Factor Markets

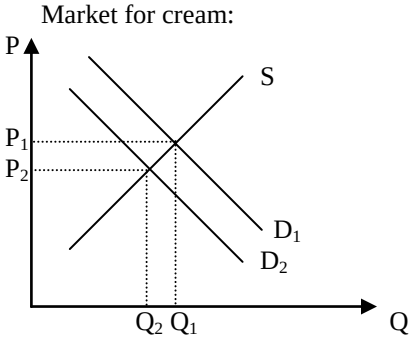
Problem 1 (APT'93, P2)

Two goods, coffee and cream, are complements. Due to a natural disaster in Brazil that drastically reduces the supply of coffee in the world market the price of coffee increases. Explain the effect of this increase in the price of coffee on each of the following.

a) The equilibrium price and quantity sold of cream
b) The supply and demand for workers who produce cream

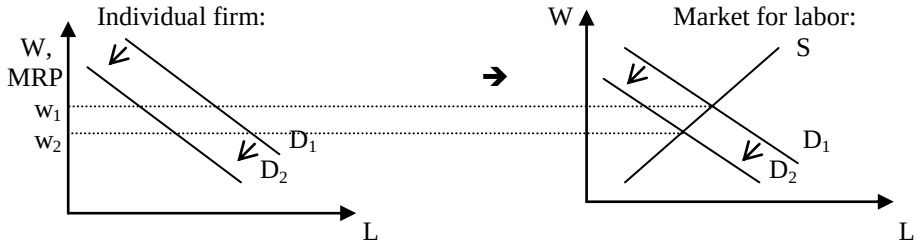
Sample answer:

a) Since coffee and cream are complements, they tend to be consumed together, so that the increase in the price of the former will reduce the demand for the latter. This, as the following graph shows, will decrease both the price and quantity of cream produced:



b) Labor demand is a derived demand, in a sense that it depends on the conditions in the market for the good the labor is used to produce. Thus, when the price of cream falls, the demand for workers producing cream decreases. This becomes obvious when we consider the way firms choose the number of workers they employ to maximize short-run profits.

An individual firm employs workers until the marginal revenue product of the last employer equals his or her wage rate. When the price of the good (in our case cream) drops, the marginal revenue product of workers, equal to the price times the marginal physical product of labor, falls. As a result, the firm's demand for labor decreases causing the industry's demand curve for labor, which is the aggregate of individual firms' demand curves, to shift in:



In contrast to labor demand, labor supply does not depend on the price of the final good, so that the decrease in the price of cream will have no effect on the supply of labour of workers who produce it.

Problem 2 (APT'94, P1)

Initially a country's labor market is competitive and in long-run equilibrium. Now assume that new workers enter the labor market.

(a) Assuming no other changes, explain how the increase in the number of workers will affect each of the following in the short run.
  (i) The wage rate of workers
  (ii) The costs of production of a typical firm
  (iii) The price of goods produced by the workers

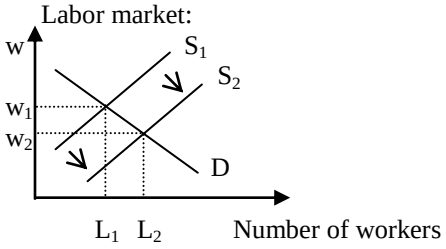
(b) Assume that the demand for the goods produced by the workers in part (a) decreases. Explain the effect of this decrease on each of the following.
  (i) The price of goods produced by the workers
  (ii) The demand for labor
  (iii) The wage rate of workers

(c) Now assume that legislation requiring the establishment of a national minimum wage is proposed. Explain at what level this minimum wage would need to be set to be effective.

