assets. The amounts spent on new assets will have the same effect as cash deposits into the owners "bank" (RAB) account. Each further deposit (asset acquisition) will earn interest until fully withdrawn through asset write-downs (depreciation). An important aspect of this analogy is that all interest is paid out in cash – none accumulates in RAB. The only way to add to RAB is to invest in new assets.

The Issue of Depreciation Scheme. The economic incentives of the asset owner in relation to its chosen depreciation scheme are straightforward. Depreciation is a return of capital out of the pool (RAB) earning a regulated ("guaranteed") rate of return (WACC). If the regulated WACC is acceptable – or more than acceptable – then the asset owner will want to depreciate its assets only minimally or not at all. The reason for this is that once a depreciation expense is recognised, the owner is "paid out" that amount and hence does not earn a WACC return on it anymore. Note that neither the NPV of the investment nor its IRR (here equal to the regulated WACC) is affected, only its duration. All else equal, an investment returning a high IRR (regulated WACC) will be extended as far as possible. This is achieved by minimising and thus effectively postponing ("back-loading") depreciation write-downs.

Constraining the service provider's economic incentive, in circumstances of a favourable WACC determination, for minimal depreciation (maximum RAB) is its obligation to pay dividends. Asset write-downs provide cash flow and in this way are advantageous. Ultimately the asset owner will have to compromise between its competing desires of maximising the asset pool earning the regulated WACC and at the same time paying a stream of dividends to shareholders of sufficient amount and consistency. All arguments about depreciation algorithms (e.g. straight line, "economic life", "CCA depreciation", "competition depreciation"; cf. Davis 2000, pp.4-6; King 2001) should be seen in this light.

4. Private Sector Rejection of RC Valuations as Too Subjective

DORC and its close relatives (DRC and "deprival value") have a long and exhausting history in the accounting literature. During the era of high inflation in the 1970s and 1980s there was a strong push in the UK, Australia and New Zealand for shifting the basis of external financial reporting in the private sector away from the traditional historical cost (DAC) framework onto a replacement cost (RC) footing. Ultimately, after extensive scrutiny, the RC proposal was defeated from both within and outside the accounting profession. This was for a multitude of reasons, of which perhaps the most telling was the inherent practical difficulty of measuring the RC of assets in any way "objective" or independently verifiable,[4] and hence the latitude for management interference in the asset values and related cost measures:

> There is no way in which the resultant income and capital measures can be treated as being independent of management. (Peasnell 1984, p.192)

Because of their subjectivity, Whittington, a stalwart of the RC debate and an avowed in-principle supporter of RC for financial reporting purposes (although not tariff regulation), effectively dismisses the possibility of RC methods becoming standard financial accounting practice:

> The accounting standard perspective suggests that CCA [replacement cost accounting] is, at best, a remote prospect as standard accounting practice in the UK. Systematisation of the valuation base, to include more current values, possibly on a VTB [deprival value] basis, has been proposed rather tentatively. However, the subjectivity of such valuations, especially for specific operating assets, such as plant and machinery, is likely to rule them out as standard practice for some time. (Whittington 1994, pp.88-101)

DORC is Unauditable. Auditing in the sense of *independent corroboration* (cf. Wolnizer 1987) is impossible with DORC. No two firms of valuers working independently can be expected to come up with equal or even nearly equal DORC

[4] There were also problems with finding any workable concept of financial or operating "capital". These are largely irrelevant here because the tariff equation has its theoretical justification not in an accounting concept of "capital maintenance" but in its reconciliation with the NPV (economic value) of the tariff stream.

valuations. The problem is that DORC valuations embody multiple subjective and at worst completely arbitrary choices, and can only be verified when these are specified and then taken as given. In the end, the only independent verification is of the arithmetic.[5]

The unavoidable discretionary choices that underlie all DORC valuation occur in response to the following problems:

(a) the *asset definition* problem. The cost of replacing an asset depends on how that asset is defined. Is it the physical item in question (e.g. a pipe) or it's future "service potential" (the latter is the usual accounting definition of an asset). Since the measurement required is ORC rather than RC, it is implicitly the latter. But what specifically constitutes "service potential", and for how long and to whom, and by what measure? This raises the issue of expected useful life. Just how much service potential does an existing asset have left? Is it 25% or 55% depreciated in this regard? Will it be bypassed and will the energy (e.g. gas) available at its source remain economically extractable? Who can say, and on what objective grounds? There are no objective (uniquely sensible) criteria on which to answer any of these questions. The valuer has no alternative but to rely on discretionary "professional judgement" and therefore retains the ability to arbitrarily affect the bottom line.

(b) the *optimisation problem*. By what engineering criteria is an asset or arbitrary grouping of assets optimised? How far is the engineer allowed to go in hypothetically re-designing the asset base? Is it only a matter of fine tuning or should the engineer start with a blank canvass (e.g. greenfields Melbourne)? What customer base (throughput) is relevant, is it the current situation or a projection of demand in 5 or 25 years time? Does the notion of asset optimisation relate only to cost or more to a set of engineering parameters? If both, which should be given more emphasis? Moreover, if the notion of an engineering optimum depends on cost, is there a different optimum for every different cost level?

(c) the *quote variance problem*. If the valuer relies on just one estimate of the RC of a particular asset (however defined for the purpose of getting a quote) then the valuation is subject to high sampling error (variance). If a larger sample of quotes is drawn, which should be given the most weight?

