Report on the construction of DORC from ORC

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This report addresses a number of specific questions relating to the method of DORC construction proposed by Agility Management. In particular, I have been asked to address the following issues:

(i) Is the Agility NPV approach to the construction of DORC from ORC, as set out in the Agility submission of August 2000, consistent with the interpretation of DORC enunciated by the Australian Competition and Consumer Commission (ACCC) and the Victorian Office of the Regulator General (ORG) in relevant documents such as the ACCC's Statement of Principles for the Regulation of Transmission revenues? [1]

(ii) Is the approach to the construction of DORC from ORC adopted by the ACCC in the Draft Decision on EAPL consistent with the interpretation of DORC under (i)? [2]

(iii) What relevance, if any, does past actual/accounting depreciation have to the construction of DORC from ORC if that construction is performed in a manner that is consistent with the interpretation of DORC under (i)?

(iv) What is the relationship between DORC, as consistently derived with the interpretation under (i), and on-going depreciation? How is this relationship affected under the Gas Code where DORC valuation is a maximum valuation for

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[1] Australian Competition and Consumer Commission, *Statement of Principles for the Regulation of Transmission Revenues*, Draft, 27 May 1999.

[2] Australian Competition and Consumer Commission, *Access Arrangement by East Australian Pipeline Limited for the Moomba to Sydney Pipeline System*, Draft Decision, 19 December 2000.

the initial capital base (ICB) and the initial capital base might be set less than DORC? In particular, is consistency between DORC and on-going depreciation under the Gas Code maintained under the following rule: "Irrespective of whether the ICB is set at DORC or something less, the actual price path for the asset should not at any time exceed the new entrant competition depreciation price path assumed in the calculation of DORC. This constraint does not of itself impose any limitation on the form of on-going depreciation."?

(v) Comment on the relationship between the DORC valuation established by the Agility NPV approach and the written down value calculated under the ACCC's competition depreciation scheme, in the context of the Code requirement to establish the DORC value at a particular point in time (30 June, 2000 in the case of EAPL). Can the two values be reconciled? If so, how and subject to what conditions? To what extent is each of these two approaches generally applicable?

An introduction to the Agility Management construction of DORC is provided in the Agility Management report *The construction of DORC from ORC*, August 2000. Earlier comments on this approach are found in my *Report on Agility's approach to DORC valuation*, October 2000.

The issues discussed in this report need to be considered in the context of The National Third Party Access Code for Natural Gas Pipelines (the Gas Code). Clause 8.10 of the Gas Code states that "the following factors should be considered in establishing the initial capital base … (a) the value that would result from taking the actual capital cost of the Covered Pipeline and subtracting the accumulated depreciation for those assets charged to Users (or thought to have been charged to Users) prior to the commencement of the Code; (b) the value that would result from applying "depreciated optimised replacement cost" methodology in valuing the Covered Pipeline; (c) the value that would result from applying other well recognised asset valuation methodologies in valuing the Covered Pipeline; (d) the advantages and disadvantages of each valuation methodology applied under paragraphs (a), (b) and (c); … (f) the basis on which Tariffs have been (or appear to have been) set in the past, the economic depreciation of the Covered Pipeline, and the

historical returns to the Service Provider from the Covered Pipeline; … (k) any other factors the Relevant regulator considers relevant".

Clause 8.11 of the Code states that "[t]he initial Capital Base for Covered Pipelines that were in existence at the commencement of the Code normally should not fall outside the range of values determined under paragraphs (a) and (b) of section 8.10".

One of the objectives of the Code, presented in clause 8.1, is the replication of the outcome of a competitive market.

This report will proceed as follows. I first briefly discuss the background to DORC. In particular, I will focus on the theoretical justifications provided by the ACCC and others for the use of DORC as a method of asset valuation. I then consider what form of translation or adjustment from an Optimised Replacement Cost (ORC) to a Depreciated Optimised Replacement Cost (DORC) is consistent with these theoretical justifications. I will then consider each of the five questions noted above.

Background

Replacement cost valuation of assets is well known in the field of regulatory economics. "Replacement costs are the costs of replacing the facility with another facility that would provide comparable services, but would not necessarily be the same plant. That is, it measures what it would cost today to provide the same capacity".[3]

The National Third Party Access Code for Natural Gas Pipelines requires the relevant regulator to consider DORC valuation when setting an initial capital base for an existing pipeline. "For existing pipelines, the Code (sections 8.10(a) and (b) and 8.11) requires that normally the initial capital base should not fall outside the range of depreciated actual cost (DAC) and depreciated optimized replacement cost (DORC)".[4] The Code does not, however, specifically state how DORC should be constructed.

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[3] Bonbright, J., Danielsen, A. and Kamerschen, D. (1988) *Principles of Public Utility Pricing* (2nd ed.), Public Utility Reports Inc. Virginia, p.239. In this sense, replacement cost valuation is a well recognized asset valuation methodology.

[4] *op. cit.* n.2., p.17.