(d) Explain how the imposition of the effective minimum wage in part (c) would affect each of the following.
  (i) The number of workers employed in the labor market
  (ii) The costs of production of a typical firm

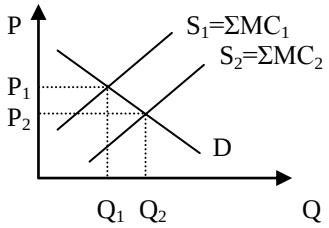
Sample answer:

a) (i) With the increased number of workers, there will be an excess supply of labor at the initial wage rate. Some unemployed workers will be willing to work at a lower wage, hence, the wage rate will ultimately go down.

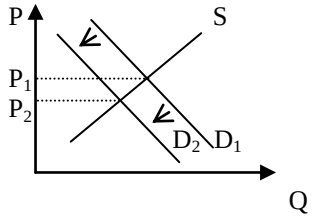


(ii) As the wage rate decreases, so do the costs of a typical firm, which uses labor in its production .

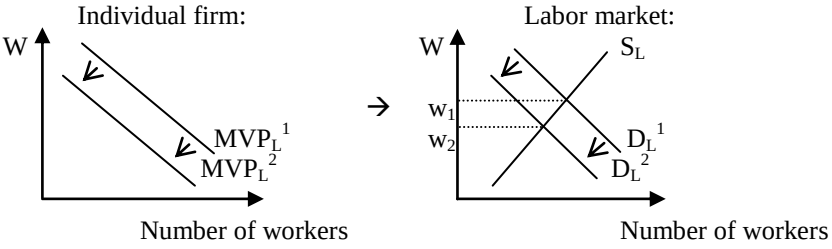
(iii) With decreased costs of production, the supply of goods produced by the workers will increase leading to a reduction in their price (see the following graph).



b) (i) As the following supply-demand diagram illustrates, the price of goods produced by the workers will go down:



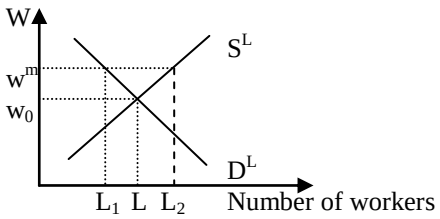
(ii) and (iii) Since labor demand is 'derived', in a sense that it directly depends on the price of the final product, the decrease in the demand for goods produced by the workers will cause the demand for workers both by individual firms and industry as a whole to decrease:



As depicted in the graph above, the wage rate of workers will fall from w_1 to w_2.

c) To be effective the minimum wage rate must be set above the equilibrium level. Otherwise, it will have no impact on the market, as the going wage rate is higher anyway.

d) (i) If an effective minimum wage is imposed on the labor market, the number of people willing to work will increase to L_2, whereas the number of workers firms are willing to hire will go down to L_1. As a result, only L_1 workers will be able to find a job, so that employment will decrease (see the graph below).



(ii) The increase in the wage rate firms have to pay to their employees will inevitably raise the cost of labor and of production as a whole.

Problem 3 (APT'97, P1)

Workers	Output
3	60
4	80
5	105
6	125
7	140
8	150

The table above describes the production function for John John's T-shirt firm. Jones can hire as many workers as he wants for $75 per day and can sell as many T-shirts as he wants for $5 each.

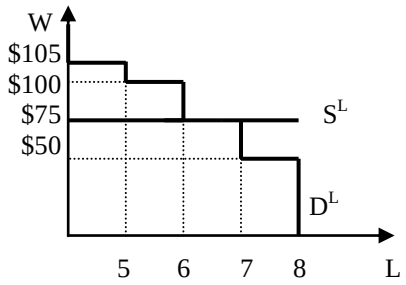
(a) Given the production information above, do each of the following.
   (i) Draw a graph showing this firm's demand and supply curves for workers.
   (ii) Explain how Jones will determine the number of workers to hire.
   (iii) Indicate how many workers Jones will hire.
(b) Assume the wage rate at which Jones can hire workers he wants increases to $120 per day, and the selling price of T-shirts increases to $6. Do each of the following.
   (i) Explain how the demand for workers will change.
   (ii) Indicate how many workers Jones will hire.
   (iii) Indicate the quantity of T-shirts Jones will produce.
(c) In which type of market structure does Jones sell his T-shirts? Explain how you know.

