The DORC valuation model of regulated infrastructure assets

The absence of an agreed methodology in valuing infrastructure assets has traditionally left governments, regulators and industry disagreeing over the worth of a particular project. **DAVID JOHNSTONE** and **WAYNE LONERGAN** look at a new methodology.

Regulatory agencies in Australia, particularly the ACCC, ORG in Victoria, and IPART in NSW, have advocated and approved the valuation of gas pipelines, electricity transmission networks, port facilities, rail networks, airports and other natural monopoly infrastructure assets at their *depreciated optimised replacement cost* (DORC). The purpose of this paper is to provide a succinct explanation of the DORC model, how it should be applied, the published statements and arguments of regulators, and completing missing details and essential mathematical connections. (An extensive list of related publications by the ACCC, ORG, IPART and the Productivity Commission is provided below).

Debate about asset valuation, not only in regulation but in virtually all contexts, is often inconclusive and confusing for the reason that different contributors have different implicit understandings of the underlying conceptual framework (where indeed there is any such framework). To avoid confusion and argument at cross-purposes in relation to DORC, it is essential to establish a common understanding of why DORC arose as a regulatory valuation standard, and its economic justification. If this justification is accepted, both the regulators and the valuation industry can proceed to discussing practical implementation issues with a clear and agreed perspective on what is the theoretical objective. Otherwise, any theoretical criticism or development of DORC will not rest on a common understanding of the DORC financial model.

It is useful to understand the ways in which DORC should be applied to regulatory asset valuation of natural monopoly assets, or to the more basic objective of setting the tariffs payable by users of these assets to their owners. Whether DORC has the same conceptual relevance when the assets in question are unregulated (e.g. public roads or non-monopoly businesses, public or private) and are not subject in the same circumstances to regulatory tariff setting, is another question. By first understanding the economic basis for DORC in the case of regulated assets, the matter of whether it has an analogous or related justification when used more generally becomes much more evident.

The exposition of DORC provided in this paper should assist regulators, Government departments and trading businesses, and the valuation industry generally in deciding what aspects of regulatory asset valuation, particularly infrastructure valuation by DORC, can be transported appropriately to broader asset valuation and price...
setting applications, including in particular fundamental problems of financial decision making and financial reporting by both public and private sector asset owners.

**TARIFF SETTING BY DORC**

The underlying purpose of regulatory asset valuation is to establish an economic basis on which to determine the tariffs payable by the users of monopoly infrastructure assets such as gas pipes to their public or private sector owners. Regulators must decide, for example, what price a gas retailer should pay to the trunkline pipe owner for the transport of a quantity of gas from its source to the region where it is finally distributed (perhaps through yet another company’s local distribution network) to retail or industrial customers. Regulatory agencies in Australia have faced this fundamental issue in many different contexts over the last decade. Their general solution rests on just two fundamental economic assumptions:

(a) The regulatory asset value at any time \(t\) is the discounted present value at time \(t\) of the future tariff stream generated by that asset;

(b) The remaining tariff stream allowable to the owner of a regulated asset should not exceed the amount that is just high enough that a potential new entrant (or existing asset user) could at any time \(t\) during the life of that asset earn an NPV equal to zero by reproducing (and thus bypassing) the existing asset.¹

The first of these principles is axiomatic, and the second can be understood intuitively in the following simple example. Suppose that a shopkeeper pays a carrier \(x\) per parcel for deliveries. At some point (dependent on volume) \(x\) becomes so high that the shopkeeper can economically buy a truck and employ a driver. Or a new entrant can set up and displace the existing carrier. This is the price at or below which the contractor must work if he is to be confident of holding on to his business. Long-run tariffs are bounded, therefore, by the cost of replacing or effectively bypassing existing assets. This was summarised by the ACCC as follows:

A return on replacement cost is the maximum that a monopoly firm could earn in a perfectly contestable market. (ACCC 1998b, p. 32) [emphasis added].

