Abstract: This paper shows the integration of the competitive output and input markets. Text books frequently separate the teaching of these two fundamental concepts (with several intervening chapters) to the extent that students do not easily grasp the vital interrelationships between these two markets and the representative firm. With this paper as a teaching tool, both faculty and students will have a more efficient and clearer way of teaching these concepts.

1. Introduction

When studying introductory college economics, students frequently do not grasp the workings of the input market. Toward the end of the semester, teachers may not have enough time to provide good nuanced teaching. In more instances, insufficient contrast between the input and output markets can leave students baffled about the most basic of concepts, such as what is being measured on the quantity axis in the labor market. Even fewer students have a level of comfort that permits them to integrate well the competitive input market and the competitive output market.

1 The author wishes to thank Wilson Turner and Will Damron (Davidson College ’15 and ’17) for work as research assistants, Professor Dennis Appleyard (Emeritus, of Davidson College) for his helpful comments, and two anonymous reviewers for their suggestions.
The principal reason for this omission and failing is the current teaching of these topics in introductory economics. Frequently, text books that include detailed coverage of both the competitive output market and the competitive input market separate the discussion by intervening chapters, typically on other market structures. When students reach the discussion of the input market, they are not reminded of the natural relationship, shown on the production function, that in the short-run more labor employed must correlate to more output produced, and the converse.

There is a clear dilemma. Market structures are covered over time, maybe three weeks, in a predictable order: perfect competition, followed by monopoly, then followed by other forms of imperfect competition (e.g., oligopoly or monopolistic competition). Then the labor market is considered. In few cases are direct references and analogies made between the perfectly competitive market and representative firm with output and with an input, such as unskilled labor.

Also, texts fail to define clearly the participants in the labor market, particularly on the demand side. Often students will believe that the firm’s hiring of labor constitutes all the hiring in the labor market (almost like a monopsonist) or, at best, can influence the wage rates with its own labor hiring. In a truly perfectly competitive labor market, a single firm has no ability to influence the wage rate. And, in fact, unskilled labor is likely to be hired in a range of industries, not in just one industry.

A Sampling of Leading Textbooks

In Mankiw’s 7th edition of Principles of Economics, he discusses the output market in chapter 14 and introduces the input market in chapter 18. In trying to show a linkage between the input and output markets he states in one place “When labor demand increases from D1 to D2, perhaps because of an increase in the price of the firm’s output, the equilibrium wage rises from W1 to W2 and employment increases from L1 to L2.” The statement, relating to the firm, could suggest that the firm’s hiring of labor could have a discernable effect on both wage and employment in the labor market (causing the labor demand curve to shift out). This does not represent a rigorous analysis of the firm in the output market or in the labor market. Greater care could be introduced.

In the Krugman and Wells text some greater care is implicitly given. When the output price increases, they do show the firm’s hiring of labor increasing without any impact on the wage rate.3 They do not, however, link explicitly a change in the output market (the firm’s producing more output following an increase in consumer demand) with a change in the input market (corresponding increase in the hiring of labor).

The McConnell, Brue, Flynn text discusses perfect competition in chapter 10, followed by other market structures (chapters 10-13). Chapter 14 of the text has a good explanation of the individual firm’s initial hiring of labor. They also state that changes in product price and changes in productivity will affect the demand for labor. They do not, however, close the circle within the firm.

---

by stating that there will also be an impact on the firm’s output. For instance, they write: “Other things equal, an increase in the productivity of a resource will increase the demand for the resource and a decrease in productivity will reduce the demand for the resource.” Given that the output market was discussed three chapters previous, why not remind students that it is an individual firm being considered and that there will also be a change in the firm’s output level, not just input hiring (i.e., “…an increase in the productivity of a resource will increase the firm’s demand for the resource and increase the firm’s production of output, shifting down the firm’s marginal cost curve.” Article author’s suggestion in italics).