(d) the *aggregation* or *non-additivity* problem. In general, the RC of a conjunction of assets $\{a, b, c, d, e\}$ is not equal to the sum of the RCs of the individual assets $\{a\}$, $\{b\}$, $\{c\}$, $\{d\}$, $\{e\}$. Nor is it equal to the sum of the replacement costs of any mutually exclusive and jointly exhaustive subsets of those assets, such as for example $\{a, b, c\} \cap \{d, e\}$. Moreover, by re-partitioning the asset set into another of its possible groupings, such as say $\{a, b\} \cap \{c, d, e\}$ or $\{a\} \cap \{b, c, d\} \cap \{e\}$, the aggregate replacement cost can be made arbitrarily higher or lower. To escape this arbitrariness, practitioners suggest that the appropriate asset bundling is that which minimises aggregate RC, a rule consistent with the notion of "optimised" RC. The

[5] Walker et al. (2000a) have recently shown up this deficiency in the financial reports of a string of water and electricity utilities in NSW. Whatever their theoretical appeal for the purposes of financial reporting, the endemic subjectivity and ultimate arbitrariness of RC valuations remains their Achilles heal.

problem with this criterion is that it generally leads to a very high level of aggregation. Natural economies of scale mean that hypothetical asset replacement cost is minimised, in the limit, when infrastructure is replaced as a "single" asset. But at such high levels of aggregation, RC quotes are bound to exhibit extreme variance from one estimate to another, based on different guesses about the potential economies of such large scale construction. The "least cost" rule is therefore ineffective in removing subjectivity and discretionary latitude from the bottom line. By culminating in the entirety of the firm's assets being defined as one, it effectively defeats the purpose of a "balance sheet" approach to asset valuation.

Bureaucratic Suppression of Criticism. During the private sector RC debate of the 1970s and 1980s, DORC style asset valuations were disparaged and ultimately rejected for their incorrigible subjectivity and inherent susceptibility to "creative accounting". There is nowadays a consensus among academics who endured this debate that little of what was learned has reached or been heeded by those now advocating RC for use in the public sector:

> ...what does seem to be unjustifiable is the apparent lack of a coherent approach to the issue of "current value" accounting in the non-business sector. There seems to have been no concerted effort to draw lesssons from the ultimately unfavourable attitude of business. The various regulations give the impression of as many ad hoc choices, sometimes leading to possibilities of opportunistic accounting policies, sometimes resulting in figures which even the entities involved have difficulty interpreting. (Camfferman, K. 1998, pp.???)

> Clearly those who have promoted the drift of both DV [deprival value] and ODV into the public sector have either not heeded that experience with CCA, DV and related concepts in the private sector, or did not know of it. If it is the former, then the public sector reformers must be considered to suffer a certain lack of candour. (Clarke 1998, pp.???)

RC based accounting has been promulgated at all levels within the Australian public sector. In 1994 the *Steering Committee on National Performance Monitoring* (SCNPM 1994) set out to institutionalise a RC framework by its publication and wide dissemination of asset valuation guidelines closely resembling those of the various CCA (current cost accounting) proposals of the 1970s. By supporting RC (in fact "deprival value") without qualification or reference to any of the relevant academic or professional literature, this publication (known as the "red book") effectively suppressed all existing criticism of RC valuation methods, thereby raising questions of the competence if not integrity of the political process that led to RC being adopted (cf. Johnstone and Gaffikin, 1996 and Johnstone and Wells, 1998). The same questions now arise in regard to the regulators' effectively unqualified and seemingly apolitical support for DORC. In all their various publications dealing with the asset valuation issue, there is no mention whatsoever that RC has a long history of rejection in the private sector.

The other more astounding precedent overridden by regulators, and curiously not mentioned in any of their written deliberations, is that in the USA where asset valuation for the purposes of tariff setting has a 100 year history and a vast literature, replacement cost based asset valuation has been either not taken seriously or considered and

rejected. The authoritative American text on asset valuation for regulation purposes, Bonbright et al. (1988, pp.296-8), rejects replacement cost valuation as being neither economically appropriate nor practically administrable. For example (see also later quotes):

> ...the answer must lie in a recognition by practical minded judges, commissioners, and experts, that estimates of the cost that would be incurred in replacing the service by means of a new type of plant if the existing plant were to disappear into thin air are altogether too speculative and too litigious for purposes of feasible administration. (Bonbright et al. 1988, p.298)

5. The Regulators' Argument for DORC

Asset owners formal submissions to regulators and the written determinations of the regulators themselves (particularly ACCC and ORG) contain repeated albeit scantly supported claims that replacement cost asset valuation, particularly DORC, has a derivation in economic theory (e.g. ORG 1998 pp.9; ACCC 1999, pp.43-4). This view has been promulgated and recited to the point that its wisdom is widely taken for granted, albeit without demonstration or acknowledged authority (cf. Productivity Commission 2001, pp.216,220,222).[6]

The economic argument on which the regulators justify their commitment to DORC, as best as can be construed from their published statements (cf. King 2001, pp.14-5), is that RAB=DORC emulates rational market settings by producing the highest possible tariffs short of those at which a new entrant might be encouraged to duplicate the existing provider's infrastructure (and compete for those tariffs). According to this argument, a profit maximising asset owner, operating opportunistically in a free market, would stretch tariffs to this level for the long run:

> ...DORC is the valuation methodology that would be consistent with the price charged by a new entrant into an industry, and so is the equilibrium price that would prevail in the industry in long run equilibrium. (ACCC 1999, p.39)

The economic theory underlying this argument is built around a construct called "Tobin's q", after its inventor, Nobel prize winning economist James Tobin. Tobin's q is defined as the ratio of the value of the firm to the replacement cost of its assets. That is:

