FIXED VERSUS SUNK COSTS: CREATING A CONSISTENT AND SIMPLIFIED COST FRAMEWORK

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ABSTRACT

Common textbook presentations of fixed and sunk costs are often unclear and theoretically inconsistent. The introduction of this inconsistency into the firm cost structure can render the associated total cost and supply functions economically irrelevant. Even worse, using improperly specified functions can lead to sub-optimal production decisions. The confusion between fixed costs and sunk costs extends beyond the classroom and into the boardroom. Business managers allocate capital inefficiently when they treat fixed costs as sunk. This paper suggests a simple framework for specifying fixed and sunk costs that adds clarity to the common textbook treatment and eliminates confusion among students and practitioners. The framework begins with avoidable and unavoidable costs, their relationship to opportunity costs, and a suggestion for an intuitive and theoretically consistent specification of total cost. After specifying total cost in terms of opportunity costs, a simple derivation of the firm supply function and shut down rule results. The proposed framework avoids the pitfalls that arise in the standard analysis and has historical antecedents in the writings of Fritz Malchup, John Maurice Clark, Ronald Coase, and Joseph Stigler. The author has found that utilizing the opportunity cost principle in teaching fundamental theories of cost enables students to learn the principles of production theory with greater ease and understanding. Evidence also exists that consulting firms using a similar framework, such as Economic Value Added, have improved their clients' profitability.

INTRODUCTION

The distinction between fixed and sunk costs is a one of the most important concepts in production theory and one of the most likely to frustrate students. It is built upon the foundation of opportunity cost and is crucial to the construction of the total cost curve, the firm supply curve, the notion of economic profits, and the firm's shutdown condition. Common textbook presentations of fixed and sunk costs, however, are often unclear and theoretically inconsistent. When beginning production theory, students learn that opportunity costs are the only costs to be considered when making decisions. Opportunity costs are defined, in part, as costs that are avoidable and thus are factored into economic decision-making. Sunk costs, on the other hand, are unavoidable and, as such, should not affect decisions. After learning this opportunity cost rule, students are told that total costs are equal to the addition of fixed costs and variable costs.

Somewhere in the discussion, however, an implicit assumption is made that fixed costs are costs that cannot be avoided; that is, fixed costs are synonymous with sunk costs. Assuming fixed and sunk costs are synonymous creates unnecessary complications for producer theory and presents an inconsistency in the core concept of economic costs.

The assumption of equality between fixed and sunk costs appears in the majority of microeconomics texts and on some occasions is made explicit. For example, Steven E. Landsburg writes in *Price Theory and Applications* (2002)

> *"In the short run, fixed costs are unavoidable. As a result, they have no bearing on any economic decision . . . Because sunk costs are sunk, and because the firm's fixed costs are sunk in the short run, it follows that fixed costs are irrelevant to the firm's short-run supply decisions, including the decision about whether to shut down."*

Two potential problems arise from this assumption. First, some costs are fixed in both the short run and long run, an idea that contradicts the standard claim that fixed costs, by definition, do not exist in the long run. Second, many short-run fixed costs can be avoided and therefore are not sunk. These problems are resolved by categorizing all costs based on their "avoidability". This simple and intuitive remedy is founded on the core notion that the only costs that matter to economists are opportunity costs. The solution is shown to simplify cost analysis without sacrificing mathematical rigor or important cost relations such as the envelope theorem relating short-run to long-run costs. This simple revision to the principles analysis extends easily to the analysis at the intermediate and advanced levels and follows the early work on costs by writers including John Maurice Clark, Fritz Malchup, and Ronald Coase.

The rest of the paper is organized as follows. Section 2 discusses the standard incorporation of sunk costs into the total cost function and the resulting problem of measuring economic profits. The avoidability criterion is then introduced to remedy the problem. Section 3 discusses how using this criterion allows for a simple and theoretically consistent derivation of the firm supply curve and shutdown condition that improves upon the standard textbook exposition. Section 4 explores the nature of fixed and sunk costs. Section 5 shows how the avoidability criterion ensures important cost relations between the short run and long run that might be unwittingly compromised using the standard pedagogy. Section 6 illustrates the gains from these simple cost revisions with numerical examples. The simplicity of deriving of long-run and short-run cost functions from standard production functions under the avoidability framework is shown. Section 7 provides evidence that indicates the confusion between fixed and sunk costs may extend beyond the classroom to the boardroom in actual firm behavior. Various consulting firms have used techniques along the lines suggested herein to resolve the problem by attributing the relevant opportunity costs to fixed costs formerly assumed to be sunk. In the end, the gains from the proposed revisions appear to greatly outweigh the costs of adoption.

