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A Mean-Variance Synthesis of Corporate Financial Theory: A Note

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THIS NOTE CLARIFIES a common misinterpretation of Rubinstein's result [2] concerning the relationship between operating leverage and operating risk of the firm in the context of the CAPM. We show that, contrary to the general interpretation, Rubinstein's model indicates an inverse relationship between operating leverage and operating risk.

The operating risk of the firm can be defined as

$$\beta = \frac{\text{cov}(R, R_M)}{\text{var}(R_M)}, \quad (1)$$

where β is the operating risk of the firm, R is the return on the firm, R_M is the return on the market portfolio, cov is the covariance operator, and var is the variance operator. Assuming that the firm produces only one product, equation (1) can be expressed as

$$\beta = \frac{(p - v) \rho(Q, R_M) \sqrt{\text{var}(Q/V)}}{\sqrt{\text{var}(R_M)}}, \quad (2)$$

where Q (a random variable) is the output in units, v is the variable cost per unit, p is the price per unit, ρ represents correlation coefficient, and V is the value of the firm. Equation (2) can be rewritten as

$$\beta = \frac{(p - v) \text{cov}(Q, R_M)}{V} \times \frac{1}{\text{var}(R_M)}. \quad (3)$$

The value of the firm, in the context of the CAPM, can be expressed as

$$V = [(p - v)\bar{Q} - F] - \lambda(p - v)\text{cov}(Q, R_M)/(1 + r), \quad (4)$$

where $\bar{Q}$ is the expected output, λ is the market price per unit risk, F is the total fixed cost, and r is the riskless rate of return. Substituting (4) in (3) results in

$$\beta = K_1/[K_2 - F/(p - v)], \quad (5)$$

where $K_1 = \text{cov}(Q, R_M) (1 + r)/\text{var}(R_M)$ and $K_2 = \bar{Q} - \lambda\text{cov}(Q, R_M)$. K_2 can be interpreted as the certainty equivalent of output. (K_1 and K_2 are positive constants).

Rubinstein states that $(p - v)$ reflects operating leverage. Therefore, (5) indicates that operating leverage and operating risk are inversely related. This is so because, although an increase in operating leverage magnifies the uncertainty

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of cash flows, it increases the value of the firm as well. The model, however, implies that the increase in the uncertainty of cash flows is more than compensated by the increase in the value of the firm. The common misinterpretation that operating risk increases with operating leverage (in Rubinstein's framework) is due to the assumption that the value of the firm is invariant to operating leverage.¹

In the analysis of the firm under uncertainty, it is assumed that the firm is either "price setting" or "quantity setting." Rubinstein [2] considers the case of the price-setting firm, whereas Subrahmanyam and Thomadakis [3] examine the quantity-setting firm. However, both studies suggest that the operating risk of the firm is inversely related to operating leverage.

¹ See Lev [1], p. 632, and Subrahmanyam and Thomadakis [3], p. 445.

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