The ACCC has proposed a methodology for calculating DORC. "The determination of a valuation of a transmission system on the basis of DORC involves three stages. The standard approach has been for these three steps to comprise: Optimisation – determine the optimal configuration and sizing of transmission assets; Replacement costs – a modern engineering equivalent (MEE) is established for each asset in the optimized system and a standard replacement cost (SRC) established; and Depreciate those assets (usually straight line) using the standard economic life (SEL) of each asset together with an estimate of the remaining life (RL) of each asset".[5] The issue at the center of this report is the third step in the ACCC's process. In particular, what form of translation or adjustment should be used to change the optimized replacement cost (ORC) into a DORC valuation?[6]

The use of a DORC valuation has been justified on a number of grounds. For example "it is the valuation methodology that would be consistent with the price charged by an efficient new entrant into an industry, and so it is consistent with the price that would prevail in the industry in long run equilibrium".[7] Alternatively, "it is the price that a firm with a certain service requirement would pay for existing assets in preference to replicating the assets".[8]

The first justification has been interpreted in two ways. The Code, in section 8.1.b has "replicating the outcome of a competitive market" as one objective of the regulatory regime. For an industry with a natural monopoly technology involving large (often sunk) fixed costs and relatively low marginal costs (up to capacity), standard multi-firm competition is both socially undesirable and unlikely to emerge in the market. It is socially undesirable because, given any relevant quantity of output, the cost-minimising

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5 *op. cit.* n.1., p.42.

6 To avoid confusion as to whether 'depreciation' refers to the adjustment of ORC to DORC or historic accounting records that might have been maintained by the relevant company, I will avoid using the term 'depreciation' to refer to the derivation of DORC from ORC.

7 *op. cit.* n.1., p.39.

8 *ibid.*

way to produce that output involves a single producer.[9] An alternative interpretation of a competitive market in the presence of natural monopoly technology is provided by the theory of contestability. This theory states that, under certain assumptions, an incumbent monopoly will be constrained by incipient competition to set prices no higher than the average cost that would be faced by a new entrant if that entrant supplied all relevant market demand. It is claimed that a DORC valuation is consistent with a contestability standard and, as such, satisfies the objective in 8.1.b of the Code.[10]

Secondly, the relationship between DORC and a new entrant has been interpreted as meaning that DORC is the maximum value consistent with avoiding (economically inefficient) system wide bypass.[11]

I have previously commented on the limitations of using DORC as an asset valuation technique for regulatory purposes.[12] However, DORC is specifically referred to in clause 8.10(b) of the Gas Code. For the purpose of this report, I will take as my starting point the justification of DORC provided by the ACCC. In other words, if a DORC valuation is meant to reflect a new entrant's costs, and this is desired to allow comparison to a 'perfect contestability' benchmark or a benchmark of system-wide by-pass, what is an economically correct approach to measure DORC? In particular, what form of adjustment would need to be used to transform a measure of Optimised Replacement Cost into a Depreciated Optimised Replacement Cost in a way that is consistent with both the justifications based on contestability and maximum asset price that have been presented by the ACCC?

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[9] This is essentially the definition of a natural monopoly technology.

[10] See for example Australian Competition and Consumer Commission, *Access Arrangement by Transmission Pipelines Australia Pty Ltd*, Final Decision, 6 October 1998, p.32.

[11] *op. cit* note 1, p.40.

[12] For example, see "Asset valuation and access to essential infrastructure facilities under Part IIIA of the Trade Practices Act 1974", p.94-116 in *Deregulation of public utilities: current issues and perspectives*, (Megan Richardson ed.) Centre for corporate law and securities regulation, The University of Melbourne, Melbourne, 1996.

The construction of DORC from ORC

Suppose that a new firm was to begin to provide all the relevant services currently provided by an existing gas company. This new firm will be the sole provider and the existing company will cease to operate. The ORC valuation, if correctly calculated, is the new capital cost incurred by the new firm. This capital cost will be calculated using the best currently available technology to provide the relevant services. The assets associated with this capital cost (and with on-going maintenance) will be able to operate for many years into the future.

As an alternative to purchasing new capital equipment, the new firm could purchase the assets of the existing firm. DORC may be interpreted as the maximum price that a new entrant would be willing to pay for these existing assets rather than purchase new assets. The transformation of ORC to DORC must then leave the new firm indifferent between buying the existing assets and purchasing the new assets.[13]

In order to calculate the relevant maximum price for the existing assets, we need to make certain assumptions about the life-span of both existing and new assets, the changing nature of technology, and the changing demand for the relevant services. The first and last of these is obvious. The maximum price that can be charged for the existing assets, given the alternative of buying new assets, will depend on the expected life of both the

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[13] As noted above, the ACCC uses this as a basis for justifying DORC in its Draft Statement of Principles for the Regulation of Transmission Revenues. "Finally, another justification for DORC setting the upper limit to valuations comes from what a DORC valuation actually is attempting to measure. This is the maximum price that a firm would be prepared to pay for 'second-hand' assets with their remaining service potential, higher operating costs, and (old) technology - given the alternative of installing new assets which embody the latest technology, and which generally have lower operating costs, and which will have a greater remaining service potential. Therefore, if prices reflect a value that is in excess of DORC, then users would be better off if the existing system were scrapped and replaced by new assets. Similarly, if assets are sold for prices above the DORC valuation, then this implies that scarce investment funds are being inefficiently applied: in this case, it would have been a more efficient use of investment funds for the existing assets to be scrapped and a duplicate system installed" (*op. cit.* n.1, p.40). Similar statements have been made elsewhere by the ACCC (*op. cit.* n.10, p.33) and by the Victorian Office of the Regulator General in *Access Arrangements – Multinet Energy et. al.*, Final Decision, October 1998, p.58.

existing and the new assets. Expected changes in demand will impinge on the adequacy of current assets and the potential need for short-term capacity expansion. Also if demand for the service is expected to fall in the future, this will affect technological choice. Expected changes to technology are also relevant. If technology is rapidly changing then there can be value to the new firm of waiting for future developments. This can affect the willingness-to-pay for existing assets relative to new assets.[14] For example, the purchase of existing assets might allow the firm to cover its short-term obligations while maintaining an option to upgrade to improved technology when it becomes available.