**THEORETICAL DERIVATION OF DORC**

DORC measured at any time \(t\), hereafter denoted by \(\text{DORC}_t\), is the present value of all future tariffs produced by the infrastructure in question, until such time \(T\) that the assets in question expire either physically or because they are economically best replaced with new assets.

The “optimised” (engineering and economic minimum) cost of replacing existing assets with new equivalents at time \(T\) equals:

\[
\text{ORC}_t (1+g)^{T-t}
\]

where \(\text{ORC}_t\) is the optimised cost of such assets as at time \(t\) and \(g\) is the rate at which this cost grows over time (note that \(g\) can be negative, if for example technology improvements mean new cheaper infrastructure).

At the time of expiry, the existing asset owner or potentially a new entrant invests in new (replacement) infrastructure at an optimised replacement cost equal to \(\text{ORC}_t (1+g)^{T-t}\). The net present value at the time of this investment is zero, as is ensured by the regulator following principle (b) above, meaning that the tariff stream flowing to the new assets from time \(T\) onwards has present value at time \(T\) equal to \(\text{ORC}_t (1+g)^{T-t}\).

Now, suppose that instead of waiting until existing assets expire at time \(T\), a new entrant bypasses those assets at time \(t\) \((t<\text{T})\). On the assumption that all current and future tariffs flow to the new entrant (the existing asset owner is bypassed), the total present value obtained by the new entrant measured at time \(t\) is:

\[
\text{DORC}_t + \frac{\text{ORC}_t (1+g)^{T-t}}{(1+WACC)^{T-t}}
\]

where \(WACC\) represents the weighted average opportunity cost of capital applicable to such (regulated) assets. Note that after much debate, Australian regulators, in recent times, have generally settled on a (after tax) nominal \(WACC\) of around 6.4%² as sufficient to satisfy the capital markets called on to fund such infrastructure investments.

To ensure that the NPV of the new entrant’s investment equals zero, as required in principle under DORC principles, the necessary condition is that:

\[
\text{ORC}_t = \text{DORC}_t + \frac{\text{ORC}_t (1+g)^{T-t}}{(1+WACC)^{T-t}}
\]

from which it follows that:

\[
\text{DORC}_t = \text{ORC}_t \left[1 - \frac{1+g}{1+WACC} \right]^{T-t}
\]

\(\text{DORC}_t\) is therefore a function of three factors, namely the current new replacement cost \(\text{ORC}_t\) of the infrastructure, the growth rate \(g\) of this cost, and the required weighted average rate of return on private investment in such infrastructure.

**IMPLIED DEPRECIATION**

A theoretically admirable aspect of \(\text{DORC}_t\) is that as the time \(t\) bypass-exclusion limit on future tariffs is that this asset valuation rule applies continuously at all times \(t\) and therefore contains its own built-in depreciation scheme.³ Theoretically, therefore, there is no need to consider whether depreciation should be on a straight-line or any other
conventional or non-conventional basis. Rather, 
depreciation in period \( t \) is simply, by definition, 
\( DORC_{t-1} - DORC_t \), which from (1) equals:

\[
DORC_{t-1} \left\{1 - \frac{1 + g}{(1 + WACC)}(T^{-t+1})\right\} - DORC_t \left\{1 - \frac{1 + g}{(1 + WACC)}T^{-t}\right\}
\]

Simplifying this expression gives the period \( t \) write-down:

\[
DORC_{t-1} - DORC_t = ORC_t \left\{\frac{WACC}{(1 + WACC)^{T-t}} - \frac{g}{(1 + g)^{T-t}}\right\}
\]

Equation (2) with \( g=0 \) coincides with the ACCC (1999a, p. 66) 
definition of “annuity depreciation”. The term “annuity 
depreciation” arises for the reason that when \( g=0 \), the tariff 
stream ensuing from depreciation defined by (2) is an 
annuity. That is, tariffs are constant over all periods \( t \leq T \). 
This is demonstrated below.