THE PROBLEM BEGINS WITH TOTAL COST

The standard microeconomics textbook treatment of production costs is as follows. Total cost is defined as the sum of all costs of production whether avoidable and unavoidable (e.g., Hall and Lieberman, 177). The definition of costs is then distinguished from the accounting definition by the inclusion of implicit costs. These implicit costs are opportunity costs, such as the value of an owner's time, unrecognized in the firm's accounting records but crucial for economic decision making. In the next step, total costs are categorized into variable costs and fixed costs. The "fixed costs" term includes non-sunk fixed costs and sunk fixed costs, where the former refers to costs that do not change with production but may be avoided if production ceases and the latter refers to costs that are incurred regardless of production.

$$\text{Total Costs} = \overbrace{\text{sunk fixed costs} + \text{non-sunk fixed costs}}^{\text{Fixed Costs}} + \text{variable costs.} \qquad (1)$$

This is where the problem begins. This total cost definition violates the opportunity cost principle of economic decision making by including sunk costs and as such, commits the proverbial problem of "adding apples and oranges". Non-sunk costs have an opportunity cost and factor into decisions. Sunk costs have no opportunity cost and do not factor into decisions. Using a total cost function with this theoretical inconsistency leads to an incorrect assessment of economic profits and may lead to incorrect decisions on the profit-maximizing production level.

To illustrate, consider Figure 1 which illustrates the standard textbook plots of total revenues, total costs and profits. Profit, π, is given by the difference between the total revenue function and the total cost curve, *TC*. Total cost includes a fixed cost of \$300 that is split between a sunk fixed cost of \$150 and a non-sunk fixed cost of \$150. Profits are maximized at a production level of $q = 15$ with profits of \$100. But what kind of profits are these? They cannot be accounting profits because the student has already been told that accounting profits neglect opportunity costs. Are they *economic profits*? The standard definition of economic profit is illustrated in Roger A. Arnold's *Microeconomics* (2001, 187) in which economic profit is defined as "total revenue less total opportunity cost". This definition appears in *Principles of Microeconomics* (2001, 272), *Microeconomics with Calculus* (1988, 249), *Intermediate Microeconomics: A Modern Approach* (1996, 318) and many others. If economic profit relies upon economic costs, and economic costs are comprised solely of opportunity costs, a theoretically-consistent total cost function must exclude sunk costs. Excluding sunk costs implies the economic profits are actually \$250 and the total cost and profit curves in Figure 1 are invalid.

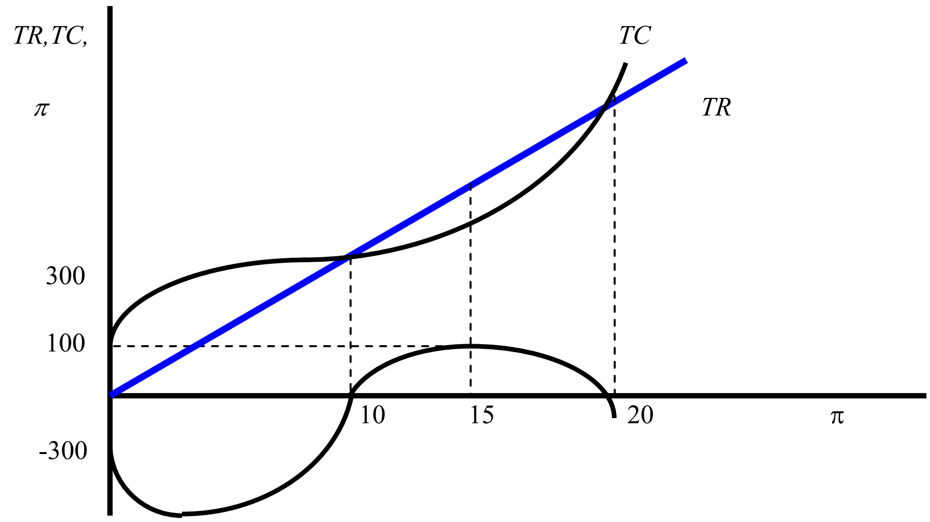


Figure 1 – Total Revenue, Total Cost and Profit

The mistake of including sunk costs in economic decisions would be fatal if the sunk cost were larger by $110. Figure 2 shows the original revenue, cost, and profit functions superimposed on a plot of those same cost and profit functions but with the additional $110 sunk cost. The latter curves are given as dotted lines and labeled as TC_{+110} and π_{+110}. The graph illustrates the danger of incorporating sunk costs into cost functions: were sunk costs $110 more, the firm would mistakenly conclude that there exists no output level at which profits are positive. The optimal production level would appear to be zero when in actuality, optimal production remains at q = 15 with economic profits unchanged at $250. Thus the inconsistency is not a mere difference of presentation or taxonomy. If total costs include sunk costs, the graph has no economic relevance. One cannot look at the graph of the totals and make an economic decision about whether production will occur or not. It shows neither accounting profits nor economic profits. The solution to this problem is simple and intuitive: exclude sunk costs from the total cost function.

