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Capitalism *With* Capital: A Suggested Remedy to the Absence of Investment Decision-making in Basic Microeconomics Teaching

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Abstract: "[U]nder competition, the rate of return on investment tends toward equality in all industries." Introductory and intermediate microeconomics textbooks are sketchy in explaining how capital is allocated by financial markets. Capital budgeting techniques, primarily net present value, deserve a more prominent role. This article suggests ways in which financial economics can be integrated into undergraduate courses to illuminate entry into (and exit from) industries in response to profit opportunities, as an essential part of economists' narration of resource allocation in a capitalistic, market economy.

Key words: capital budgeting, present value, competitive equilibrium, economic education

JEL Codes: A20, D24, G31

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Capitalism *With* Capital: A Suggested Remedy to the Absence of Investment Decision-making in Basic Microeconomics Teaching

> There is no more important proposition in economic theory than that, under competition, the rate of return on investment tends toward equality in all industries. Entrepreneurs will seek to leave relatively unprofitable industries and enter relatively profitable industries, and with competition there will be neither public nor private barriers to these movements. This mobility of capital is crucial to the efficiency and growth of the economy: in a world of unending change in types of products that consumers and businesses and governments desire, in methods of producing given products, and in the relative availabilities of various resources—in such a world the immobility of resources would lead to catastrophic inefficiency.

George J. Stigler,1963. *Capital and Rates of Return In Manufacturing Industries*, NBER, Princeton University Press, p. 54

"Mobility of capital is crucial", but in our teaching we economists neglect how investment decisions are made and how capital is allocated. Textbooks in introductory economics and in intermediate price theory are remarkably sketchy in explaining the market adjustments toward long run competitive equilibrium, how "the rate of return on investment [in the long run, under competition] tends to equality." The texts slight (or ignore) the motivating force of the market(s) for investment in new capacity; "entry" and "exit" in response to (economic) profit and loss receive little explanation. The short run competitive market supply curve shifts right or left with little analytic support. When we teach about capitalism we neglect firms' decisions to invest in capital projects.

Consider the following examples of recent decisions to invest in new capacity.

In May 2005 the Toyota Motor Corporation announced plans to begin U.S. production in 2006 of the hybrid Camry. Toyota will invest $10 million to expand its plant in Georgetown, Kentucky, to produce 48,000 hybrids per year. (Wall Street Journal, 18 May 2005)

In the same month the Royal Dutch/Shell Group announced plans to develop (with PetroChina Co.) an onshore natural gas field in northwest China. Royal Dutch/Shell will invest $600 million in this joint venture. (Wall Street Journal, 18 May 2005)

At the 2005 Paris Airshow airlines purchased over 400 aircraft from Boeing and Airbus for an investment of about $45 billion. The two companies "have had orders [January-June] for almost 1200 planes." The aircraft prices varied from $50 million to $250 million each, and were for the A350 (not yet launched), the A380 (555 passengers, launched 2000), and the Boeing 787. The development (design and tooling) costs, investments for the aircraft manufacturers, are $10 billion for the 787 and $12 billion for the A380. (The Economist, June 25, 2005, pp. 12, 67-70)

In July 2005 the Census Bureau reported an increase in construction (investment) in the U.S. manufacturing sector. In May the seasonally adjusted annual rate was $1.1 trillion. Projects include the following: Proctor and Gamble, multimillion (a laundry detergent factory); Intel, $2 billion (chips); Phelps Dodge, $20 million (molybdenum mine). (Wall Street Journal, July 5, 2005 p.A-3)

Each of these examples—automobiles, natural gas, aircraft, detergent, chips, molybdenum—involves an increase in industry capacity and an increase in quantities supplied in the respective markets. Each also involves a large expenditure now—the investment—for the prospect of future returns—the cash (in)flow.