The Baumol and Blinder text introduces the behavior of the perfectly competitive firm in the output market in chapter 10. Then following chapters on other market structures, an allocative assessment of competitive markets, externalities, and taxation, chapters 18 and 19 focus on factor markets and marginal productivity pricing. This separation is both large in chapters and large conceptually. For, the discussion centers principally on aggregate labor issues such as the “backward-bending” labor supply curve, unions, and monopsony. There is a minimal tying of the labor market to the behavior of the firm.

The Gwartney, Stroup, Sobel, and Macpherson text has three chapters on inputs: one (chapter 12) in which marginal productivity theory is explained and applied to a competitive firm’s hiring of labor (and consequent output level). As with the other texts, however, there is not a direct linkage to changes in the input market or the output market that initiate related changes in the firm’s hiring of labor and production of output. There are additionally two chapters, one relating to the labor market and one relating to investment and the capital market (chapters 13 and 14).

Two of the leading Essentials books (Bade and Parkin, and Hubbard and O’Brien) do not even have a chapter on the labor market in which there is a discussion of the marginal revenue product of labor and its role in hiring labor to produce output. (6) This paper could be viewed as both a necessary and excellent supplement for students who are using an Essentials book.

Not one of the five full texts reviewed, despite—in some cases—devoting considerable attention to resource markets, had a clear and concise section showing a simultaneous interaction of the input and output decisions by a perfectly competitive firm. For that reason, this paper should make a clear contribution to the teaching of the relationship and interaction of the input and output decisions by the firm, both for students who have an unabridged introductory economics text or an Essentials text.

---

Plan of Work

This paper, will show faculty and, hopefully students, how to integrate correctly the output and the input markets, respecting the assumptions that economists make about competitive markets. The student of introductory economics should be able to grasp the logic shown below. Students need not wait until intermediate microeconomic theory or labor economics to study this basic theoretical integration.

Section II of this paper will review quickly the competitive output market, using side-by-side graphs of the industry or the market and the individual or representative firm. Section III will introduce the basic theory of the input market, including graphs of the entire market for unskilled labor and the representative firm’s hiring of unskilled labor.

Finally, Section IV will integrate the input and the output markets with some examples of how changes in exogenous parameters, such as the demand for the output or the supply of labor, have effects on the firm’s production of output and short-run hiring of labor. The paper concludes with a section (V) on additional teaching challenges or complications.

The principal contribution of this paper to teaching is the integration of both the input and the output markets in a simple but effective way, allowing students to test rigorously their understanding of these important microeconomic concepts. Using this paper as a teaching tool should increase the effectiveness and efficiency with which these important topics are explained. This work can be used either as a complement to the textbook treatment of these issues or as a substitute for those concentrating on competitive markets.

2. The Competitive Output Market

In this competitive output market (Figure II-A), assume we have many apparel firms producing t-shirts, located in all sections of a country (for instance in each of the states of the United States). The representative firm shown in Figure II-B is located in one of these locales—call it Norta. The many firms produce an identical basic white t-shirt, assumed to be a normal good. Thus, with many small firms, easy entry and exit, and a homogenous product, we can assume that the output market approaches the perfectly competitive model.

Since most students tend to grasp the workings of the competitive output market, the following explanation of the “four curves” in the two graphs will be brief.

Output Market for the Industry:

1. The demand for output (t-shirts) is downward sloping. Since it is a normal good, the income and substitution effects of an output price decrease reinforce each other, leading to a greater quantity demanded in the market.
2. The short-run output supply curve is upward sloping. It is constructed by summing horizontally the rising portion of each firm’s short-run marginal cost curve, above the intersection with average variable cost. The upward slope shows that with a higher output price, existing profit-maximizing firms (no new firms in the short run) will use more labor (assumed to be the variable input) to produce more output.
The intersection of the market or industry demand and supply will lead to an equilibrium market price for t-shirts ($5.00 per t-shirt in this example) and equilibrium market quantity. See Figure II –A below.