For the purpose of this report, I will assume that both new and existing assets have well specified lives. I will also assume that there is no relevant expected changes in demand or predicted changes in technology that impinge on the relationship between the ORC and the valuation of existing assets.[15] While these are strong assumptions, they appear to be consistent with the general approach adopted by Australian regulators. For example, when moving from ORC to DORC, these regulators generally do not appear to consider future technology changes.[16] Similarly, while there is some discussion on asset lives, when calculating DORC from ORC, regulators choose well-specified lifetimes for new and existing assets.[17]

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[14] An additional factor, of particular importance to gas services, is the potential finite supply of gas. This can impinge on the alternatives faced by a new firm. For example, if there is only ten years expected supply and both existing and new assets have an expected life-span exceeding ten years, then the constraint on raw product means that both existing and new assets have an economic life of only ten years. This issue was raised by Incitec in the discussion of the EAPL decision (*op. cit.* note 2, p.23) but was interpreted as an argument against DORC rather than as an argument that affected the transformation of ORC to DORC.

[15] I will return to the issue of expected productivity improvements in my discussion of question (v).

[16] Note that this does not mean that the relevant regulators do not consider these issues elsewhere in their reports. For example, the issue of new technology has been extensively discussed in relation to the allowed WACC for regulated firms. The point here is simply that these issues do not enter the specific transformation from ORC to DORC.

[17] For example, see the ACCC draft decision re: EAPL (*op. cit.* note 2) p.31-33.

Given an ORC valuation of V_n, a real interest rate of r and the assumptions noted above, the new firm faces two alternatives. It can invest in new technology with a cost of V_n and an expected life of T_n or it can purchase the existing assets at price P. The existing assets have an expected life of T_o. In either case, when the relevant assets reach the end of their life, the firm will purchase new assets to continue serving the market. Under the 'maximum price' interpretation, the DORC value of the existing assets will be the maximum value of P that just makes the new firm indifferent between these two alternatives.

To calculate the value of P, it is convenient to annualize the new asset cost. Let v_n be a constant amount of dollars per year over the life-time of the new assets that is equivalent in present value to the new assets. In other words, $V_n = \frac{v_n}{(1+r)} + \frac{v_n}{(1+r)^2} + \ldots + \frac{v_n}{(1+r)^{T_n}}$.

Then, for the new firm to be indifferent between buying the existing assets or purchasing new assets we require that

$$\frac{v_n}{r} = P + \frac{v_n}{r(1+r)^{T_o}}$$

The left hand side of this equation is the present value cost to the new entrant of supplying the relevant services using current technology forever. The right hand side is the cost of purchasing the existing assets plus the present value cost of providing the relevant services with the new technology after the existing assets cease to be viable. In other words, purchasing the existing assets allows the new firm to postpone its purchase of new assets by T_o years. Rearranging, this implies that $P^* = \frac{v_n}{r}\left(1 - \frac{1}{(1+r)^{T_o}}\right)$ where P^* is the DORC valuation.

This value of DORC can be easily related to the ORC. To see this, suppose that the value of ORC is annualized and consider the net present value of the first T_o years of this annual flow. This is given by $\frac{v_n}{(1+r)} + \frac{v_n}{(1+r)^2} + \ldots + \frac{v_n}{(1+r)^{T_o}}$. It is easy to confirm that

this finite geometric sequence is equal to P^*, the DORC value given by the new entrant counterfactual. Thus, the DORC value is simply the present value of the annualized cost of the new assets or ORC over the remaining life-time of the existing assets.

Alternatively, note that the ORC is equal to $\frac{v_n}{(1+r)}+\frac{v_n}{(1+r)^2}+\ldots+\frac{v_n}{(1+r)^{T_n}}$ by definition. Comparing the ORC and the DORC geometric series we see that the difference is given by $\frac{v_n}{(1+r)^{T_o+1}}+\frac{v_n}{(1+r)^{T_o+2}}+\ldots+\frac{v_n}{(1+r)^{T_n}}$. In other words, to transform ORC to DORC, the net present value of the annualized cost of the new assets after the life of the existing assets is deducted from the ORC. Put simply, the DORC is simply equal to the present value of the flow of new asset cost that is avoided by purchasing the existing assets rather than the new assets.

