Principles of Microeconomics : Chapter 4
Input Markets and Market Equilibria

I. Review: Consumer Tastes and Income

Final goods markets exist because individuals have demands for various goods and services, which means (1) that individuals have the income or credit necessary to pay for them and (2) believe that purchasing some products or services will improve their lives in some way. The term "tastes" is often used by economists to describe the underlying desire for some goods and services. The term "tastes" doesn't really capture the full range of desires that consumers believe goods and services may satisfy or advance, but it is a neutral enough term to convey the idea that individuals may have different "tastes" or "preferences" and that no person's tastes or preferences are privileged—e.g. necessarily better or more important than another's.

Tastes and Income Determine Marginal Benefits

In addition, it provides a basis for understanding that marginal benefits (the highest price that one is willing to pay for successive units of a good) are partly determined by tastes and partly by income. The stronger the preference that one has for a particular good or service the higher are its marginal benefits—other things being equal. And the higher one's wealth or income is, the higher the price that one is willing to pay for successive units of a good tends to be. Together tastes and income largely determine one's marginal benefit curve for all the goods that might be purchased in a market and for many others that cannot be purchased.

One's income is thus an important factor in determining one's marginal benefit curves and thereby the demands for goods that has at a point in time and through time. An increase in one's personal income affects their demand—partly by increase marginal benefit curves and thereby broadening the range of goods that one is likely to purchase.

You will all—hopefully—have more income after you complete your college degree and take a job. That higher income will allow you to pay a higher price for successive units of goods that you desire—including such things as larger apartments, newer cars, more travel, more elaborate clothing, and so on. You will still have to economize—but will do so over a broader range of possibilities. (Those of you who go on to intermediate microeconomics will learn utility-maximizing models of consumer choice that show more clearly why the range of possibilities increases with income.)

What Is Income?

For the most part, income in a commercial society is what you receive for services that you sell to other individuals directly or to economic organizations that value your services. Labor services include services that you may directly provide with body, senses, mind, and education. The latter, acquired skills, are often referred to as human capital or skilled labor by economists. Economic organizations "demand" various labor services because they help it produce other goods and services that generate profits for its owners.

Most people sell their labor services to economic organizations and realize most of their income from their wages. Thus labor markets are one of the most important markets for inputs.

If one inherits some wealth or saves and invest over the course of one's life, the service that you sell might also include rental appartements, interests on loans that you make with your financial assets (if you have inherited some or accumulated some by saving). If one inherits, founds, or creates a firm that sell intermediate goods to firms producing final goods, your profits or share of the profits are also part of your income. And, if one owns or owns share in a final goods producing firm, your share of the profits are also part of your income.

In the last case, one is not necessarily selling productive services or inputs that contribute to the output of final goods and services, but in all the other cases, one's income can be regarded as based on sales of inputs. It is such cases that account for most of the income earned in a commercial society, and it is the one focused on in this chapter.

