Determination of the WACC in the Setting of a 5 year Regulatory Cycle

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17 February, 2011

This analysis answers the question of the appropriate term for the risk-free rate, the debt margin and equity risk premium given a five year regulatory cycle. The conclusion drawn is unequivocal. If comparable unregulated entities finance with *T*-year debt, then the appropriate term for the risk-free rate, the debt margin and equity risk premium when determining the WACC of a regulated firm is *T* years irrespective of the length of the regulatory cycle. This result is first demonstrated in the benchmark setting of a perfect capital market examined in Section 1. The result is then demonstrated in section 2 in a setting with transactions costs of issuing securities and managing the firm's capital structure and transactions costs when trading securities. The cause of the flaw in the Lally (2010) analysis of the question is investigated in Section 3. [1]

1. Determining the WACC in a Perfect Capital Market

As demonstrated in the Nobel Prize winning Miller-Modigliani theorems, the total value of all debt and equity claims on a business is the same for all combinations of securities that are observed in practice for a given firm type.[2] This result holds whenever there are no transactions costs in issuing or trading securities and is true irrespective of whether the entity is financed with a small amount of debt and a large amount of lightly-levered equity or a large amount of debt and a small amount of highly-levered equity. Equally importantly, the value of the business is unaffected by whether that debt is long-term or short-term, convertible or non-convertible, senior or junior, domestic or foreign, etc., etc., etc.[3] If the value of alternate sets of observed claims on

[1] Lally, Martin, 2010 "The appropriate term for the risk free rate and the debt margin" Report prepared for the Queensland Competition Authority.

[2] Miller, M. and Modigliani, F., 1958, "The cost of capital, corporation finance and the theory of investment," *American Economic Review*, 48, pp. 261-297.

[3] One of the many such variants of the Miller-Modigliani invariance theorems can be found in the Mayers and Smith (1982) analysis of the value of insurance.

assets were affected by their design, the entity would be costlessly recapitalized and the less valuable forms of financing would no longer be observed.

The total value of all the claims on a business is the present value of the entity's future net cash flows discounted at the weight average costs of capital (the WACC) of the business. Thus the Miller-Modigliani theorems are equivalent to observing that the WACC (i.e., the discount rate used by the market in valuing a business) is unaffected by the term of the debt used to finance the assets.

While the Miller-Modigliani theorems are a classic foundation of the theory and practice of finance, some of the immediate implications of this result are less well understand. Since the WACC is unaffected by whether a firm finances with 5-year debt or 10-debt, the correct calculation of the WACC requires only that one be consistent in considering the cost of debt and cost of equity whose weighted average gives the WACC.

$$WACC \text{ when finance 60\% with 10-year debt} = WACC \text{ when finance 60\% with 5-year debt.}$$

The correct value for the WACC, *Correct WACC*, satisfies

$$\begin{aligned} Correct\ WACC &= 0.6 \times r_{d \text{ given 10-year debt}} + 0.4 \times r_{e \text{ given 10-year debt}} \\ &= 0.6 \times r_{d \text{ given 5-year debt}} + 0.4 \times r_{e \text{ given 5-year debt}}. \end{aligned} \quad (1)$$

Given an upward-sloping term, the cost of 10-year debt will exceed the cost of 5-year debt. How then can the WACC be unaffected by the choice of 5-year debt versus 10-year debt; i.e., how can the left and right-hand-sides of relation (1) be equal if $r_{d \text{ given 10-year debt}} > r_{d \text{ given 5-year debt}}$? It must be that the cost of equity given 10-year debt financing is lower than the cost of equity given 5-year debt financing; i.e.,

$$r_{e \text{ given 10-year debt}} < r_{e \text{ given 5-year debt}}. \quad (2)$$

In a perfect capital market all differences in required returns on different assets over a common horizon are due to differences in the assets' risks. If future 5-year rates are not expected to rise relative to current rates, an upward sloping term structure implies that 10-year debt is more risky than 5-year debt. When more of a firm's risk is borne by its debt holders, less risk

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Mayers, David and Clifford W. Smith, Jr., 1982, "On the corporate demand for insurance," *Journal of Business* 55, pp. 281-296.

remains to be borne by the equity holders. An immediate implication is that if for regulatory purposes the cost of debt is estimated from the returns on the equity of comparable firms that do issue 10-year debt, then the regulatory WACC will be biased down if a regulator were to calculate the WACC by combining such an estimate of the cost of equity with the cost of 5-year debt. Such a term mismatch will not satisfy the NPV = 0 principal and suppliers of capital will not earn the opportunity cost of capital.