The above calculations were based on the counter-factual that a new entrant could purchase the existing assets rather than purchase new assets to provide the service. As noted above, an alternative justification for DORC is that it mimics a perfectly contestable market. Using the same assumptions and notation as above, this means that the incumbent firm using existing assets can gain a return of no greater than v_n per year on these assets. The DORC under this counterfactual is simply equal to this maximum flow of funds over the remaining lifetime of the asset. This equals $\frac{v_n}{(1+r)}+\frac{v_n}{(1+r)^2}+\ldots+\frac{v_n}{(1+r)^{T_o}}$, which is identical to the value of DORC calculated under the 'new entrant' valuation.[18]

In summary, if DORC is justified by either the claim that it represents the maximum amount that a new entrant would be willing to pay for the existing assets, or if it is justified as reflecting a perfectly contestable market, then the adjustment from ORC to DORC is given by deducting from ORC the net present value of the annualized cost of

[18] For a more complete discussion of the contestability basis for the DORC valuation, see S.P. King (2000) *Report on* Agility's *approach to DORC valuation*, Report to IPARC.

the new assets after the life of the existing assets. Equivalently, DORC is the net present value of the annualized cost of ORC over the remaining existing-asset lifetime.

Specific Issues

(i). *Is the Agility NPV approach to the construction of DORC from ORC, as set out in the Agility submission of August 2000, consistent with the interpretation of DORC enunciated by the Australian Competition and Consumer Commission (ACCC) and the Victorian Office of the Regulator General (ORG) in relevant documents such as the ACCC's Statement of Principles for the Regulation of Transmission revenues?*

The above discussion highlights a number of characteristics of DORC valuation. First, it is a well-recognized valuation methodology although there is considerable debate about how it is applied in practice. Second, if the economic justification for using DORC is that it either mimics a contestable market, is a maximum value to prevent system-wide by-pass, or reflects the maximum price that a new operator would be willing to pay for the existing assets, then only one form of adjustment of ORC to DORC is consistent with each and every one of these interpretations. That adjustment is the one derived above. The basic result is that ORC is transformed into DORC by annualizing the ORC over the new asset lifetime and taking the net present value of this annual flow over the life-time of the existing assets.[19] No other form of adjustment of ORC to DORC is consistent with the economic justification for DORC.

Agility Management has provided an approach to constructing DORC from ORC. "The ORC to DORC methodology proposed by Agility, however, is based on the NPV of prospective cash flows that the existing assets might earn over their remaining life relative to the NPV of revenues that a new replacement asset might be expected to earn in

[19] As noted above, the calculations presented here are based on certain assumptions about future market conditions. The relationship between ORC and DORC will generally become more complex if these assumptions are weakened, but the basic nature of the relationship will remain.

a hypothetical contestable market".[20] It is my understanding that the Agility approach is the same approach discussed above to calculate P^*.

The above discussion shows that P^*, or in other words the Agility NPV approach to the construction of DORC from ORC as set out in the Agility submission of August 2000, is consistent with the interpretation of DORC presented by the ACCC and the ORG. In fact, it can be argued that the Agility approach is the *only* form of adjustment of ORC to DORC that is consistent with these interpretations.

(ii). *Is the approach to the construction of DORC from ORC adopted by the ACCC in the Draft Decision on EAPL consistent with the interpretation of DORC under (i)?*

The ACCC and the ORG have used a straight-line adjustment to convert ORC to DORC. In terms of the notation presented above, a straight-line adjustment gives a value $\frac{T_o}{T_n}V_n$. It is not obvious what this valuation means. It clearly is not consistent with the value of DORC calculated above and, as such, it is not consistent with the contestability or new-entrant justifications used by the regulators for DORC. In this sense, the use of a straight-line adjustment to convert ORC to DORC is arbitrary and appears to lack any economic justification.

The use of a straight-line adjustment will lead to a value for DORC that is consistently below the calculated value P^*. To see this, note that when ORC is written as a finite geometric series, each successive term is less than the previous term by $\frac{1}{(1+r)}$. If $r = 0$ then $P^* = \frac{T_o}{T_n}V_n$. But for $r > 0$, P^* deletes the tail of the geometric series that contains relatively small terms, while straight-line depreciation averages over the series. As a result $P^* > \frac{T_o}{T_n}V_n$.

It could be argued that the value of DORC (P^*) calculated above by the Agility approach is 'too high'. Such an argument seems to have little basis. If DORC is justified on the

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[20] *op. cit.* n.2., p.27.

basis of contestability or the other economic arguments noted above, then the calculated value of DORC, P^*, is the only value consistent with both the calculated ORC and the stated justification for DORC. If the arguments used to justify DORC presented by the ACCC and the ORG are taken seriously, then there is a well-defined value of DORC.[21] To claim that the arguments used to justify DORC are correct but that the resulting value of DORC is excessive seems inconsistent. Further, under the Code, the DORC value represents an upper bound on asset valuation. As such, there appears to be no constraint on the regulator to set the asset value at, or close to, DORC. If the regulator believes that the calculated DORC is too high then the regulator has the ability to set a lower initial capital base under the Code.

In summary, the straight-line adjustment to transform ORC to DORC adopted by the ACCC in the Draft Decision on EAPL is clearly inconsistent with the Commission's stated economic underpinnings and justification of DORC.

