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Risk Sharing and Access Pricing

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Abstract:

The determination by regulators of access prices in the case of natural monopolies and network operators involves judgements about the sharing of risks between suppliers and customers and the appropriate compensation for risk bearing. This is reflected in ongoing debate about the appropriate cost of capital for regulated industries, including how it may be affected by particular features of the regulatory arrangements. This paper provides an analysis of how such factors such as "asymmetric risks", technological change and "asset stranding", and regulatory risk affect access provider risk. In particular, it demonstrates how "loss carry-over" and similar arrangements affect systematic risk and thus cost of capital, and create a circularity in the regulatory "building block" model which requires resolution.

Keywords: Access Pricing Regulation, Systematic Risk, Cost of Capital

1. Introduction

Across a wide range of industries exhibiting features of natural monopoly and network provision, Australian regulatory bodies[1] such as the ACCC, AER, IPART, and QCA are required to make determinations on “access prices” – the prices which monopoly suppliers are allowed to charge those wishing to access that service. Examples include gas and electricity transmission and distribution services, rail services, and telecommunications services.[2] In making such determinations, regulators are charged with developing a fair and efficient regime for setting prices, which encourages efficient usage of those services, appropriate investment in the regulated industry, and incentives for improvements in operational efficiency. Gray (2009) provides a recent overview of the development and application of access pricing regulation in Australia.

The determination of access prices is a complex, and usually controversial, process, not least because of the need to identify and appropriately compensate, through the price setting process, risk bearing activities of the service suppliers. But the design of the regulatory system can itself affect the level and sharing of risk between suppliers and their customers (and taxpayers), and that is the focus of this paper.

Most of the debate surrounding risk issues and access pricing in Australia has focused on the appropriate compensation for risk in the determination of the cost of capital. This is hardly surprising. The industries involved are generally characterised by large capital outlays relative to operating costs, such that compensation for the opportunity cost of capital tied up in the industry (the return on capital) and return of capital invested (depreciation) dwarf operating expenses in the determination of required revenue streams. In many cases the investments involve “sunk costs” where the assets have limited or no other feasible uses, creating extra complications for the determination of appropriate risk sharing arrangements and compensation for risk bearing.

The objective of this paper is to provide an overview of the approach to risk assessment, risk sharing, and compensation for risk adopted by Australian regulators to date, and identify some important, unresolved, issues. The paper provides, in section 2, an overview of the basis of the regulatory model adopted by Australian regulators which provides a framework for identifying

[1] Access price regulation responsibilities are currently the responsibility of both Federal and State government authorities. The ACCC (Australian Competition and Consumer Commission) and the AER (Australian Energy Regulator) are federal bodies, while authorities such as IPART (Independent Pricing and Regulatory Tribunal), and QCA (Queensland Competition Authority) are state bodies.

[2] Access pricing determinations of the ACCC can be found at their web site http://www.acc.gov.au , together with links to other regulatory web sites and determinations.

and clarifying risk related issues which have occasioned debate. These include the treatment of systematic versus non-systematic risk, the treatment of “asymmetric” risks, the risk of “asset stranding”, allocation of inflation risk, determination of systematic risk, regulatory risk. Since the structure of the regulatory system can itself influence the allocation of risk, section 3 addresses this issue in the context of “loss carry-forward” provisions (“unders and overs”) including the use of a “loss-capitalisation” model proposed by some access providers, and provides an explicit example of determination of the cost of capital where compensation was given for Community Service Obligations (CSOs) as a further illustration. In Section 4, the issues of “asymmetric” risks and “asset stranding” and their treatment in the regulatory framework are considered, while section 5 concludes.

2. The Regulatory Approach to Access Pricing

In Australia, regulators have adopted a “building block” approach to the determination of access prices, based upon a relatively simple framework which identifies a target revenue stream for the regulated firm.[3] The target revenue model (ignoring, for ease of exposition, the treatment of additions to the capital stock and tax issues) is based on a version of Equation 1:

Total Revenue = Operating Costs + Return of Capital + Return on Capital [1]

or, in symbols,

$$TR_t = OC_t + rK_{t-1} + D_t \qquad [2]$$

in which TR is total revenue, r is the cost of capital, K is the regulatory asset base (RAB), D is depreciation, and OC is operating costs. (For ease of exposition, it is sometimes convenient to subtract OC from both sides to give a simplified equation for net operating cash flow as: $C_t = rK_{t-1} + D_t$).