**EFFECT ON TARIFFS**

Since \( DORC_t \) is the present value of future tariffs earned 
between times \( t \) and \( T \), it is easily shown that:

\[
DORC_{t-1} = \frac{\text{Tariff}_t + DORC_t}{(1 + WACC)}
\]

where \( \text{Tariff}_t \) is the tariff paid to the asset owner at time \( t \). 
It follows that the time \( t \) tariff is given by:

\[
\text{Tariff}_t = [DORC_{t-1} - DORC_t] + DORC_{t-1} (WACC)
\]

which can be described as period \( t \) depreciation (return of 
capital) plus period \( t \) cost of capital (return on capital).

Substituting for \( DORC_t \) and \( DORC_{t-1} \) from (1) gives, after 
simplification:

\[
\text{Tariff}_t = ORC_{t-1} (WACC - g)
\]

The tariff earned at the end of period \( t \) (at time \( t \)) is 
therefore a surprisingly simple function of the cost of new 
replacement infrastructure at the start of that period.

**EXAMPLE DORC CALCULATIONS**

Numerical consequences of the economic theory of \( DORC \) 
outlined above are illustrated in Figures 1 and 2. Figure 1 shows 
the behaviour of \( DORC_t \) over all periods \( t \leq T \) (\( T=30 \)) 
under the assumed parameter values \( g=-0.02, g=0 \) and 
g=0.05. These results are based on an \( ORC_0 \) of \$100 and a 
WACC of 7.75%. Figure 2 shows corresponding period \( t \) tariffs 
over the same time interval \( t \leq T \), with the same three possible 
values of the growth rate \( g \).

Some qualitative explanation of these results is useful. 
To understand the behaviour of \( DORC_t \), it is helpful to 
rewrite (1) as:

\[
DORC_t = ORC_t \frac{\left[\frac{ORC_t (1+g)^{T-t}}{(1+WACC)^{T-t}}\right]}{}
\]

\[
= ORC_t \frac{ORC_t}{(1+WACC)^{T-t}}
\]
This alternative expression reveals that $DORC_t$ is equal to $ORC_t$ minus the present value of the cost of new assets due at $T$. In general, therefore, $DORC_t$ falls as $T$ (asset expiry) approaches.

The exception to this rule is where $g$ is high, meaning that $ORC_t$ increases rapidly over time, in which case $DORC_t$ is very low relative to $ORC_0$. This can be explained by the insight that with high $g$ the cost of new assets is growing quickly, and therefore a new entrant is more motivated than when $g$ is zero or negative to invest immediately rather than wait until $T$. To close off this heightened threat of system bypass, the incumbent should be able to charge tariffs based on only a low $DORC_t$ in the early periods. Tariffs should then rise for a time with increasing $ORC_t$, and finally, as expiry draws closer, the physical state of existing assets takes over and their value approaches zero regardless of the cost of their replacement.

Turning now to Figure 2, note from (4) that time $t$ tariff is a linear function of $ORC_{t-1}$. When $ORC_{t-1}$ is constant ($g=0$), so are tariffs, and when $ORC_{t-1}$ increases (decreases) over time, tariffs should also, provided that $WACC > g$. Such direct positive connection between new-entrant-exclusion tariffs and the replacement cost of the underlying infrastructure is an intuitively plausible aspect of the theory of $DORC$. The most striking observation in Figure 2 is the initially very low level of tariffs under high $g$. This relates to the correspondingly low $DORC$ and is explained (the same way) by the extra incentive which should be allowed to bypass ageing assets when their replacement cost is rising quickly.

To see the “$g$ effect” clearly at work, imagine that $g=WACC$. In this case, $DORC$, and thus period tariff is always zero as per equation (1) or (4). There are several ways to understand this. The most intuitive is that because the cost of new assets is growing at a rate equal to the cost of capital, there is no reason not to make their inevitable replacement immediately. By implication, existing assets are redundant and valueless.

