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Two Paradoxes in the Theory of Capital Investment and Competition

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On many occasions during my long experience as a teacher of economics, I have been puzzled by the disparity between what our textbooks propound and the real world. Here I discuss two such paradoxes that have been particularly persistent and attempt at least a partial explanation.

The Capital Rationing Ladder

When I was an MBA student during the late 1950s, we learned, as have probably all MBA students ever since, how to compute the internal rate of return (IRR) on the individual investment opportunities confronting one's organization and to choose the subset suitable for actual investment. According to the leading practice-oriented textbook of the time (Dean 1951, pp. 17-19), the prospects (assumed to be independent) were to be arrayed on a "ladder" from the highest to the lowest in terms of the estimated IRR.[1] Figure 1 reproduces the numerical example provided by Professor Dean, with the average rate of return for each of five groups plotted on the vertical axis and the cumulative volume of investment on the horizontal axis. Dean calls this ladder "the demand schedule of capital." In this he emulates earlier traditions. Keynes (1936, p. 136) calls such an ex ante return schedule "the schedule of the marginal efficiency of capital" or alternatively the "investment-demand schedule." At pp. 139-141 Keynes cites even earlier conceptions of the same idea by Alfred Marshall and Irving Fisher.

If one weights Joel Dean's mean group rates of return by the associated incremental investment quantities, one finds the average return over all alternatives analyzed to be 14.2 percent.[2] At the time of my MBA studies (I read Dean's book in a course taught by John Lintner, one of the original Capital Asset Pricing Model theorists), long-term Baa (i.e., relatively low-grade) bond rates averaged about 5 percent, and in our capital budgeting exercises, we tended to use cut-off rates (i.e., estimates of the marginal cost of capital) of from 6 to 8 percent. Thus, Dean's specific example and indeed all of the classic textbook examples imply *average* rates of return on capital investment well in excess of the marginal cost of capital, which, one is assured, should serve as the cut-off rate.

This has always seemed a paradox to me. We teach our students that in a competitive market, profits are driven by competition to a "normal" return on capital -- i.e., the marginal cost of capital to the investing enterprise. Distinctions between marginal returns and the average of infra-marginal returns are seldom made. Yet what we teach in courses on capital budgeting implies, without any differentiation between competitive and monopolistic firms, that the capital budgeting ladder leaves many projects earning returns well above the marginal cost of capital. And in our empirical studies of industry profitability, we tend to find average returns approximating "normal" at least in many industries, even if not in those which approximate monopolies or tight oligopolies structurally. See e.g. Schmalensee (1989) and Scherer and Ross (1990, Chapter 11).

One explanation could be that, as Keynes (1936, p. 136) argued, investment analysts and decision-makers are blinded by "animal spirits" and hence make many investments that after-the-fact yield returns much lower than those originally expected and indeed lower than the cost of capital. Correcting for the difficult-to-predict cyclical events emphasized by Keynes and others may be infeasible. Still one might suppose that textbooks and actual practice would adjust for routine non-cyclical biases, modifying individual project return estimates by a factor correcting for the average rate of bias. But if so, the mismatch between textbook approaches and actual practice deserves more attention in what we teach our students.

It is also possible to reconcile the discrepancy between competitive theory and capital budgeting practice by recognizing that some supra-normal incremental returns on investment are rents attributable to the superior productivity of specific inputs. In agriculture, for example, widely accepted as a competitive industry despite numerous government interventions, supra-normal returns for any individual farm are likely to be capitalized into the value of the land. The farmer as typical land-owner benefits eventually in the form of capital gains. After capitalization, the industry as a whole shows no supra-normal gains.[3] It seems much less likely that superiority is fully capitalized into the value of equipment in which business firms have invested.[4] It is also possible, although here the evidence is stretched beyond the breaking point, that superior profitability associated with infra-marginal investment projects becomes capitalized into managerial salaries and bonuses.

The Paradox of Pharmaceutical Innovation Returns

Another paradox also had its origins, at least in my thinking, during the late 1950s. At the time Senator Estes Kefauver was chairing an investigation of "administered prices" in the pharmaceutical industry, spurred by the observation that the industry had extraordinarily high price-cost margins, as ascertained inter alia from Census of Manufactures data, and regularly led Fortune 500 lists in terms of profit returns on stockholders' equity. Consultants to the pharmaceutical companies advised their clients in effect, "When Kefauver says profits, you say R&D." The industry followed this counsel. I was one such (junior) consultant and often wondered, "Is there anything more than propaganda to the industry's claim"?