Early 20th century economists converged on the simple opportunity cost principle of only including avoidable costs in the formulation of total costs. This distinction was important to these authors, many of whom were writing during the Great Depression about the relation between costs and production. Understanding firm costs was critical in thinking about policies that could stimulate production and employment. Writing in 1934, Fritz Machlup stated that "What one has to spend if one produces, and does not have to spend if one does not produce, is the cost of production" (p. 561). In an effort to edify accountants about costs in 1938, Ronald Coase wrote "[w]e may, however, lay down as a general rule that it will pay to expand production so long as marginal revenue is expected to be greater than marginal cost and *the* *avoidable costs of the total output less than the total receipts* [italics added] . . . This particular concept of costs would seem to be the only one which is of use in the solution of business problems, since it concentrates attention on the alternative courses of action which are open to the businessman" (1938, *The Accountant*). Even before the 1930s, many economists proposed the avoidability criterion. In speaking about fixed costs, which he termed "overhead", John Maurice Clark wrote, "Should we, or should we not, count "overhead costs" in deciding whether a given thing is worth producing? . . . [I]n a general way the rule is: whenever a policy is being considered which will involve *'overhead expenditures' that could otherwise be avoided, they are part of the cost of that policy*" [italics added] (1923, 21).

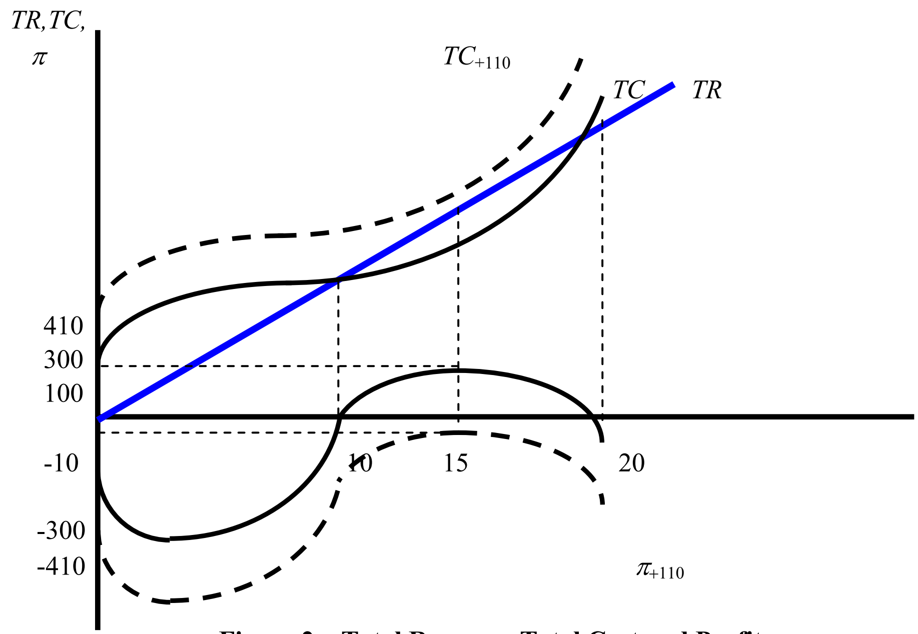


Figure 2 – Total Revenue, Total Cost and Profit

The avoidability criterion is easy to incorporate into modern cost analysis when distinguishing between sunk and fixed costs. A *sunk cost* is a fixed cost that cannot be avoided while an *avoidable fixed cost* is a fixed cost that can be avoided. A cost that is "fixed" in the sense that its associated input cannot be varied and has no alternative use, is sunk because it is unavoidable. Examples include a nontransferable, nonrefundable license to fish or practice law and a firm-specific asset that is undesirable to other firms and has no other productive use (e.g., a machine tool designed specifically for a particular plant or product). Avoidable fixed costs are costs that are fixed but may be avoided if the firm shuts down and costs whose associated inputs have alternative uses. Examples include fire and auto insurance policies that can be canceled if production stops and assets that are not firm-specific (e.g., computer servers that may be rented to other firms).

The direct link between the avoidability criterion and the opportunity cost rule is clear: if a cost is avoidable, it is an opportunity cost. If the cost is unavoidable, it has no opportunity cost and is therefore, sunk. A fixed asset that can be leased to other firms has an opportunity cost: every hour the asset is used in production is an hour of rent forgone. The only way the cost of an asset is an unavoidable fixed cost is if no alternative use of the asset exists and payments for it would occur whether or not production occurs. With this in mind, total cost may be defined as follows.

$$\text{Total costs} = \text{avoidable fixed costs} + \text{variable costs.} \quad (2)$$

Given the notion that sunk costs are ignored in decision making and that the total cost function is specified for economic decision-making, the total cost function may equivalently be written in the standard form of fixed costs and variable costs. We will see that this definition of total cost is appropriate for both the short and long run. Thus we have our proposed change to the analysis.