(iii). *What relevance, if any, does past actual/accounting depreciation have to the construction of DORC from ORC if that construction is performed in a manner that is consistent with the interpretation of DORC under (i)?*

In the EAPL Draft Decision, the ACCC considered a number of alternative approaches to both ORC and DORC.[22] The Commission refers to one approach as the 'traditional' approach. "The traditional approach to deriving a DORC from an estimated ORC has been to assume that the asset depreciates uniformly in real terms over the life of the asset. This leads to a relatively simple calculation so that the DORC is equated to a percentage of the ORC with the percentage equal to the expected remaining life of the existing asset expressed as a proportion of the expected life of an (*sic*) replacement asset".[23] This

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[21] As I stated in my earlier report to IPARC, this "approach is the only valuation methodology consistent with the contestable income flow". *op. cit.* n.13, p.6.

[22] *op. cit* n.2.

[23] *ibid*. p.27.

traditional method is the straight-line method of adjustment of ORC to DORC discussed above.

The ACCC rejects the Agility approach on a number of grounds. First, it argues, "the threat of redundancy and by-pass in the gas transmission industry could justify greater depreciation in earlier years" (p.27). If such possibilities exist then these would modify the calculation of P^*. However, it is not obvious that they would raise the rate of depreciation in the ORC to DORC calculation. For example, take the simple case where both the existing assets and new assets would have a life-span exceeding the remaining known life of the gas reserves. Then this finite life might effect the ORC calculation. The new assets would not be designed to last eighty years if the expected life of the gas fields were only 10 years. But given the value of ORC, the existing assets will have a DORC value equal to ORC if DORC is justified as the maximum price that the existing assets can be sold for relative to new assets. In this situation, the life of the new and existing assets are equally limited by the life of the gas fields and so there is no difference between their expected life. The existing assets are perfect substitutes for new assets.[24]

In brief, the ACCC argument could be used to modify the calculation of DORC, but is not an argument for the use of *ad hoc* straight-line adjustment.

The ACCC argues that if it uses straight-line depreciation for the on-going regulatory depreciation methodology, then it should use the same methodology to transform ORC to DORC (p.27-28). I discuss the consistency between DORC valuation and on-going depreciation under (iv) below.

Third, the Commission claims that the contestability assumption used to justify the DORC calculation is an invalid benchmark (p.28). However, the Commission itself justifies the use of DORC on the basis of the contestability and new-entrant arguments that lie at the heart of the value of P^*. If these justifications presented by the Commission are taken seriously, then the DORC value is the one presented by the Agility approach.

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[24] Of course, given the finite life of the fields and the level of gas demand, a new entrant might not find it economically viable to build any assets to transport gas. Such redundancy is considered in optimized deprival valuation of assets but not under DORC measurement.

The Commission argues (p.29) that "if the hypothetical contestable market is to be relevant for a regulated business, it must be one that shares key features of the natural monopoly industry it purports to model. In the gas industry, it is one where straight line real depreciation is the norm". The Commission goes on to note that the value of assets in a regulated industry are the present value of future regulated revenue flows so that if these flows are based on straight line depreciation then this will be reflected in the asset value.

The Commission is clearly not using the term 'contestable market' in its standard economic use in this argument. A contestable market in economics has certain well-defined characteristics. These characteristics are captured in the calculation of P^* and are inconsistent with straight-line depreciation. In other words, saying that a contestable market model must include straight-line depreciation of asset value is economic nonsense. Similarly, noting that if regulated revenues have certain characteristics then so too must the imputed value of regulated assets is clearly correct, but is also not based on a contestable market as the term is understood in economics.

The discussion in footnote 42 suggests that what the Commission means by contestability is not the strict economic use of the term as derived by Baumol, Panzar and Willig.[25] Rather, the Commission seems to use the term contestability in a looser way, referring to some form of competition for the market. The Commission derives such an alternative form of competition in footnote 42.[26] If this is indeed the Commission's position and its use of the term contestability is not meant to reflect the standard economic use of this term, then the Commission needs to make this clear, and make clear exactly what it does

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[25] For example, see W. Baumol, J. Panzar and R. Willig (1982) *Contestable Markets and the Theory of Industry Structure*, Harcourt Brace, New York.

[26] The model used by the Commission in this footnote is clearly problematic when discussing DORC in the context of the Code. Under the Gas Code, DORC is used as an input to setting a regulatory asset base and hence future regulated revenues. As is well recognized, to argue back from those imputed revenue flows to the regulated asset base is technically problematic and would require a fixed-point solution for consistency. In the literature, this problem is referred to as 'circularity'.

mean by the term and how this term is to be interpreted as a justification for DORC valuation.

Finally, the Commission argues that to use P^* as DORC would be inconsistent with paragraphs 8.10.f and 8.10.g in the Code. Paragraph 8.10.f requires that when setting the initial capital base, the Commission should consider past tariffs, economic depreciation and historical returns. The Commission's argument appears incorrect. Paragraphs 8.10.f and 8.10.g are requirements, in addition to DORC and DAC, which the Commission needs to consider when setting the initial capital base. As such, these requirements should not alter the DORC calculation, but might alter the degree of emphasis placed on DORC when setting the initial capital base.