This paper provides suggestions on how well known financial economics might be integrated into introductory and intermediate courses in microeconomics. The basic (and analytically correct) capital budgeting technique is the (net) present value equation used by business firms to evaluate investments. The NPV equation provides links between investment decisions and long run (tendency toward) equilibrium, between accounting and economic income statements (and the firm's cost curves), between economic profit, normal profit, and accounting profit, and between accounting and economic break-even. The NPV equation also allows an understanding of the internal rate of return as well as certain aspects of risk.[1] Each of those topics receives some consideration in this paper; all can receive some space in basic microeconomics teaching; and several—NPV, normal (vs. accounting) profit, and risk—deserve high priority in undergraduate micro courses.

I. Capital Budgeting and Net Present Value

As an example of an investment opportunity and the use of the net present value technique, suppose a firm considers the following financial data to be the most likely outcome of accepting that opportunity:

Investment cost: \$400,000
Life of the investment: 4 years (with no salvage value or removal cost)
Annual sales: 10,000 units (rate of output)
Sales price: \$50
Direct cost per unit: \$25 (raw materials, labor, and other variable costs)
Annual overhead: \$110,000
Accounting depreciation: straight line (\$100,000 per year)

Financing, the financial capital necessary to undertake this project, is available (it is assumed here) at 10%, the annual opportunity cost of this financial capital to those individuals and institutions providing the financing, assumed here, for simplicity, to be entirely common stock.[2] The tax rate on corporate income (profit) is 25% of accounting profit. For algebraic simplicity assume that the cash flows are equal for each of the four years, also that no inventories of unsold finished goods are carried from one year to the next, and that all cash transactions occur at the end of each year.[3] Also assume (for analytic simplicity) that entry and exit of other firms in this industry do not take place. How does the firm evaluate this project, to decide whether to accept it (acquire the \$400,000 asset) or reject it (walk away)?

Each of the four annual *pro forma* accounting income statements (as an accountant would the display the accounting data) would look like this:

Sales revenue (SR)	\$500,000	(10,000 units @ \$50)
Direct cost (DC)	-250,000	(10,000 units @ \$25)
Overhead cost (OV)	-110,000	
Depreciation (D)	-100,000	(\$400,000/4)
Income before tax	40,000	(SR-DC-OV-D)
Tax	- 10,000	(tax rate t=.25 x income before tax)
Income after tax	30,000	(SR-DC-OV-D)(1-t)

The annual cash flow from this opportunity is thus projected to be \$130,000 (\$100,000 of accounting depreciation, “an expense but not an expenditure”, plus \$30,000 of income—accounting profit—after tax, the bottom line), or (SR-DC-OV-

D)(1-t) + D. This entire annual cash flow could be returned each year to the suppliers of financial capital, if the firm has no other investment opportunities which are expected to earn the 10% cost of financial capital. In practice, of course, some of the cash flow is usually returned to the suppliers of financial capital as dividends, interest, and/or stock repurchases, but the majority (not paid out) is retained in the firm to finance further investment.[4]

Is this opportunity financially worthwhile, i.e. will it earn (or more than earn) the 10% opportunity cost of capital? Will accepting the project add to the owners' wealth? The \$400,000 investment returns a cash flow, \$130,000 per year for four years. Discounted at the cost of capital, the net present value of this stream of future values is $\text{NPV}= -\$400{,}000 + \frac{\$130{,}000}{(1.10)} + \frac{\$130{,}000}{(1.10)^2} + \frac{\$130{,}00}{(1.10)^3} + \frac{\$130{,}000}{(1.10)^4}$

or $\text{NPV}= -\$400{,}000 + \sum_{T=1}^{4} \frac{\$130{,}000}{(1.10)^T} = \$412{,}082.51 - \$400{,}000 = \$12{,}082.51$

Based on these estimates, the project should be accepted; the positive NPV suggests that the investment is expected to produce an addition to the owners' wealth. The investment will produce an annual return expected to exceed the 10% opportunity cost of financial capital.[5]

How might the *pro forma* accounting income statement be reformed to reflect the economic concepts (all annual) of total revenue, variable costs, fixed costs, and (economic) profit? This reformulation requires the calculation of normal profit, the annual cash flow necessary to return exactly the 10% cost of capital. This calculation requires the use of the NPV equation: setting NPV=0, with the annual (and equal) cash flow (not the NPV) as the algebraic "unknown":

$$\text{NPV}= 0= -\$400{,}000 + \sum_{T=1}^{4} \frac{CF}{(1.10)^{T}} = -\$400{,}000 + CF\left[\frac{1-(1.10)^{-4}}{.10}\right]$$

