REVIEW OF THE SCHMALENSEE REPORT

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EXECUTIVE SUMMARY

Lally (2021) argues that, in order to satisfy the NPV = 0 principle, the regulator must at the beginning of each regulatory cycle set the allowed cost of capital for a term that matches the term of the regulatory cycle. He credits Schmalensee (1989) with first recognizing this point. In response, Schmalensee (2022) argues that his earlier paper did not address this term issue and was instead concerned solely with demonstrating that any regulatory depreciation method would satisfy the NPV = 0 principle. This paper has reviewed this issue and the principal conclusions are as follows.

Firstly, if Schmalensee (2022) is correct, then the only error in Lally (2021) would be in attributing credit to Schmalensee (1989) that was not warranted. This would not undercut the analysis in Lally (2021), and therefore would have no implications for the AER's cost of capital review. Secondly, I consider that Schmalensee (1989) does warrant credit for this term issue, because it is proved in his paper despite that not being his intent. Thirdly, Schmalensee (2022) uses contradictory notation, and seems to make contradictory claims on the question of whether the allowed rate is chosen by the regulator to match the market-determined cost of capital or vice versa. These contradictions do not afflict his earlier work in Schmalensee (1989). Fourthly, Schmalensee (2022) makes a number of other statements that I do not consider to be correct. Finally, Schmalensee (2022) characterizes his earlier paper as being too abstract to be useful to regulators. However all mathematical modelling of issues that are important to regulators will involve some degree of abstraction, and modelling is often improved in the sense of adopting more realistic assumptions. This improvement has happened in the present case, to accommodate more realistic assumptions, but the fundamental insight in Schmalensee (1989) is still valid.

1. Introduction

As part of the AER's recent review of its cost of capital methodology, it commissioned a report by Lally (2021) concerned with the appropriate term for the allowed cost of capital. The latter report asserted that:

"A fundamental requirement of regulation is the NPV = 0 principle, i.e., at the time a firm invests in regulated activities, the present value of its future cash flows must be equal to its initial investment. Schmalensee (1989) shows that satisfying this principle requires that, at the commencement of each regulatory cycle (when the allowed cost of capital is set), the term to which the allowed cost of capital relates matches the term of the regulatory cycle. Lally (2004) extends this to the situation in which cost and volume risks are present, and revaluation risks arising from the use of ODRC methodology; the conclusion is the same."

In response, Schmalensee (2022) argues that his earlier paper did not address this term issue and was instead concerned solely with demonstrating that any regulatory depreciation method would satisfy the NPV = 0 principle. This paper seeks to review Schmalensee's (2022) claim.

2. The Fundamental Issues

The AER is concerned with the appropriate term for the allowed rate of return. Lally (2021) argued that the appropriate term is that matching the regulatory cycle. So, if the regulatory cycle were five years, the allowed cost of capital should also be for a term of five years. In addition to presenting a proof of this, Lally (2021) credits Schmalensee (1989) with this result under more restrictive assumptions. In response, Schmalensee (2022) denies that his earlier paper does so. For example, Schmalensee (2022, page 8) states that: "Schmalensee (1989) certainly does not show that the term of the allowed return must match the term of the regulatory cycle." If Schmalensee (2022) is correct, then the only error in Lally (2021) would be in attributing credit to Schmalensee (1989) that was not warranted. This would not undercut the analysis in Lally (2021), and therefore has no implications for the AER's cost of capital review.

Furthermore, despite Schmalensee (2022) denying credit for this idea, I consider that credit to him is warranted. In proving that any depreciation schedule will satisfy the NPV = 0 principle, subject to the standard requirement that the depreciation allowances aggregate to the initial investment, Schmalensee (1989, page 294) considers a scenario in which the regulated assets have a life that may cover multiple periods, with the regulator setting the allowed revenues at the beginning of each such period, and the revenues are received at the end of the period. So, each period is a regulatory cycle. These allowed revenues comprise the allowed depreciation plus the allowed rate of return applied to the depreciated book value of the regulated assets. Implicitly, there are no operating costs or taxes, and revenues are certain. The allowed rate of return for period *t*, set at the beginning of the period, is designated r_t. Schmalensee (1989, page 294) shows that NPV = 0 for any choice of depreciation schedule so long as $\varepsilon_t = 0$, with ε_t defined as $r_t - \rho_t$, and ρ_t defined as the cost of capital in period *t*, i.e., NPV = 0 if the allowed rate of return r_t is equal to the cost of capital ρ_t. In respect of the term to which the cost of capital ρ_t relates, Schmalensee states that "Under certainty, ρ_t is just the one-period interest rate in period *t*." By certainty, he means certainty over everything except future interest rates, and the one-period interest rate he refers to is the (risk-free) rate that corresponds to the length of period *t*, which in turn is the length of the regulatory cycle. So, if the regulatory period in question were one year, the one-year cost of capital would be the one-year risk-free rate observed at the beginning of the year. Thus, under certainty over everything except future interest rates, Schmalensee (1989) proves that NPV = 0 for any choice of depreciation schedule if the allowed rate of return set at the beginning of a regulatory cycle has a term equal to the regulatory cycle.