Representative Firm’s Output Decision:

1. As a price taker, the representative firm faces a perfectly elastic (horizontal) demand curve. The firm is able to sell no output above the competitive price and has no incentive to sell output below the competitive price. With a perfectly elastic demand curve, Price (P) = Average Revenue (AR) = Marginal Revenue (MR).

2. The individual profit maximizing firm’s supply decision can be shown by using the rising portion of the short-run marginal cost curve above the intersection with average variable cost.

Using the current competitive output price, this profit-maximizing firm produces where P = MR equals MC. See in Figure II – B below. The firm will earn economic profit as long as P or AR is above Average Total Cost (ATC).

3. The Competitive Input Market

The competitive input market requires additional explanation. Our labor market is in a defined geographic locality, say Norta, as above. On the horizontal axis is quantity of unskilled labor in total hours used in all industries in Norta. So, a very small number of the unskilled labor are employed by the one apparel firm (described above) in Norta. Other unskilled labor are employed in factories producing other goods or in service industries, like health care or education. The vertical axis shows the per hour price or wage for unskilled labor. A perfectly competitive input market is assumed. This means that there are many small buyers.
(demanders) of labor, such as the many small firms in Norta, and many individual sellers (suppliers) of labor. We assume that these unskilled workers bring identical characteristics (e.g., education, workplace experience, attitudes and aspirations) to the labor market. Thus, unskilled units of labor can be considered “standard” or homogeneous, just as we assume about units of output in the perfectly competitive output market.

Labor Market for the Geographic Area:

The demand for unskilled labor by all the firms in Norta is downward sloping. At higher wages, firms wish to employ fewer units of labor. The decrease in the quantity demanded of labor when the wage rises is motivated by two principal factors. The first, both in the short-run (when wages vary but other factors influencing the use of labor by firms such as worker skills, and available technology or plant and equipment are fixed) and the long-run (when these other factors are variable), is a desire to produce less output, as the price of an input price increases (the output effect shown by an increase in the firm’s short-run marginal cost).

The second, more relevant in the long-run, is a desire to substitute other inputs for labor, the price of which has relatively increased in this example (the substitution effect can be shown by the output cost-minimizing formula of equating marginal product per input price for each input). For instance, we have seen groceries stores, in checking-out customers, substitute machinery (automatic scanners for unskilled labor), as the relative price of labor to price of capital seems to have risen.

The supply of unskilled labor is upward sloping. At higher wage rates we assume that individuals will work more hours, given that the opportunity cost of leisure has increased. [More formally, we argue that the substitution effect of the wage increase (more labor and less leisure) will be stronger than the income effect of the wage increase (additional leisure, as leisure is presumed to be a normal good). Also, some individuals who are not labor force participants at the lower wage will enter the labor market and seek employment at a higher per hour wage rate.

Representative Firm’s Labor Hiring Decision:

The representative firm in Norta, our apparel firm producing t-shirts, will have both a demand for and supply of labor that jointly determine the quantity of labor hired by the firm.

The supply of labor to the firm is perfectly elastic at the prevailing wage. The firm in the input market is a wage taker. The firm can hire all the labor it wishes at the equilibrium wage. As a very small employer within the geographic area, it can hire all the labor it wishes at the prevailing wage, negating any need to increase the wage to hire more people. It can hire no units of labor at a wage below the prevailing wage. All workers can find employment at the prevailing wage and need not work for any lower wage. To argue that the firm would increase the wage to hire a more productive worker has a logic, of course; however, in that case the labor market is no longer perfectly competitive with homogeneous units of labor. Thus, for the firm Wage (w) or Price of Labor is equal to the Average Cost per unit of labor and is equal to the Marginal Factor Cost of Labor (MFC) or Marginal Resource Cost of Labor (MRC). The MFC or MRC is defined as the additional cost of an additional unit of input, labor in this example.
The most complicated explanation for the student requires introducing the concept of the marginal revenue product of labor (more correctly called the value of marginal product of labor, VMP\(_L\), when the output market is competitive); this measure embodies the marginal contribution to revenue made by a unit of labor. The marginal revenue product of labor is determined by the amount of extra output produced by a unit of labor and the value of that output, measured by the price of output in a competitive output market. A student should understand intuitively that a unit of labor is more valuable to a firm as the laborer produces more output per hour for the firm (higher marginal product of labor per hour) and that the output is more valued (higher price of output).