Solving, CF=$126,188.32, the annual normal profit—an economic cost—which is less than the $130,000 estimated annual cash flow by $3,811.68, the estimated annual supranormal or economic profit. The *pro forma* economic income statement[6] for each of the four years, using conventional economic terms:

Total revenue	$500,000
Variable cost	
Labor, raw materials	-$250,000
Tax	-$ 10,000
Fixed Cost	
Overhead cost	-$110,000
Normal profit	-$126.188.32
Economic Profit	$ 3,811.68

Tax is a variable cost because an alteration in the rate of output (more than or less than 10,000 units per year) will alter the annual tax; if few enough units are sold per year the accounting profit and thus the tax will become zero. Normal profit is a cost once the asset has been acquired and financed (both for $400,000). The present value of the four years' annual economic (or supranormal) profit, discounted at 10%, is $12,082.51, the increase in owners' wealth at T=0 when the project is accepted.

II. Financing and an Efficient Stock Market

What happens to the value of this firm's shares of stock? Presume, now, (1) that this firm is newly established, that the firm has no other assets or liabilities or net worth and thus is financed by an initial public offering (IPO) of common stock specifically to undertake this project and that flotation costs are zero, (2) that all the cash flow will be returned (when earned at the end of each year) to the stockholders,

(3) that no other firm enters the industry, and (4) that the firm will be killed off when the assets become worthless at T=4.

Suppose that 5,000 shares of common stock are sold at a price of \$80 per share to raise the necessary financing of \$400,000. Once the assets are acquired (at T=0) and knowledge of this new firm becomes known the price will quickly be bid up (the efficient market hypothesis). How high? The present value of the cash flow on which all shareholders have a claim is \$412,082.51. The price of one share, thus, is

$$\frac{\$412{,}082.51}{5{,}000} = \$82.42.$$

At this price, the owners will receive exactly 10% on their shares: the CF per share per year is \$130,000/5000=\$26, so the present value (price) of one share is

$\sum_{T=1}^{4} \frac{\$26}{(1.10)^T} = \$82.42$. As four years pass, the price fluctuates; it rises during the first year (as the cash flow comes nearer) to reach $\$26 + \sum_{T=1}^{3} \frac{\$26}{(1.10)^T} = \$90.66$ just before the first \$26 is paid. Then at T=1 just after the first \$26 is paid out the share price falls to \$64.66, which is the discounted value (at 10%) of the remaining three payments of \$26. At T=2,3,4 (just after the second, third, and final \$26 payments are made) the price is successively \$45.12, \$23.64, and zero. The owner of one share has earned precisely 10% per year on the value of that one share.[7]

III. Depreciation

Depreciation is the recognition that as time passes and the asset is used the value of the asset declines. Accounting depreciation reduces the book value (accounting value) of those assets, and is based on the original or historical cost, the expected life, the salvage value or removal cost at the end of its life, and the method of depreciation employed by the accountants and allowed by the Internal Revenue Service.

In this example the accounting depreciation of $100,000 per year by the straight line method is arbitrary; various other accounting schedules have been used, generally accelerated so that accounting depreciation is greater in the earlier years (and taxes smaller) compared with later years. Accelerated depreciation thus accelerates the cash flow and hence increases the NPV at the time the potential investment is evaluated, T=0.

Economic depreciation can be calculated from the declining price of one share. The decline in that price is the depreciation in economic value of the asset acquired at T=0.