Schmalensee (1989) cannot be unaware of the fact that he has proved this result because he states (ibid, page 296) that "*The Invariance Proposition (that any depreciation schedule satisfies NPV = 0) rests on the assumption that the regulated firm's actual rate of return on the book value of its assets is adjusted each period to equal the current one-period interest rate*." Clearly, Schmalensee's (1989) focus was upon the depreciation schedule when he showed that the NPV = 0 result held for any depreciation schedule so long as the allowed rate was for a term matching the regulatory period. He therefore viewed the requirement for the allowed rate of return to match the regulatory cycle as a mere ancillary assumption to his Invariance Proposition. This was entirely legitimate, but it still remains true that he has proved a second proposition without him intending to do so: NPV = 0 if the term for the allowed cost of capital matches the regulatory cycle.

3. Further Issues

In addition to these fundamental issues, I comment here on various other statements in Schmalensee (2022).

Schmalensee (2022) uses contradictory notation. On page 2 he defines ρ as the discount rate in valuing cash flows as shown in his equation (1). He repeats this definition of ρ on page 3. However, on page 4, he instead defines ρ as the regulator-determined allowed cost of capital. On page 5, he again defines ρ as the rate determined by the regulator, and distinguishes it from the "*firm's actual, market-determined cost of capital*." Later on page 5, he defines ρ_1 and ρ_2 as the "*allowed rates of return*". However, on page 6, he defines ρ_2 as the "*market-determined required return*." No such problem of oscillating definitions is present in Schmalensee (1989), who consistently defines the allowed rate of return for period t as r_t, the cost of capital for period t as ρ_t, and shows that NPV = 0 if r_t is equal to ρ_t.

Schmalensee (2022) also appears to make contradictory claims on the question of whether the allowed rates are determined by the market-determined discount rates or vice versa. In the paragraph preceding his equation (4), he states that the allowed rates are generally set by regulators to match market-determined discount rates: "*In practice, regulators generally attempt to set allowed rates of return to match investors' market-determined required rates of return*." However, at the bottom of page 5, he implies that the regulator first sets the allowed rates: "*Suppose the regulator somehow sets the allowed rates..*". These allowed rates are then also used as the discount rates in his equation (6). He does the same in the second paragraph following his equation (6): "*It is then appropriate to use the allowed rate of return in period 1, ρ_1, to discount those discounted returns..".* He then again reverses himself in the next paragraph to assert that the allowed rates are determined by the market-determined discount rates: "*All that is required is that it is known that the regulator will set the allowed return equal to ρ_2 (the market-determined required return) whatever that turns out to be*." He makes the same point on his page 7: "*Of course…to avoid granting rents…the regulator should set allowed rates of return to match the rates that investors require*." No such contradictions are present in Schmalensee (1989), who shows that NPV = 0 if $r_t = \rho_t$ (the allowed rate equals the market-determined cost of capital for each regulatory period), and adds that the r_t are chosen to match the ρ_t as is evident in the following statement: "*The*

Invariance Proposition (that any depreciation schedule satisfies NPV = 0) rests on the assumption that the regulated firm's actual rate of return on the book value of its assets is adjusted each period to equal the current one-period interest rate." Schmalensee (1989) is correct, and the contrary suggestions in Schmalensee (2022) are incorrect: the discount rates are determined in the capital market rather than by regulators, and the regulator chooses allowed rates to match these market-determined discount rates so as to ensure that the NPV = 0 test is satisfied. Naturally, market-determined discount rates are not observable and must be estimated, so the regulator first estimates the discount rate using empirical data, and then sets its allowed rate to match that estimate.