A proof of this result is as follows. The cost of new assets at any time $t$ is $ORC_t$. If $g=WACC$, this is exactly equal to the present value of the cost of new assets in one period’s time. It follows, therefore, that the investor (either the incumbent or a new entrant) is indifferent between buying new assets today or at any time in the future. Replacement of existing infrastructure will therefore occur immediately unless transmission services are provided by the incumbent free of any capital charge. Existing assets are thus of no value.

The more extreme possibility is $g > WACC$. In these circumstances, the incumbent or new entrant is motivated to buy new assets as soon as possible, since their cost is increasing at a rate greater than the cost of capital. In this case, existing infrastructure takes not zero, but negative value, since the capital component of tariffs must be negative (owners must pay users) if system bypass is to be prevented. This will of course not occur, since the incumbent is better off ceasing all operations. System
replacement will therefore proceed immediately, as is sensible in the circumstances.

Note that the DORC financial model summarised above, including all equations and calculations, theoretically holds either in real or nominal terms. All that is required is mathematical consistency. If WACC and g are expressed in real (nominal) terms, then \( P_t, ORC_t, \) and \( DORC_t \) must also be in real (nominal) dollars.

CONCLUSION

Australian infrastructure regulators, most particularly the ACCC, ORG and IPART, have developed a financial model of infrastructure valuation based on depreciated optimised replacement cost (colloquially known as DORC). This paper provides the most succinct possible summary and rationalisation of what the regulators’ “in-principle” position should be (but, in practice, often isn’t), and presents a platform on which their model can be tested at both conceptual and practical levels.

In future work, we propose to publish a series of practical commentaries on the strengths and deficiencies of the DORC financial model, as applied in both regulatory and non-regulatory asset valuation. These will include consideration of case problems and specific issues arising in practice. Discussion cannot proceed meaningfully at this level without first understanding the financial model at a conceptual level.

Our objective in this first paper is to ensure that the valuation profession and the regulators both have a full theoretical understanding of the DORC valuation model, so that practical issues that arise in its implementation can be resolved on a basis consistent with its underlying economic objectives. By making those objectives apparent, practitioners will be better able to judge whether DORC valuation principles are well suited to tariff regulation and whether the DORC financial model can be transported usefully to other non-regulatory asset valuation. These will include consideration of case problems and specific issues arising in practice. Discussion cannot proceed meaningfully at this level without first understanding the financial model at a conceptual level.

NOTES

1. Regulators assess this reproduction cost on a depreciated or “used” basis (i.e. the reference point is the depreciated state of the asset, not its new cost). Some regulators also consider that reproduction cost should be assessed on a greenfields rather than brownfields basis.

2. Although regulatory decisions vary, this WACC is based on a market risk premium generally of 6%, a debt to equity ratio of 60/40, a debt margin of around 1.25% and a franking credit allowance generally of around 0.5.

3. The position is more complicated when significant replacements are required during the regulatory review period (say five years). Where replacement capital expenditure is imminent and material, the DORC asset base has to be adjusted for the present value of imminent capital expenditure.

4. This is logically consistent with the treatment of depreciation in conventional DCF valuations. That is, non-cash flow charges such as depreciation are added back to profit.

5. We will explore in a later article the issue of regulatory risk on the resetting of the allowable WACC on the tariff review date.

6. The three practical regulatory issues that then arise are:

   (a) if tariffs are set too low the incumbent will not have sufficient financial reserves to replace the regulated asset when it is worn out;

   (b) alternatively, the new tariff will reflect a substantial uplift on the historic tariff with consequential “political” ramifications compared to a more smoothed approach to tariff rates;

   (c) regulators are naturally disinclined to allow a sufficiently high tariff to both recover sunk costs and also build up reserves to fund replacement expenditure (but consequentially regulators risk causing infrastructure to run down).