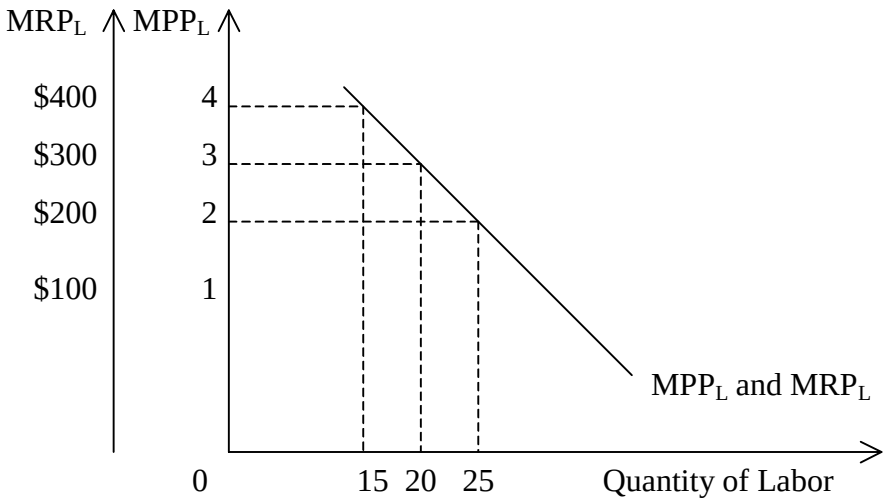
Employment and Pricing of Inputs

Previously we studied the factors that determine the output and price of goods. In chapters 16 and 17, we will focus on the factors that determine the employment level and the prices of inputs that are used to produce goods. The tools of analysis for goods markets and input markets are very similar. Chapter 16 examines the basic principles common to all input market analysis, whether the input is labor, land, capital, or raw materials. First, we examine the demand for inputs by competitive firms. Second, we investigate the supply of inputs. Third, we determine the employment and price of inputs by the interaction of input demand and supply. Finally, we analyze input markets under noncompetitive conditions.

The Input Demand Curve of a Competitive Firm

Consider a competitive firm's demand for labor in the short run (SR). We assume that all other inputs, such as raw materials and machinery, are held fixed. In the SR, the law of diminishing marginal returns indicates that eventually each additional worker results in a smaller addition to output. The downward sloping portion of the firm's marginal physical product of labor (MPP_L) curve is shown below.



The MPP_L indicates that if the firm hires 20 workers a day, the output produced by an additional worker is 3 units. If employment is increased to 25 workers, then the output produced by an additional worker is lower (i.e., 2 units) because of diminishing MPP_L.

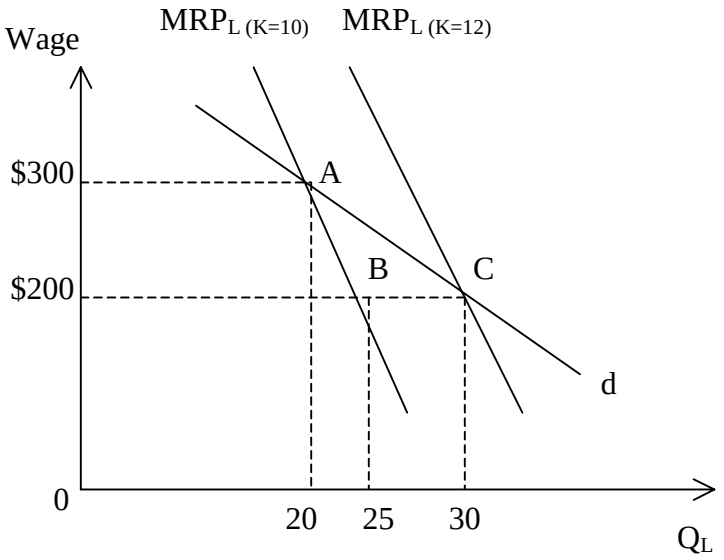
How does the firm determine the number of workers to hire? It compares the cost of each worker (i.e., their wage) with the revenue generated from each worker (i.e., P_{output} x MPP_L). If the firm sells its output for $100 a unit, then MRP_L = $100 x MPP_L, which is shown in the diagram above. The MRP_L curve is the firm's SR demand for labor. If the daily wage rate is $300 per worker then the firm will hire 20 workers. If the firm hires 25 workers, then the cost of

each worker ($300) is greater than the revenue they generate so the firm loses money on each worker hired beyond 20.