This bias is evident in four of the five alternative methods for determining the WACC considered in Lally (2010). To see the bias, assume that the term structure of interest rates is upward sloping and hence

$$r_{d \text{ given 10-year debt}} > r_{d \text{ given 5-year debt}} \tag{3}$$

and

$$r_{f \text{ 10-year debt}} > r_{f \text{ 5-year debt}}. \tag{4}$$

One can always express $r_{d \text{ given } T\text{-year debt}}$ as

$$r_{d \text{ given } T\text{-year debt}} = r_{f\ T\text{-year debt}} + T\text{-year debt premium.}$$

One can also express the cost of equity given that the firm finances with *T*-year debt as

$$r_{e \text{ given } T\text{-year debt}} = r_{f\ T\text{-year debt}} + T\text{-year equity margin.}$$

The *T*-year equity margin is estimated as the return on the equity of firms issuing *T*-year debt over and above the *T*-year risk-free rate.

In a perfect capital market with no transactions costs (e.g., no annualized issuance costs or transactions costs of swap contracts), Lally's first and second options both use as the estimate for the regulated firm's WACC the following sum:

$$0.6 \times \left(r_{f \text{ 5-year debt}} + \text{5-year debt margin}\right) + 0.4 \times \left(r_{f \text{ 5-year debt}} + \text{10-year equity margin}\right).$$

But this will produce a downward estimate for of the regulated firm's *Correct WACC*. In the setting of Lally's Option 1 the firm is assumed to issue 10-year debt. The *LALLY WACC Option* 1 estimate for the WACC given a perfect capital market is

$$0.6 \times \left(r_{f \text{ 5-year debt}} + \text{5-year debt margin}\right) + 0.4 \times \left(r_{f \text{ 5-year debt}} + \text{10-year equity margin}\right).$$

$$
\begin{aligned}
& 0.6\times\left(r_{f \text{ 5-year debt}} + \text{5-year debt margin}\right) + 0.4\times\left(r_{f \text{ 5-year debt}} + \text{10-year equity margin}\right) \\
&= 0.6\times r_{d \text{ given 5-year debt}} \qquad\qquad + 0.4\times\left(r_{f \text{ 5-year debt}} + \text{10-year equity margin}\right) \qquad (5) \\
&< 0.6\times r_{d \text{ given 10-year debt}} \qquad\qquad + 0.4\times\left(r_{f \text{ 10-year debt}} + \text{10-year equity margin}\right) \\
&= 0.6\times r_{d \text{ given 10-year debt}} \qquad\qquad + 0.4\times r_{e \text{ given 10-year debt}} \\
&= \mathit{Correct\ WACC},
\end{aligned}
$$

where the inequality follows immediately from the inequalities in (3) and (4); i.e., from the fact that the term structure is upward sloping. No bias will arise if the 5-year equity margin is used rather than the 10-year equity margin. Determination of the *Correct WACC* requires consistency when considering the debt and equity whose weighted average cost gives the WACC.

In the setting of Option 2 the firm is assumed to issue 10-year debt and to use interest rate and credit default swaps to transform the risk exposure of its debt and equity to that of a firm that has issued 5-year debt.

$$
\begin{aligned}
& \mathit{Lally\ WACC\ Option}\ 2 \text{ given a perfect capital market} \\
& = 0.6\times\left(r_{f \text{ 5-year debt}} + \text{5-year debt margin}\right) + 0.4\times\left(r_{f \text{ 5-year debt}} + \text{10-year equity margin}\right).
\end{aligned}
$$