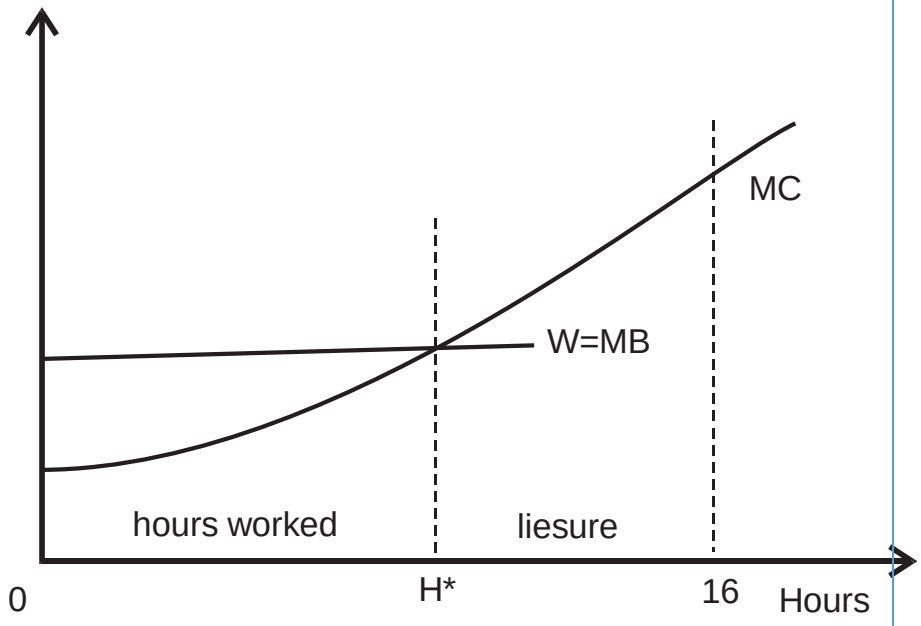
That is to say, individuals in commercial societies acquire most of their income by (1) "hiring themselves out for wages" and (2) selling other inputs into specific processes for producing the "final goods" sold to consumers in the markets focused on in the previous chapters.

In this chapter, we'll analyze both the supply and demand for labor and/or other inputs. We'll also analyze how input markets affect output markets and vice versa. It is such linkages that create much of the network of exchange and production in today's global markets.

II. Opportunity Cost and the Supply of Labor

Scarcity implies that most activities have "opportunity costs." That is to say, when one uses something (as with your time and attention) for one thing (studying economics) you have sacrifices other possible uses for your time (studying calculus or playing video games, hanging out with friends, or taking a nap). A net-benefit maximizing individual will use his or her time for the highest valued use. The second most valuable use is said to be your "opportunity cost." You sacrifice the marginal benefits associated with your second most valuable use of your time in order to realize the marginal benefits of your highest valued use of your time (at least at the "margin"—you might do a bit of both). Figure 4.1 illustrates a net benefit maximizing decision between labor and leisure.

Figurer 4.1 MC and Work Decisions



The marginal cost of labor (hours worked) is generated by referring to a marginal benefits from leisure curve (which is not shown). The idea is that diminishing marginal benefits implies that the last hour of leisure is less valuable than the second to last, which is less valuable than the third to last and so on. Thus, the marginal opportunity cost of hours spent working for money (at wage rate w) is an upward sloping curve reflecting the diminishing marginal benefits (or utility) of leisure.

One works the number of hours where the marginal benefit from additional income, which is represented as a horizontal line equal to the hourly wage—although it could be argued that it should be a downward sloping line (explain why?). As a result, this individual works H* hours and uses the remainder of his or her day for leisure (depicted as 16-H* in figure 4.1).

Deriving and Individual's Supply of Labor Curve

To derive an individual's supply of labor curve, one determines how much labor he or she will supply at different wage rates. To do so, one chooses a wage rate (w) and finds the associated net-benefit maximizing number of hours worked (H*). This process is repeated until the supply curve is traced out. (Normally just a few wage rates are tried, the resulting w, H points plotted, and the rest is interpolated, as in chapter 2's derivation of individual supply and demand curves.)

Notice that if the marginal opportunity cost is upward sloping, then the individual's supply of labor curve will go through exactly the same points as that curve—although the supply curve will be a mapping from wage rates (the vertical axis) into labor hours (the horizontal axis) rather than from the horizontal axis (hours worked) into the vertical axis (marginal opportunity cost of hours worked in $/hour).

Thus, supply functions of labor tend to be upward sloping in wages just as supply curves for final goods tend to be upward sloping in prices.

The relevant wage rate is the highest in "real" terms that the individual may obtain for his or her skills and talents, where the real wage includes both the money wage and the job satisfaction associated with alternative jobs for which he or she is qualified (e.g. has the skills and talents that employers seek for specific types of jobs within their organization. Notice, that this implies that the typical persons works just one type of job. It also implies—in most cases—that he or she has specialized by acquiring a specific combination of skills, talent, and other traits that employers find useful such as diligence and honesty.