At lower wages it becomes profitable to hire more workers. If daily wages fell from $300 to $200, it would pay to hire 25 workers. It is no longer sensible to hire just 20 because each additional worker hired (up to 25) adds more revenue than they would cost because MRP_L > wage. The firm should hire workers up until the point where MRP_L = wage.

Profit is maximized when wage = MRP_L. This can be related back to the firm's profit maximizing output level. Recall that competitive firms maximize profit by selecting the output level where MC = P_{output}. Rewriting the optimal input purchase rule gives us wage/MPP_L = P_{output}. The left-hand side of this equation is just MC, so the optimal input purchase rule is equivalent to the rule for producing the profit maximizing level of output. When a firm hires workers so that the wage = MRP_L, it is also producing where P_{output} = MC.

We need to consider the competitive firm's input demand curve in the LR when all inputs are variable. In general, a reduction in an input's price leads a firm to hire more of that input *and* more of other inputs. For example, a firm may hire more workers if a reduction in the cost of computers leads to greater computer usage. Consider the demand for labor when two inputs -- capital and labor-- are employed by the firm.



Suppose the firm is initially operating at point A, employing 20 workers for $300 a day. The amount of capital (K) is fixed at 10 units along the firm's MRP_L curve. If the wage rate falls to $200 and the firm does not increase its use of K, it will hire 25 workers (point B). The movement from point A to B does not show the complete adjustment to the wage reduction, because the firm may buy more equipment for the additional workers to use.

An increase in the use of K (from 10 to 12 units) shifts the MRP_L outward, because the workers are more productive once they have more "tools" to work with. Assuming an unchanged product

price, the firm will now hire 30 workers at point C. Notice that the firm continues to hire workers up until the point where the MRP_L = wage.

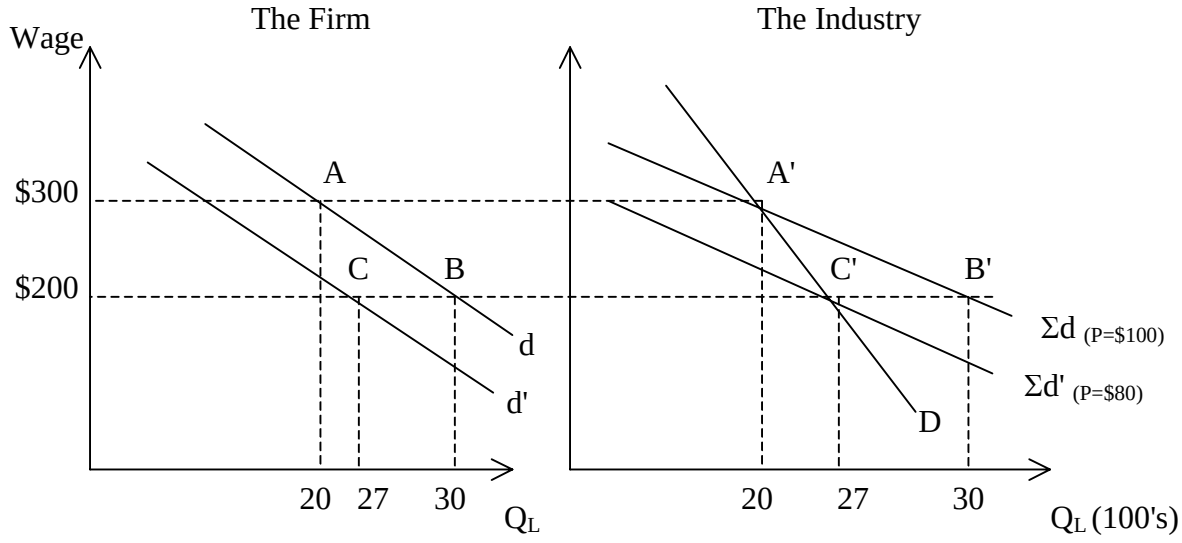
A and C are points on the firm's labor demand curve (d), when input usage can vary in response to the wage rate. Since this curve allows the firm to vary all of its inputs, it is the firm's LR demand for an input. When deriving this curve, we assume that other input prices remain the same and that the firm's product price is constant.