Schmalensee (2022, page 2) states that "*Schmalensee (1989) was concerned with the effects of depreciation methods on accounting rates of return of regulated firms, taking as given regulators' determination of the allowed rate of return*." The first part of this statement is correct, but the second is not correct. Schmalensee (1989) does not take regulators' behavior as given. For the NPV = 0 condition to hold, regulators must set the allowed rate of return for a regulatory cycle equal to the market-determined discount rate (i.e., cost of capital) for that cycle, as shown in the previous section.

Schmalensee (2022, page 4) also states that "*In practice, regulators generally attempt to set allowed rates of return to match investors' market-determined required rates of return, but nothing in Schmalensee (1989) depends on how the allowed rates of return are determined*." The first part of this statement is correct, but the second part is not correct, and is contradicted by Schmalensee himself. In particular, Schmalensee (1989, page 296): "*The Invariance Proposition (that any depreciation schedule satisfies NPV = 0) rests on the assumption that the regulated firm's actual rate of return on the book value of its assets is adjusted each period to equal the current one-period interest rate*."

Schmalensee (2022, page 7) states that "*Dr Lally's characterization of Schmalensee (1989) is almost exactly backwards*." I do not understand this claim, and Schmalensee does not identify precisely what in Lally (2021) warrants his claim. However, Schmalensee does state in this paragraph that "*Of course…to avoid granting rents…the regulator should set allowed rates of return to match the rates that investors require*." I completely agree, and this process for setting the allowed rates is reflected in Lally (2021).

Schmalensee (2022, pp. 8-9) also offers some comments on analysis in Lally (2021, pp. 7-8). In his equation (8), Schmalensee uses r_t to denote the discount rates, he correctly notes that r_1 is defined by Lally (2021) as the "one-year cost of equity prevailing at time zero", and then seeks clarification on why Lally defines the discount rate in this way rather than as the market cost of capital. The explanation is thus: the discount rate is the market cost of capital, and this is the same as the cost of equity capital when all capital is equity (as assumed by Lally, 2021).

Schmalensee (2022, page 9) then makes the following statement: "*In an amazing bit of sleight of hand, Dr Lally then asserts that in order for V_0 to equal I, so that NPV = 0 is satisfied, the ρs must be set equal to the rs. He does not note that replacing the rs with the ρs, as in equation (6) above and from Schmalensee (1989), accomplishes the same thing in a much more logical fashion*." This statement can only be properly interpreted if there is uniform use of notation across Schmalensee (1989), Schmalensee (2022), and Lally (2021). Unfortunately, that is not the case. Lally (2021) uses k to denote the allowed cost of capital and k_e to denote the market-determined discount rate. Schmalensee (1989) uses r to denote the allowed cost of capital and ρ to denote the market-determined discount rate. Schmalensee (2022) sometimes uses ρ to denote the allowed rate and sometimes uses it to denote the market-determined discount rate, as noted above. In view of the latter inconsistency, it is impossible to clearly determine the meaning of Schmalensee's (2022, page 9) quoted words. However the following is clear. Lally (2021, pp. 7-8) argues that the regulator should set the allowed rate to match the market-determined discount rate, so as to satisfy the NPV = 0 test. Schmalensee (1989) does the same, as shown in the previous section. Schmalensee (2022) also does the same at times, as shown above, but appears to do the opposite at other times. Since Schmalensee (1989) is consistent, and Schmalensee (2022) is not, one should follow Schmalensee (1989), which matches Lally (2021).

Schmalensee (2022, page 9) offers comments on work by the AER (2022, pp. 103-104). In particular, Schmalensee asserts that the AER assumes that the parameter r_1, being the expected return on equity in period 1, *may* differ from the firm's market-determined cost of capital in that period. I do not consider that the AER is making any such assumption; r_1 is an expected rate of return in equilibrium because the denominator in the AER's equation (1) is a market price, and therefore r_1 is a market-determined cost of equity, i.e., a market-determined cost of capital.

Schmalensee (2022, page 10) also states that "*Schmalensee (1989) takes the regulator-determined allowed rates of return as exogenous; the proof of the Invariance Proposition does not depend on how the allowed rates of return are determined*." This is not correct. As shown in the previous section, Schmalensee (1989) requires the regulator to set its allowed rate at the beginning of a regulatory period equal to the market-determined discount rate for that period in order to satisfy the NPV = 0 test. To quote from Schmalensee (1989, page 296): "*The Invariance Proposition (that any depreciation schedule satisfies NPV = 0) rests on the assumption that the regulated firm's actual rate of return on the book value of its assets is adjusted each period to equal the current one-period interest rate*."