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[6] The consultant on tariff setting issues with apparently most influence over the ACCC is economics Professor, Stephen King, of the University of Melbourne. In several of his papers King has argued that DORC (and possibly the building block model in general) is inappropriate in this function (e.g. 1996, p.295; 1997, p.198; 1998, p.3). For example, King (2000, p.7) writes "...as I have noted elsewhere, the contestability justification for DORC is dubious and it may not be desirable to replicate the fictitious path of revenues that result from [this] model" (see also p.2). However, in his most recent work, King (2001, p.5) concedes that despite his previously oft stated critique of DORC, he will for the sake of assisting in current deliberations take DORC as given. This resignation would seem to be indicative of the ACCC's committed and apparently ideologically axiomatic acceptance of DORC.

$$q = \frac{M}{ORC},$$

where M is defined as the market value of the firms securities (debt plus equity) and ORC is the minimum (optimised) cost of replacing its current productive capacity, making allowance for the fact that some of its assets are not of the same capacity as when they were new (i.e. they are used). Tobin introduced the q ratio as a way of measuring the level of monopoly power of the firm (Tobin, 1969; Brainard and Tobin, 1968) and of assessing the market incentive for further capital investment. Large q is associated with large surpluses or economic rents (profits exceeding costs, including capital costs), these being capitalised by the market in its assessment of M.

In the absence of monopoly rents, the value of q is expected to be near one. For the value of q to exceed one, the market value of the firm (the present value of its projected net cash flows) must be greater than the RC of its assets. In these conditions there are incentives for new entrants or for expansion by existing firms, with the effect that prices will be reduced and q driven towards a value of one.

> ...The essence of the argument is that for a competitive firm, one would expect q to be close to one, and as we examine firms with increasing monopoly power (increasing ability to earn above a competitive return), q should increase. If a firm's q is greater than one, the market value of the firm is in excess of its replacement cost. If there is free entry other firms could enter the industry by purchasing the same capital stock as the existing firm. Furthermore, they would anticipate an increase in value over their investment because its market value would exceed its cost. Thus, in the absence of barriers to entry and exit, q will be driven down toward one as new firms enter... (Lindenberg and Ross 1981, p.2)

According to Tobin's argument, q=1 characterises a firm operating in a competitive market in long run equilibrium. In these circumstances, the firm is extracting the maximum attainable income stream (product price) without admitting any hint of opportunity to potential price cutting competitors. Conversely, if q was less than one there would be no incentive for existing firms to renew their assets and the number of competitors would shrink to the point where prices could be raised and q pushed back towards one.

On the basis of this logic, q=1 is taken to be the definitive measure of an appropriately regulated monopoly stripped of any economic rents:

> ...a firm which is regulated so as to earn no monopoly rents would have a q close to one. A monopolist, however, who can successfully bar entry and is not adequately regulated will earn monopoly rents in excess of ordinary returns on the employed capital. The market will capitalise these rents, and the market value of the firm will exceed the replacement cost of its capital stock, that is q will persist above one. (Lindenberg and Ross 1981, p.2)

> It can be argued that in a competitive market, if a supplier charges a price above minimum efficient cost of supply, then new entrants will be attracted into the market by the abnormal profits that are available; as a result, market prices for outputs, and the market value of business enterprises supplying those outputs will

> tend towards cost. ...The above propositions are consistent with the theory of the relationship between the market value of assets and their replacement cost developed by the economist James Tobin. The ratio of the market value of the company's debt and equity to the current replacement cost of its assets is known in the finance literature as Tobin's Q. ...Tobin argued that when Q is greater than 1 (that is, when capital equipment is worth more than it cost to replace), firms have an incentive to invest, and that they will stop investing when Q is less than 1 (when equipment is worth less than its replacement cost). ...On this basis, it is accepted, in principle, that the use of ODRC asset values and a market based estimate of the WACC is intended to mimic the outcomes of a competitive market... (ORG 1998, p.5)

To measure q the regulator has to find the minimum ("optimised") RC of the firms used assets, or more precisely, of the cost of replacing the partially depleted productive capacity represented by those used assets. To prevent confusion with the replacement cost of all new assets, this cost is labeled ORC*used*. The measure intended by Tobin is then

$$q = \frac{M}{ORCused}.$$

Because there are no second hand markets for the kinds of assets in question (excepting scrap metal markets), regulators have treated *DORC* as a proxy for *ORCused*, and hence implicitly re-defined Tobin's q as

$$q = \frac{M}{DORC}. \qquad (5)$$

The final step in the regulators' effort to set Tobin's q=1 is to fix the initial regulatory asset base, RAB_0, such that the market value of the entity, M, equals *DORC*. Thinking of M as the NPV of the tariff stream, this requires merely that RAB_0=*DORC*, since NPV=RAB_0 as shown by equation (4) above.

6. The Argument for DORC is Sophistry

The regulators' position, reconstructed as faithfully as possible above, is that DORC based tariffs build in and thus mimic the discipline of a competitive market. Although superficially appealing, this argument is simplistic and deceptive for the following reasons at least:

(a) A new entrant in the market for energy transmission services would have to pay full (undepreciated) ORC to duplicate or bypass existing infrastructure. There is no second hand market on which one can buy a used *in situ* electricity grid or a gas pipe network, or even the individual components thereof. Hence, provided that the DORC value

claimed by the existing asset owner is less than the actual (i.e. "true") ORC, there is no possibility of competition. To the contrary, asset owners can value depleted (used) assets at a book DORC up to the amount of their true ORC – that is, book ORC can greatly exceed true ORC – and thereby lay claim to a stream of tariffs consistent with all transmission assets being new rather than used.[7]

Proof. Consider the position of a potential new entrant under the following four simplifying assumptions: (i) zero inflation, (ii) zero growth in the tariff market, (iii) constant ORC (i.e. no technological change), and (iv) new assets last "forever" (i.e. to the point that subsequent cash flows make no difference in PV terms). The new entrant expects to take from the incumbent a proportion ρ of the existing tariff stream, tariffs being determined by the regulator using the incumbent's "book DORC" (as per tariff equation (3) above).