Industry and Market Demand Curves for an Input

We derive the market demand curve for an input by adding up the demand curves of various firms that buy the input. Firms in many different industries hire inputs, like labor, so we proceed in two steps. First, we determine each industry's demand curve for labor. Then we horizontally sum each industry's demand curve to obtain the overall market demand for labor.

When deriving the competitive firm's demand for labor, we assumed the product price remained constant. The firm expanded its use of labor when the wage fell, implying that its production also increased. The competitive firm was able to sell the increased output at constant prices because the firm faces a horizontal demand for its output. However, if reduced wages lead every firm in the industry to expand their use of labor and therefore output, the product price must fall because industry demand for the product is downward sloping. Thus, we cannot assume that the product price remains constant when deriving the industry demand curve for labor.

Consider the diagram below.



In the diagram, d is the labor demand for a single firm when the product price is $100. The wage is initially $300 a day and the firm hires 20 workers (point A). With 100 identical firms in the industry, total employment is 2,000 workers (point A'). Point A' lies on the Σd curve, which is the horizontal summation of the individual firm's d curves.

Point A' is one point on the industry's labor demand curve. To determine another point on this curve, consider what happens when the wage rate falls to $200. The individual firms will now hire 30 workers (point B). As the firms expand their use of labor the output level will rise. This increase in industry output causes the product price to fall to $80. But, the lower product price reduces the firm's demand for labor to d', because the MRP_L (i.e., P_{output} x MPP_L) has fallen. The firm now employs 27 workers at point C. The industry diagram shows that all firms begin expanding their use of labor when the wage falls to $200 (point A' to B'). But, the expanded use of labor is reduced somewhat by the falling product price, and the firms end up at point C'. Point C' is the second point on the industry's labor demand curve.

Note that we assume the demand curve for the product is fixed when deriving the industry's input demand curve. Economists often refer to an industry's input demand curve as a derived demand. For example, the software industry's demand for computer programmers is derived from the consumer demand for software. Software firms are willing to pay computer programmers only because consumers are willing to pay for software. If the demand for software shifts, then so does the industry's demand for computer programmers.

There are four major determinants of the elasticity of an industry's demand for an input.

(1) The greater the elasticity of demand for the industry's product, the more elastic the input demand. If consumer purchases respond strongly to a slight price reduction (i.e., a highly elastic demand), then firms in the industry will produce much more when an input price falls by using substantially more of the input. Consider our earlier diagram; if wages fell from $300 to $200 *and* the consumer demand for the industry's product was perfectly elastic, then the greater output could be sold at the $100 price. So the firms would expand labor use to B' and Σd would be the industry's labor demand curve.

(2) The industry's input demand is more elastic when it is easier to substitute one input for another in production. For example, if machines could replace workers at a *slightly* greater cost, then a wage increase will lead firms to switch entirely to machines thereby reducing their employment of workers to zero --a very elastic response to higher wages.

(3) An industry's input demand is more elastic when the supply of other inputs to the industry is elastic. If machine prices rise sharply after firms switch from workers to machines (implying an inelastic supply of machines), then the amount of profitable switching is reduced. This reduces the elasticity of demand for workers.

(4) The longer the time allowed for adjustment, the more elastic an industry's demand for an input becomes. For example, a rise in wages may mean that switching to machines is profitable. But, it takes time for the machines to be chosen, ordered, and installed; so few workers are laid off in the very SR.