T	P	Proportion of original value	Proportional decline from original value	Annual Difference (economic depreciation)
0	$82.42	-		
1	$64.66	.7845	.2155	.2155
2	$45.12	.5474	.4526	.2371
3	$23.64	.2868	.7132	.2606
4	$0	0	1.000	.2868
				1.000

IV. Capital Budgeting and the Internal Rate of Return

This investment opportunity is projected to return more than the 10% cost of capital, since NPV is positive. How much more, in percent? The NPV equation, with the discount rate as the unknown, provides the solution, known as the internal rate of return:

$$\text{NPV} = 0 = \text{-\$400,000+} \sum_{T=1}^{4} \frac{\$130{,}000}{(1+r)^T} \Rightarrow r \approx 11.388\%$$

This algebraic solution (the IRR) is the annual rate of return, in cents per dollar per year, paid (by the firm as the acquirer of financial capital) and received (by the owners as suppliers of financial capital) on the unpaid off balance of the funds. The cash flow of $130,000 is returned to the owners each year. Part of this annual payment is the rental cost of funds, the opportunity cost of 11.388%, applied to the principal outstanding (unpaid off) , and part is a return of some portion of that outstanding principal. As the original funds are repaid, the interest portion decreases and the repayment portion increases.

To see how this works:

T	1	2	3	4	Σ
CF	130,000	130,000	130,000	130,000	520,000
Rental cost at 11.388% on unpaid off balance	45,552	35,935.06	25,222.95	13,290.94	120,000.95
Return of original financial capital	84,448	94,064.94	104,777.05	116,709.06	399,999.05
Unpaid off balance	315,552	221,487.06	116,710.01	$0.95 \approx 0$	-

The original owners have earned, and the firm has paid, 11.388% on the unpaid off balance of the funds. Since the expected IRR=11.388% exceeds the 10% cost of capital, this is an attractive potential investment.[8]

The IRR suggests an approach to the market demand for (financial) capital. At any time (or in any year) there exist a number of investment opportunities in the economy. Arrayed in decreasing IRR, they provide the demand schedule, with the IRR as the interest rate cost or price of capital on the y-axis and the prospective investment expenditures accumulated, as the IRR declines and more investment projects are evaluated with NPV>0, on the x-axis.[9] Restrictive monetary policy raises short term interest rates, and possibly long term rates as well, and thus raises the cost of capital, reducing investment: loose monetary policy which lowers interest rates and the cost of capital stimulates investment.

V. Entry and Exit: The Competitive Long Run

This example assumes (so far) that market conditions remain unchanged for four years, that the $130,000 annual cash flow neither falls nor rises and that 11.388% is paid and earned for the life of the physical assets. The rate of return to this firm in its industry exceeds the rate of return in other industries; 10% money (financing) is chasing a 11.388% investment opportunity. The "rate of return on investment" has not tended "toward equality in all industries". Entry is blockaded. "Under competition" when entry is free and the market is contestable other firms will enter in response to the profit opportunity, industry output will increase, and market price will fall, driving down (over time) the rate of return below 11.388%.[10] Entry, of course, ceases to be attractive when the return has fallen to 10%, the opportunity cost of capital.

Assume that the entire adjustment for this (incumbent) firm falls on the market price; i.e. as entry of new firms occurs this firm continues to sell 10,000 units per year at the same cost but at a lower price. New entrants enjoy no advantages in lower cost or technology or better product, and the firms face infinitely elastic supplies of factors of production, so input prices do not rise with entry of new firms. How low can the price fall before this incumbent firm (and new entrants) earn exactly the 10% cost of capital? In this example, not much: a price of about $49.49 reduces the cash flow to $126,188.32, the normal profit. Here the short run supply has, with entry, increased enough to reduce price and bring the return on invested capital down to the 10% cost of capital. Entry is no longer attractive; long run equilibrium in this market is attained.[11]

Capital mobility will differ across industries, between the extremes of absolutely blockaded entry and contestability. Barriers to entry are impediments to capital mobility in response to profit opportunities, any market condition or strategic behavior by incumbents that slows (or prevents) the long run adjustment process. No agreement has emerged on a single definition of BTE, but examples include licensing, intellectual property (patents, copyrights, trade secrets), control of essential resources (e.g. Alcoa's control of bauxite before World War II), strategic behavior (limit pricing, bundling, price discrimination, raising rivals costs), and Bain's original barriers (scale economies and sunk costs, absolute cost advantages of incumbents, product differentiation). (Gilbert 1989) No one requires that entry be instantaneous;

construction of a new plant takes time (after the entrant recognizes the opportunity), and even shifting an existing airplane from route A to route B (the original example of contestability) can hardly be accomplished overnight. Capital budgeting and NPV nevertheless provide the rationale for capital mobility, whether slowed by BTE or not.