It follows from the set of relations set out in (5) that Lally's Option 2 gives a downward biased estimate of the regulated firm's *Correct WACC*. This is so because in a perfect capital market the *Correct WACC* is unaffected by the hedging decision that transforms 10-year debt into 5-year debt. This can be demonstrated directly.

$$
\begin{aligned}
& \mathit{Lally\ WACC\ Option}\ 2 \text{ given a perfect capital market} \\
& = 0.6\times\left(r_{f \text{ 5-year debt}} + \text{5-year debt margin}\right) + 0.4\times\left(r_{f \text{ 5-year debt}} + \text{10-year equity margin}\right) \\
& = 0.6\times r_{d \text{ given 5-year debt}} \qquad\qquad + 0.4\times\left(r_{f \text{ 5-year debt}} + \text{10-year equity margin}\right). \qquad (6)
\end{aligned}
$$

The 10-year equity margin can be expressed as

$$
r_{e \text{ given 10-year debt}} - r_{f \text{ 10-year debt}} .
$$

$$
\begin{aligned}
&\text{10-year equity margin} \equiv r_{e\ \text{given 10-year debt}} - r_{f\ \text{10-year debt}} \\
&= \left(\frac{Correct\ WACC - 0.6 \times r_{d\ \text{given 10-year debt}}}{0.4} \right) - r_{f\ \text{10-year debt}} \\
&= \left(\frac{\left(0.6 \times r_{d\ \text{given 10-year debt}} + 0.4 \times r_{e\ \text{given 10-year debt}}\right) - 0.6 \times r_{d\ \text{given 10-year debt}}}{0.4} \right) - r_{f\ \text{10-year debt}} \\
&= \left(\frac{\left(0.6 \times r_{d\ \text{given 5-year debt}} + 0.4 \times r_{e\ \text{given 5-year debt}}\right) - 0.6 \times r_{d\ \text{given 10-year debt}}}{0.4} \right) - r_{f\ \text{10-year debt}} \\
&= r_{e\ \text{given 5-year debt}} - r_{f\ \text{10-year debt}} - \frac{0.6}{0.4}\left(r_{d\ \text{given 10-year debt}} - r_{d\ \text{given 5-year debt}} \right) \\
&< r_{e\ \text{given 5-year debt}} - r_{f\ \text{10-year debt}} \\
&< r_{e\ \text{given 5-year debt}} - r_{f\ \text{5-year debt}},
\end{aligned}
$$

where the two inequalities follow in turn from relations (3) and (4) respectively; i.e., from the fact that the term structure is upward sloping. Thus *Lally WACC Option* 2 given a perfect capital market is

$$
\begin{aligned}
&0.6 \times r_{d\ \text{given 5-year debt}} + 0.4 \times \left(r_{f\ \text{5-year debt}} + \text{10-year equity margin} \right) \\
&< 0.6 \times r_{d\ \text{given 5-year debt}} + 0.4 \times \left(r_{f\ \text{5-year debt}} + \left(r_{e\ \text{given 5-year debt}} - r_{f\ \text{5-year debt}} \right) \right) \\
&= 0.6 \times r_{d\ \text{given 5-year debt}} + 0.4 \times r_{e\ \text{given 5-year debt}} \\
&= Correct\ WACC.
\end{aligned}
$$

Again, no bias would arise if the 5-year equity margin were used rather than the 10-year equity margin. The determination of the *Correct WACC* again requires consistency when considering the term of the debt and the equity whose weighted average cost is the WACC.

Lally WACC Option 3 given a perfect capital market also gives a downward biased estimate of the regulated firm's *Correct WACC*. The *Lally WACC Option* 3 uses as its estimate for the regulated firm's WACC in a perfect capital market the following sum:

$$
\begin{aligned}
&0.6 \times \left(r_{f\ \text{5-year debt}} + \text{10-year debt premium} \right) + 0.4 \times \left(r_{f\ \text{5-year debt}} + \text{10-year equity margin} \right) \\
&< 0.6 \times \left(r_{f\ \text{10-year debt}} + \text{10-year debt premium} \right) + 0.4 \times \left(r_{f\ \text{10-year debt}} + \text{10-year equity margin} \right) \\
&= 0.6 \times r_{d\ \text{given 10-year debt}} + 0.4 \times r_{e\ \text{given 10-year debt}} \\
&= Correct\ WACC.
\end{aligned}
$$