Equation 1 states that in any year, total revenue should be sufficient to cover projected operating costs (based on demand projections), an appropriate return of capital (depreciation), and an appropriate return on capital. Once a revenue target is determined, a per unit price to achieve that target can be set based on projected demand.[4] Incentives for improved efficiency are built into the system by (for example) allowing the regulated firm to profit (for some

[3] AER (2010) provides an overview of the approach. In the currently applied approach by the AER (but not necessarily all other regulators), total revenue in Equation 1 is post tax and deducts tax paid by the (levered) business from the right hand side and use of a “vanilla” WACC based on the pre-tax interest cost of debt.

[4] Typically projections of the composition of demand will be also needed for multi output activities and the pricing structure may not a simple per unit price.

period) from reductions in operating costs below those projected.

If applied over the life of the asset in question, such that the cumulated return of capital just equals the original cost, equation 1 is equivalent to a zero NPV (or "fair pricing") condition.[5] To see this, consider an initial investment of K_0 in an asset with a life of N years for which the required rate of return is r% p.a. Denote net cash flows (revenue minus operating costs) in period t by C_t. Suppose per period net cash flows are set equal to $C_t = r.K_{t-1} + D_t$ where D_t is depreciation in period t, and K_{t-1} is the written down book value of the investment at the end of year t-1 (so that $K_t = K_{t-1} – D_t$). The net cash flows thus comprise a return of capital (D_t) and a return *on* capital (rK_{t-1}). For any depreciation schedule (D_1,…… D_N) where $D_1 + …. + D_N = K_0$, the investment will have an NPV=0.

This can be seen by reference to the following table which sets out net cash flows which are based on a return of capital D and a return on capital rK, and the NPV of each of those cash flows

Year	**0**	**1**	**2**	**……..**	**N**
Cash Flow	$-K_0$	rK_0+D_1	rK_1+D_2	…….	$rK_{N-1} +D_N$
NPV	$-K_0$	$(rK_0+D_1)/(1+r)$	$(rK_1+D_2)/(1+r)^2$	…….	$(rK_{N-1} +D_N)/(1+r)^N$

Substitute $D_t = K_{t-1} – K_t$

Year	**0**	**1**	**2**	**……..**	**N**
NPV	$-K_0$	$K_0-K_1/(1+r)$	$K_1/(1+r) – K_2/(1+r)^2$	…….	$K_{N-1}/(1+r)^{N-1} – K_N/(1+r)^N$

Adding the NPV's of each cash flow to get the overall NPV we can see that provided

that $K_N = 0$ (ie that $D_1 + …..+ D_N = K_0$), the overall NPV = 0.

Note that the *ex post* actual outcome will generally differ from the zero NPV outcome because of deviations of demand from those projected such that net cash flows (C_t) do not equal $r.K_{t-1} + D_t$. This is, of course, a typical business risk. But importantly, this zero NPV demonstration also applies in an *ex ante* expected sense to investment decision making. If it is expected that annual revenues will cover annual operating costs, plus return of the original investment over the life of the asset, plus a return on capital each year equal to the required rate of return

5 [5] See, for example Schmalansee (1989) for further discussion of this point.

applied to the written down asset book value, then the investment will be worth undertaking.

In practice, the regulatory approach operates by using a sequence of regulatory horizons (typically 5 years) and determining at the start of the horizon an expected revenue stream for that horizon which, in conjunction with the end of horizon (expected) value of the RAB has an expected zero NPV. The condition for this to hold can be seen by noting that since $D_t = K_t - K_{t-1}$, (2) can be rewritten as:

$$(1+r)K_{t-1} = (TR_t - OC_t) + K_t \qquad [3]$$

where r is the required rate of return. Using a 5 year regulatory horizon, successive substitution in (3) and rearrangement leads to:

$$K_0 = \sum_{t=1}^{5} \frac{(TR - OC)_t}{(1+r)^t} + \frac{K_5}{(1+r)^5}$$

where K_5 is the end of horizon RAB. Because r is the required rate of return, this is a zero NPV relationship if the market value of the end of horizon RAB equals its accounting value at that time. Stated differently, but equivalently, as long as it is expected that the end of horizon RAB value will equal the market value of the assets at that time, the expected return over the regulatory horizon equals the required return. At each regulatory reset date regulatory settings are usually designed to achieve the outcome that the market value of the RAB at that date equals the RAB. Because the start of an horizon is the end of the previous horizon, the zero NPV condition that the expected end of horizon market value of the RAB equals the RAB is thus achieved, and expected returns equal to required returns.