VI. Remain in Operation?

> "Normal profits. That minimum amount of profit [i.e. cash flow] which a firm must acquire in order to induce the firm to remain in operation. This is where all opportunity costs are just covered by total revenue and therefore corresponds to a zero level of [economic] profits."
>
> David W. Pearce, ed., The MIT Dictionary of Modern Economics, 4th ed., The MIT Press, 1992, p. 310

At long run competitive equilibrium, with annual (4 years) cash flow of $126,188.32 producing a 10% rate of return on a $400,000 investment will the firm choose "to remain in operation"? Of course the firm (at T=4) may repeat the process of acquiring the funds (through a follow-on offering or secondary offering) to replace the now worn out (and worthless) original assets; this would be necessary if the entire cash flow had been paid out each year as it had been received, as was assumed above. Exact replacement of the physical assets presumes that market conditions (demand, technology, factor prices) are the same at T=4 as at T=0.

Alternatively the annual cash flow can be considered in two parts: (a) the annual opportunity cost on the $400,000, 10% or $40,000 per year paid annually to the owners as a rental fee on the funds, and (b) the remainder (\$126,188.32-\$40,000= \$86,188.32) retained in the firm and invested in some other opportunity to earn the firm's 10% cost of capital.[12] Will this second part (the \$86,188.32 per year for four years) accumulate to an amount which will allow the firm "to remain in operation" in the long run by replacing the assets at T=4 (or if it so decides, to return the original amount to the suppliers of the financial capital)? What is that future value? It is

$$\$86{,}188.32\ [(1.10)^3 + (1.10)^2 + (1.10)^1 + (1.10)^0] = \$86{,}188.32 \left[\frac{(1.10)^4 - 1}{.10}\right] =$$

\$400,000.

The firm can, at T=4, use the \$400,000 either to replace the now worthless original assets with an identical investment, or to return the principal amount to the original suppliers of the financial capital. The annual normal profit of \$125,188.32 is just adequate "to induce the firm to remain in operation" by replacing the worn out assets at T=4.[13]

VII. Risk

So far the discussion has proceeded with no allowance for risk; the financial numbers presupposed that the investors can predict present and future cash flows with precision. The basic example can be modified and interpreted to describe how a firm might view imperfect knowledge about how the investment may fare, i.e. how the firm might handle risk.

a. Risk-adjusted discount rates

The firm's discount or interest rate may be set to reflect the degree of risk inherent in the proposed project; higher risk projects require higher rates of discount of future cash flows. If the original example is one investment opportunity available to a firm which already owns a portfolio of assets, then the 10% cost of capital can be viewed as applying to new projects of average (to the firm) risk. If the project is less risky than the average riskiness of the firm's other assets, a lower rate would be appropriate; similarly a more risky project would require a higher discount rate. Put differently, the risk premium in the cost of capital (discount) rate reflects the degree of risk. For example, using the same projected cash flows (I= \$400,000, CF_T = \$130,000, T=1,…,4) the NPV can be recalculated using the lower and higher costs of capital assumed to be 8% and 12% per year:

Risk	Cost of Capital	NPV
Less risky	8%	\$30,576.49
Average risk	10%	\$12, 082.51
More risk	12%	-\$5,144.58

Clearly, if those cash flows are considered to be more risky than the firm's average, at 12% the project would not be undertaken; NPV<0. Otherwise the project would be accepted. The IRR of 11.388% is the dividing discount rate, where NPV=0.

b. Probability Distributions

Each of the variables in the NPV equation can be assigned a probability distribution rather than a single value to reflect risk. As an example, suppose that all values used in the original example are "certain" except for the annual quantity of sales. The marketing department, unsure of projected *Q*/year, estimates a probability distribution, at a price of \$50:

Probability	*Q*/year
.25	9,500
.50	10,000
.25	10,500

The *pro forma* annual accounting income statements used to decide whether to accept or reject this project would appear thus[14]:

Q/year	9,500	10,000	10,500
Sales Revenue (P=\$50)	\$475.000	\$500,000	\$525,000
Direct Cost (AVC=\$25)	-237,500	-250,000	-262,500
Overhead cost	-110,000	-110,000	-110,000
Depreciation	-100,000	-100,000	-100,000
Income before tax	27,500	40,000	52,500
Tax	-6,875	-10,000	-13,125
Income after tax	20,625	30,000	39,375
Cash flow	120,635	130,000	139,375
NPV@10%	-17,634.98	+12,082.51	+41,780
IRR	7.95%	11.388%	14.74%

In all three scenarios the accounting profit is positive, but for one (Q=9,500) the economic profit is negative; the CF (\$120,635) is less than the normal profit (\$126,188.32) and the IRR is less than the cost of capital. Now the decision depends on the probability of economic gain (.50+ .25= .75 if Q=10,000 or 10,500 per year) and the probability of economic loss (.25, if Q=9,500/year). Is this risk worth taking? The answer depends on the taste or preference for risk possessed collectively by the suppliers of financial capital and expressed by the directors and the CEO.

Each of the other values can also be assigned probability distributions, and simulations using them simultaneously can produce probability distributions for the outcomes, i.e. for NPV and for IRR on which the directors and the CEO can base their decision.

c. Downside Risk

A third approach to risk involves the answers to this question: how bad can things get (how far off) before NPV becomes negative and IRR falls below the cost of capital? This question can be asked of each of the variables in turn (keeping the other variables unchanged); several answers are already apparent above.

i. Cost of capital. How bad can financial markets get (for the users of finance) before the NPV turns negative, i.e. what is the highest cost of capital that will support this project? The IRR provides the answer. Under tighter conditions in financial markets, and hence higher interest rates, any cost of capital above 11.388% will cause this project to be rejected.

ii. Cash flow. How bad can the cash flow get before the NPV turns negative? The normal profit of $126,188.32 provides this answer. For lower CF, the return to capital falls below the cost of capital. Cash flow may unexpectedly be lower than normal profit for any or all of a number of reasons: price is below $50, *AVC* is above $25, and the tax rate may be raised above 25%, among them.

iii. Durability. Suppose the assets turn out to be less durable than expected, i.e. the assets wear out and are scrapped before 4 years. NPV is negative for a life of less than 3.8 to 3.9 years. This answer is the solution to the NPV equation with NPV=0 and the life of the asset as the algebraic unknown.[15]

iv. Construction costs. Engineering estimates of the construction costs of new investment are often too low, sometimes much lower than they actually turn out to be.[16] For the original example above, if the investment cost exceeds $415,067.67, the NPV is negative.[17]

VIII. Break even

How many units must be sold each year, or how great must the annual revenue (or cash flow) be, for the firm to "break even"? It depends on whether an accountant or an economist gives the answer.

a. Accounting BE

For the firm to cover accounting costs and show a zero accounting profit, the gross margin of $25 per unit ($50 price less average variable-and marginal-cost of $25) times the number of units sold per year must equal the overhead plus the depreciation:

$$(\$50-\$25)\bullet Q=\$110{,}000+\$100{,}000$$

$$Q=\frac{\$210{,}000}{25}=8{,}400 \text{ units per year.}$$

At this annual of quantity of sales, accounting profit (and thus tax) will be zero. Below Q=8,4000 the firm will report an accounting loss.

If the firm is to cover its fixed accounting expenditures (i.e. the direct costs only and not the depreciation expense which is not an expenditure), then ($50-$25)•Q= $110,000. Q=4,400 per year. At this rate of output the firm will report an annual accounting loss of $100,000, but as long as the firm is covering its out-of-pocket accounting expenditures (the cash out flow of $110,000 of overhead plus the direct costs of (also) $110,000) with its revenue of cash inflow, then it will continue to operate. Q=4,400 per year represents this firm's (short run) shut down point.

b. Economic BE

The economic break even revenue (or quantity) must cover the opportunity cost of capital (the normal profit) as well as other costs; the cash flow must (at least) equal the normal profit. Following the annual accounting algebra of the original example above, sales revenue (*SR)* less direct cost (*DC*), overhead cost (*OV*), and depreciation (*D)*, less tax (t = the tax rate on accounting profit) plus depreciation (all of which produce the annual CF) must equal normal profit (NP): $(SR - DC - OV - D)(1-t) + D = NP$.