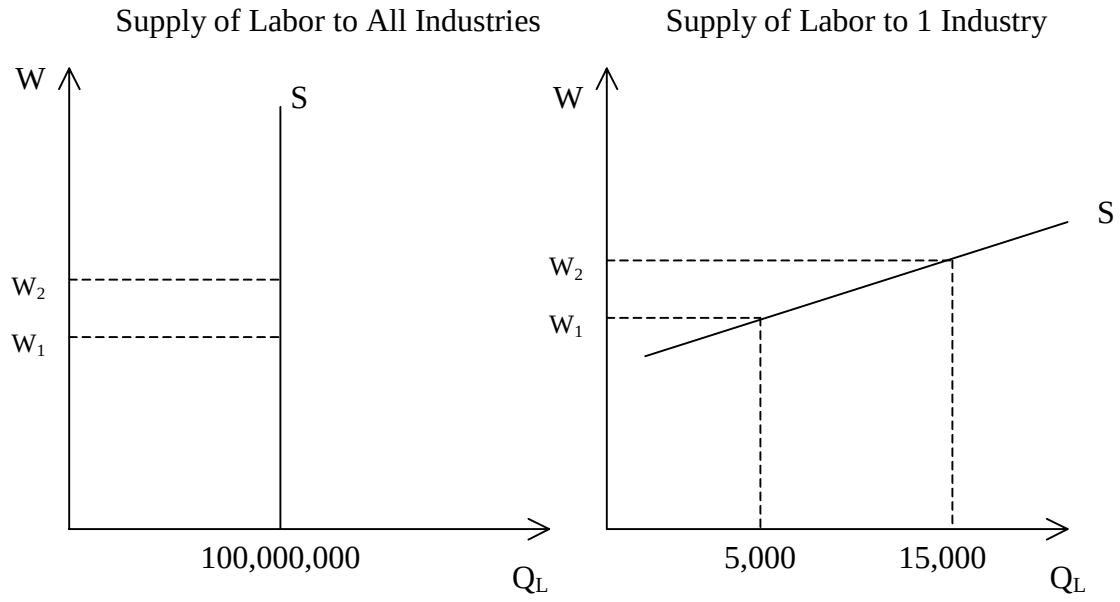
Once we understand the derivation of the industry's input demand, the derivation of total market demand for an input is simple. First, we must recognize that many industries compete for the use of the same inputs. For example, the aircraft, automobile, and farm equipment industries all use

steel, engineers, and machine setup operators. The market demand for a particular input is determined by horizontally adding the various industry demand curves for that input. It is the interaction of market demand and input supply that determines the employment and price of an input in the economy.

The Supply of Inputs

The supply side of input markets is complicated because the shape of the supply curve depends on the type of input under consideration. Here we make some general comments that apply to all inputs and save our discussion of specific input supply curves for Chapter 17. Inputs can be broadly defined as labor, land, or capital. More narrow definitions might distinguish between skilled and unskilled workers, land in Santa Monica and land in Northridge, and computer equipment and buildings. Here we focus on broad classifications to make general points.

The shape of an input supply curve depends on the market for which the supply curve is drawn. Consider the supply curve of labor to all industries in the economy. To simplify matters, assume that workers are identical so there is only one wage rate. Will the total amount of labor supplied increase if wages rise? The total amount of labor supplied can only increase if workers decide to work more hours or if more individuals enter the labor force. If the workers' response to higher wages is slight, then the labor supply to all industries may be vertical. This is shown in the diagram below.