Precise formulation, and implementation of this model for regulatory determination of access prices involves a number of conceptual and practical difficulties[6], many of which relate to risk sharing and compensation. For example, the *regulatory horizon* is of short duration (typically five years) relative to the asset life. For the current regulatory period, forecasts of output, operating costs, and inflation are among those required. How the regulatory model permits revenues and prices to be adjusted in response to forecast errors in such variables is clearly an important aspect of risk sharing between the regulated firms and their customers. These factors may impact upon the determination of an appropriate *rate of return* to compensate investors for risks associated with provision of funds. One important issue here is that while the building block model of equation (1) refers to a *target* cash flow stream (with revenues potentially

[6] Some fundamental ones include: whether to focus on cash flows to the *entity* or to *equity* holders; how to allow for taxation; whether to use a real or nominal rate of return framework; what depreciation schedule to adopt; how to determine initial asset values in the case of application of the regulatory regime to existing activities

above or below that value), the regulatory approach involves setting of a *maximum* allowable revenue or price path cap. In practice, prices set at the start of a year may lead to revenue above the revenue cap, raising issues of how that is treated. If, for example, above-cap revenues are not permitted, the possibility of revenue shortfalls in some periods mean that expected cash flows will be below the cap. Consequently there needs to be some flexibility built into the application of the cap, either by having some “allowable band” of revenues or some form of carry-over of between periods.

Over the longer term, the regulated firms face the prospect of *regulatory risk*, reflecting several factors. One is that the rules applied by regulators and governments may change from one regulatory period to the next. A second is that regulatory reviews involve a resetting (updating) of key parameters in the regulatory model. The significance of this can be seen by noting that the preceding demonstration of the zero NPV result assumed that the rate of return *allowed* by regulators in determining cash flows is the same as that used by investors in discounting future cash flows. If regulators set a different rate of return to the (unknown) rate required by investors, windfall gains or losses can occur. Such a resetting of key parameters in response to market developments is also relevant to the nature of market risks borne by the regulated entity over the life of the asset and thus to the determination of the required rate of return.

Also relevant over the longer term (but not confined to the distant future) are the risks associated with unanticipated changes in operating costs or in demand. For example, a particular investment in a sunk asset may prove to be a failure due to an absence of demand for that service, creating what is referred to as a *stranded asset*. With no demand, it is not possible to generate revenues. If there is some possibility of asset stranding, then use in the regulatory model of a typical depreciation schedule allowing 100 per cent of original purchase price will not lead to an *expected* return of capital equal to the original purchase price. This is taken up in Section 4. Likewise, an unexpected event (such as a fire) which interrupts ability to provide service and creates unexpected costs in particular periods creates another potential complication, particularly if such risks are one-sided or *asymmetric*. The appropriate treatment of such *asymmetric risks* is also taken up in Section 4.

3. Regulatory Design and Risk Allocation

The structure of the regulatory system affects the allocation of risk associated with the provision of access services.[7] This section first demonstrates how adjusting regulatory parameters at each reset date to incorporate in the next periods target revenue deviations of actual from the last period's target revenue ("unders and overs"), affects both the total and systematic risk of the project. This is followed by a second illustration involving the cost of capital for the provision of *Universal Service Obligations (USOs)* in telecommunications. This gives a stark illustration of how regulatory design affects risk bearing. Following that, some general features of regulatory design in Australia and implications for risk bearing are considered.