This can also be demonstrated directly by observing that in a perfect capital market the *Correct WACC* for a firm that follows the strategy implicit in Option 3 of using interest rate swaps to transform the interest rate exposure of the 10-year bonds used to finance the business to that of 5-year bonds can be calculated as

$$
\begin{aligned}
&\textit{Correct WACC} = \\
&0.6\times r_{d \text{ given 10 year debt with interest exposure swapped to 5 years}} \\
&\quad +0.4\times r_{e \text{ given 10 year debt with interest exposure swapped to 5 years}} \\
&=0.6\times\left(r_{f \text{ 5-year debt}}+10 \text{ year debt premium}\right)+0.4\times r_{e \text{ given 10 year debt with interest exposure swapped to 5 years}} \\
&>0.6\times\left(r_{f \text{ 5-year debt}}+\text{10-year debt premium}\right)+0.4\times r_{e \text{ given 10 year debt}} \\
&=0.6\times\left(r_{f \text{ 5-year debt}}+\text{10-year debt premium}\right)+0.4\times\left(r_{f \text{ 10-year debt}}+\left(r_{e \text{ given-10 year debt}}-r_{f \text{ 10-year debt}}\right)\right) \\
&>0.6\times\left(r_{f \text{ 5-year debt}}+\text{10-year debt premium}\right)+0.4\times\left(r_{f \text{ 5-year debt}}+\left(r_{e \text{ given-10 year debt}}-r_{f \text{ 10-year debt}}\right)\right) \\
&=0.6\times\left(r_{f \text{ 5-year debt}}+\text{10-year debt premium}\right)+0.4\times\left(r_{f \text{ 5-year debt}}+\text{10-year equity margin}\right) \\
&=\textit{Lally WACC Option } 3.
\end{aligned}
$$

The first inequality follows from the fact that after the interest rate swap the equity holders must bear the risk of changes in the risk free rate and as a consequence require a higher return. The second inequality reflects the upward sloping term structure. Thus the bias reflects the twin errors of using the 5-year risk free rate as the first term of both the cost of debt and the cost of equity when the second term reflects the decision to issue 10-year debt. No bias would arise if the 10-year risk-free rate were used in determining both the cost of debt and the cost of equity. Again, the determination of the *Correct WACC* requires consistency when considering the debt and equity whose weighted average cost is the WACC.

In the setting of Lally's Option 4 the firm is assumed to issue 10-year debt and to not use either interest rate or credit default swaps. The *Lally WACC Option* 4 estimate for the WACC given a perfect capital market is given by

$$0.6\times\left(r_{f \text{ 10-year debt}}+\text{10-year debt margin}\right)+0.4\times\left(r_{f \text{ 5-year debt}}+\text{10-year equity margin}\right)$$

and this is also a downward biased estimate of the *Correct WACC*. The error arises because of the use of the 5-year risk-free rate as the first term within the cost of equity and again illustrates the fact that the determination of the *Correct WACC* requires consistency when considering the debt and equity whose weighted average cost is the WACC.

$$\begin{aligned} & 0.6 \times r_{d \text{ given 10-year debt}} + 0.4 \times \left(r_{f \text{ 5-year debt}} + \text{10-year equity margin} \right) \\ < {} & 0.6 \times r_{d \text{ given 10-year debt}} + 0.4 \times \left(r_{f \text{ 10-year debt}} + \text{10-year equity margin} \right) \\ = {} & 0.6 \times r_{d \text{ given 10-year debt}} + 0.4 \times r_{e \text{ given 10-year debt}} \\ = {} & \mathit{Correct\ WACC}. \end{aligned}$$