Rule 1: Replace the current definition of total costs as

TC **= fixed costs + variable costs,** ***where sunk costs are included***

with

TC **= fixed costs + variable costs,** ***where sunk costs are excluded.***

Those who want to keep costs in terms of only opportunity cost may define total cost by stating *total cost is the sum of all opportunity costs of production.*

FIRM SUPPLY CURVE AND SHUTDOWN CONDITION

The analysis of the firm supply curve and shutdown condition provides the clearest examples of the problems associated with including sunk costs in total costs. The standard textbook definition for the firm supply curve is that it is "made up of the marginal cost curve at all prices above minimum average variable cost and the vertical axis at all prices below minimum average variable cost" (Parkins, *Economics 9th Edition*, p. 279). The addition of sunk costs to opportunity costs prevents a mathematical derivation of the supply curve from the initial total cost curve. Instead, a cumbersome heuristic derivation is given along with an equally cumbersome graphical depiction. This graph combines with marginal costs (*MC*), average total costs (*ATC*), average variable costs (*AVC*) and average fixed costs (*AFC*) as seen in Figure 3.

Figure 3

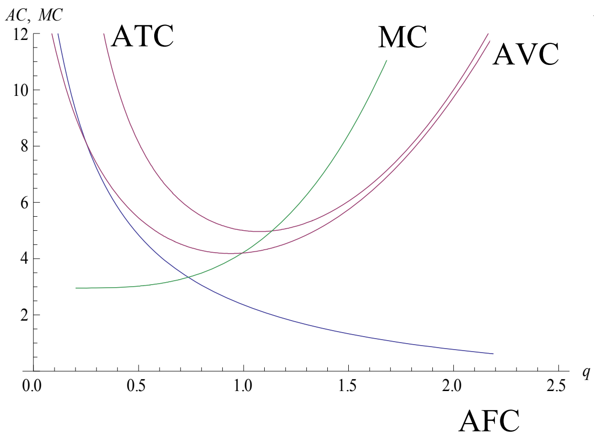
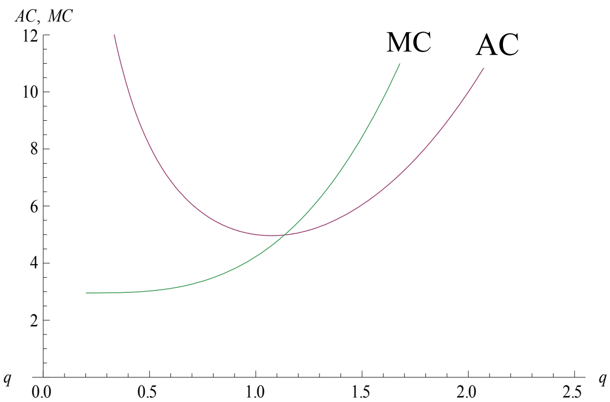


Figure 4



Because sunk costs were included in the initial cost function, the instructor must back-track to eliminate the sunk cost from the decision making rule for firms deciding how much to supply and at what price. The student is then told that the firm will shutdown if it cannot cover its *AVC*: that is, shutdown occurs if *P* falls below minimum *AVC*. Note the implicit reliance on the opportunity cost criterion: if fixed costs are truly fixed, they are not opportunity costs in the short run so they are irrelevant to the shutdown decision. As with the firm supply function, no mathematical derivation from earlier principles exists because of the theoretical inconsistency. Instead, what typically follows is an extensive explanation of the importance of variable costs in decision making and the unimportance of fixed costs in it. Students are invariably confused by this as they should be: the instructor has been carrying a cost throughout the analysis that the student must later be persuaded to ignore. This situation is made worse by the fact that the resulting supply curve is not relevant if any portion of the fixed costs from the total cost function is avoidable. If *TC* includes an avoidable fixed cost, such as a fixed capital that may be rented out to other firms, the standard decision rule for production may lead the firm to produce when it actually is not covering its opportunity costs.

Excluding sunk costs from the definition of total costs enables students to derive a firm supply function and shutdown condition mathematically. Because of its theoretical consistency, the result is a simpler and more intuitive firm supply curve and shutdown condition than the standard textbook presentation. Deriving the firm supply function with the avoidability criterion is done by using the production rule already taught to students: firms maximize profits when $MR = MC$ as long as $TR \geq TC$. This is shown in two simple steps. In the first step, students use the profit maximization rule that $TR \geq TC$ and divide each side by output, $\frac{TR}{q} \geq \frac{TC}{q}$, to give

$$\boldsymbol{AR \geq AC} \qquad \textbf{(3)}$$

The second step is to substitute the relationship $AR = MR = MC$ under perfect competition into (1) giving the firm supply relationship of

$$\boldsymbol{MC \geq AC.} \tag{4}$$

This condition states that the firm will supply output where marginal cost is greater than or equal to average cost. Note that average variable costs need not be addressed when the total cost function includes only opportunity costs. Because $MC = AC$ at minimum average cost, the supply curve is shown graphically to occupy the same locus of points as the marginal cost curve above minimum average cost. Figure 4 illustrates the firm supply curve under the opportunity cost criteria.

Deriving the firm supply curve and shutdown conditions requires instructors to jump through heuristic hurdles to convey what is simply the opportunity cost rule that they themselves have complicated by equating sunk and fixed costs. The shutdown rule for production is easily stated using the opportunity cost criterion:

The firm will shut down when it cannot cover its opportunity costs.