(a) The effect of allowing "Unders and Overs"

In some circumstances, the regulatory arrangements may allow for the possibility that shortfalls or surpluses of revenue relative to the target revenue during one regulatory period are incorporated in the target revenue for the next regulatory period. In principle this can be done by either (a) adjusting the operating costs by the relevant amount, or (b) adjusting the regulatory asset base at the start of the period by the relevant amount. Thus, if revenue in period *t* falls below the target (expected) value, the target revenue for period *t+1* would be increased above that implied by the "building block" model of equation 1. Whether this creates a fundamental inconsistency within the regulatory structure is the question considered here. Target cash flows are calculated based on a regulatory rate of return equal to the required rate of return based on an estimate of the systematic risk of the business. If "unders and overs" reduce the systematic risk (as well as the total risk), the regulatory rate of return will, unless adjusted, exceed the required rate of return.

To examine this question, consider the following simple two period example, in which at date 0, an initial investment outlay of K_0 in an asset with a two period life is made by the regulated business. The asset is depreciated over its life, with a book value at date 1 of K_1 and at date 2 of zero. There are no operating costs. The regulator sets the permissible price at the start of each period which, given expected demand at that price, generates an expected cash flow such that the expected rate of return in that period on the start of period regulatory asset base (K_i) is the required rate of return. Thus, letting c_i^* be expected cash flow in period i, the expected rate of return (cash flow plus change in asset value) in each period is equal to the required rate of

[7] Crew and Kleindorfer (1996) provide an overview of different styles of incentive regulation approaches. See also Australian Treasury (1999) and ACCC(2010).

return r*

$$\frac{c_1^* - (K_0 - K_1)}{K_0} = \frac{c_2^* - (K_1 - K_2)}{K_1} = r^*$$

Because actual demand in each period is stochastic, the actual cash flow and rate of return will differ from their expected values. Denote the actual rate of return in period i by,

$r_i = r^* + bm_i + de_i$ [5]

where m_i is a (zero mean) market risk factor with variance σm^2 and e_i is a (zero mean) idiosyncratic risk factor. Consequently, Cov (r_i,m_i) = Cov $(bm_i,m_i) = b\sigma m^2$, so that b is the systematic risk of asset.

Provided that the required rate of return used in the regulatory pricing (r*) is that required for an asset with systematic risk of b, the market value of the asset at date i (MV_i) will equal K_i. This can be seen by noting that (because the asset has zero value at date 2), such that $MV_2 = K_2 = 0$:

$MV_1 = E(c_2)/(1+r^*) = c_2^*/(1+r^*) = K_1(1+r^*)/(1+r^*) = K_1$.

Consequently, $MV_0 = [E(c_1) + MV_1]/(1+r^*) = [K_0(1+r^*) - K_1 + K_1]/(1+r^*) = K_0$.

Now consider the case where the regulator decides to use an "unders and overs" approach to the regulatory arrangements, where if any shortfall or surplus in cash flow relative to the target occurs in period 1, there is some offsetting adjustment to pricing and expected cash flow for period 2.[8] Thus, if bm_1+de_1 is non-zero, expected cash flow $c_2^{\#}$ is given by:

$c_2^{\#} = c_2^* - \gamma(bm_1 + de_1)K_1$

Hence the market value at date 1 (MV_1) will now be given by:

$$MV_1 = \frac{c_2^*}{(1+r^*)} = \frac{c_2^* - \gamma(bm_1 + de_1)K_1}{(1+r^*)} = \frac{r^* K_1 + K_1 - \gamma(bm_1 + de_1)K_1}{(1+r^*)} = K_1(1 - \frac{\gamma(bm_1 + de_1)}{(1+r^*)})$$

such that MV_1 is greater (less) than K_1 as first period cash flow was less (greater) than target cash flow. Note that $r_2 = c_2^{\#}/MV_1 - 1$, and it is straightforward to show that the systematic risk of r_2 is still given by b.

8 Note that the regulator, in the absence of such adjustments is setting a price such that expected quantity demanded is at the level consistent with perfect competition and zero economic profit, which involves a lower price, higher quantity, and lower total revenue than would occur under monopoly. Making adjustments such as a carry forward of losses which generate higher expected revenue is thus feasible.