The calculation in *Lally WACC Option 5* is the only one that is not biased and the only one that does satisfy the NPV = 0 rule. Lally (2010, page 4) contains an incorrect claim that Option 5 violates the NPV = 0 rule. Under Option 5, the cost of 10-year debt is the cost of 10-year debt issued by comparable firms and the cost of equity for a firm that issues 10 year is the cost of equity issued by comparable firms that finance with 10-year debt. This is exactly the meaning of the opportunity cost of capital and the meaning of a NPV = 0 valuation standard throughout the Finance literature. Lally (2010, page 4) claims that “equity holders would be consistently over compensated by about 0.20% in the risk free rate if T=10 years.” The 0.20% is suggestive of a typical difference between 5-year and 10-year costs of debt. The claim seems to be that firms could reduce their cost of equity by about 0.20% by financing with 5-year debt rather than 10-year debt. The claim falsely assumes that the equity premium is unaffected by the maturity of the debt that the firm issues and hence falsely assumes that the cost of equity would decline by 0.2% if the firm were to finance with 5-year rather than 10-year debt. In fact, in a competitive market if the firm did finance with 5-year debt and the equity holders did then bear the additional risks associated with 5 yearly moves in the interest rates, then they would require a higher return on the firm’s shares. The required return on the equity of a firm that finances with 5-year debt in excess of the 5-year risk-free rate will then actually be more 0.2% greater than the return on the equity of a firm that finances with 10-year debt in excess of the 10-year risk free rate.

$$\begin{aligned} & r_{e \text{ given finance with 5 year debt}} - r_{f \text{ 5 year}} \\ > {} & r_{e \text{ given finance with 10 year debt}} - r_{f \text{ 5 year}} \\ = {} & r_{e \text{ given finance with 10 year debt}} - r_{f \text{ 10 year}} + \left(r_{f \text{ 10 year}} - r_{f \text{ 5 year}} \right) \\ = {} & r_{e \text{ given finance with 10 year debt}} - r_{f \text{ 10 year}} + 0.2\% . \end{aligned}$$

The conclusion that there is a 0.2% per annum violation of the NPV = 0 rule is flawed. The reasons for the flaw are given in the final section of this Report.

2. Determining the WACC recognizing the Costs of Issuing and Trading Securities

The results from the previous section carry over to a setting where one wishes to determine the WACC for regulatory purposes when firms bear costs in issuing securities and managing their capital structure and investors bear costs when trading securities. If comparator firms finance with 10 year debt, the *Correct WACC* is a weighted average of the cost of 10-year debt and the cost of equity of those comparator firms plus the annualized issue costs of 10-year debt ; i.e., the *Correct WACC* is given by *Lally WACC Option 5*.

In the presence of transactions costs a firm will design its capital structure so as to minimize its WACC including both its annualized cost of issuing securities and the costs of managing its capital structure (for example, the transactions costs of optimal interest rate swaps and the costs of managing temporarily surplus cash) and thereby maximize firm value. All else equal, if minimizing WACC simply means minimizing annualized debt issuance costs and the annualized cost of longer-term debt were declining with the life of the debt then all firms would issue very long-term debt. But the set of investors whose future desired consumption profiles match the maturity of such long-dated bonds would eventually decline and more of the purchasers of these very long-dated bonds would begin to build the transactions costs of selling the bond prior to its maturity into the price they were willing to pay up front. In turn, the required return on the firm's debt would become higher. Similarly, issuing enough long-term debt to finance a lengthy series of future investments would mean a large temporary cash surplus and the attendant costs of the weakened managerial incentives that arise when a firm's large cash surpluses (known in the academic literature as the "free cash flow problem") allow managerial slack. The optimal maturity for the firm's debt will therefore reflect a trade-off of issuance costs, cash management costs, and the higher yields required to compensate for the higher transactions costs associated with the subsequent resale of relatively illiquid long-term bonds. If comparable firms do find it optimal to issue 10-year debt, this is consistent with WACC being minimized by financing with 10-year debt.

