6 September 2022

AER questions on the expert statement by Professor Richard Schmalensee (July 2022)

Overview of notation of Schmalensee (1989) and Schmalensee (2022)

In Schmalensee (1989):

- Variable ρ_t denoted **the cost of capital in period** *t*; it was also noted that '[u]nder certainty, ρ_t is just the one-period interest rate in period *t*' (page 294).
- Variable r_t denoted the **allowed rate of return** in period *t* (page 294). It was assumed actual earnings of the regulated firm to equal allowed earnings (page 294), and r_t was also later referred to as the **actual rate of return** and the **accounting rate of return** (page 296).
- Both rates r_t and ρ_t were allowed to vary over time *t*.

The key result of Schmalensee (1989), referred to as the **Invariance Proposition**, stated (p. 293):

> '… if a regulated firm is allowed to earn its actual (nominal) one-period cost of capital on the depreciated original costs of its investments, and if actual earnings equal allowed earnings, then the net present value of all investments is zero for any method of computing depreciation.'

Further (p. 296):

> '… the net present value of any investment will be zero as long as regulators adjust the accounting rate of return [r_t] to equal to ρ_t in each period and depreciation deductions eventually add up to the asset's initial cost. … Even if regulatory behaviour is uncertain, as long as the expected value of r_t is equal to ρ_t for all values of ρ and *t*, then … the expected NVP [is equal to zero].'

The notation and definitions used in Schmalensee (2022) appear to be different:

- ρ is first referred to as the **economic rate of return** on page 2 and then again on the bottom of page 4, where it says that ρ can be determined 'in any way whatever'.
- On the top of page 4, on the other hand, ρ is also referred to as the 'regulator-determined allowed cost of capital' or simply as the '**allowed rate of return for the life of the asset**'.
- On top of page 5, it is discussed that ρ may be set above or below the firm's actual, market-determined cost of capital, though it would have consequences for the profitability of the regulated firm. However, on page 6, ρ_2 is referred to as the market-determined required return.
- r_t is introduced as the **accounting rate of return** (page 3), but it does not appear as prominently in the subsequent derivations as r_t did in Schmalensee (1989).

The fundamental result of Schmalensee (1989) is described as follows in Schmalensee (2022): 'if the regulator determines *in any way whatever* that the regulated firm should earn an economic rate of return of ρ, and it requires the firm's accounting rate of return always to be ρ, the firm will in fact earn an economic rate of return equal to ρ' (page 4).

Questions

Question 1

It appears that the definitions and notation employed in Schmalensee (1989) and (2022) are different.

What adjustments should be made to Schmalensee (2022) so that the notation and definitions are consistent with Schmalensee (1989)?

In addition, please explain the differences in the following terms used in your two papers:

- the cost of capital
- the allowed rate of return
- the actual rate of return
- the accounting rate of return and
- the economic rate of return.

Question 2

Please comment on the following derivations and conclusions.

Part 1

Using the notation of Schmalensee (1989), if an asset's accounting lifetime, *T* = 2 periods, then combining equations (1) and equation (2) of Schmalensee (1989) results in the following:

$$NPV = -I + \frac{r_1 I + D_1}{1+\rho_1} + \frac{r_2(I - D_1) + I - D_1}{(1+\rho_1)(1+\rho_2)} \qquad (*)$$

Notation: D_1 is depreciation in period 1, I is the asset's initial cost, r_1 and r_2 are allowed rates of return in period 1 and 2, respectively and ρ_1 and ρ_2 are the costs of capital in period 1 and period 2, respectively.

Assume that actual earnings equal allowed earnings. If a regulator sets the allowed rate of return in periods 1 and 2 to match the costs of capital in period 1 and 2, respectively, that is, if $r_1 = \rho_1$ and $r_2 = \rho_2$, then the resulting NPV would be zero:

$$NPV = -I + \frac{\rho_1 I + D_1}{1+\rho_1} + \frac{\rho_2(I - D_1) + I - D_1}{(1+\rho_1)(1+\rho_2)} = 0 \qquad (**)$$

The above equation appears similar to equation (6) in Schmalensee (2022). However, the difference is in the notation. In the above equation (**), ρ_1 and ρ_2 are the (market-determined) costs of capital in period 1 and period 2. In equation (6) of Schmalensee (2022), ρ_1 and ρ_2 stand for the allowed rates of return and equation (6) is said to hold for *any* ρ_1 and ρ_2.