Sample answer:

The supply curve the firm is facing is horizontal, as the wage rate it has to pay its workers is given to the firm by the market and it can employ as many people as it wants for $75 per day.
To work out the firm's demand curve for workers one has to calculate the marginal revenue product of each employee and plot it as a function of the number of workers in the wage-labor space (to be precise, only that part of it which is below the average revenue product curve):

Workers	Output	Marginal physical product	Marginal revenue product	Average revenue product
3	60			100
4	80	20	100	100
5	105	25	125	105
6	125	20	100	104
7	140	15	75	100
8	150	10	50	94

As one can see, the firm will hire no workers at all if the wage rate is more than $105 per day (the maximum average revenue product of labor), as the revenue received from selling T-shirts will not even cover the variable costs of production, i.e. the wage bill. The moment the wage rate falls below $105, the firm will re-open with 5 workers and will continue to hire additional workers until the marginal revenue product of another employer is less than the wage rate. Hence, the firm's demand curve for labor coincides with its marginal revenue product curve and has the following shape:

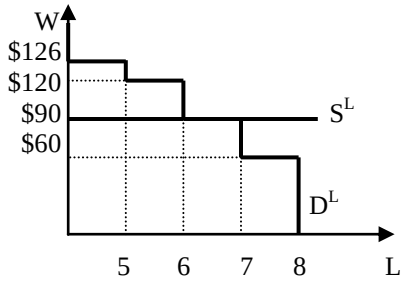


ii) and iii) In order to maximize profits, Jones' will hire workers up to the point where the marginal revenue product of one additional employer is less than his wage rate. Thus, provided that the wage is $75 per day, Jones will surely employ 6 workers. However, as far as the 7th worker is concerned, it is not clear whether Jones will decide to hire him or not: his wage rate is exactly equal to his marginal revenue product, so that he neither adds to, nor subtracts anything from the firm's total profits. Hence, given the information about the firm's production function, all we can say is that Jones will hire either 6 or 7 workers.

b) i) To see what will happen to the demand for workers we recalculate the marginal and average product of labor taking into account the increased selling price of T-shirts:

Workers	Output	Marginal physical product	Marginal revenue product	Average revenue product
3	60			120
4	80	20	120	120
5	105	25	150	126
6	125	20	120	125
7	140	15	90	120
8	150	10	60	112.5

Again, the firm will shut down if the wage rate is above $126 and will start straight off with 5 workers as soon as the wage rate goes down to $126. Its demand for workers for wages below $126 coincides with the new marginal revenue product of labor curve and has the following form:



Thus, the increase in the price of T-shirts has shifted the marginal revenue product curve for labor up, resulting in an increase in the firm's demand for workers.

ii) Again, just like in the previous part, it is not obvious how many workers Jones will hire, as he is actually indifferent between employing 5 or 6 people. The wage rate is exactly equal to the marginal revenue product of the 6^{th} worker so that profits are the same in both cases.

iii) If the firm decides to employ 5 people, it will produce 105 T-shirts. If, however, Jones prefers to hire 6 workers the firm's output will increase to 125 T-shirts per day.

c) Jones can sell as many T-shirts as he wants at the going market price, which means that his firm operates in a perfectly competitive market.

Problem 4 (APT'2000, P2)

Assume that a firm produces output using one fixed input, capital, and one variable input, labor. The firm can sell all of the output it produces at a market price of $3 each, can hire all of the workers it wants at a market wage rate of $11 each, and has fixed costs of $10. It faces the following production schedule.