To calculate the WACC for some capital structure other than that chosen by comparable firms would, if those calculation were undertaken in an internally consistent manner, lead to an upward bias in the allowed WACC for regulatory purposes since this would be the WACC if a firm did not minimize. If a regulator were to allow such a WACC, too high a cost would be imposed on the consumers of the regulated entity's output. But if the calculation of the WACC were to involve the downward biases associated with the internal inconsistencies of any of *Lally WACC Options* 1, 2, 3 or 4 then the direction of the net bias is unknown. But whenever comparable firms issue 10-year bonds then *Lally WACC Option* 5 will lead to an unbiased result for the regulated firm's WACC because (a) the WACC is calculated as the WACC of optimizing comparable firms and (b) the calculation is undertaken in an internally consistent manner as the weighted average of the cost of 10-year debt and the cost of the equity of comparable firms issuing 10-year debt. If desired for the purposes of a building block approach, one can always chose to (i) express the cost of 10-year debt as the sum of the 10-year risk free rate and the 10-year debt premium and (ii) the cost of the equity of comparable firms issuing 10-year debt as the sum of the of the 10-year risk free rate and the premium in the cost of the equity of comparable firms issuing 10-year debt over and above the 10-year risk free rate.

3. Flaws in Lally's Analysis of the NPV = 0 Rule

The Lally (2010) analysis of the NPV = 0 rule is primarily flawed because of a lack of consistency within each of the analyses. These inconsistencies lead to apparent violations of the Miller-Modigliani theorems. Lally (2010) suffers from a failure to fully understand the implications of the Miller-Modigliani theorems. In fact, pages 24 and 25 of Lally (2010) claim in reference to a prior CEG (2010) report[4] that

> .… CEG's references to Miller and Modigliani (1958) in support of their claim that lower debt maturity raises the cost of equity are completely unwarranted because Miller and Modigliani make *no* reference whatsoever to any such connection or even to the debt maturity decision by firms.

It is true that Miller and Modigliani demonstrate their result that in a perfect capital market the design of a firm's securities does not affect the firm's value by investigating the effect on firm

[4] CEG, 2010, "*Estimating the risk free rate and debt risk premium*," submission to the QCA.

value of the face amount of the debt to be issued. But the Miller-Modigliani value invariance result is much broader than simply the face amount of the debt issued; the result applies to all elements of the debt's design. As argued in the Grundy (2001) [5] review of Merton Miller's lifetime contribution to economics and finance,[6]

> Merton's faith in the M&M [Miller and Modigliani] propositions was such that for him, all repackagings were value-irrelevant until proven otherwise by reference to the relevant asymmetry or imperfection. Not just debt versus equity, but short versus long-term debt, secured versus unsecured debt, and the leverage implicit in a futures or forward position.

As a demonstration of the often subtle flaws in the Lally (2010) investigation of the NPV = 0 rule, consider Lally's Appendix 2 which examines the setting of *Lally WACC Option* 5. When a regulator resetting the cost of debt and equity every 5 years uses the risk free rate and debt premium applicable to 10 year bonds and the cost of equity of comparator firms which themselves optimally finance by issuing 10 year debt, then the NPV = 0 rule will be satisfied. Yet Lally's Appendix 2 claims otherwise.

The first subtle flaw in Lally's Appendix 2 that gives rise to this claim occurs in the valuation equation on page 42 thereof. The numerator gives the expected payoff to the equity holders at time *N* if and only if the debt is certain to be repaid in full; i.e., there is no possibility of bankruptcy. But if that is the case then the return on the debt of true comparator firms would be the return on default free debt; i.e., the risk free rate. Given this implicit assumption the terms for the debt premium should be set at zero throughout Appendix 2. Leaving this error aside, consider the second term in the last of the equations on page 43. This second term looks deceptively reasonable. It involves the discounting of the expectation of a future random amount. It is common in the finance literature to write expressions like

$$\frac{E\left(\text{Future Random Amount}\right)}{1+\text{appropriate discount rate given the risk}}. \tag{7}$$

[5] Grundy, Bruce D., 2001, "Merton H. Miller: His contribution to financial economics," *Journal of Finance*, 56 (4): pp. 1183-1206.

[6] See also Grundy, Bruce D., 2002. *Selected Works of Merton Miller: A Celebration of Markets. Vol I Finance* and *Vol II Economics*.