Partial reassurance came from a careful study by the (now abolished) U.S. Office of Technology Assessment (OTA) (1993), on which I served as advisory committee chair. One focal issue was the way industrial research and development outlays were (and still normally are) treated under generally accepted accounting principles. They are written off as current expenses, even though they are investments in an uncertain future and should arguably be capitalized and then depreciated over the expected economic life of the resulting innovations. At the time and even more so recently, R&D expenditures in the pharmaceutical industry have been atypically high relative to sales (e.g., 18 percent in the early 2000s), and the lags between their incurrence and the attainment of positive cash flow are unusually long. Theoretical analyses led by Stauffer (1971) showed that under plausible growth and R&D intensity scenarios, the standard accounting treatment tended to reduce asset values more than it constrained return-reducing expenses, resulting in upward-biased rates of return on assets and stockholders' equity. When the accounting values were reconstructed by OTA to capitalize and then depreciate R&D outlays,[5] much of the apparent supra-normal profitability vanished, leaving returns on pharmaceutical R&D investments only two to three percentage points higher than the estimated 10 percent real (i.e., inflation-adjusted) cost of capital.[6]

My own research (Scherer 2001) helped resolve a second part of the paradox. Statistical analysis revealed that upward or downward percentage changes in aggregate pharmaceutical industry R&D outlays were strongly associated over time with similar changes in gross margins -- i.e., the difference between sales revenue and variable costs, assumed to be crude predictors of future profitability. (Changes in the U.S. political environment disrupted the relationship after the early 1990s.) Thus, there was some apparent validity in the consultants' cynical advice, "When Kefauver says profits, you say R&D."

A third aspect of the paradox resolution is more complex, but some insights have at least been gleaned. Economists have come to recognize that technological innovation is responsive to, i.e. "induced" by, changes in both demand and supply conditions. It is also widely accepted that there are strong externalities in the supply of innovative goods, including new pharmaceuticals. Social benefits tend to exceed private (innovator) revenues by often substantial margins. See e.g. Hall et al. (2010). When the demand for innovative products and the costs of R&D are changing at a smooth exponential rate over time, the "breakeven" or zero economic profit date -- i.e., the date at which discounted quasi-rents barely exceed discounted R&D costs -- can approximate the date at which the discounted surplus of social benefits less R&D costs is maximized, assuming (plausibly) that the social surplus is twice the private surplus. For proofs, see Scherer (2010, pp. 565-567) and Scherer and Ross (1990, p. 641). Yoram Barzel (1968) argued first that in such an induced innovation framework, competition pushes innovation dates forward in time toward the breakeven date, even though a secure monopolist would wait much longer to innovate and realize a positive surplus of quasi-rents minus R&D costs.[7] Thus, by accelerating technological progress, the Invisible Hand of competition leads to at least an approximation, often crude, of socially optimal innovation dates. Competition under these circumstances often entails the pursuit of parallel R&D paths by appropriately motivated firms, which accelerates the date of a first product launch, increases the probability of successful innovation, and increases product diversity. The welfare implications are complex, with much remaining to be resolved. William Comanor and I (2013) argue that, although pharmaceutical companies have in fact pursued parallel R&D paths competing with one another as well as (more rarely) internally, the extent of parallelism has recently been less than optimal. Here, however, it must be admitted, paradoxes remain, and much is still to be learned.

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End Notes

1. For possible complications, see Hirshleifer (1970), pp. 51-56.

2. To be sure, very high internal rates of return are rarer than those at the right-hand side of Dean's diagram. But they are hardly non-existent. I once analyzed the complete capital investment portfolio of a large U.S. industrial corporation. I found numerous projects expected to yield more than 100 percent.

3. In fact, profit returns on farmers' net worth for U.S. agriculture are remarkably low. See Scherer (1996, p. 29). Later data reveal returns on farm equity between 1997 and 2001 averaging 4.6 percent with government subsidies included and 2.6 percent without subsidies.

4. Equipment purchasers appear to realize substantially higher rates of return on their purchases, inferred from productivity growth rates, than the original equipment sellers. This implies the existence of significant externalities, which would not be capitalized or obscured by capitalization. See Scherer (1982).

5. Analogous capitalization of R&D in the gross domestic product accounts was adopted by the United States in August 2013, leading to a one-time reported GDP jump.

6. Except in the forward-shifting of tax savings under current-costing of R&D, internal rate of return profiles should not be distorted when Joel Dean-like capital rationing analyses are conducted.

7. An historical point: Barzel and I have subsequently agreed that his mathematical formulation was first suggested by me in Scherer (1967, note 11) and presented at a 1966 seminar in which Barzel participated. Barzel's model was formulated before the time of the seminar. Thus, the "inventions" were presumably parallel and simultaneous.

Figure 1
Joel Dean's "Demand Schedule for Capital"