DORC, as characterized by P^*, does take past depreciation into account. However, this is not arbitrary 'book valued' depreciation set for example by rules of accounting. Rather, P^* has an inbuilt 'market' value of depreciation. Current assets have depreciated from their original cost on the basis of the change in their market value. For example, if there has been technological innovation that has lowered the value of V_n, then this depreciation due to technical obsolescence is automatically built into the construction of P^*. Similarly, if an unexpected capital deterioration occurs that lowers the expected life of the existing assets, then this directly effects P^*.[27]

The approach to DORC summarized by P^* does not and should not take account of past accounting measurements of depreciation. Such figures often have no economic meaning in the context of market value and as P^* is a market-based method of determining DORC from ORC, including arbitrary non-market depreciation in calculating P^* would be nonsensical. The irrelevance of past accounting depreciation is intrinsically linked to the

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[27] This relationship between the value of DORC and depreciation has been noted by the ORG. **"Depreciation is implied** - the value of an asset in a competitive market is the net present value of future income from that asset, which will be lower for an asset that is part of the way through its life. Similarly, assets which have a lower remaining life will need to be replaced earlier than new assets, implying that a buyer would pay less for older assets" (*op. cit.* n.13, p.65).

motivation underlying P^*. This is a market-based measure of DORC and accounting numbers only have value in such a measure to the degree that they are in line with the value of the assets as seen by market participants, such as the hypothetical new entrant.

In summary, if the adjustment of ORC to DORC is made consistent with the interpretations of DORC presented by the ACCC and the ORG, then past accounting depreciation is completely irrelevant to that adjustment. Further, in my opinion, there is nothing in the Code that requires past depreciation to be considered when constructing DORC from ORC. While such factors might enter into the setting of the initial capital base, they are irrelevant when establishing DORC from ORC.

iv. *What is the relationship between DORC, as consistently derived with the interpretation under (i), and on-going depreciation? How is this relationship affected under the Gas Code where DORC valuation is a maximum valuation for the initial capital base (ICB) and the initial capital base might be set less than DORC? In particular, is consistency between DORC and on-going depreciation maintained under the Gas Code maintained under the following rule: "Irrespective of whether the ICB is set at DORC or something less, the actual price path for the asset should not at any time exceed the new entrant competition depreciation price path assumed in the calculation of DORC. This constraint does not of itself impose any limitation on the form of on-going depreciation."?*

As noted in my earlier report, "the valuation methodology [embodied in P^*] and the depreciation methodology are inseparable".[28] If the DORC value calculated as P^* was then combined with an alternative depreciation schedule (including straight line depreciation) then after one year the regulated asset values would no longer be consistent with the 'contestability' or 'new entrant maximum price' arguments used to justify the DORC calculation. In other words, if P^* is used as a DORC value and the reason for this was to satisfy, say, the contestability benchmark, then the form of adjustment used to

[28] *op. cit.* n.17, p.8.

calculate DORC from ORC needs to be used for on-going depreciation if this benchmark is to continue to be satisfied in the future.

If an alternative method of depreciation, such as straight-line depreciation, was required, then this problem could be avoided by altering another variable, such as the allowed rate-of-return each year. The adjustment in DORC valuation between any two years involves both a 'return on capital' and a 'return of capital'. If depreciation (return of capital) were fixed then any specific adjustment to the DORC valuation could be achieved by altering the 'return on capital'. In other words, an inconsistent value for depreciation could always be offset by adjusting the interest rate (or WACC) that would apply over the year.

While such an adjustment is mathematically trivial, it seems undesirable to use such a method to avoid an exogenous constraint on depreciation. The adjustment could, for example, involve large negative values for the WACC, particularly for relatively new assets. While the resulting DORC values would be consistent with P^*, the values of the WACC used to calculate the return on capital would have no relationship to the actual market returns on comparable assets.

If there is an exogenous constraint on depreciation that is inconsistent with P^* and is to be applied to a DORC capital value, then this seems to suggest that the relevant DORC valuation envisaged by those drafting the regulations is not P^*, and as such is not one based, say, on contestability.

Within the context of the Gas Code, however, the initial capital base is not necessarily set at DORC. Rather, DORC represents a cap on the initial capital base. In this sense, it would be possible to interpret both P^* and the associated on-going capital value with consistent depreciation as a cap on the regulatory revenue flows over time. Because DORC is simply a cap, the initial capital base might be set below DORC. This capital base might then be subject to straight-line depreciation leading to a set of regulated revenue flows over time. To the extent that these flows are always below the flows associated with consistent revaluation of P^*, then the regulated flows satisfy the cap set by DORC.

One way to formalize the use of DORC and consistent depreciation as a price or revenue cap is provided by the following rule. *"Irrespective of whether the ICB is set at DORC or something less, the actual price path for the asset should not at any time exceed the new entrant competition depreciation price path assumed in the calculation of DORC. This constraint does not of itself impose any limitation on the form of on-going depreciation."* Such a rule maintains consistency of the DORC valuation over time and, in my opinion, is a legitimate approach under the Gas Code. Used in this way, the value of DORC over time provides an on-going 'check' on regulated revenues.

(v). *Comment on the relationship between the DORC valuation established by the Agility NPV approach and the written down value calculated under the ACCC's competition depreciation scheme, in the context of the Code requirement to establish the DORC value at a particular point in time (30 June, 2000 in the case of EAPL). Can the two values be reconciled? If so, how and subject to what conditions? To what extent is each of these two approaches generally applicable?*

In the Statement of Principles for the Regulation of Transmission Revenues, the ACCC presents a method of depreciation that it calls competition depreciation.[29] Competition depreciation involves turning an initial asset value into a flow of revenues over the finite asset life. The value of the asset at any future period is given by the net present value of the remaining flow of revenues. Depreciation is a residual item in the revenue flow each year after return on capital is deducted.