But this method for determining a present value is only appropriate when the Future Random Amount is always non-negative. This discounted valuation technique was initially developed for valuing shares where it is appropriate since equityholders enjoy non-negative future payoffs from dividends and limited liability. The Miller-Modigliani valuation technique of discounting the non-negative payoffs to the firm's owners at the WACC is also an appropriate use of the technique.

To see that this familiar expression is not though always applicable, imagine trying to determine the change in the wealth of an individual who borrowed for one year $100 on order to purchase shares with a view to holding them for one year and who pledged her home as security for the loan, thus guaranteeing that it would be repaid in full at the end of the year. She would be able to borrow at the one-year risk free rate of, say, 5%. At the time the $100 is initially borrowed and invested in $100 worth of shares, the change in our investor's wealth is exactly zero: $0 = $100 share acquisition − $100 debt taken on.

Suppose the shares are expected to increase in value over the year by 20%. Try calculating the present value of the strategy's payoff to be received at the end of the year using the expression in (7). We know the result should be zero.

$$
\begin{aligned}
\$0 &= \frac{E\left(\text{Future Random Amount}\right)}{1+\text{appropriate discount rate given the risk}} \\
&= \frac{E\left(\text{year-end value of the shares purchased}\right)-\text{year-end debt repayment with interest}}{1+\text{appropriate discount rate given the risk}} \\
&= \frac{\$100\times 1.20-\$100\times 1.05}{1+\text{appropriate discount rate given the risk}} \\
&= \frac{\$15}{1+\text{appropriate discount rate given the risk}}.
\end{aligned}
$$

Reaching the correct answer of zero immediate change in wealth merely from borrowing a dollar in order to invest a dollar requires that one discount at an appropriate discount rate of infinity! The problem arises because the Future Random Amount can be negative and will be negative whenever the shares turn out to underperform bonds – our speculator will owe more than she has earned.

While expression (3) is familiar, careful analyses of settings where the Future Random Amount can be either positive or negative, such as that in Rubinstein (1976), do not use expression (3). Rather, expected future payoffs are correctly valued as

$$\frac{E\left(\text{Future Random Amount}\right) - \text{appropriate adjustment for risk}}{1 + \text{risk free rate}};$$

i.e., the correct adjustment for risk is an appropriate subtraction in the numerator rather than an increase in the discount rate.[7] In the example of our levered share speculator, the appropriate adjustment for risk is a \$15 deduction in the numerator and the immediate change in our speculator's wealth is correctly shown to be

$$\frac{\$15 - \$15}{1 + \text{risk free rate}} = \$0.$$ [8]

Returning to the second term of the last of the equations on page 43 we see that the Future Random Amount whose expectation is to be discounted will be negative whenever interest rates decline significantly during the 5 year regulatory cycle. Thus the attempted valuation technique of discounting a future expectation is not appropriate in a setting where interest rates can decline significantly.

Page 44 of Appendix 2 then goes on to claim that it is appropriate to apply the "usual practice in discounting cash flows … to treat future costs of equity as both certain and equal to the current value." But Lally's claimed violation of the NPV rule in Appendix 2 only occurs when interest rates are not constant. Even if the equity risk premium component of the cost of equity were a constant through time, the cost of equity would rise and fall in line with changes in interest rates and the "usual practice" would be inapplicable. As the Miller-Modigliani theorem makes clear, the Lally conclusion that the NPV = 0 rule is violated in Appendix 2 does not in fact follow when internal consistency is applied throughout the analysis.

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[7] Rubinstein, Mark, 1976, "The valuation of uncertain income streams and the pricing of options," *Bell Journal of Economics* 7 (2), pp. 407-425

[8] The appropriate adjustment for risk is \$15 since investors in \$100 worth of such shares (who require a 20% return given the shares' risk) require on average an additional \$15 payoff over and above the 5% return available by instead investing in risk free securities.

4. Conclusion

If comparable unregulated entities finance with *T*-year debt, the appropriate term for the risk-free rate, the debt margin and equity risk premium when determining the WACC of a regulated firm is *T* years irrespective of the length of the regulatory cycle.