Schmalensee (2022, page 10) also states that "*Schmalensee (1989) deals with a very idealized world without risk, competition, or taxes. It is asserted that under certainty the period t cost of capital is just the one-period interest rate in period t – implicitly the riskless rate for a year or some shorter period. This is obviously correct in very abstract theory but completely irrelevant for long-term investments in the real world: neither Dr Lally nor anyone else to my knowledge has argued that regulated firms operate under certainty or that costs of capital are equal to short-term risk-free rates*." I do not agree with many of the claims here. Firstly, in respect of the claim that Schmalensee (1989) assumes certainty, he instead does allow for uncertainty over future interest rates. Schmalensee's (1989, page 294) statement that "*Under certainty, ρ_t is just the one-period interest rate in period t*" is a reference to certainty over cost and demand, and the statement remains true even when future interest rates are unknown, as he allows for.[1] Secondly, in respect of the claim that the period in Schmalensee (1989) is no more than a year, the mathematics in the latter paper is valid for any length of period. Thirdly, in respect of the claim that Schmalensee (1989) has no relevance to long-term investments, his analysis relates to an asset with a life of multiple periods and he does not restrict the number of periods. So, even if a period corresponded to only one year, an asset life of 100 periods would imply an asset life of 100 years.

Schmalensee (2022, page 10) also states that regulated firms operate under uncertainty, and I agree. One source of uncertainty is future risk-free rates, and Schmalensee (1989) allows for

[1] The clearest statement on the issue of future discount rates being uncertain is in Schmalensee (2022, page 6): "..the regulator will set the allowed return equal to ρ_2 (the market-determined required return) whatever that turns out to be."

that. Other sources of risk are in costs and demand, and Lally (2004) extends Schmalensee (1989) to address that situation. The result of this is that the cost of capital for a regulated firm may differ from the risk-free rate, which requires a model to price the cost of capital, and the AER uses the Capital Asset Pricing Model to do so.

Schmalensee (1989, page 294) assumes that regulated firms receive revenues only at the end of the regulatory cycle. If the regulatory cycle is one year, the result would be revenues received only at the end of each year, which is not realistic but no more unrealistic than the standard assumption in capital budgeting that projects deliver payoffs only at the end of each year. If the regulatory cycle is longer, such as five years, the assumption is untenable. Lally (2021, section 2.2) addresses this situation and concludes that use of the yield to maturity for the five-year risk-free rate (rather than the five-year spot rate) deals with it.

It is standard practice in mathematical modelling of financial issues to start with a set of quite restrictive assumptions, and then attempt to relax them in the direction of greater realism. Schmalensee (1989) is the first attempt at specifying the appropriate rates of return for regulators to allow to regulated firms, even though this was not the intent of his paper. Subsequent work, including Lally (2004) and Lally (2021, section 2.2) extends this analysis to accommodate more realistic assumptions, but the fundamental insight in Schmalensee (1989) is still valid: satisfying the NPV = 0 test requires that the term for the allowed rate that is set at the beginning of a regulatory cycle must match the length of the regulatory cycle.

4. Conclusions

Lally (2021) argues that, in order to satisfy the NPV = 0 principle, the regulator must at the beginning of each regulatory cycle set the allowed cost of capital for a term that matches the term of the regulatory cycle. He credits Schmalensee (1989) with first recognizing this point. In response, Schmalensee (2022) argues that his earlier paper did not address this term issue and was instead concerned solely with demonstrating that any regulatory depreciation method would satisfy the NPV = 0 principle. This paper has reviewed this issue and the principal conclusions are as follows.

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analysis in Lally (2021), and therefore would have no implications for the AER's cost of capital review. Secondly, I consider that Schmalensee (1989) does warrant credit for this term issue, because it is proved in his paper despite that not being his intent. Thirdly, Schmalensee (2022) uses contradictory notation, and seems to make contradictory claims on the question of whether the allowed rate is chosen by the regulator to match the market-determined cost of capital or vice versa. These contradictions do not afflict his earlier work in Schmalensee (1989). Fourthly, Schmalensee (2022) makes a number of other statements that I do not consider to be correct. Finally, Schmalensee (2022) characterizes his earlier paper as being too abstract to be useful to regulators. However all mathematical modelling of issues that are important to regulators will involve some degree of abstraction, and modelling is often improved in the sense of adopting more realistic assumptions. This improvement has happened in the present case, to accommodate more realistic assumptions, but the fundamental insight in Schmalensee (1989) is still valid.

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