Labor is far more specialized today than it was 200 years ago, so there are many more types of labor (combinations of skills, talents, and traits sought) today than there were back then. However, this specialization is not complete. If the wage rate for one's combination of skills talents and traits declines, one may look for other types of jobs that require somewhat different combination of skill, talent and traits that one also possesses, or "retool" by acquiring additional or different skills that make one eligible for other types of jobs and careers.

Deriving a Market Supply Curve for Labor

To derive the market supply for a particular type of labor (e.g. for persons with particular combinations of talents and skills), first identify all the persons with the required skills. Then repeat the process undertaken to derive supply curves in chapter 2. (1) Choose a wage rate and find out how many hours all the persons of interest are willing to work at that wage rage. (2) Add up those numbers of hours and plot the wage rate and total number of hours on a separate diagram. (3) Repeat these steps with different wage rates to trace out the market supply of the type of labor that you are interested in.

Since each individual's supply curve tends to be upward sloping, the market supply does as well.

The logic of suppling other inputs to the market's network(s) of production is fundamentally similar to that for labor, although the MC curve may be less induced by an opportunity cost and more by production, harvesting, and transport costs than tends to be the case for labor markets. (Of course, skills are often produced in ways that require money expenditures and other opportunity costs. They are rarely free. Even apprentices "pay" to acquire their skill sets by taking lower wages during their apprenticeships than they could be earning elsewhere.)

III. The Demand for Inputs

Firms demand inputs because they need them into order to produce goods in services demanded by consumers (and other firms in the case of producers of "intermediate goods"). Firm owners may have various reasons for engaging in production—they may enjoy bringing products to market, they may enjoy running their companies, they may take pride in providing consumers with useful goods that they either need or enjoy. However, all firm owners share an interest in realizing profits from their production. This provides their own livelihood (income) and also provides the firm with the resources that it needs to grow (both directly through "savings" and indirectly by generating greater lines of credit).

Thus, the simplest model of firm behavior is that firms are profit maximizers, as assumed in chapter 2. Even though many owners have other interests as well, maximizing profits is a goal shared to a large degree by all firm owners.

This implies that firms will employ the profit-maximizing combination of inputs—given their expectations about prices of their outputs, their prices for inputs, and the productivity of their inputs. It also implies that firms will not hire workers or use other inputs unless they "earn their keep," unless they produce more revenue than they cost.

Marginal Product and Marginal Revenue Product

Every input of interest adds to the output of final goods created by a firm. The increase in the firm's output of final goods (or other goods sold in markets for intermediate goods) is called the input's "**total product**." The increase in final output generated by a "one unit" increase in an input is called its "**marginal product**," which is denoted in this course as MP. Most production processes are subject to "diminishing marginal returns," which means that most inputs have marginal product

curves (or marginal product function, MP(Q)) that decline with their usage.

The logic behind this assumption is similar to that used for declining marginal benefits for consumers. Each firm uses the first unit of an input for its most productive purpose, the second unit for the second most productive purpose, and the third for the third most productive purpose, and so on. This process generally implies that marginal product curves are downward sloping just like marginal benefit curves for consumers.

(There are exceptions to this rule, but we'll stick with the "normal" cases for the most part in this course, because as commonplace cases, they are the most likely to be encountered by all but the largest firms.)

Illustration: Production of Doughnuts

Table 4.1: A Production Function and MRP

Quantity of Labor	Quantity of Output	Marginal Product	Marginal Revenue Product
0	0	0	(assume P = 10)
1	20	20-0= 20	20P=20(10)=200
2	38	38-20=18	18P=18(P)=180
3	54	54-38=16	16P=16(10)=160
4	66	66-54=12	12P=12(10)=120
5	76	76-66=10	10P=10(10)=100
6	84	84-76=8	8P=8(10)=80

The first two columns of Table 4.1 characterize a simple 1-input "production function." A production function simply maps various combinations of inputs in the outputs that can be produced via a given technology. Here there is just one input, so increasing output always requires additional units of that input. If the input is labor, the first and second columns show how much output (column 2) is produced by efficiently using 1, 2, 3, … 6 units of labor (from column 1). Although 1-input production methods are pretty rare—they allow us to show how two other ideas—marginal product and marginal revenue product---affect a firm's demand for inputs.