However, the systematic risk of r_1 is now lower. If the actual cash flow is below (above) the target in period 1, the end of period market value will be higher (lower) than the regulatory asset base (as shown above), such that cash flow deviations from expected value are partially offset by opposing changes in end of period asset value. To examine the systematic risk consequences, note that the relationship between actual cash flow and the stochastic rate of return measured using the regulatory asset base (r_1) as defined in (5) is:

$c_1 = K_0(1+r_1)-K_1$

Thus if MV_0 is the market value at date 0, the rate of return on MV_0 given by r_1^{**} is:

$$r_1^{**} = \frac{c_1 - (MV_0 - MV_1)}{MV_0} = \frac{K_0(1 + r^* + bm_1 + de_1) - MV_0 + K_1(1 - \frac{\gamma(bm_1 + de_1)}{(1+r^*)})}{MV_0}$$

Hence

$$\operatorname{cov}(r_1^{**}, m_1) = \operatorname{cov}(\frac{K_0}{MV_0}bm_1 - \frac{K_1\gamma bm_1}{MV_0}, m_1) = b(\frac{K_0 - K_1\gamma}{MV_0})\sigma_m^2 < b\sigma_m^2$$

such that the systematic risk of the period 1 rate of return is less than b.

Providing a regulated rate of return of r* based on an assumed systematic risk of b, but allowing “unders and overs” means that the date one market value of the asset varies inversely with the actual cash flow in period 1 thereby reducing the systematic risk in period 1 to below b. Consequently, the market value of the asset at date 0 (MV_0) will exceed its initial cost of K_0, and there is a fundamental inconsistency in the regulatory approach.

(b) The Cost of Capital for USOs and CSOs[9]

Universal or Community Service Obligations (USO’s or CSO’s) occur when a service provider is required by government to provide services by investing in a project which is expected to be unprofitable, but deemed necessary for social reasons. Typically this will be for provision of services to some particular rural region (such as for telephones or postal services), and may lead to cross-subsidisation from other users, acceptance of a lower return by a government-owned entity, or explicit subsidy from the government.

In this section a specific example is considered where, if the return is not “adequate” compensation is paid sufficient to bring the sum of project return and compensation up to the “adequate” level. If the return exceeds the “adequate” amount, no compensation is paid, nor is

[9] This discussion and that in the appendix relates to the USO scheme for telecommunications which applied in Australia for the period 1997-98 until 1999-2000. Similar issues have been relevant in air services, postal, and water regulation.

there any claw back of the excess return. Some (such as the USO service providers) have argued that an “adequate” return should be based on a rate of return involving compensation for risk derived using the project’s underlying beta. However, because of the operation of such a compensation scheme it can be shown (see Appendix 1) that a rate of return at (or even below) the risk free rate (ie a cost of capital associated with a zero beta) is appropriate.

The reason why the regulatory rate of return is below the risk free rate and below the required rate of return for a “normal” project is straightforward. Investors in risky assets require an expected rate of return above the risk free rate of return because of the possibility of bad (and good) outcomes different from the expected return. If the downside risk is taken away by the compensation scheme, the rationale for the higher required rate of return disappears. The required rate of return has nothing to do with the physical characteristics of the project – the fact that the physical assets might be used in some other location to generate a higher rate of return is irrelevant. The required rate of return is the return that suppliers of funds used to purchase those assets require given the risk characteristics of the payoffs arising from use of those funds. Only if there were some form of capital rationing in place (such that use of financial capital to undertake a USO project meant that another non USO project could not be undertaken) might there be some argument for use of the underlying asset required rate of return for calculating compensation. In a free capital market, such as Australia, that is not a relevant consideration.

Risk sharing arrangements for Inflation and Demand forecast errors

The regulatory approach used in Australia derives an initial set of target revenues for the 5 year regulatory horizon, and then applies a “CPI-X” smoothing adjustment (based on projected inflation) to ensure that expected nominal revenues (and/or prices) grow at a steady rate over that period.[10] The revenue path thus derived provides for an “appropriate” rate of return provided that the inflation and product demand outcomes match those projected.

Inflation risk is largely passed onto customers, since prices during the regulatory period are adjusted in line with the CPI outcome (minus the X factor). Consequently the real rate of return achieved by the regulated firm will be largely unaffected by the actual inflation experience over the regulatory period.

[10] The methodology involves finding a CPI-X price path such that the present value of those revenues equals that arising from the initial outcome of the target revenue model. It should be noted that the “X” factor has nothing to do with efficiency/productivity improvements, but is a result of the shape of the depreciation schedule assumed in the regulatory model.