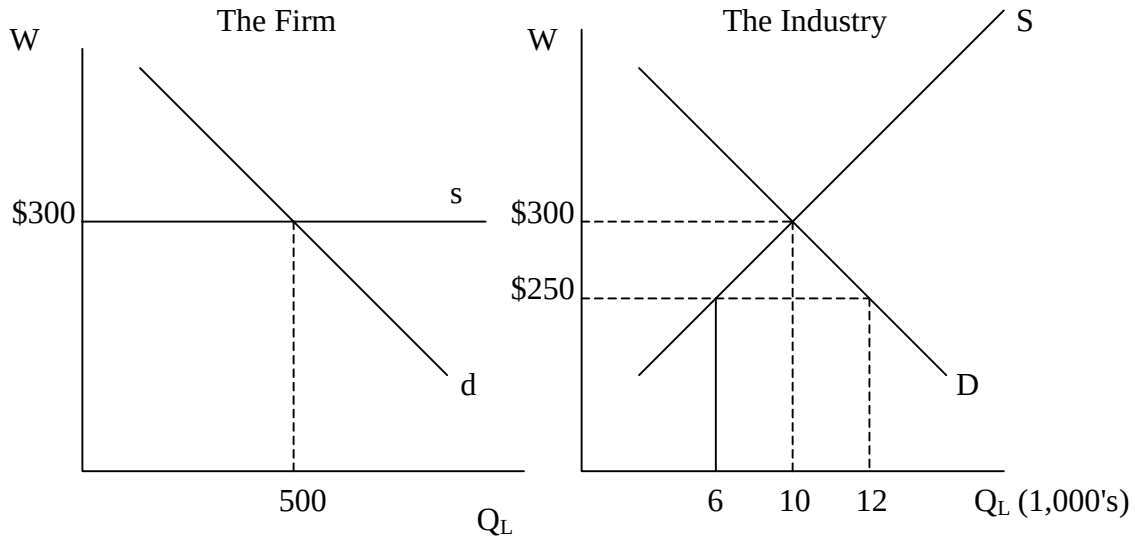
An increase in wages from W1 to W2 leaves the number of workers unchanged in the overall economy. Although the labor supply to all industries could be vertical, the labor supply to a single industry should be much more elastic. For example, if wages rise in the auto industry, workers will leave their jobs in other industries to acquire the higher wages in the auto industry. This adjustment doesn't change the total number of workers employed, but it does change the number of workers in the auto industry. Thus, the supply curve of workers to the auto industry is

upward sloping. When wages rise from W_1 to W_2, 10,000 workers leave their previous industries to enter the auto industry. Because the auto industry is only a fraction of the overall labor market, its labor supply curve is more elastic than the labor supply curve of the economy.

This concept applies to inputs other than labor. Although the total supply of land to an economy may be fixed, the supply curve to any one industry is not. The dairy industry can bid land away from other uses, like chicken farming ☺. Thus, the input supply curves for individual industries will usually be very elastic. Yet, the supply curves to more broadly defined markets will be less elastic.

Industry Determination of Price and Employment of Inputs

The interaction of supply and demand determines the equilibrium price and quantity of an input. The following diagram shows one competitive industry's demand and supply curves for labor.



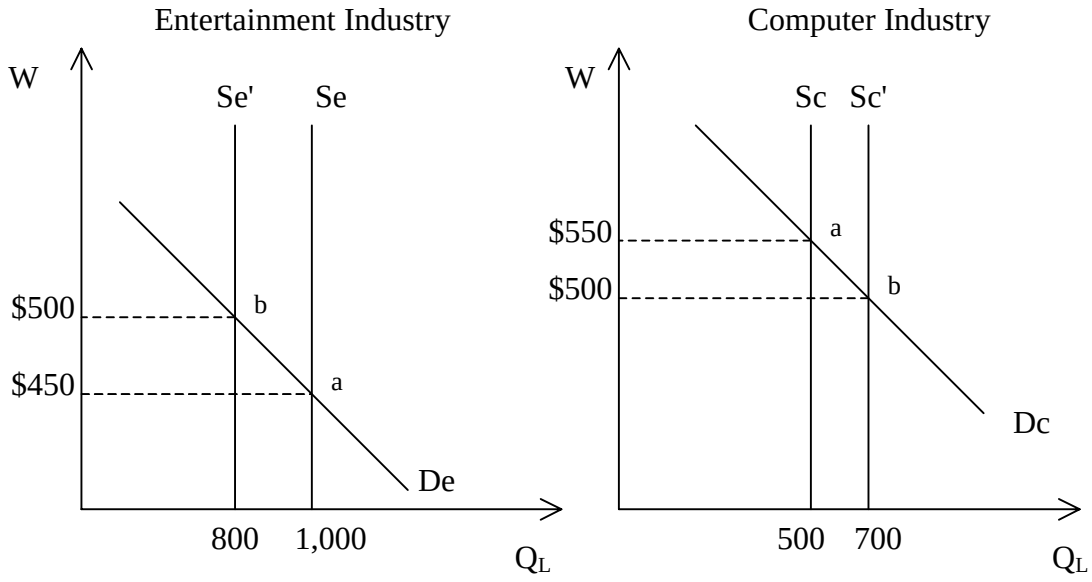
In equilibrium, the competitive industry hires 10,000 workers for a daily wage of $300. No other wage rate will clear this market. Consider what would happen if the wage were below the equilibrium level, say $250. Only 6,000 workers would agree to work at this wage and the industry would like to hire 12,000 workers at this low wage. A shortage of 6,000 workers will exist if the wage is $250. The labor shortage means that firms will have difficulties filling their job vacancies and they will offer workers higher wages to lure them away from employers in other industries.