(One does not have to assume that there is just one input to construct such a table like Table 4.1. One can also do so by holding all other inputs constant and "adding" the input of interest to the mix of available inputs which jointly determine total output in the second column. The one input production process just makes its total, marginal product, and marginal revenue product more obvious.)

Marginal product is the change in total produce (total output) generated by a one unit change in the input of interest (here labor). Column 2 shows how this is calculated. You just take the total output associated with a particular quantity of the input (say 3, which would be 54 units of output (as with 54 dozen doughnuts) and subtract from that output the output realized without the last unit of that input (e.g. the output of 2 units of the input, 38). So the marginal product of the third unit of labor is 54-38=16. The same process is used to calculate all of the marginal products of labor in column 3.

Firms, of course, want to produce output to sell, but what is most important is the revenue generated by that output. A particular unit of an input is worth employing only if it generates more revenue than it costs to employ (and therefore is profitable to employ). To determine how much revenue is generated by each successive unit of an input, one just multiplies its marginal product by price—this is called an input's **marginal revenue product**. The last column of Table 4.1 computes the marginal revenue product of successive units of labor. It does so by assuming that the market price of the output produced is $10/unit.

One can create a graph of a marginal revenue product curve by using inputs as the horizontal axis and marginal revenue product as the vertical axis. Simply plot each of the points characterized by columns 1 and 4 to do so.[1]

Marginal Revenue Product Curves and the Demand for Inputs

An input's productivity is determined by its marginal product curve. The higher that curve is, the more output is produced by the input of interest. As above, the marginal benefit of an input is the revenue that it directly or indirectly generates for the firm. If one multiplies marginal product by the prevailing market price of the firm's output, the result is an input's **marginal revenue product (MRP(Q) = MP(Q)*P)**.

A marginal revenue product curve describes how much a firm's revenue increases as it uses more and more of the input of interest, as for example more and more of a particular type of labor or a particular type of machine. Every useful input has both a marginal product curve and a marginal revenue product curve associated with it. (Areas under the curve correspond to the revenue generated by a particular range of inputs or all of that input. If one calculates the area under a MRP curve from 0 to L, one gets the total revenue that is produced by L units of the input of interest.)

A firm's marginal revenue product curve for an input is the basis of its demand for inputs. Figure 4.2 illustrates how MRP curve can be used to make decisions about hiring a particular type of labor. The marginal revenue product curve is the downward sloping line. The marginal cost of labor is its wage rate, which is determined by the market

[1] Technically, these **point**s are the actual marginal revenue product "curve" if only whole units of the input can be used. To get a "curve" that you can take areas under requires more work and a bit more math. (Don't worry about this footnote too much if it seems unclear to you.)