In present value terms, the new entrant would then earn tariffs worth

$$\left\{P + \frac{ORC}{(1+WACC)^T}\right\}\rho$$

where *ORC* is the (constant over time) replacement cost of all new assets, *WACC* is the regulated and actual cost of capital, *T* is the time (number of years from now) at which the incumbent's assets will require replacement, and *P* is the present value of the tariff stream to be earned by the incumbent from those assets prior to their eventual obsolescence.

There is no obvious basis on which to estimate the new entrant's possible market share, but to be consistent with the regulators' argument, it must be assumed that ρ=1, meaning that the new entrant will completely displace the incumbent, taking over the entire tariff market. This is of course an utterly unrealistic possibility (see below), and can be treated only as a "theoretical" limiting case. Its event would require circumstances where, for example, the new entrant, before making any investment, tied all asset users into very long term (e.g. 30 year) contracts. Equivalently, the new entrant might theoretically be a co-operative of all asset users, bound together by an effectively permanent contract to self-supply using newly constructed assets.

The indifference condition for any new investment, is NPV=0. Hence, a potential new entrant is motivated to invest provided that the PV of its tariff revenues equals the cost of all new assets, *ORC*. Thus, taking ρ=1

$$\left\{P + \frac{ORC}{(1+WACC)^T}\right\} = ORC.$$

implying

[7] Given the effectively unlimited lives of many transmission networks, regulators must preclude asset valuations (write-ups) to prevent asset owners, without any further investment, from continually increasing tariffs in line with increasing network replacement costs.

$$P = ORC\left\{1 - \frac{1}{(1+WACC)^T}\right\}$$
$$= (ORC \times WACC)\left[\frac{1}{WACC}\left\{1 - \frac{1}{(1+WACC)^T}\right\}\right].$$

Noting that the term in square brackets is the usual mathematical "annuity factor" for a T period annuity at discount rate $WACC$, it is evident that the minimum tariff revenue acceptable to a new entrant in the time prior to the incumbent's replacement date equals (or is equivalent to) an annuity of amount ($ORC \times WACC$) per period. This is proof of the ability of the incumbent to set its book $DORC$ up to a limit of actual ORC, and effectively hold it constant at that level over all of the years before it replaces its assets, without offering the incentive necessary for a new entrant.[8]

To allow for this market reality, the regulators' must substitute true ORC for book DORC in their measure of Tobin's q (equation (5) above), in which case q=1 occurs when tariffs are set on an ORC rather than DORC basis. It is, however, unlikely that this less naive application of the Tobin's q argument would be acceptable to regulators. The political costs of determining tariffs explicitly and effectively perpetually as if all existing infrastructure was new (in fact, as if it had all just been built at current new replacement cost) would likely overshadow the niceties (e.g. intellectual kudos) of a model based more carefully in economic theory.

The following quotation summarises the ACCC position, and is correct to the point that it concedes that there is little practical likelihood of any system bypass (new entrant) apart from possibly some peripheral links in national infrastructure networks:

> ...any value that is in excess of DORC is likely to imply pricing of services that will expose the service provider to being by-passed. While the significant entry and exit costs that characterise electricity [energy] transmission make large-scale duplication of the existing system unlikely, by-pass may be feasible at the edges of the network. (ACCC 1999, p.xi)

The fundamental mistake, however, is that the theoretical asset value threshold, up to which there can be no threat of a new entrant, is not DORC but ORC, as demonstrated above. The ACCC argument is therefore invalid by its own economic logic, with the practical ramification that tariffs will almost certainly be fixed at levels significantly higher than necessary according to the ACCC's intended economic logic.

(b) Yet more realistically, it is likely that despite being appreciably higher than DORC, ORC also grossly underestimates the level required of RAB to entice a new entrant. Even at tariff levels well above those based on DORC or ORC, the real world possibility of major network bypass is likely to remain negligible (cf. King 1998, pp.3, 10). Moreover, even if tariffs were high enough to warrant a competitor, or user co-

[8] Note that if ρ is taken to be less than one, as is undoubtedly more realistic, the incumbent can set DORC not merely at ORC, but at approximately ($DORC / \rho$) for small ρ (e.g. at 5×DORC for ρ=0.2).

operative, contemplating duplication from scratch of such massive infrastructure, what market share would such a new entrant be guaranteed when the incumbent could hit back with cut rates commensurate with the relatively very low marginal capital costs attaching to sunk assets? Moreover, at this point the two competing networks would both be sunk, forcing the competitors into either sharing the market or a price war based in the extreme on short run marginal costing. Neither prospect can have any appeal to a potential new entrant.

It is almost too ridiculous to contemplate two (or more) rival infrastructure owners sharing the market. A new entrant would not likely invest with the prospect of say a 50% market share unless tariffs were greatly in excess of their existing book-DORC (albeit possibly inflated to true ORC) rates. Thinking in no more than these simple terms, tariffs would have to be based on a RAB (book DORC) of double-ORC or more before any genuine possibility of economically driven duplication could occur. Given the manifest risks, technological and other barriers to entry, and general political inconceivability of any investor, private or government, duplicating already functional and typically much less than fully-utilised energy transmission networks, the RAB level truly required to prompt such a decision is hard to imagine. In reality it is only in circumstances where existing infrastructure assets are at or approaching full usable capacity, or grossly below par (e.g. technologically outdated or greatly inefficient in terms of operating costs) that there is actually any threat of a new entrant.