The wage rate will rise to clear the market. As wages rise, the quantity of labor supplied to this industry rises as workers quit their jobs in other industries. The rising wage also reduces the quantity of labor demanded. This process continues until we reach equilibrium, wherein the number of workers willing to work for firms in the industry equals the number of workers firms are willing to hire.

Each firm faces a horizontal labor supply curve at the equilibrium wage. An individual firm is a small fraction of the labor market, so it can hire as many or as few workers as it likes without impacting the prevailing wage. Each competitive firm employs labor so that the wage = MRP_L.

Different industries often compete for inputs because they employ the same inputs. For example, most industries use labor, electricity, buildings, and computers. If inputs are mobile across industries, then identical inputs should receive the same price regardless of which industry employs them.

Suppose that the entertainment and computer industries both employ business graduates (i.e., MBAs), and for some reason MBAs receive higher wages in the computer industry. This wage difference cannot persist for long, because MBAs can leave the entertainment industry and enter the computer industry. The following diagram illustrates this concept.



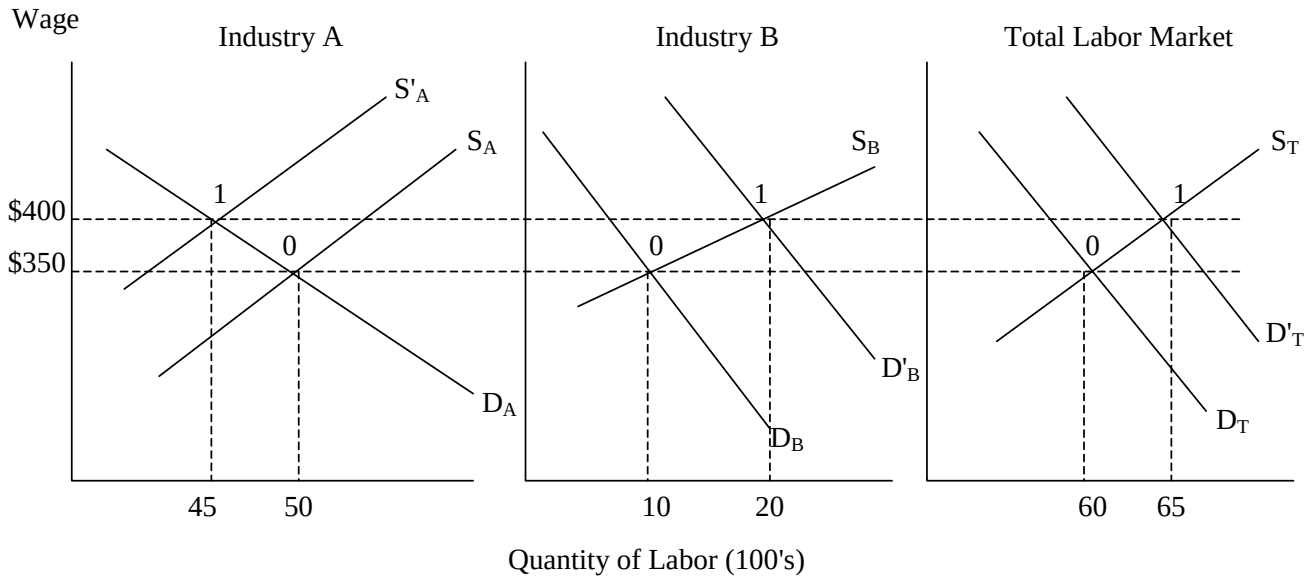
Let's assume that the two industries together employ 1,500 MBAs. Initially, the computer industry employs 500 MBAs while the entertainment industry employs 1,000. At these employment levels, the entertainment industry pays $450 a day, while the computer industry pays $550. The supply curves are drawn vertically because the number of MBAs is fixed in the very SR for each industry. The two industries are not in equilibrium at point a, because the wage differential encourages the movement of labor from the low-wage to the high-wage industry.