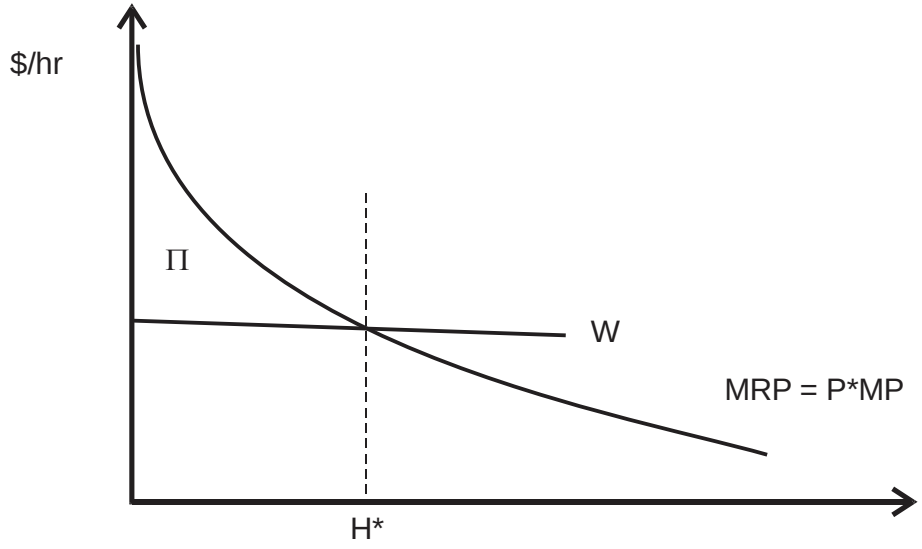
A marginal product curve, unfortunately, **cannot** be constructed by simply connecting the points up for cases in which fractions of a unit of inputs can be used. Instead, one should construct another table with different fractions of the input being employed (which in a sense just changes the units of measure, say from hour to minutes of labor). This would give you a series of numbers for the MPR of labor in terms of minutes with a lot more points over the 6 hours of the first figure (and generally smaller numbers).

As one reduces the unit size (say to seconds) one gets more and more points and they are closer together and begin to resemble a curve. That curve, in the limit, would be an exact marginal revenue product curve—as oppose to an exact series of points that exactly characterize marginal revenue product.

To get a perfectly accurate MRP curve, the best way is to use Calculus. If one can write down a production function mathematically as a function(for example, $Q = aL^b$), then **marginal product** is just the first derivatives of the production function with respect to the input of interest $dQ/dL = abL^{b-1}$. And, **marginal revenue product** is just P times the marginal product function ($MRP = PabL^{b-1}$).

equilibrium for this particular type of labor. **Every unit of labor that has a marginal revenue product larger than its marginal cost is profitable for the firm and so will be employed.** In this case, the quantity of labor employed (in man hours) sets its marginal cost (here the equal to the market wage rate) equal to its marginal revenue from the input (here equal to the marginal revenue product of the input).

Figurer 4.2 MRP and Hiring Decisions



Deriving a Firm's Demand for Labor

To derive a firm's demand curve for an input such as a particular type of labor. First, determine the firm's marginal revenue product curve for that input. Second pick a price or wage rate for that input. Third, find the profit maximizing quantity of labor to hire at the wage rate or price. Third, plot the wage rate or price and the quantity of labor or another input that is employed at that wage or price. Fourth, repeat with another wage rate or price until the demand curve for the input of interest is traced out.

Notice that i**f the MRP curve is downward sloping, the firms demand curve for the input of interest (here labor) will include all the points on the firm's marginal revenue product curve**, although as before the direction of the function is opposite that of the marginal revenue product curve. The demand curve goes from input prices into quantities employed whereas the marginal revenue product curve goes from employment levels (quantities) into revenue per unit of the input of interest.

Notice also, that some inputs may be too expensive to employ, ether because market prices for the input are too high or because its marginal product is too low or because prices of the final good to be sold are too low. **Only units of labor and other inputs that are profitable fore the firm are employed.**

Employees and other inputs have to "earn their keep," which is to say they must be profitable to employ otherwise the firm will go out of business as often happens for new firms.

Deriving a Market Demand for an Input from Firm Demand Curves

Like other market demand curves, the market demand for an input is the sum of many different demand curves—here the demand curves of all firms that make use of the input of interest.

The market demand for a particular type of labor or particular type of input is determined more or less in the same way as other market demand curves. Geometrically one does this by (1) choosing a price for the input of interest, (2) finding the quantities of that input that would be demanded by each firm from its input demand curve, (3) adding those quantities up, (4) plotting the price and the total quantity demanded (employed), then (5) repeating with other prices until the market demand curve is traced out.