This is equivalent to saying the firm will shut down when it cannot produce profitably. Because (economic) profitability is defined as $TR \geq TC$ (where TC includes only opportunity costs) and is the same as saying $P \geq AC$ [a variant of Eq. (4)], the firm will shut down when the price it receives is lower than its average total costs. Basing the shutdown decision on opportunity costs is both intuitive and easy for students to learn. Two rules result.

Rule 2: Replace

The firm supply curve is represented by the $MC \geq AVC$

with

The firm supply curve is represented by the $MC \geq AC$ and zero elsewhere

and replace Figure 3 with Figure 4.

Rule 3: Replace

The firm will shut down if it cannot cover its average variable costs: that is, shutdown occurs if $P < AVC$

with

The firm will shut down if it cannot cover its opportunity costs: that is, shutdown occurs if $P < AC$

THE GENERAL NOTION OF FIXED COSTS

The more deeply one considers the notion of fixed costs, the more difficult it becomes to define a fixed cost. One must begin with the assumption that costs are determined by inputs: the cost of a fixed input is a fixed cost. Defining an input as "fixed" generally means one of two things, though they are not mutually exclusive: (1) production in the short run can be increased without varying the input or (2) the quantity of the input cannot be varied. The first definition is technical in nature while the second is based on costs. The first definition does not impose a restriction on obtaining the input while the second does.

To illustrate the distinction between the two definitions, consider short-run production occurring in a single fixed plant. Under (1), the plant is a fixed input if production may be increased by using more of the variable inputs holding plant size constant. Under (2), the plant is a fixed input in the sense that the owner is unable to alter the plant size during the current operating period. For example, a university may claim that its buildings represent fixed inputs as they cannot be expanded in the current school term. This is not a technical limitation but a cost limitation. The university could rent trailers overnight to use for classrooms or pay above-market prices to induce a builder to build another building. The second meaning was well articulated by Joseph Stigler who wrote

> " . . . *when a proprietor says that he can quickly buy more steel sheet, but requires 7 months to obtain a new stamping machine, he is not being precise. At a sufficiently high price, one can buy a stamping machine from another company and have it installed in 24 hours; at a very high cost one can have a new machine built in a month by working around the clock. When we say that in the short run some inputs are freely variable, we mean that their quantity can be varied without affecting their price (for given quality)*."
>
> *The Theory of Price* (p. 134)

Given Stigler's statement, definition (2) can be more accurately written as "the quantity of the input cannot be varied *without affecting its price*". From this discussion it is clear that (1) implicitly speaks of fixed inputs in the past tense as those inputs already purchased while (2) refers to future input purchases.

The difficulty in delineating fixed costs from variable costs may be the most persuasive reason to focus on opportunity costs. It is a clear, simple and economically consistent measure on which to make decisions. This is not to say that fixed costs have no value in economic analysis. The importance of fixed costs is that they do not affect decisions *at the margin*. How much a firm should produce is unaffected by fixed costs. Whether to produce at all, however, involves both variable and fixed costs. We ignore fixed costs at the margin not because they are sunk, but because they need not be altered to alter production levels.

LONG-RUN VERSUS SHORT RUN COST CURVES

The opportunity cost framework clarifies the relationship between long-run and short-run costs while preserving important principles such as the *envelope theorem* wherein long run costs are shown to be the envelope of short run costs. The preservation of these principles, however, requires theoretical consistency. For example, the long run is often defined as the period in which all costs are variable. Having clarified the notion of fixed costs, it should be clear that many investments, however, are fixed but avoidable before they are made. Various textbooks recognize this fact by describing investments that are lumpy or indivisible. Thus it is more accurate to state that the long run is the period in which all costs are avoidable.

Besides their real-world validity, an additional benefit of recognizing long-run avoidable fixed costs is that they simplify the mathematical modeling from production to costs. This strengthens the link of the qualitative analysis of the principles courses to the quantitative analysis in intermediate and advanced microeconomics courses. For example, Figure 5 shows the standard textbook plot of the envelope relation between long-run and short-run costs. Principles instructors use this graph to illustrate the various economies of scale so important to understanding industry structure. The standard discussion is of a firm that enjoys economies of scale by producing up to q_1, constant economies of scale (CEOS) from q_1 to q_2, and diseconomies of scale beyond. It becomes clear in intermediate courses, that assuming there are no fixed costs in the long run means the inverted-hyperbola LRAC graph can only be generated by assuming a cubic cost function. Unfortunately, the production function that generates a cubic cost function is mathematically daunting. To avoid this problem, a discrete jump occurs in intermediate textbooks from mathematically tractable production functions used to illustrate firm optimization (shown by the tangency between isocosts and isoquants) to the multiple-economies-of-scale average cost functions (shown in Figure 5). This complication is easily removed by allowing for the existence of long-run avoidable fixed costs.