Thus, the MRP\(_L\) (or VMP\(_L\)) = MP\(_L\) \times P\(_Q\).

Students should recall the short-run production function that links units of labor to output, for a given capital stock. From that function, the marginal product of labor in units of output, t-shirts for instance, can be calculated. From the marginal product of labor, the transformation to the marginal revenue product of labor is quite simple. It is the MP\(_L\) \times the Price of output (P\(_Q\) in a competitive market), perhaps $5.00 per t-shirt, from the output market of Section II.

For instance,

<table>
<thead>
<tr>
<th>Labor (hours)</th>
<th>Quantity of Output</th>
<th>Marginal Product of Labor</th>
<th>Marginal revenue Product of Labor</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>5</td>
<td>5</td>
<td>$25 ($5 \times 5)</td>
</tr>
<tr>
<td>2</td>
<td>11</td>
<td>6</td>
<td>$30 ($5 \times 6)</td>
</tr>
<tr>
<td>3</td>
<td>16</td>
<td>5</td>
<td>$25 ($5 \times 5)</td>
</tr>
<tr>
<td>4</td>
<td>20</td>
<td>4</td>
<td>$20 ($5 \times 4)</td>
</tr>
<tr>
<td>5</td>
<td>23</td>
<td>3</td>
<td>$15 ($5 \times 3)</td>
</tr>
<tr>
<td>6</td>
<td>25</td>
<td>2</td>
<td>$10 ($5 \times 2)</td>
</tr>
<tr>
<td>7</td>
<td>26</td>
<td>1</td>
<td>$5 ($5 \times 1)</td>
</tr>
</tbody>
</table>
This production function has increasing returns through two units of labor, then diminishing returns, consistent with the law of diminishing returns. It is critical that the student understand the meaning of the marginal revenue product of labor. This table shows that the first unit of labor will add five t-shirts to production, each of which can be sold in a competitive market for $5.00; thus the marginal contribution to revenue or the marginal revenue product of the first unit of labor is $25. Each of the others can be explained in an analogous manner.

Now, if the price per hour of labor or the wage rate is $10.00, this firm will hire six units of labor to maximize economic profit. Each unit of labor until the 6th contributes $10 or more to revenue, increasing the firm’s profit; thus, we assume that the firm will hire each of the first six units. The seventh unit of labor adds $5 of additional revenue but would cost the firm $10. The firm will not hire the 7th unit of labor, as profit would decrease by $5.00 from hiring that unit of labor.

In essence, the decreasing portion of the marginal revenue product of labor becomes the firm’s demand curve for labor. More accurately, it is the decreasing portion of the marginal revenue product of labor below the intersection with the average revenue product of labor. At any wage rate above the maximum of the average product of labor, the firm would shut down, as Total Variable Cost would exceed Total Revenue (or from the output perspective Average Variable Cost > Price).

The graph below, Figure III–A, shows a competitive labor market with an equilibrium wage of $10.00 per hour. Beside the labor market graph is the competitive apparel firm (producing t-shirts), showing its hiring of labor where the wage rate or supply of labor (perfectly elastic at $10.00 per hour) equals the marginal revenue product of labor, with six units of labor hired in this example. In other words, the profit-maximizing firm is hiring labor where the Marginal Factor Cost of labor (labor supply to the firm) equals the Marginal Revenue Product of labor (the firm’s labor demand).
4. Comparative Statics

Using three hypothetical changes we can illustrate the integration of the output and the input market. Each of these changes: a change in the price of output, a change in the wage rate or the price of the input, or a change in marginal productivity of labor will alter the firm’s hiring of labor.