Solving for sales revenue minus direct cost, what is termed annual operating or gross profit: $(SR - DC) = \dfrac{NP + OV(1-t) - D \cdot t}{(1-t)}$. Using the accounting figures in that example

$$(SR - DC) = \frac{\$126{,}188.32 + \$110{,}000(1-.25) - 100{,}000(.25)}{1-.25} = \$244{,}917.76, \text{ the}$$

annual operating profit (of sales revenue less direct cost) necessary to cover all costs (the necessary return to capital, taxes, and overhead), i.e. the economic break even. If this operating profit is not earned, then in the long run the firm will not earn the cost of capital and thus will not replace the assets when they wear out.

If price and average variable cost are presumed independent of the firm's annual quantity of sales (Q), then the economic break even annual quantity (Q) can be calculated. Since $SR = P \cdot Q$ and $DC = AVC \cdot Q$, where *P*=\$50 and *AVC*= \$25, then

$$P \cdot Q - AVC \cdot Q = Q(P - AVC) = \$244{,}917.76. \quad Q = \frac{\$244{,}917.76}{50-25} = 9{,}796.7 \text{ units per}$$

year. This provides the numerically precise quantity which falls between the 9500 and 10,000 the marketing department used in VII above to reflect *ex ante* risk, i.e. where NPV= 0 and IRR= cost of capital. If price and *AVC* are not independent of *Q*, then dividing by *P-AVC*= 50-25 is illegitimate. Assuming that *P* and *AVC* are unaffected by *Q* is equivalent to assuming (respectively) that the firm is a price-taker in the product market and that the firm's *AVC* (or average direct cost) is horizontal.[18] These two figures ($244,917.76 and 9796.7) represent the long run economic shut down point.

IX. Conclusion

Stigler properly emphasized the tendency under competitive conditions for the rate of return to approach equality across industries, an equality which characterizes long run competitive equilibrium emphasized in microeconomics texts. Two sorts of influences modify this tendency. First, competitive conditions may not prevail; entry barriers (including exit barriers) may slow, or for a time halt, investment and the expansion of capacity in response to profit opportunities. Monopolists may for a time, perhaps an extended time, earn supranormal profit, rates of return above their costs of capital.

Second, production techniques will improve, new sources of inputs will emerge, new products will be developed and offered, and consumer's tastes may change. Alterations in supply and demand conditions will likely affect the rates of return and thus modify the capital budgeting calculations—Stigler's "world of unending change in types of products…, in methods of produc[tion]…, and in the availabilities of various resources…." In such an Austrian economy buffeted by the Schumpeterian perennial gale of creative destruction, equilibrium (market or general) is elusive, a moving target, and capital budgeting appropriates still greater importance in economists' narration of how resources are allocated.

Students in courses in basic microeconomics deserve some discussion of these issues of NPV, normal (vs. accounting) profit, rates of return, and risk. Virtually all introductory and intermediate micro texts give short shrift to these issues, thus denying students an exposure to a fundamental mechanism in a market economy. We teach capitalism with out discussing capital; students deserve better.

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[1] Capital budgeting and NPV also provide analytic support for much of macroeconomics: the Keynesian investment and aggregate expenditure (C+ I+ G) functions, IS-LM, and fiscal and monetary economics.

[2] The opportunity cost of capital as a single number, here 10% per year, is a function of the various forms which financing may take: common and preferred stock, long and short term borrowing, and delayed payments to suppliers and governments. The calculation is usually a weighted average of the after tax costs of these individual forms.

[3] This allows us to avoid some mismatches of revenues and costs.