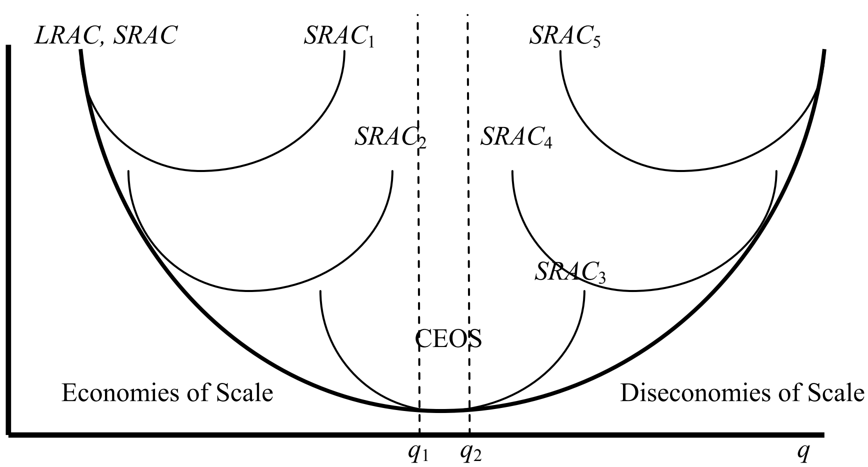


Figure 5

As will be shown in the next section, a simple production such as $q = 2K^{1/4}L^{1/4}$ with fixed factor prices and no long-run fixed costs generates a diseconomies of scale *LRAC* of

$$\boldsymbol{LRAC = Aq} \qquad \textbf{(5)}$$

where *A* represents a constant term. The associated *SRAC*s take the form

$$\boldsymbol{SRAC = C + Bq^4.} \qquad \textbf{(6)}$$

where *C* and *B* represent constant terms. The linear *LRAC* gives way to a quadratic *LRAC* once the existence of a long-run avoidable fixed cost – call it *Z* – is assumed. In this case, the *LRAC* becomes

$$\boldsymbol{LRAC = \frac{Z}{q} + Aq.} \qquad \textbf{(7)}$$

Such a *LRAC* function and its associated *SRACs*, have the general shapes seen in Figure 5. Instructors will find this closes the analytical gap between principles, intermediate, and advanced microeconomics courses. The recognition of long-run avoidable fixed costs is all that is required to make a mathematically-tractable production function generate the inverted-hyperbola *LRAC* curve and the various economies of scale. This change simultaneously simplifies the mathematical modeling while allowing for a complete mathematical framework within which all cost function can be derived from production functions and vice versa. The proposed change in terminology is as follows.

Rule 4: Replace

"In the long run, all costs are variable"

with

"In the long run, all costs are avoidable"

An ardent subscriber of the opportunity cost principle would simply state that "in the long run, all costs are opportunity costs."

NUMERIC EXAMPLE

As previously stated, the proposed changes greatly simplify terminology and analysis without sacrificing mathematical rigor. In fact, instructors are able to increase the rigor of analysis easily. To illustrate these concepts, consider a firm that produces modems, q, given a production function of

$$q = 2K^{1/4}L^{1/4} \tag{8}$$

where K represents the factory and equipment that constitute the firm's capital and L represents the labor employed. The capital is fixed at 1 (K = 1) in the short run and cannot be adjusted quickly without paying a large premium above its market price. Output may be increased (up to a point) without an increase in K. Thus capital is fixed in a financial rather than a technical sense, as described in Stigler (1987). Capital is not firm-specific and could be leased out to other modem producers at a price of \$4 per hour. Assuming an hourly wage of \$16, the firm has the following two costs.

A variable cost of q^4 for costs associated with its workers.
An avoidable fixed cost of \$4 representing the imputed costs associated with the factory and equipment.

Using the opportunity cost framework, the short-run total cost function is

$$SRTC = 4 + q^4. \tag{9}$$

Note that whether the firm owns its capital, leases it, or is making loan payments on it, does not alter the *SRTC*: the firm incurs a \$4 opportunity cost every hour it uses the capital rather than renting it out. Assuming modems sell in a competitive market for \$32 each, the *TR* and *SRTC* and profit, π, plots are given in Figure 6 and Figure 7, respectively.

Figure 6

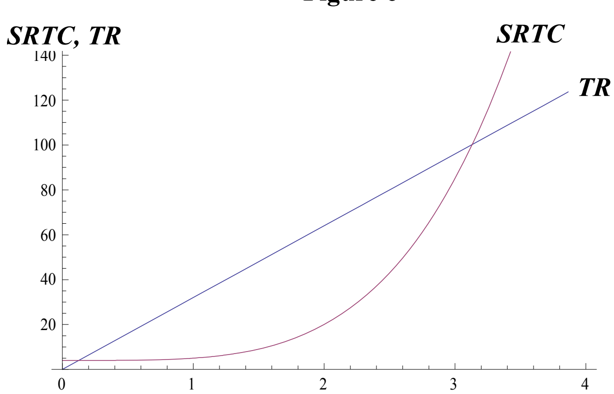
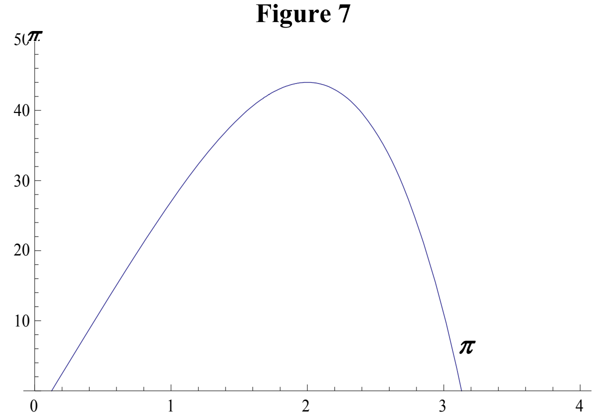