1. An Increase in the Demand for T-shirts

As a result of a change in tastes towards t-shirts, assume that the market demand for t-shirts increases. Intuitively, we should assume that the short-run market price of t-shirts will increase, the quantity of t-shirts sold in the market will increase, and our representative firm will produce more t-shirts employing more labor, the variable input. In the short-run there can be no increase in the use of capital, the fixed input, or in the number of firms. Changes in the amount of capital or in the number of firms can only occur in the long run.

The four graphs below, two for the output market and two for the input market show these intuitive results.

In the output market below, we see the demand for output increases, leading to a higher equilibrium market price and quantity. The demand facing the individual firm shifts up with the higher price and continues to be horizontal or perfectly elastic. The new intersection of MR and MC (for output) has the representative firm producing more output, moving from q₀ to q₁. The increase in the market level of output represents the additional output (t-shirts) produced by all existing firms who benefit from the increased output price.

In the labor market, the individual firm’s marginal revenue product of labor increases or shifts to the right. Since the MRP₁ is the MP₁ x Pq, the higher price of t-shirts—up from $5 per t-shirt—means that each unit of labor, while contributing the same extra output in t-shirts, now has a higher incremental value to the firm with t-shirts selling for a higher price. For a given price of labor, or horizontal labor supply, the firm will increase its hiring of labor from l₀ to l₁.

Now, in the labor market there is no perceptible change. There is no reason that the market supply of labor will shift. Given that the labor market encompasses all demands for unskilled labor and only this apparel firm increased its hiring of labor, then there is an imperceptible increase in the demand for labor. The equilibrium price of labor does not change. As an example, consider the labor market in Norta. If there is only one apparel firm in this area, then the firm’s additional hiring of labor will have no perceptible effect on the overall demand for unskilled labor in Norta. These changes are shown in Figures IV-1: A, B, C, and D.

[Additionally, there could be an offsetting reduction in the demand for labor by others firms producing goods for which there has been a negative change in tastes (i.e., change in tastes away from these goods).]

Recall the other apparel firms are located throughout the country in many different labor markets. Each will be hiring an incremental amount of labor in its own labor market. However, no labor market must have a perceptible increase in the demand for labor. Were there to be a perceptible increase in the demand for labor and increase in the market wage rate, then the supply of t-shirts in the output market would decrease or shift left and there would be an additional increase in the price of t-shirts. The marginal factor cost of labor to the
firm would shift up and there would be an offsetting reduction in labor hiring. The simple interaction between the output market and the input market would no longer exist. There would be a more complicated, simultaneous interaction with both the price of output and the price of labor changing.

2. A Decrease in the Supply of Labor in one Labor Market

Here, begin in the market for unskilled labor. With an increase in retirements or departures from the local labor market (only in Norta), the labor supply curve decreases or shifts to the left. The equilibrium wage rate increases and the equilibrium quantity of labor decreases. (Figure IV-2:C) Take the new higher wage (the perfectly elastic labor supply to the firm or the marginal factor cost of labor) over to the firm graph; with the higher wage, the firm will reduce its hiring of labor. (Figure IV-2:D) With this higher wage rate, all firms in Norta or this geographic area, regardless of what they are producing, hire less labor, as reflected in a reduction in the quantity demanded of labor.
If the firm hires less labor, it should be producing less output. How do we show that in the output graph for the representative firm? Recall that the marginal cost of output is equal to \( P_l \) (or the price of the variable input)/\( MP_L \). With an increase in the price of labor, the marginal cost of producing the output increases. With an upward shift of marginal cost, then at a given output price or given marginal revenue (of output), the firm will produce less output. (Figure IV-2:B) Thus, following the reduction in the supply of labor and the increase in the local wage rate, the firm will hire less labor and will produce less output.