[4] Some firms carry what appears to be excess cash; Microsoft has about $30 billion of cash on its balance sheet, and has only recently started to pay a modest cash dividend. For the business sector more generally, over the past 20+ years internal financing has provided between 62% and 100% of investment expenditures (capital spending and net working capital). Brealey and Myers 366-367; Ross, Westerfield, and Jaffe 395. Internal financing, of course, should pass the NPV test; if it doesn't, then the suppliers of finance have better opportunities. That's what the 10% opportunity cost is all about. Microsoft? Who knows.

[5] Present value (discounting a future value to the present) is a difficult concept for many beginning economics students. One way to introduce the concept is to start with compound interest (calculating a future value given the known present value and growth rate); most students have bank accounts earning interest and have had exposure to compounding in algebra 1. Then switch the algebraic unknown from the future value to the present value and solve the equation for PV. Then apply the general formula to a series of future values.

[6] This income statement provides the numbers in this example for values associated with a firm's cost curves: TR, VC, FC, and profit, also P ($50), AVC ($26), AFC ($23.62), and profit per unit ($0.38), all for Q=10,000 per year.

[7] This is identical to a level payment 4 year mortgage, with annual payments of $26, a 10% interest rate, and a principal of $82.42

[8] The IRR is an alternative to the NPV as a capital budgeting technique. However, the IRR may give incorrect guidance when mutually exclusive investment opportunities of different sizes are being evaluated, and the IRR may produce multiple roots as solutions to the algebraic equation. As a result NPV is preferable to IRR in capital budgeting analysis.

[9] Ryan (1965, 159-163) provides a brief discussion of these algebraic equations in the context of the firm's purchases of capital and capital services.

[10] Capital budgeting need not assume a constant cash flow (here $130,000 per year) over the life of the project. The *pro forma* income statements may contain estimates of increases in costs and reductions in prices, due to entry, changes in labor wage rates (or oil prices), the learning curve phenomenon, changes in consumer preference functions and tax rates, etc. Multiple forms of finance and quarterly (or monthly) cash flows may also be incorporated.

[11] This conclusion holds, even though the incumbent firm is assumed to persist in selling 10,000 units per year; here its supply curve is assumed perfectly inelastic.

[12] If the $86,188.26 retained in the firm does not earn the 10%, then it should be returned to the owners.

[13] Inflation (or deflation) can hit the reproduction cost of that asset. If the asset is more (or less) expensive at T=4 that it was at T=0 (with no change in its productivity), then the annual $86,118.32 invested at 10% will be inadequate (or more than adequate) to replace that asset when it wears out. For example, if the price (the cost of acquiring the same asset new) of that asset rises at 3% per year, its acquisition at T=4 would require an investment of expenditure of (about) $450,000. The necessary annual retained cash flow (after the $40,000 annual rental fee) would be $96,961.86. Instead, if the price of that asset falls at 3% per year, its acquisition at T=4 would require an investment expenditure of (about) $354,000. The necessary annual cash flow would then be $76,276.66.

[14] The price of $50 and the average variable cost of $25 are assumed to remain unchanged at different Q's. For a justification of the latter assumption see Miller, (2000).

[15] If the cash flows are spread equally (per month) over a life of 48 months (i.e. $130,000/12= $10,833.33/month) then the solution is about 45 months.

[16] Two examples: The "Big Dig" in Boston, which has submerged a major highway (I-93) underground through downtown, originally had an estimated construction cost of $4-5 billion; the actual cost has now passed $14 billion, and the new tunnel still leaks. The Trans-Alaska pipeline was projected to cost one-tenth the actual cost. However, Boston's "Big Dig" is a public project, and construction of the pipeline faced major environmental challenges.

[17] This is the solution to the following equation where I is the unknown:

$$\left(140{,}000 - \frac{I}{4}\right).75 + \frac{I}{4} = I\left[\frac{.10}{1-(1.10)^{-4}}\right].$$

The left hand side is cash flow (profit after tax plus depreciation) and the right hand side is normal profit. The cash flow per year is $130,941.73, an amount which (for 4 years) will exactly justify an investment expenditure of $415,067.67 at 10% discount rate. This is greater than $412,082,51 because of the greater depreciation tax shield.

[18] This is the derivation of the formula in Ross, Westerfield, and Jaffee (2005) 218-219. For similar analysis, see Brealey and Myers (1996) 243-245.