Figure 7



The short run supply curve exists where $MC \geq AC$ and is zero elsewhere. With $MC = \frac{dSRTC}{dq} = 4q^3$ and $AC = \frac{4}{q} + q^3$, the minimum average cost is found where $MC = AC$, at $AC =$ \$4.96 for an output level of $q = 1.075$. Thus the firm's supply curve is given by

$$\boldsymbol{P = MC = 4q^3 \text{ for } P \geq \min AC = 4.96 \text{ and 0 otherwise.}} \qquad \textbf{(10)}$$

The supply curve is shown in Figure 8. For comparison, the standard textbook supply curve is shown in Figure 9. Because *AVC* is below *MC* for all positive values of output, the standard formulation of the supply curve dictates that supply begins at the origin and there is no minimum price. This mistakenly indicates that production will occur at any price and illustrates another problem of equating fixed and sunk costs.

Figure 8

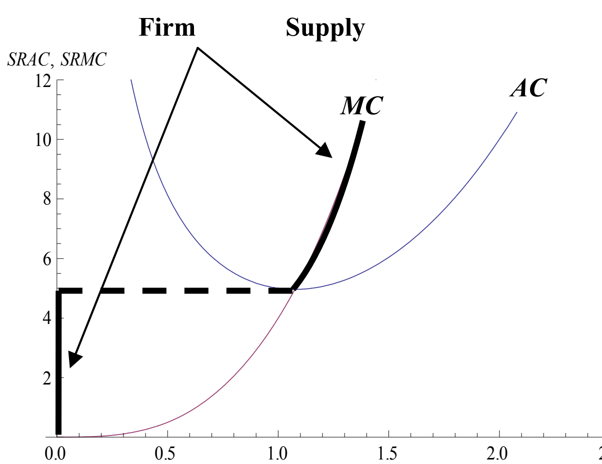
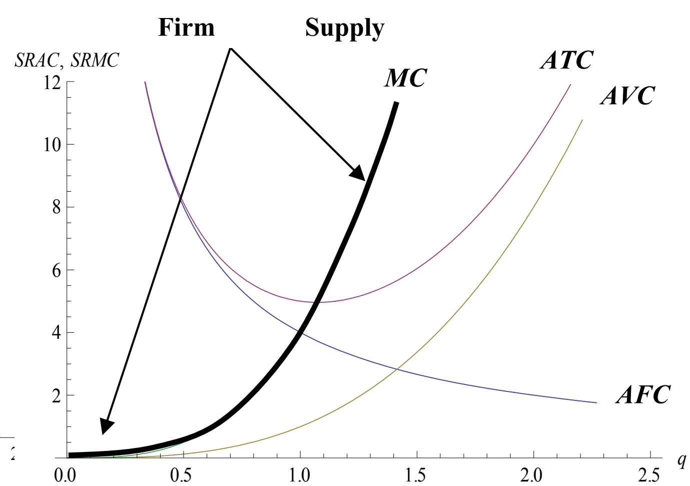


Figure 9

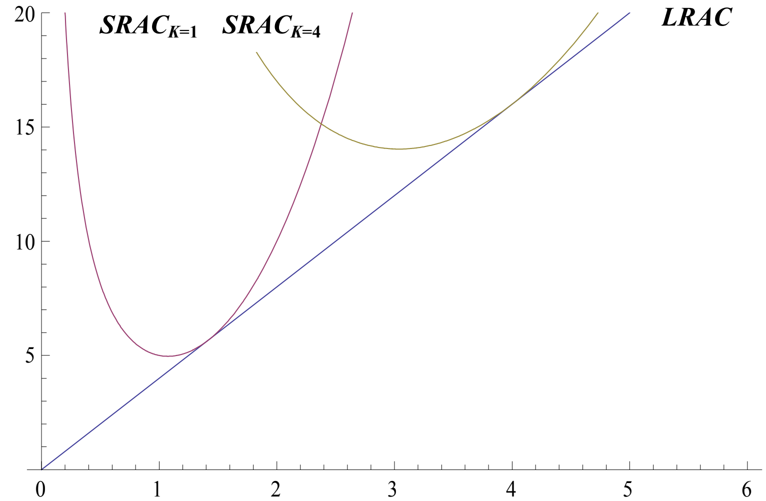


In the long run all costs are avoidable and the optimal value for capital and labor is determined by constrained optimization – for this example, the Lagrangian function is $\mathscr{L} = wL + rK + \lambda(q_0 - K^{1/4}L^{1/4})$ with $w =$ \$16 and $r =$ \$4. The optimal input values are found to be $L^* = 2$ and $K^* = 8$, which yields a long run total cost function of