The practical effect of this market reality is that incumbent asset owners, establishing their initial RAB are virtually unrestrained by the risk of competition, contrary to the regulators' supposed economic logic. In practice, initial DORC could be set at double-ORC and there would still be negligible risk of a new entrant. The only effective constraint on existing asset owners' initial DORC valuation, apart from any indirect benchmarking by the regulator, is the level to which the "independent valuers", hired by asset owners to find this value, are ready to stretch. Given the known failures of "independent auditors" of the highest professional repute in other, inherently less subjective asset valuation contexts, the analogous economic incentives applying to engineering based DORC-valuers in tariff setting should be of great concern to regulators.[9] The potential for "creative engineering" is perhaps as much a problem with DORC as its flawed theoretical foundations.

In summary, the Tobin's q argument for DORC valuation is theoretically and practically ingenuous. At a theoretical level, the problem is that in markets requiring entry-level investment of such scale and complexity, potential new entrants will surely not be attracted unless expected tariffs are considerably higher than, rather than merely equal to, those based on DORC or even RC. As a result, the practical as opposed to theoretical upper limit on the existing service provider's book DORC is not actual or "true" DORC but some unknown, possibly large multiple thereof. Moreover, book DORC can equal and probably greatly exceed true ORC without any realistic threat of competition. This must be obvious to asset owners, and is bound to encourage

[9] The valuer J.P. Kenny (commissioned in March 1996 by the Gas Council to audit the AGLGN ORC estimates) revealed its own dissatisfaction with what was manageable and conceded that it was only the time and other constraints imposed on it that justified its "interactive" (with AGLGN) approach to the AGLGN valuation. See Johnstone (1999) for general discussion regarding this valuation process.

pervasive overstatement of asset values (ORCs and thus DORCs). From this perspective, the market discipline purportedly inherent to tariff settings based on DORC is more a product of economic sophistry than economic theory.

7. Broader Economic Argument against Replacement Cost

In discussion above, the Tobin's *q* argument for DORC valuation is considered and rejected on its own terms. Widening the economic criteria on which replacement cost (DORC) valuation of existing assets is evaluated, leads to a considerably stronger rejoinder. The following economic arguments are all relevant and all point to DORC as either having no special importance or being flawed and bound to produce undesirable outcomes. These arguments are provided not in any order of importance.

(i) DORC Not Necessary to Ensure Continued Optimal Asset Use

Economic theory reserves special treatment for sunk assets. These are assets which have been built and are in place in given physical condition as the result of previous decision making. From the point of view of optimal resource allocation, sunk assets should be viewed only in terms of what they can still contribute and what they could be sold for. If they are more valuable for what they can add to future production, they should be retained and used. Otherwise they should be sold for their remaining net realisable (scrap) value (NRV). Moreover, what they would cost to replace is of no relevance to present or future decision making. The entity has already built them and the current cost of doing so (again) is irrelevant to any present or future decision of how best to utilise or scrap them.

Taking this resource allocation perspective, regulators must ensure that assets are valued at or above their NRV. If the value attributed to an asset in the RAB of a regulated firm is lower than its NRV, the firm will rationally sell the asset (its NRV will exceed the NPV of its contribution to the tariff stream). The economic lower bound on the RAB is thus NRV (cf. Whittington 1997, p.5; King 1998, pp.1-3). Provided RAB is not less than NRV, existing productive assets will remain in current (presumably optimal) use. Apart from the fact that for specialised infrastructure assets, DORC is generally greater than NRV, the economic objective of continued optimal allocation of existing assets affords no special significance to RAB=DORC.

(ii) DORC Harms Downstream Allocative Efficiency

Given the importance of energy transportation tariffs to users and their customers along the production chain, it is essential that regulators think carefully about actual rather than theoretical (e.g. DORC) capital costs. The marginal capital cost of using an existing asset when that asset has little realisable value is by necessity very low. Moreover, marginal access costs are greatly overstated if capital charges are based on DORC or any asset valuation significantly higher than NRV. This leads to systematic underuse of existing transmission assets by energy users. King (1996, p.293-5; 1997, p.198; 1998, p.3) refers to this unfortunate consequence of RC based asset valuation as

a type of allocative inefficiency. In essence, users ready to pay the "true" (long run marginal) cost of access are priced out of the market by tariffs significantly greater than marginal cost:

> The deprival value methodology promoted by the draft electricity access code will set an initial base for transmission utility assets that significantly exceeds scrap value. These inflated valuations of existing, sunk assets will feed into retail electricity prices, resulting in a reduction in allocative efficiency. ...The valuation rules chosen by the NGMC [National Grid Management Council] are likely to be administratively difficult, contentious and inefficient. (King 1996, p.295)

> To the degree that regulated asset valuations feed into uniform prices that exceed (congestion adjusted short-run) marginal cost, either directly or further down the production chain, then the deviation of price from marginal cost will lead to a reduction in trade from the economically efficient level. Such a reduction leads to what economists call an "allocative inefficiency" or a "dead weight loss". It represents a decrease in gains from trade from the production and consumption of the relevant product(s) compared to the best achievable level of gains from trade. (King 1998, p.4)

Closely related arguments on allocative efficiency underpin the rejection of replacement cost valuation by Bonbright et al. (1988):