Number of Employees	Total Output
0	0
1	14
2	26
3	35
4	42
5	46
6	48

(a) In what kind of market structure does this firm sell its output? How can you tell?
(b) In what kind of market structure does this firm hire its employees? Ho can you tell?
(c) Using marginal revenue analysis, how many employees should this firm hire to maximize short-run profits? How can you determine that?
(d) Based on your answer in part (c), how many units of output will this firm produce?
(e) At the level of output you identified in part (d), is the firm earning an economic profit, a normal profit, or suffering a loss? How can you tell?

Sample answer:

a) In so far as the firm sells all of its output at the going market price it is bound to be a price-taker and is therefore operating in a perfectly competitive market.
b) Again since the firm hires as many workers as it wants paying them the established wage rate the labor market is also perfectly competitive.
c) In order to maximize profits the firm should hire workers up to the moment when the marginal revenue product of the last worker equals his wage rate. As soon as the marginal revenue product falls below the wage rate it becomes unprofitable to hire new workers as every additional employee adds less to the total revenue than to the costs of the firm. Thus, to determine how many workers the firm will take on we calculate the MRP of each worker and see at what point the firm should stop hiring laborers:

Number of Employees	Total Output	Marginal Product	Marginal Revenue (MP) Product (MRP = MP * P)
0	0		
1	14	14	52
2	26	12	36
3	35	9	27
4	42	7	21
5	46	4	12
6	48	2	6

Since the wage rate is $11, a profit-maximizing firm will hire 5 workers, as the MRP of each of the first 5 employees is higher than their wage rate, and it is only for the 6^{th} worker that w > MRP.

d) Using the production schedule we find that 5 workers will produce a total output of 46 units.

e) To answer this question we simply calculate the profit the firm is earning when hiring 5 workers and see whether it is positive, negative or equal to zero. The total costs of the firm are comprised of fixed and variable costs. Fixed costs are equal to $10 and do not change with output. Variable costs are merely the wage bill, which, with 5 workers being hired and a wage rate of $11, is equal to $55. Selling 46 units of output at $3 each the firm receives a total revenue of $138. Hence, the firm's economic profit is equal to $138-$55-$10=$73 which is positive.

Problem 5 (APT'99, P1)

In the United States, textiles are sold in two separate and perfectly competitive markets. The textiles produced in the United States are sold in market A, and imported textiles are sold in market B.

(a) Explain how the supply curve for textiles produced in the United States will be affected by each of the following.

i. A decrease in the number of firms in the United States producing textiles
ii. An increase in the price of textiles

Assume that textiles produced in market A and market B are close substitutes.

(b) Using one graph for market A and another for market B, show and explain how a substantial increase in the tariff on textiles imported into the United States will affect each of the following.

i. Equilibrium price and quantity of textiles sold in market B (imported textiles)
ii. Equilibrium price and quantity of textiles sold in market A (textiles produced in the United States)

Assume that the labor market for textile workers is perfectly competitive. Following a decrease in the supply of textile workers, the wage rate of textile workers increases.

(c) Using a new graph for market A, show and explain how a substantial increase in the wage rate of textile workers will affect the equilibrium price and quantity of textiles sold in market A.

(d) Using a graph, show and explain how the increase in the wage rate of textile workers and the change in the equilibrium price and quantity of textiles you identified in part (c) will affect each of the following.

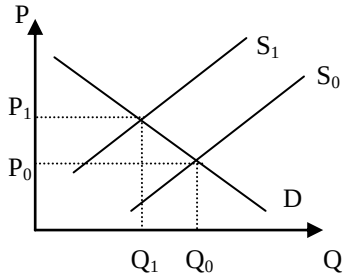
i. A firm's demand for labor
ii. A firm's supply of labor

Sample answer:

a) i) Since in the case of perfect competition the industry's supply curve is a horizontal sum of the supply curves of all the individual firms operating in the market, when the number of producers decreases it shifts to the left.
ii) When the price of textiles increases the supply schedule will not be affected. The supply curve reflects the relationship between the price of a good and its quantity supplied other things being equal. Thus, unless one of the underlying factors changes, the supply curve stays the same and a rise in price will only cause a decrease in the quantity supplied, which is depicted by a movement along rather than a shift of the curve.