With this firm producing less output, does the supply of output or the supply of t-shirts shift in and increase the price of t-shirts? In this case the reduction in the supply of t-shirts is imperceptible and there is no change in the price of t-shirts. (Figure IV-2:A) Remember there are many firms producing t-shirts throughout the country; if the wage rate increases only in this one locality (Norta) then just this one firm will have an increase in its wage rate, decrease in its hiring of labor and resulting decrease in production of output (t-shirts). Thus, there is no visible effect on the supply of output. Now, if all firms had experienced an increase in the cost of labor and if all firms had reduced output levels, then the supply of output would fall, with a corresponding increase in the market price of output.
3. An Increase in the Marginal Product of Labor

Assume that our firm increases its stock of capital or initiates a reorganization of its labor force. In each case there will be an increase in the marginal physical product of labor. For a given price of output, the increase in the marginal product of labor will increase or shift out the marginal revenue product of labor. The firm, for a given input price will now hire more labor and should produce more output. (Figure IV-3: D) The firm will indeed produce more output, as the marginal cost of output will fall. Recall the marginal cost is $P\,\text{labor}/MP_L$; with an increase in the marginal product of labor, there is a decrease in the marginal cost of output. For a given price of output or marginal revenue of output, the firm will produce more output where $MR = MC$. (Figure IV-3:B)

Assuming that this firm alone has the productivity gain, there is an imperceptible increase in the demand for labor, keeping the wage rate the same; there is also an imperceptible increase in the supply of output, keeping the output price the same. Thus, there
are no changes in either the output market (Figure IV-3:A) or the input (labor) market (Figure IV-3:C).

5. Additional Complications

A principal complication in this analysis would be the possible secondary impact from a change in the wage rate or the price of labor following an increase in the demand for t-shirts and corresponding increase in the price of t-shirts. Recall that the firm produces more t-shirts and hires more labor. The analysis had an imperceptible increase in the demand for labor and an unchanged wage rate.

Were there many producers of t-shirts in the same area (e.g., Norta) and should the increase in labor hiring represent a perceptible increase in the demand for labor, then the wage rate would increase. There would then be an increase in marginal cost for firms and then a corresponding reduction in the supply of output, somewhat offsetting the increased output from the original increase in demand. Also, the firm’s increase in the hiring of labor would be somewhat offset by the increased wage rate.

Equivalently, following the decrease in the supply of labor and the increase in the wage rate, the firm produced fewer t-shirts; but with an imperceptible impact on the supply of t-shirts. Had many firms experienced a higher wage rates and produced fewer t-shirts, then the supply of t-shirts would have perceptively decreased, resulting in a higher price of t-shirts, necessitating an additional iteration of output and labor changes.

For the student in introductory economics, these are more complicated scenarios that do not add to a basic understanding of the labor market and the integration with the output market.

6. Conclusion

Far too few students of introductory economics grasp the importance of the interaction between the input and the output market. The current teaching of these concepts encourages separation and not integration. Frequently, as shown in the introduction, these concepts are taught very individually and in text book chapters that are spaced far apart. When the student reaches the input market chapter, it is as though previous chapters on productivity, cost, and competitive price and output determination are long in the past and no longer relevant.

This brief lesson effectively links the output and input market in a clear and time-efficient manner. The analysis should aid students in understanding i) the input market and firm’s hiring of an input, ii) the integration of the input market and the output market, and iii) the importance of clearly defining the boundaries and number of participants, particularly firms in this case, in both the relevant output and input markets.

Understanding this relationship is critical not only to understand well microeconomics but as a critical building block for macroeconomic analysis and policy discussions relating to unemployment. Moreover, within the introductory course, itself, this analysis provides a vital test to students to determine if they understand the most important basic concepts of a competitive output and competitive input market.
References