> With a public utility system operating at a scale at which further enhancements in rates of output can take place with less than a proportionate increase in operating and capital costs (conditions of decreasing unit costs), such rates will exceed the incremental or marginal costs of the service. Yet, under the economists' theory of socially optimum pricing, the important relationship between prices and costs is an equality, under long-run equilibrium conditions, between prices and *marginal costs*. Hence, if socially optimal resource allocation were to be accepted as the primary objective of ratemaking policy, as the replacement-cost advocates insist, what would be required is not a mere transfer from original-cost standard to a replacement-cost standard, but rather a transfer from any standard to a standard of incremental cost. ...if we accept provisionally the assumption that most public utility enterprises are operating under conditions permitting the enjoyment of further economies of scale, and if we also assume that current replacement costs of service would be higher than historical costs, the acceptance of a replacement cost principle would seem to be a step in the wrong direction. (Bonbright et al. 1988, p.297)

From an obvious practical viewpoint, there is something wrong with a tariff base that works against expanded and perhaps even existing use of a gas or electricity transmission network currently at much less than full capacity. For a country or economy to build such a long-lived infrastructure at great cost and then not use it to anything like its available capacity for the reason that it would cost a lot to replace verges on economic absurdity. It might be reasonable to restrict usage of something which has already been built (a sunk cost) if usage of itself meant added costs, such as "wear and tear", and thus added maintenance and refurbishment costs, or if additional usage brought forward the time at which the network was no longer large enough and

required parallel enlargement. But in the case of Australian gas pipelines, main trunks are typically at approximately half or much less than full capacity and the additional throughput does not cause wear and tear or any economic loss. Rather, the life of the network, if not effectively infinite, is limited primarily by corrosion rather than usage. Each period of underuse represents an irrecoverable opportunity to make something of an asset which is already in place and able to be used at essentially negligible marginal capital cost.

It could be argued that access prices which are "too low" themselves result in allocative inefficiency by encouraging the establishment and expansion of user businesses which cannot remain viable once existing network assets require replacement and tariffs are increased to match those costs of replacement (i.e. once the new assets came onto the RAB at cost). However, given the currently relatively low use of the existing infrastructure and its likely very long engineering life, this argument has much less weight than in more normal circumstances.

(iii) DORC Provides Existing Asset Owners with a Free Lunch

Perhaps the most disconcerting argument for regulators against revaluation of existing assets to DORC is that every extra dollar allowed onto the regulatory balance sheet (RAB) amounts to a dollar of present value in the pocket of asset owners (paid by the shareholders of asset users and downstream industry and other consumers). This is because under the regulators tariff formula (3) each dollar granted in RAB locks in place a future tariff stream with NPV (at discount rate r=WACC) of one dollar. By writing up the value of existing assets from whatever their current book value to DORC, the asset owner profits *prima facie* by the amount of that write-up (revaluation). This NPV windfall – and consequent share price increase – is achieved by a mere book entry with no actual cash outlay.

Whittington (1994, 1998) made a similar observation in relation to some British gas and water privatisations. It was typical in Britain that the amounts paid by the new private owners of these entities were significantly less than aggregate asset book values. Whittington warned that tariffs based on book values rather than the actual cost (AC) asset base would present the new asset owners with large wealth windfalls at the expense of gas and water consumers who would be left to pay the inflated RAB (rather than cash investment) based tariffs:

> To adopt a replacement cost or current cost approach at this late stage would involve a very large transfer of wealth from the consumer to the shareholder, which would be inconsistent with the requirement that the regulator strike a balance between these interests by allowing a return sufficient to justify the shareholders' investment but not excessive from the perspective of the consumer. (Whittington 1998, p.4)

The legacy of inflated asset values according to Whittington is that regulators will have signed off on a tariff stream that over time looks increasingly anomalous (Whittington 1994, p.93).

In Australia, the case of AGLGN (Australian Gas Light Gas Network) differs from the British experience only in that the company already owned all existing assets. AGLGN has been arguably even better treated than the British companies, in that it is has been allowed a large upward shift in its asset values above depreciated cost, and consequently a significantly enhanced tariff stream, all for no additional investment at all. It is difficult in the AGLGN case to value objectively the "free lunch" alloted to the company by the regulator's acceptance of DORC. When a DORC based tariff stream is bought by additional investment, as in the circumstances described by Whittington and those of the Victorian privatisations, the NPV windfall is measured by the difference between the amount paid and the deemed RAB on which subsequent tariffs are based. But when a RAB=DORC based tariff stream is simply decreed to an incumbent owner whose existing assets have no objective current market value – that is, no value independent of their regulated (deemed) book value – there is no theoretically relevant benchmark against which to compare the NPV of the new tariff stream.

Perhaps the only meaningful comparison is that of the so-called "line in the sand approach". This was a notion initially favoured by IPART, where to get around the problem of the non-existent market value of existing assets, the regulator worked backwards taking pre-existing tariff levels as a pragmatic starting point. The imputed asset value is then the capitalised value of future tariffs, where their existing level is specified and taken as given like a "line in the sand". Taking this approach, the windfall to the existing owner can be gauged by simply comparing the new DORC based tariff stream with the old tariffs as they existed when regulatory reforms and "access regimes" were initially introduced.