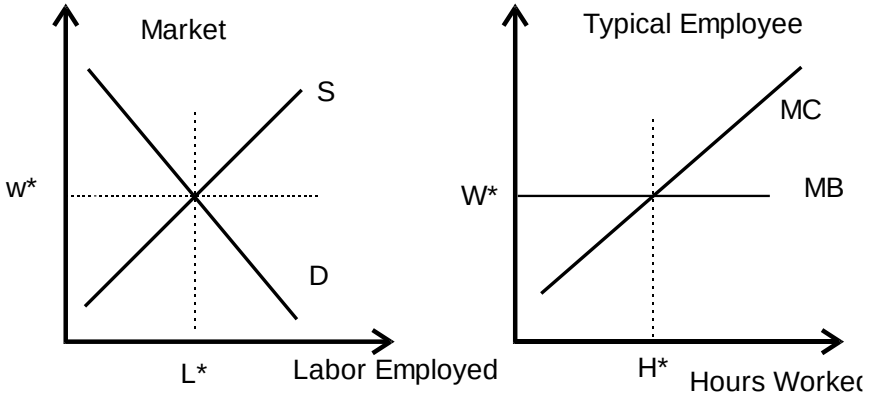
Since each firm's demand for inputs tends to be downward sloping, market demand curves for inputs also are downward sloping—just as demand for consumer goods are—but for some different reasons. It is because, at the margin, there are diminishing returns from using every input at the level of the firm.

Demands for input change as market prices for final goods change and whenever technology changes, and in some cases because of regulations that firms have to satisfy. All such changes affect MRP, ether through effects on P (sales price of the firm's output) or through effects on MP (marginal product).

IV. Equilibrium Prices in Input Markets

The equilibrium employment rates of inputs sold in reasonably competitive markets can be characterized with the supply and demand curves developed above. Figure 4.3 illustrates such an equilibrium for a labor market.

Figure 4.3 Equilibrium Wage Rates



From our derivations, we know that the market demand for each type of labor is downward sloping reflecting the downward marginal revenue product curves associated with inputs subject to diminishing marginal returns. We also know that the supply curve for each type of labor is upward sloping reflecting the upward sloping marginal opportunity cost of hours spent hiring oneself out for wages (and the opportunity cost of acquiring various types of skills valued by markets).

Thus, the demand and supply curves have the usual shapes. The areas under those curves can be used to characterize the net benefits of labor suppliers and purchasers of labor in the usual way. Both curves are again based on the net benefits that individual suppliers of inputs (such as labor) and individual purchasers of inputs (such as employees) realize at the market equilibrium. For a labor market, the net benefits of workers is the profit area of the diagram. The profits realized by employers (the buyers) is the usual consumer surplus areas—although that area now represents profits.

As in final goods markets, **prices affect the behavior of both sides of every input market**. In labor markets, the wage that emerges affects both each worker's supply decisions and also each firm's employment decisions.

V. Simultaneous Equilibria in Output and Input Markets

We are now in a position to illustrate how equilibrium market prices coordinate the decisions of firms, input sellers, and consumers in final goods markets simultaneously. We are also in position to analyze how changes in market conditions in either the input or final goods markets affect the others.

To fully characterize even a relatively simple equilibrium between the input and output markets requires six diagrams. One market diagram for each level, plus two diagrams representing supplier and demander interests at each level. Figures 4.4a and 4.4b below illustrate such an equilibrium. **Notice that every supplier and demander is in equilibrium at the same time that the overall markets are. They have all maximized their own net benefits given the prices that the face.**

The output price affects the demand for inputs by affecting the marginal revenue product curve for each firm in the relevant input market, and therefore affects the location of the input demand curve in the relevant input market (here a labor market). The price of the input, here wage rates, affects the marginal production cost of all firms in the relevant output market(s) and thereby the location of the market supply curve for the output of interest (and every other output market in which such inputs are used).

Thus, any change in conditions that affects input prices or final goods prices will tend to cause adjustments by consumers, firms, and input providers in both markets. In this way, input and output prices do a lot of the work to assure that decisions of consumers, firms, and input providers are consistent with one another—they are all the ones that produce the equilibrium outcomes (supply equal demand) in all the markets connected.