$$\boldsymbol{LRTC = 4q^2.} \qquad \textbf{(11)}$$

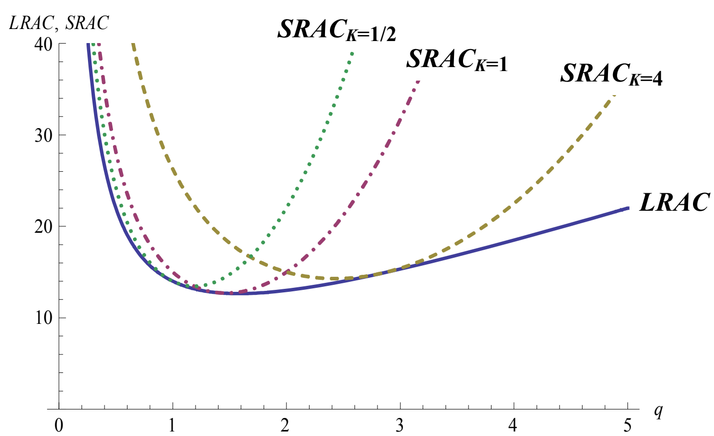
Figure 10 shows the resulting *LRAC* and both the *SRAC* with $K = 1$ and another *SRAC* with $K = 4$. Together they illustrate the envelope relation for a firm producing with diseconomies of scale.

Figure 10



If we assume a long-run fixed cost of 10, say legal fees that do not vary by output but are avoidable each period of production, the *LRTC* and *SRTC*s will change. The resulting *LRAC* and *SRACs* can account for all possible economies of scale as shown in Figure 11. Economies of scale exist up to around q = 1.5 where constant economies of scale exist, and beyond which production is characterized by diseconomies of scale.

Figure 11



CONCLUSION: IMPORTANCE TO CLASSROOM AND BOARDROOM

Opportunity cost is the fundamental concept of decision making and indeed, economic theory. The idea of avoidability has been crucial to the notion of costs presented in this paper.

Determine whether a cost is avoidable and you have determined whether it has an opportunity cost. If the cost is unavoidable, it has no opportunity cost and is therefore sunk. Because opportunity costs are the only costs that matter to economists, sunk costs must be excluded from total costs. Instructors will thereby avoid the problematic practice of adding sunk costs and opportunity costs after imploring students that only opportunity costs matter for decision making. In addition, the confusion inherent in discussing minimum average variable costs as the criterion for shutdown and as a factor in the construction of the firm supply function is also avoided. Students, instead, need only be told that production occurs so long as the firm can cover its avoidable costs. All costs that are unavoidable, and therefore sunk, are ignored in production decisions. By relying on the opportunity cost principle to construct the total cost function, students are better able to grasp the principles of production and cost theory and instructors are able to quantify these concepts starting from production to costs all within a tractable mathematical framework.

Discussing proposed revisions to well-subscribed current cost analysis, such as Wang and Yang (2001), Colander (2002) states that any revision must pass two tests to be accepted. The first test, KISS (Keep it Simple Stupid), is passed because the analysis adds no unnecessary complications and instead, simplifies and eliminates confusion. It passes the second test, CLAP (Change as Little as Possible – of the standard text), as evidenced by the fact that the 4 Rules presented herein, appear as more of a change in emphasis than of substance. In fact, a movement to simplify pedagogy exactly along these lines is clear from Principles of Microeconomics textbooks such as Cowen and Tabarroc (2010) and Frank and Bernanke (2005) who have already adopted a similar pedagogy. The changes suggested herein add to these improvements and bring greater clarity to the standard exposition of costs.

In the end, it is worth asking whether the theoretical inconsistency has had any impact on the real world. That is, do businesses that actually have money on the line confuse avoidable fixed costs with sunk costs? There is evidence that the answer is "yes". Stern Stewart & Company, a financial consultancy, created a tool known as Economic Value Added (EVA) to provide an accurate measure of a corporation's economic profits by attributing an opportunity cost to firms' capital employed by their investments. (Other consulting firms employing similar techniques include Boston Consulting Group's HOLT Value Associates, KPMG Peat Marwick, and Marakon Associates.) Their results indicate that corporations commonly treat fixed costs as if they were sunk, causing an overestimation of their profits and a misallocation of their resources. Using EVA, the company CSX found that their managers were treating their existing stock of containers and trailers as sunk costs. To resolve this problem, divisions within the firm were required to "purchase" their opportunity costs. As a result, freight volume increased by 25%, while the number of freight trailers was reduced from 18,000 to 14,000 and the locomotive fleet fell from 150 to 100. This serves as a cautionary tale. Our students today are the workers, managers, and CEOs of tomorrow. The inconsistencies we pass on to them in the classroom may extend to the boardroom and beyond.

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