The treatment of deviations of demand from that projected may vary between regulated industries. In some cases (such as electricity), the regulatory framework involves determination of a revenue cap. In others (such as gas) it involves determination of an average revenue (or price) cap, and require annual adjustments to the average revenue cap to offset the revenue consequences of deviations of demand outcomes from those forecast.

These arrangements together with incentive mechanisms built into the regulatory approach are relevant for the determination of systematic risk faced by access providers and thus the required rate of return. Since such factors differ between national regulatory systems, it is not necessarily appropriate to assume that the *asset beta* for a similar activity elsewhere can be adopted for the Australian industry. Whether the Australian regulatory scheme leads to higher or lower systematic risk than regulatory schemes in operation elsewhere is a contentious question warranting further study.[11]

4. Asymmetric Risks and Asset Stranding

The appropriate treatment of two types of idiosyncratic risk has occasioned much debate in the determination of access prices. Many protagonists have argued that required rates of return should be adjusted (upwards) to allow for these types of risk. For two reasons, that is not appropriate, and some other means of allowing for such risks must be found. First, since the regulatory authorities have adopted a Capital Asset Pricing Model as the basis for determining rates of return, adjustment of CAPM based rates of return for idiosyncratic risk would seem inconsistent with the premise that only systematic (non-diversifiable) risks should be priced. Second, given the multi-period nature of the problem under consideration, ad hoc adjustment of rates of return builds in potentially inappropriate (and generally unclear) assumptions about the evolution of risk through time. For these reasons, it is appropriate to examine how such risks can be otherwise allowed for in the modelling of allowable cash flows.

Asymmetric Risks

The term asymmetric risk has been used to refer to such things as disasters (such as fire, flood, earthquake) which prevent the operation of the business for a period and prevent the generation of revenues or lead to higher operating costs due to required repairs to plant and equipment. Strike activity preventing the business from operating would be another example.

[11] Lewellen and Mauer (1993) examine analytically the relationship between risk and various types of incentive regulation. Alexander, Mayer and Weeds (1996) compare the systematic risk of similar industries operating in different countries under different types of regulation and suggest that systematic risk is higher in countries with incentive regulation than in those with rate of return regulation.

The characteristic of such events is that they involve adverse consequences for the business relative to the projected financial statements, and are not matched by the possible occurrence of good news events.

In principle, such risks cause no problems for the regulatory approach. At the start of the regulatory horizon, it is necessary to make projections of *expected* (ie *mean*) operating costs and demand. The figures used should thus take into account the probability of such adverse events occurring. The complication which arises in practice is that most projections appear to be interpreted (and formulated) by practitioners in the context of the *most likely* (ie *modal*) outcome. If there is a small probability of an adverse event occurring (not offset by a positive probability of fortuitous events), the mean will lie below the mode. If modelling is undertaken using the modal figures, appropriate account will not be given to such adverse events.

In principle, the solution is simple. One possibility is to assign probabilities for the occurrence of such adverse events, and adjust the projections of operating costs and demand to reflect this. Another is to estimate the actuarially fair insurance premium for protection against such events and include it as an additional imputed element of operating costs. In practice, of course, making such adjustments allows considerable scope for judgement (and gaming behaviour), and there may be concerns that profit outcomes will tend to appear excessive *ex post* in the high frequency event that no adverse event occurs. Nevertheless, making such adjustments to the cash flow components of the building block approach is much preferable to making an ad hoc adjustment to the required rate of return.

Asset Stranding

Asset stranding relates to the situation where an investment has been made in a sunk asset which has turned out to be a poor investment unable to generate adequate cash flows.[12] For example, construction of a gas pipeline to a planned residential development that does not eventuate would fall into this category. Likewise, investment in some network which unexpected technological change makes redundant through emergence of some much cheaper alternative, has similar characteristics. Whereas initial access pricing regulation was focused on established local markets (gas, electricity etc), further risk issues arise with its applications to access providers involved in the supply chain in “global” markets – such as rail services for transport of minerals from suppliers to port facilities. Changes in international competitiveness of domestic competitors can reduce (or eliminate) demand for use of such services.