Comparative Statics in Market Systems

Comparative statics in these systems are often complicated to draw, because so many effects have to be taken into account. But, lets consider a relatively simple "shock" to the equilibrium depicted in Figures 4.4a and 4.4b.

Suppose that the demand for the final good increases because consumer income increases or because the price of a substitute increases. Such changes cause the price of the final good to rise, which in turn causes the marginal revenue product curves for each of the firms in that market to increase, which in turn increases the demand for all inputs, here labor, out which tends to increase input prices—at least a bit—which in turn increases the quantity of labor and other inputs supplied to firms.

These cost effects in turn affect the supply curve in the final goods market by raising marginal costs a bit, which is an effect that we've not

considered before, because we've assumed that the final goods producers are a tiny part of the demand for inputs. In such cases, supply is unaffected by shifts and demand because input prices are hardly affected if at all. However, if the producers of the final goods are important users of some of their inputs, then price affects may be significant and supply curves will also be affected by shifts in demand because of indirect effects on input prices.

If the output market is "small" such effects may be so small that they can be ignored, but if the industry of interest is a relatively large employer, then the effect of an increase in demand for particular inputs on input prices should be taken into account.

(Graphically depicting these effects is left as an exercise for the students and other readers.)

Figure 4.4a Equilibrium in an Input Market

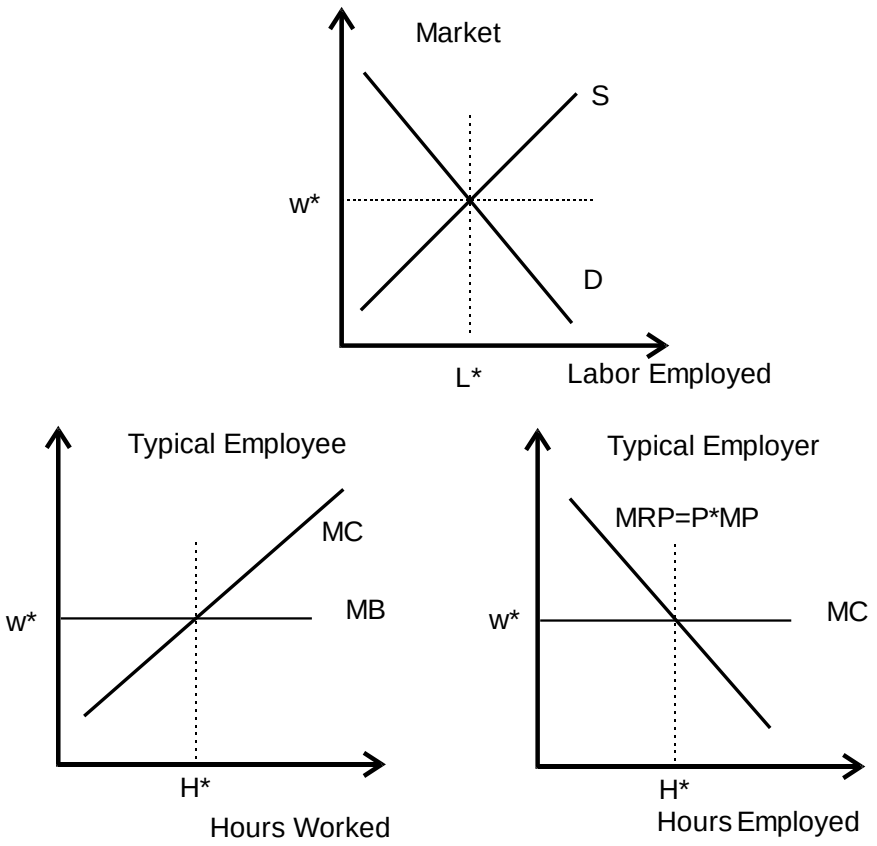


Figure 4.4b Equilibrium in a Final Goods Market