The shifts in the supply curves show the movement of MBAs between the two industries. MBAs will leave the entertainment industry (shifting supply in) and enter the computer industry (shifting supply out) until the wages are equalized across the two industries. Point b represents the equilibrium, wherein the two industries share a common wage of $500 a day.

Input and Price Determination in a Multi-Industry Market

Here we examine how a single industry fits into the broader input market, wherein several industries compete for an input. Particular attention is given to the factors that determine the shape and position of the input supply curve confronting an industry.

The market for identical engineers is shown in the diagram below.



Various industries hire engineers. Let D_B reflect just one industry's demand for engineers, while D_A combines the demands from all other industries that hire engineers (excluding B). The total market demand for engineers is D_T, which equals $D_A + D_B$. The market supply of engineers (S_T) is not vertical because higher wages encourage more people to enter the engineering field over time. The very short run supply of engineers (not shown) is vertical, because there is not enough time for individuals to receive engineering training. The initial equilibrium (point 0) in the total labor market suggests that 6,000 engineers are hired for $350 a day. Industry B employs 1,000 engineers at the prevailing wage, while the other industries combined hire 5,000 engineers.

To explore the shape of the supply curve of engineers to one industry, consider an unexpected increase in the demand (from D_B to D'_B) for engineers in industry B. This leads to a smaller increase in the overall market demand for engineers (from D_T to D'_T). The equilibrium wage is bid up to $400 a day and total employment rises to 6,500. At the new wage of $400, industry B will hire 2,000 engineers (point 1). Point 1 is another point on industry B's input supply curve. Notice that 500 engineers have left the other industries. This is shown by the inward shift in the supply to industry A. In addition, 500 additional workers have entered the engineering field in response to the higher market wage of $400.

After deriving the supply of engineers to industry B, it should be clear why the input supply curve to an industry is more elastic than the market supply curve. For the same $50 wage

increase, 1,000 engineers entered industry B while only 500 individuals entered the overall market for engineers. Industry B is only part of the market for engineers and it can bid some engineers away from other industries without dramatically increasing wages. Thus, the smaller the share of the total market accounted for by an industry, the more elastic its input supply curve.

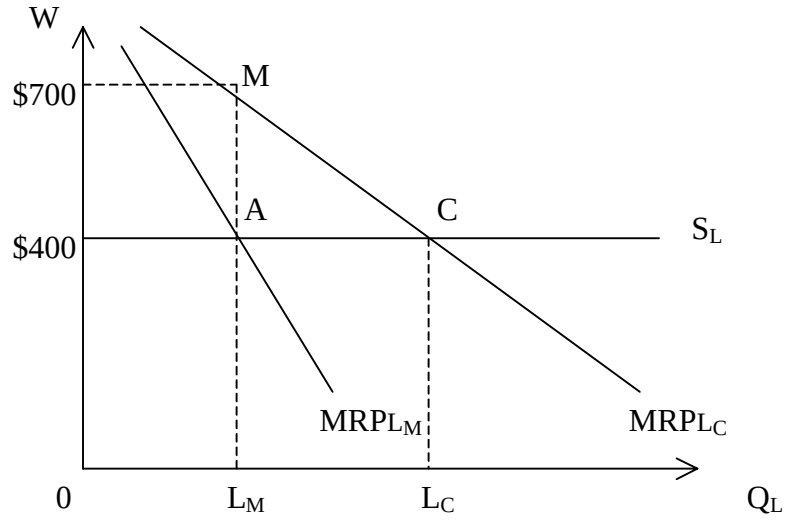
Input Demand and Employment by a Monopoly

Firms that are monopolies in their output market may still be price takers in their input markets. A firm can be the sole producer of a product, yet still compete with large numbers of other firms when hiring inputs. A monopoly follows the same optimal purchase rule as a competitive firm when hiring inputs. A monopolist will hire an input up until the point where $MRP_{input} = P_{input}$. The only difference between the two markets is how hiring one more input affects the firm's revenues.