In the case of AGLGN, DORC based tariffs are apppreciably greater than their pre-existing levels. Since these tariff increases have been achieved without anywhere near corresponding investment in new assets, it is reasonable to argue that DORC has presented AGLGN with an NPV (and thus share price) windfall. The amount of this windfall is obscured by doubts over the legitimacy of pre-existing tariff levels. For example, one point of view put by AGLGN is that these were "artificially" low and therefore not commercially sustainable. The economically logical response to this is that because AGLGN assets were already sunk, any tariff level exceeding that based on scrap value was "sustainable" in the strictest economic sense:

> A ruthless application of economic logic might suggest that as the assets are sunk assets with no alternative use except as scrap, the initial capital base should be close to zero. There is no opportunity cost where capital has been sunk. No regulated revenue stream has to be awarded to induce investment to create what already exists or to keep in place what has no alternative use. (Lim and Dwyer 2001, p.25)

From this perspective, AGLGN was really in no position to argue. Quite to the contrary, the regulator might have chosen to enact a distinction in principle between sunk assets and those not yet built. Sunk assets could have been valued at DAC or even lower, even at NRV (scrap), without prompting any misallocation of resources. Even at RAB approaching NRV, AGLGN would have no economic choice but to use existing assets in their existing (presumably optimal) way. When seen this way, the regulator's decision to treat existing and new assets alike was unnecessarily generous. By opting

essentially arbitrarily to base tariffs for existing assets on DORC, regulators have guaranteed the profitability of asset owners and gambled that infrastructure users and downstream energy consumers will cope without politically manifest damage to their profitability and economic expansion.

(iv) DORC Not Necessary to Promote New Investment.

The underlying economic rationale of the tariff equation (3) is that asset owners earn a "market" rate of return on their investments. This is achieved equally whether new investments are brought onto the regulatory balance sheet (RAB) at DORC or DAC; or more precisely at ORC or AC, since for new assets there is no depreciation. Moreover, for a new asset RC=AC by definition, and assuming the investment is "optimised" (i.e. there is no lower cost way to get the same result), ORC=OAC=AC. Provided that subsequent asset revaluations are precluded under either an ORC or AC approach, it makes no difference practically whether the amount spent on new assets, and added to the RAB, is called RC or AC (ORC or OAC). Either way, the PV of the ensuing tariff stream is equal to the cash amount invested and hence the NPV (at r=WACC) is zero, as expected of an efficient capital market.

Given that for new assets DORC≡DAC, it is curious that a view persists that unless regulators adopt DORC, there will be no sufficient incentive for asset owners to invest. It is clearly in the asset owners' interests that regulators work under this presumption. From their standpoint, any use of DAC, even if only for new assets, would leave the gate open for a shift away from DORC for existing assets also, and hence possibly large tariff losses. This would explain why the premise that DORC is a pre-requisite for new investment has been voiced so frequently during the Australian regulatory debate. Less explicably, however, regulators seem to have accepted the investment friendliness of DORC on technical grounds.

For there to be any difference between DORC and DAC in regard to new assets, regulators must envisage that DORC and DOAC asset values (and thus periodic tariff flows) will not remain the same over time despite their initial equivalence. This could be for two reasons. The first is that DORC and DAC depreciation patterns may be different. This is a likely explanation given that the ACCC advocates "competition depreciation" as essential to DORC, but not DAC. Of itself, however, a difference in depreciation flows makes no difference to the NPV of the tariff stream (see above) and hence does not explain why DORC rather than DAC is technically necessary to secure new investment. A better explanation is that regulators foresee subsequent asset revaluations (book value increases without new investment) under one approach but not the other, or by different criteria under the two valuation schemes. Indeed, in its *Draft Statement of Principles*, the ACCC clearly acknowledged its anticipation of periodic DORC revaluations:

> The NEC [National Electricity Code] does not preclude the regulator from periodically revaluing the regulatory asset base according to a valuation methodology such as DORC. (ACCC 1999, p.49)

The Admissibility of Future Revaluations. The "no free lunches" principle rules out asset revaluations – that is, increases in RAB by mere book entry – unless these are treated as income, using the extention of the usual tariff equation explained above. There is, however, some confusion surrounding this principle, caused by the regulators' determination of WACC in real (i.e. net of inflation) terms, and the technical mechanism used to achieve this effect.

There are two methods by which to calculate the "return on capital" element of the tariff formula so as to lock in a given real rate of interest. The first is to leave the initial RAB unchanged (except for period depreciation) and multiply this figure by the nominal interest rate equivalent to the given real rate. For example, to achieve a real rate r_r, the RAB is multiplied by the nominal rate

$$r_n = (1+r_r)(1+i)-1$$

where i is the rate of inflation.

The second method, thus far generally adopted by regulators, is to first "inflate" (i.e. re-scale) the RAB by multiplying it by $(1+i)$ and then multiply this new RAB figure by the given real interest rate r_r. The result (dollar amount) is obviously the same using either mathematical approach. The disadvantage of the regulators approach is that it gives the impression of breaking the "no revaluations" principle.[10] Whether in fact it does depends on answers to the following two questions:

(i) Is the criterion that new investment earn NPV=0 intended to hold in nominal or real terms? If it is determined that the appropriate ("market equivalent") return to investors is some fixed *real* rate (e.g. 7.75% real), then increasing RAB by the inflation factor $(1+i)$ before multiplying by that interest rate is admissible, and technically does not break the NPV=0 (no revaluations) rule. Whittington (1997, p.6) understood that this is what was intended when he argued that asset users bear all inflation risk.