The basic principle behind competition depreciation is that any current asset valuation can be annualized into a flow of revenues over the asset's lifetime. There are an infinite number of such revenue flows. The regulator can then choose the flow of revenue that they find most desirable and then set depreciation as the residual that will allow this flow of revenue.

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[29] *op. cit.* n.1, annex 5.1.

In its discussion, the ACCC limits attention to certain revenue flows that mimic what it sees as desirable features of a market. For example, if there is no inflation or technical progress, then revenue flows should be constant over time. If there is inflation and technical progress then revenue flows should increase at the rate of inflation less the rate of technical progress over time. The ACCC argues that these flows reflect the types of revenue flows that would be expected in competitive markets. "[T]he 'competition' term referring to the responsiveness of associated pricing to changes in replacement costs taking account of general price increases and technological change in a manner which mimics competitive market behaviour".[30] It needs to be recognized, however, that the ACCC's approach is not limited to any specific formulaic path of revenues and can apply to any set of revenues with a net present value given by the current asset value.

To see this, consider the situation where an asset with life T and initial value of A_0 is to be associated with a constant flow of revenues each year over its asset life. Denote the revenues by R. Then R is given by the finite geometric series

$$A_0 = \frac{R}{(1+r)} + \frac{R}{(1+r)^2} + \ldots + \frac{R}{(1+r)^T}$$

The solution to this series is given by

$$A_0 = \frac{R}{r}\left(1 - \frac{1}{(1+r)^T}\right)$$

It is easy to confirm that rearranging this equation gives an identical formula to that presented in Box A5.1 by the ACCC. The value of the relevant asset at time t is then given by $A_t = \frac{R}{(1+r)} + \frac{R}{(1+r)^2} + \ldots + \frac{R}{(1+r)^{T-t}}$ where $t \leq T-1$.[31] Substitution confirms that this value is identical to that presented by the ACCC.

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[30] *op. cit.* n.1, p.69.

[31] Note that in my formulation, revenues are 'paid' at the end of each period.

Alternatively, suppose that revenues are required to decline at the rate p. For instance p might refer to a predicted rate of technical progress.[32] Then R is given by the finite geometric series

$$A_0 = \frac{R}{(1+r)} + \frac{R(1-p)}{(1+r)^2} + \frac{R(1-p)^2}{(1+r)^3} + \ldots + \frac{R(1-p)^{T-1}}{(1+r)^T}$$

The solution to this series is given by

$$A_0 = \frac{R}{r+p}\left(1 - \frac{(1-p)^T}{(1+r)^T}\right)$$

Again it should be easy to confirm that this is identical to the equation presented by the ACCC "in a real context".[33]

It is clear that the ACCC's competition depreciation is simply a mathematical way to derive a required internally consistent path of revenues with a specific net present value. The economic value of this form of depreciation rests solely on the economic value of the revenue path being derived.

The dual problem to the ACCC's competition depreciation is to take a finite stream of revenues and, from this stream, to construct a path of consistent asset valuations. For example, take an arbitrary finite path of revenues, denoted R_1, R_2, …, R_T. For this revenue stream, define asset value A_t as $A_t = \frac{R_{t+1}}{(1+r)} + \frac{R_{t+2}}{(1+r)^2} + \frac{R_{t+3}}{(1+r)^3} + \ldots + \frac{R_T}{(1+r)^{T-t}}$.

Then A_t, $t = 0,\ldots,T-1$ represents a sequence of consistent asset values derived from the path of revenues. Again, these asset values only have meaning to the degree that the associated revenue flows have meaning.

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[32] It might also refer to any other constant. In fact p can be completely arbitrary.

[33] This said, the ACCC use a term Z, which is the inverse of the value given by my calculation. There is clearly a trivial error, either in the ACCC calculation or the one above.

One set of meaningful revenues are those associated with the maximum revenues that a firm in a perfectly contestable industry could earn over time. Suppose that the current contestable revenues are given by $(r+p)A_n$ where this represents the one-period rental rate on current capital required to produce the relevant services. The rental rate includes a term for return on capital r and a term for technical progress reflecting a loss in asset value p.[34] The contestable returns will fall at the rate of technical progress, p. Then the value of these contestable rents over a finite time T_0 is given by

$$A_0 = \frac{(r+p)A_n}{(1+r)} + \frac{(r+p)A_n(1-p)}{(1+r)^2} + \frac{(r+p)A_n(1-p)^2}{(1+r)^3} + \ldots + \frac{(r+p)A_n(1-p)^{T_0-1}}{(1+r)^{T_0}}$$

So

$$A_0^* = A_n\left(1 - \frac{(1-p)^{T_o}}{(1+r)^{T_o}}\right)$$

This formula is clearly equivalent to the competitive depreciation rule given by the ACCC where $R=(r+p)A_n$. In other word, if we interpret the revenue flow under the ACCC formula as representing revenues in a perfectly contestable market, then the ACCC competitive depreciation is the same as the construction of DORC from an ORC of A_n under the contestability assumption. To see that this is equivalent to P^*, note that in the earlier discussion in this report, $p=0$. Substituting this into the above formula and noting that $v_n = rA_n$ in this example immediately derives the formula for P^* presented earlier. In fact, the above formula for A_0^* is simply a generalization of the earlier formula for DORC.