[12] Kolbe and Borucki (1998) suggest that increased possibility of asset stranding can affect the systematic risk and cost of capital of a regulated utility.

The problem which this gives rise to is that lack of demand for the service means that revenues cannot be generated to provide either a return of capital or a return on capital for that investment. Ex post, the investment is a negative NPV project. In itself, that is not a problem for the regulatory model, as long as ex ante, the project is a zero NPV project. However, to achieve that latter outcome, a subtle adjustment needs to be made to the regulatory model if there is some positive probability of asset stranding over the life of the asset. For the NPV to be zero ex ante, the *expected* future cash flows required an *expected* amount of depreciation equal to the original investment amount. Implementing the regulatory model with a depreciation schedule which implies 100 per cent depreciation *in the event that* stranding does not occur means that the expected depreciation amount is less than 100 per cent.

There appears to be four possible ways to overcome this problem. The first is to assign some probability to stranding and allow for a depreciation schedule which could involve a return of capital in excess of 100 per cent (if stranding does not occur), but which has an expected value of 100 per cent. The problem here lies in the practicality of forecasting the probability of stranding. The second is to provide some ex post compensation to regulated businesses which suffer asset stranding. The problem here lies in the political practicality of such compensation payments. A third is based on noting that the likelihood of stranding is often observable several years in advance of its occurrence; such that it may be possible to adjust the revenue schedule to provide for a full return of capital prior to stranding. The problem here is the one of the ability of the (disappearing) market to bear the implied increase in service price. A fourth approach is to note that most service providers will have a portfolio of assets, only some of which may be stranded. Provided that the regulatory model operates on a firm wide basis, the total revenues of the business can provide for return on and return of the capital tied up in the stranded asset. In essence, other customers bear the cost of the asset stranding.

5. Conclusion

The regulatory approach to access pricing has developed significantly in a relatively short space of time. The debate occasioned by regulatory determinations has thrown up many contentious issues associated with optimal risk sharing and the pricing of risk, on which there is a need for further research. This is in addition to the debate and attempts at “cherry-picking” of key WACC parameters by access seekers and providers. These parameters include such things as inputs to the CAPM (the risk free rate, beta, and market risk premium), tax effects (the value of franking credits, γ), and appropriate leverage and cost of debt. In addition, there have been challenges to the use of the CAPM (rather than alternatives such as the Fama-French three factor model) as the framework for determining the required rate of return.

Many participants have argued for the need to compensate particular (idiosyncratic) risks by ad hoc adjustments to the required rate of return. In this paper, it is argued that such an approach is inherently undesirable, and that the "building block" approach to regulatory access pricing provides a framework in which many of those issues can be explicitly considered in the modelling of cash flows rather than in a rate of return determination.

However, the main contribution of this paper is to demonstrate explicitly how the structure of regulatory arrangements can affect the systematic risk of the regulated entity. In particular, where regulatory arrangements allow for some adjustment to future cash flows if the required rate of return is not achieved in a particular period, the systematic risk of the regulated entity can be affected. Since this, in turn, affects the required rate of return, an element of circularity is introduced into the regulatory process, involving adjustments to the required rate of return. Consequently, and as demonstrated explicitly in the case of USO's, the systematic risk of a particular business cannot be determined solely by reference to the nature of the assets, but needs to consider the regulatory environment. This creates complications in attempting to estimate systematic risk by reference to other similar unregulated industries or companies operating under different (international) regulatory arrangements.

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Appendix 1 The Required Return for Universal Service Obligations

To facilitate analysis, it is assumed here that projects have a one year life – such that the cash flow generated at the end of the year involves both return of capital and a return on capital.[13]

Consider two projects which involve an outlay of $1 now and which each give a once only uncertain payoff in one year's time. One is a "normal" project which has an expected payoff of $\$(1+r_a)$, where r_a is the required rate of return for this project, and thus has a zero NPV. The probability distribution of payoffs is the dashed line designated by A in Figure 1. The other is a project with the same risk characteristics but with a payoff distribution which is shifted to the left, designated in Figure 1 by B and an expected value of $1+r_x < 1+r_a$. It has a negative Net Present Value, given by:

$$NPV_B = (1+r_x)/(1+r_a) - 1 < 0$$

and would thus not normally be undertaken.