(ii) Is it intended that the Tobin's q argument will be applied continuously over time rather than merely as a way to get an initial RAB? The dynamic rather than static application of q would involve repeated DORC revaluations, applicable whenever the cost of entry (asset replication by a competitor) increases. Revaluation according to this criterion amounts to inflating RAB not by a general price index (such as the CPI) but by an industry (asset) specific index. The scale factor is not $(1+i)$ but something much more narrowly related to the construction costs of the specific infrastructure assets in question (and therefore much more subjective). Changes to RAB made on this basis are likely to break the "no free lunches" (NPV=0) rule. If the replacement cost of infrastructure assets rises by more than the general inflation rate, then the asset owner gains a tariff increase in real terms and thus a real NPV windfall. The

[10] Aware of this problem, some regulators have shifted calculations onto an explicitly nominal basis (i.e. dollar return on capital = nominal RAB × nominal WACC); see for example the discussion in ACCC (1999, pp.24, 32) and the calculations of IPART 2000, p.112.

reverse is also true, meaning that in theory the owner runs the risk of asset replacement costs, and thus tariffs, not keeping pace with inflation.

Depending on the answers to these questions, the relative effects of DORC versus DAC in regards to new investments can be summarised as follows.

(i) If DAC and DORC are inflated according to the same price index – say the CPI – then the corresponding tariffs flowing from new investments will always be the same (assuming the same depreciation scheme).

(ii) If DORC is inflated according to an industry (asset) specific index and DAC according to a more general price index such as the CPI ("indexed DAC"), the choice in regard to new assets between DAC and DORC is effectively a choice between tariffs rising with the CPI and tariffs anchored to industry-specific asset price shifts. This amounts simply to a choice between two different inflation rates. These rates might differ markedly if for instance new technology was to reduce the price (replacement cost) of energy transmission infrastructure assets while asset prices in the wider economy increased. Generally, however, both sets of prices are likely to increase, in which case the tariff effect of a choice between DAC and DORC for new assets will tend to be small compared to its effect in regard to existing assets

The results above indicate that DORC has no theoretical advantage over (indexed) DAC in encouraging new investment. Apart from any differences caused by different depreciation schemes, DAC based tariffs will follow a similar pattern over time as those based on DORC. Both will increase with price increases, DAC with the CPI and DORC with whatever index or revaluations are allowed by regulators. Indeed, an investor who does not want to risk real tariff reductions as a result of technical advancements (reductions in infrastructure costs) will prefer DAC over DORC. If DORC has any advantage as far as encouraging new investment, it is that asset owners will see it as more able than DAC to be manipulated upwards at a rate in excess of general price increases. This is, of course, hardly the kind of advantage that should be welcomed.

8. Treatment of Easements

Easements are the legal rights under which infrastructure owners were permitted to build their networks across land owned by other parties (e.g. farmers). The DORC doctrine, adhered to most purely by the ACCC, treats easements like any other asset. Again this is for reasons of economic principle, namely the principle of ensuring that the RAB equates to whatever total costs a new entrant would currently incur to replicate the existing network:.

> The normal DORC methodology would assign values to such assets reflective of their market value. ...The advantage of this approach is that the valuation remains comparable to costs faced by a potential entrant .... (ACCC 2000, pp.45-6)

Easements represent the reductio ad absurdum of DORC. For the most part, they have been obtained historically by existing asset owners, with the authority of government legislation, at zero or low cost. And yet having obtained these "access corridors" for generally little or no outlay, asset owners are now to be paid a return on their current market values (however determined) as if they were purchased today at today's market values. The DORC valuation of easements, more than any other asset, shows up the readiness of regulators to allow asset owners returns on investments that were never made. By insisting on the theoretical necessity for DORC, regulators find themselves bound to provide asset owners a conspicuous "free lunch". Moreover, this is not only a free lunch but also a long lunch, since the ACCC (1999, p.45) maintains that easements do not depreciate like other assets (and hence will remain on the regulatory balance sheet in perpetuity).

Apparently less committed ideologically to DORC than the ACCC, IPART in New South Wales has decided that unlike other assets DORC does not apply to easements. Its decision is to include easements in RAB at their actual costs. The rationale provided for this decision is revealing. Rather than conceding that there is any general absurdity about DORC based tariffs for existing assets, IPART distinguished easements from other assets on the basis that they will never be replaced and hence will never present asset owners with any additional cost:

> The issue of the treatment of easements highlights the difference between the assessment of the DORC from the perspective of a potential new entrant and that of the incumbent. For the incumbent, existing easements formerly acquired will not need to be replaced. Hence, such costs will not form part of the forward looking costs of maintaining and replacing existing capacity. (IPART "Pricing for Electricity Networks and Retail Supply")

The first problem with this explanation is that much of the physical infrastructure asset base is virtually permanent, requiring only maintenance rather than replacement, and should for consistency be valued the same way. And second, the supposed rationale for DORC is not about "the forward looking costs of maintaining and replacing existing capacity". These costs, particularly those of new investments, will be financed by capital markets, which exist for this very reason. The theoretical basis for DORC is actually backward looking – its rationale is to reimburse the asset owner for its incurrence of depreciation and opportunity costs of capital.

It is evident that by advocating DORC on grounds of economic principle, regulators find themselves painted into a corner when it comes to valuing easements. The IPART way out is to fudge, retreating conveniently to DAC and thus avoiding the patently embarrassing free lunch guaranteed by DORC. The ACCC solution is to bluff, insisting on easements at DORC as logically part and parcel of a grander economic plan. Lim and Dwyer (2001, p.26) observe that it is fortunate for the ACCC that there are no Roman built viaducts currently in use by infrastructure owners in Australia. Rewarding their current owners at DORC, and thus making downstream industry and energy users pay for the work of the Romans' slaves, as if it was new and built at today's prices, could hardly be seen as a triumph of economic reasoning.

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