Part 2

Consider the above two-period example and assume that the market-determined costs of capital in period 1 and period 2 are, respectively, ke_{01} and ke_{12}. Further, assume that the asset's initial cost equals A and depreciation in period 1 is DEP_1. That is, assume the following:

$$\rho_1 = ke_{01}$$

$$\rho_2 = ke_{12}$$

$$I = A$$

$$D_1 = DEP_1$$

Under these assumptions equation (*) above can be expressed as follows:

$$NPV = -A + \frac{r_1 A + DEP_1}{1 + ke_{01}} + \frac{r_2(A - DEP_1) + A - DEP_1}{(1 + ke_{01})(1 + ke_{12})} \qquad (*')$$

If a regulator sets the allowed rates or return in period 1 and 2 equal to the market-determined costs of capital in period 1 and 2, respectively, then this would result in zero NPV. That is, if $r_1 = \rho_1 = ke_{01}$ and $r_2 = \rho_2 = ke_{12}$, then $NPV = 0$ in equation (*').

The above notation is that of Lally (2021).

Question 3

Having regard to your answers to Question 1 and 2 above, could you please set out and explain the assumption you criticised in reference to the AER's 'first defense' of Lally's propositions (see page 9 middle paragraph starting "The AER (2022) offers …")? Please define any mathematical notation used.

We have summarised the relevant paragraphs from the AER (2022) below for you convenience.

Background summary of pages 103 – 104 of the AER (2022)

On pages 103 – 104 of our draft explanatory statement we sought to illustrate that mathematical derivations of Lally (2021) are based on the standard corporate finance mathematics underlying discounted cashflow modelling.

For that purpose, we assumed that the law of one price held over the relevant period and that a firm in question was an all-equity firm. We then considered a standard textbook formula for one-period expected return on equity as a function of the current and future market asset values and the expected free cash flows over the period. We observed that our formula was similar to Lally's (2021) equations (1) and (2). In particular, this can be seen when investors expect to recover one-period returns equal to the corresponding one-period cost of equity (for an all-equity firm).

Question 4

Could you please set out and explain the assumption you criticised in reference to the 'AER's second defence' of Lally's propositions (see page 10 first paragraph)? Please define any mathematical notation used.

We have summarised the relevant material from the AER (2022) below for your convenience.

Background summary of the AER example (pages 109 – 110)

We considered a two-period model and assumed (along with other assumptions) that investors discount all cashflows using the same long-term discount rate, which is the required return on equity over 2 periods (i.e., a two-period cost of equity).

We noted that this assumption was made for illustrative purposes and this did not imply we endorsed this discounting approach.

We considered a scenario when the long-term discount rate of 5% was observed at the start of the first period. We did not specify values for the long-term rates observed at later dates, but we allowed them to differ from 5%. This is to reflect the fact that long-term interest rates (and rates of return) move over time.

In our example, a regulator can adjust the allowed rates of return at the beginning of each of the two periods. That is, denoting the investors' two period discount rate, which is the investors' long-term required return on equity (i.e., long-term cost of equity), by ρ_{LT} and otherwise using the notation of equations (*) and (**), the resulting NPV at the start of period 1 is as follows:

$$NPV = -I + \frac{r_1 I + D_1}{1 + \rho_{LT}} + \frac{r_2(I - D_1) + I - D_1}{(1 + \rho_{LT})^2} \qquad (***)$$

We observed that if the allowed rate of return on equity in period 1 is set equal to ρ_{LT}, that is, to 5% ($r_1 = 5\%$), then the zero NPV condition would only hold if the second period allowed rate of return on equity r_2 is expected to be set at 5%. Therefore, adjusting the allowed rate of return on equity in each period to align with a *changing* long-term rate of return, in general, would mean that the NPV at the start of the first regulatory period would not be expected to be zero.

Question 5

Please explain the meaning and significance of descriptors 'period *t*', 'one-period', 'short-term', 'T-period', 'long-term' in Schmalensee (1989) for the following context:

- ρ_t being referred to as the 'cost of capital in period *t*', 'one-period cost of capital', 'one-period rate of return' or (under certainty) 'one period interest rate' in period *t*
- 'The Invariance Proposition 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. But regulators rarely look at short-term interest rates in practice. For a single project, fairness would also be ensured for any depreciation schedule if the rate of return were set equal, once and for all, to the *T*-period long rate…' (page 296).

Please comment on the following interpretation:

- In Schmalensee (1989), ρ_t is the opportunity cost of capital associated with investing the capital into the regulated asset over the duration of period *t*.

References

1. AER, 2022, Draft Rate of Return Instrument Explanatory Statement, https://www.aer.gov.au/system/files/Draft%202022%20Rate%20of%20Return%20Instrument%20-%20Explanatory%20Statement%20-%2016%20June%202022.pdf .
2. Lally, M., 2021, "The Appropriate Term for the Allowed Cost of Capital", report prepared for the AER, https://www.aer.gov.au/networks-pipelines/guidelines-schemes-models-reviews/term-of-the-rate-of-return-pathway-to-rate-of-return-2022 .
3. Schmalensee, R., 1989, "An Expository Note on Depreciation and Profitability Under Rate-of-Return Regulation', *Journal of Regulatory Economics*, vol. 1, pp. 293-298.
4. Schmalensee, R., 2022, "Statement of Richard Schmalensee, Ph.D. to the Australian Energy Regulator".