The implication of this is that the DORC valuation presented earlier in this report was simply one case of the formula presented by the ACCC for competitive depreciation.

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[34] To simplify the equation, I have assumed that new capital has an infinite life so that I can ignore new capital depreciation in the contestable revenues. Such depreciation could be included with additional notation. The 'old' capital clearly has a finite life.

More generally, a DORC valuation based on contestability will always be able to be expressed in terms of the ACCC's competitive depreciation approach. Contestability simply gives a flow of revenues over time and these can be transformed into an asset value through the sum of a finite geometric series.

The ACCC competitive depreciation formulation and the Agility approach to DORC are mathematically identical in the sense that they both simply move consistently from stocks to flows and vice-versa. Neither approach is limited to the specific examples presented here or by the ACCC. Either approach can be used to generate or value any consistent set of revenues. However, most of these streams of revenue will have no economic meaning. For example, the ACCC approach could be used to take a current asset value and generate revenues consistent with straight-line depreciation over the fixed asset life.[35] These revenues could then be used to calculate the consistent asset value at any future time or to transform the asset value to a current DORC value. However, it is unclear that the revenues generated by such a process would have any economic meaning and as a result it is unclear that the generated value of DORC has any economic meaning.

The movement from competitive depreciation to DORC does require some care. Competitive depreciation is used to take a modern asset and translate its value into a depreciated value at a future date. For example, suppose we have the value of a pipeline at the beginning of year 2001, $A_n (= A_0)$ and this pipeline will last until the end of year 2020. The asset has a twenty-year life-span. Competitive depreciation is used, given current predictions about inflation, interest rates and technical progress, to determine a depreciation profile for the asset and an asset value at any future time. Specifically, competitive depreciation determines annual revenues $R_1, \ldots, R_{20}$. We can then calculate A_9 which will be the value of the asset at the beginning of year 2010, consistent with the desired flow of revenues. This value will simply be equal to the net present value of the

[35] In this case, $R_t = \frac{\frac{n-t+1}{n} r A_0 + \frac{1}{n} A_0}{(1+r)^t}$ where R_t is the year t revenue flow, A_0 is the initial asset value and n is the known asset life.

final eleven years of revenues under the competitive depreciation scheme.[36] Thus,

$$A_9 = \frac{R_{10}}{(1+r)} + \frac{R_{11}}{(1+r)^2} + \ldots + \frac{R_{20}}{(1+r)^{11}}.$$

In contrast, DORC involves taking the same modern asset value A_n and determining the value of currently existing old assets. If, for example, the current assets will last until the end of year 2009, then the DORC that is consistent with the desired competitive depreciation is given by the net present value of the first nine years of revenue flows.

Thus $A_{old} = \frac{R_1}{(1+r)} + \frac{R_2}{(1+r)^2} + \ldots + \frac{R_9}{(1+r)^9}$.

Note again that DORC and competitive depreciation are using exactly the same information but are answering slightly different questions. To see that they use the same information, note that $A_n = A_{old} + \frac{A_9}{(1+r)^{10}}$. In other words, given any two of the ORC of A_n, the DORC of A_{old} and the competitive depreciated value A_9, it is a simple matter to calculate the other value.

To see that they are answering slightly different questions, note that the DORC is asking how much of the new asset cost can a firm avoid by using the existing assets over their remaining lifetime rather than using the new assets, where as competitive depreciation is asking what is the future market value of assets that are new today. Another way of putting it is that if a new entrant today paid the DORC for the existing assets, and then, when those assets were no longer viable bought second-hand assets that were new today, the total cost to the new entrant of providing the relevant service over the life-time of the new assets would be the same as if the new entrant had, in fact, bought the new assets today.

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[36] Note that A_9 is the value to a person of the asset at the beginning of year 2010. Whether A_9 is expressed in year 2001 dollars or year 2010 dollars simply depends on whether the desired revenue flow is expressed in real or nominal dollars.

In some situations, there might appear to be another relationship between ORC and DORC. Continue with the example of a 2001 asset and suppose that the revenues used in competitive depreciation are related by a constant. Thus, $R_t = R_{t+1}(1+g)$ where g is a constant. For example g might capture constant expected rates of asset inflation and technical progress. Then the DORC value is

$A_{old} = (1+g)^{11}\left(\frac{R_{12}}{(1+r)} + \frac{R_{13}}{(1+r)^2} + \ldots + \frac{R_{20}}{(1+r)^9}\right) = (1+g)^{11} A_{11}$. It appears as if the DORC value for an asset with nine years life can be derived from the value of the current asset nine years before the end of its life. However, this only holds in the specific case where g is a constant. If there were not a constant relationship between each successive year's revenue flow, this relationship would not hold.

In summary, the Agility approach based on contestability is an economically meaningful case of competitive depreciation. In particular, under the assumption that revenue flows must equal perfectly contestable revenues, the two approaches are identical. The DORC value represents the net present value of the revenue flows over the existing asset lifetime. Equivalently, it is the difference between the ORC and the current value of the written down ORC value at the end of the existing asset lives. More generally, the Agility approach to transforming ORC to DORC and the (generalized) ACCC competitive depreciation are mathematically identical. They use the same information to answer slightly different questions.