However, project B is a USO project which must be undertaken by some company, and for which it is to receive compensation from some party to ensure that the project, inclusive of compensation, is a zero NPV project. What is required is the determination of a particular regulatory rate of return r_r with the following properties:

- If the payoff of project B, denoted by c_1, is less than $1+r_r$, the company will receive an amount of subsidy $s_1 = 1+r_x - c_1$, such that the total return is $s_1 + c_1 = 1 + r_r$
- If the payoff is above $1+r_r$, the subsidy will be zero.

The effect of such a regime is that the total return distribution to the company is now represented by the distribution truncated at the point $1+r_r$ (and with probability at that point equal to the cumulative distribution of the original B distribution) in Figure 2. Note that (as formally demonstrated later) if the regulatory rate of return r_r is equal to or exceeds the risk free rate, the company undertaking this investment can make risk free arbitrage profits. Thus, to the extent that the compensation scheme is one sided (such that returns in excess of the regulatory minimum are retained by the company), the regulatory rate of return for measuring the cost of making the investment and thus the compensation amount must be less than the risk free rate.

To illustrate the issue, suppose that potential investors in the USO project knew that the

[13] Using instead a multi year project would not markedly affect the argument, although it would introduce the need to consider the appropriate form for the depreciation schedule (return of capital).

compensation scheme would provide a sum s_1 such that $c_1 + s_1 = 1+r_f$ if c_1 were below $1+r_f$, and that if c_1 were above $1+r_f$ there would be no compensation. As Table 1 illustrates, an arbitrage profit would be possible by raising funds at the risk free rate (which could be done since the period 1 cash flows must be no less than $1+r_f$.

	Date 0 cash flows	Date 1 cash flows	
		$c_1 < 1+r_f$	$c_1 > 1+r_f$
Project cash flows	-1	c_1	c_1
Compensation cash flows		$s_1 = 1+r_f - c_1$	0
Financing cash flows	+1	$-(1+r_f)$	$-(1+r_f)$
Net cash flows	0	0	$c_1-(1+r_f) > 0$

Set out in this fashion, it becomes apparent that the determination of the regulatory rate of return for determining the compensation amount involves an option pricing problem. If the regulatory rate is set at r_r the compensation cash flow at date 1 is $s_1 = \text{Max}\,[\,1+r_r - c_1, 0]$ which is the payoff to a put option on the variable c_1 with a strike price of $(1+r_r)$. Hence the compensation scheme is equivalent to giving the company a put option at date 0 which has a value $P[c^*,1+r_r,1,r_f,\sigma_c]$ in which c^* is the value for c_1 at which the option is to be evaluated, and σ_c is the volatility of c. A fair regulatory scheme will involve a choice of r_r such that the value of this put option exactly offsets the negative NPV of the project considered in isolation, ie that:

$$-1+ E(c_1)/(1+r_a) + P[c^*,1+r_r,1,r_f,\sigma_c] = 0$$

It is possible to solve for r_r by, for example, setting $c^* = E(c_1)$ and using the Black Scholes formula. The resulting value of r_r will depend upon $E(c_1)$, r_a, r_f and σ_c.

Figure A1

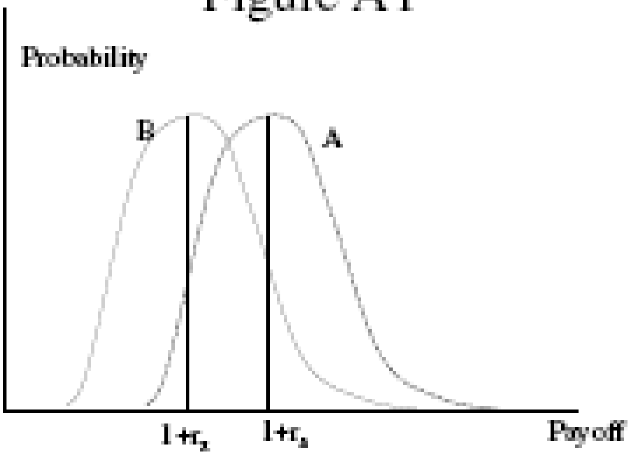

Figure A2