Recall that a monopolist has P > MR while a competitive firm has P = MR. For a monopoly, the additional revenue that is generated by hiring one more unit of the input is the additional output (i.e., MPP_{input}) multiplied by the MR associated with the additional output. The MRP of an input differs for a competitive firm and a monopolist.

Monopoly:	$MRP_{input} = MR_{output} \times MPP_{input}$
Competitive Firm:	$MRP_{input} = P_{output} \times MPP_{input}$

The diagram below examines how this difference in MRP affects the employment decisions of a monopolist versus a competitive firm.



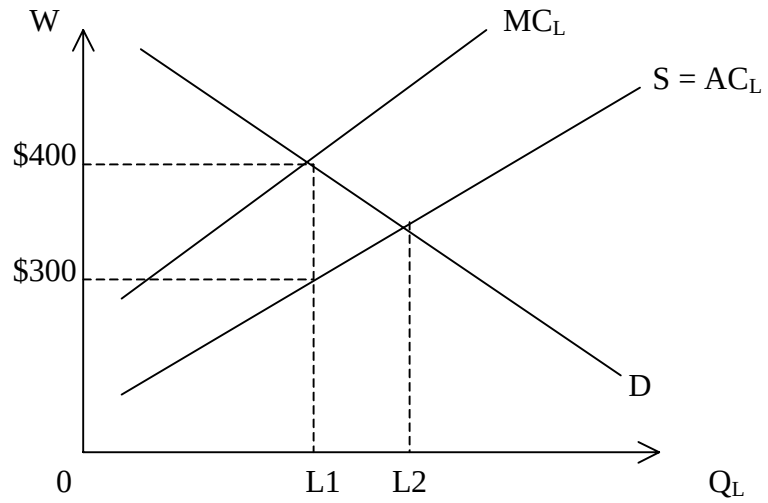
Assume labor is the only variable input so that the MRP_L reflects the demand for labor. The MRP_L curve for a monopoly (denoted by M) is below that of the competitive firm (denoted by C) because MR < P. If the prevailing wage rate is $400, then the monopolist hires L_M workers while the competitive firm hires L_C workers. Thus, the monopoly hires fewer workers than the competitive firms. This is not surprising given our discussion of how monopoly restricts output

and allocates too few resources toward the production of a good when compared to perfect competition. The area MAC shows the deadweight loss from monopoly.

Monopsony in Input Markets

Monopsony means "single buyer." Pure monopsony occurs when a firm is the single buyer of an input. For example, GM is the only buyer of parts that are tailored to its car models. The monopsonist faces the entire market supply of the input and can reduce the input price without losing all of its input supply. This case is similar to an output monopolist that faces the entire market demand for a product --it can raise the product price without losing all of its customers.

The presence of monopsony is indicated by an upward sloping input supply curve. This is shown in the graph below.



The upward sloping supply curve indicates the firm must pay higher wages to secure more workers. Until now, we have assumed that each firm faces a perfectly elastic supply of labor. When the input supply is upward sloping, the MC of an input does not equal its AC. If the monopsonist wants to hire one more worker it must raise wages somewhat to all workers. The wage rate is the AC of labor. If AC rises as more workers are hired, then MC is greater than AC.

The firm maximizes profits by hiring L_1 workers, where the MC_L equals the MRP_L. The firm pays a wage ($300) that is less than the MRP_L ($400). Equating MC_L and MRP_L gives the employment level, while the wage is determined by the height of the supply curve at that employment level.

Employment and wages are lower under monopsony than under competitive input market conditions. Wages and employment (L_2) would be higher with competition. The similarity between output monopolists and monopsonists is striking. The output monopolist restricts output to charge a higher price for its product, while the monopsonist restricts employment to reduce the price of its input.