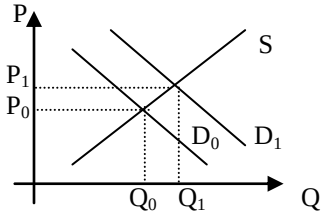
b) i) The imposition of a tariff (or an increase in its rate) will shift the supply curve in market B up by the whole amount of the tariff. As the graph below illustrates the result will be a rise in the price and a drop in the equilibrium quantity of imported textiles (from P_0 to P_1 and from Q_0 to Q_1, respectively).

Market B



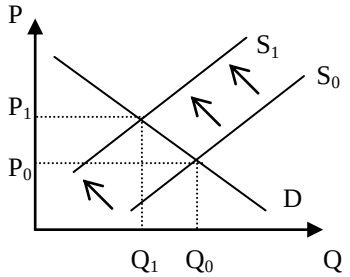
ii) Since the two types of textiles are close substitutes for one another, the increased price in the import market will cause the demand for domestic textiles to increase as people will be striving to replace imported products with less expensive US textiles. Graphically, it can be represented as an outward shift in the demand for domestic textiles (from D_0 to D_1), which, as the following diagram shows, will entail a rise in both the price (from P_0 to P_1) and the quantity of textiles sold in market A (from Q_0 to Q_1).

Market A



c) As has already been mentioned the industry's supply schedule can be obtained by the horizontal summation of individual firms' supply curves, which, in turn, coincide with the parts of their Marginal Cost curves above the minimum AVC. When the wage rate increases the costs of production go up, the MC curves shift up and so does the market's supply curve (see the next graph):

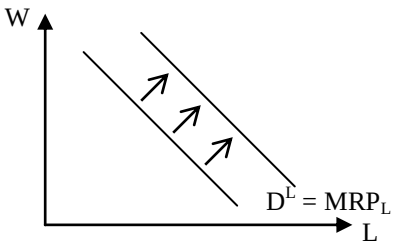
Market A (effects of a wage increase)



As one can easily see from this diagram an increase in the wage rate will result in a higher price of textiles and a lower level of output.

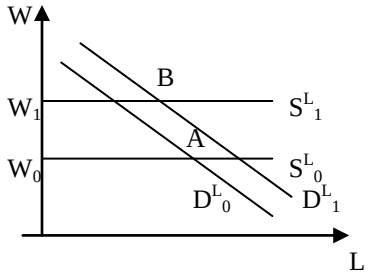
d) i) Since any profit maximizing firm is hiring labor up to the point when the Marginal Revenue Product of the last worker employed (or, in our case, the Marginal Value

Product since the market is perfectly competitive)is exactly equal to the wage rate he must be paid, a firm's demand for labor coincides with the MRP_L curve it is facing. $MRP_L = P * MP$, where MP – marginal product of labor and P – price of the textiles this labor is used to produce. Thus when the price of output goes up as in part (c) the MRP_L shifts out and a firm's demand for labor increases:



ii) In a perfectly competitive labor market the supply curve each particular firm is facing is horizontal and its position is fully determined by the going wage rate which individual firms have no choice but to accept as given. Consequently, an increase in the wage paid to textile workers will shift this curve up. Combining this conclusion with the effects of a price rise we examined just before we obtain the following picture for a single firm's decision as to how much labor to hire.

An individual firm's demand for and supply of labor.



It would seem from the graph that the total effect of all the changes described above on the amount of labor hired will depend on how far the curves shift in response to the increase in both the price of textiles and the wage rate of textile workers. However, since in part (c) we established that the overall quantity of textile produced will fall it must also be that, with the number of firms remaining constant, each firm is now using less labor and, hence, point B is definitely to the left of point A.

Problem 6 (APT'2001, P3)

Sparkle Car Wash is a profit-maximizing firm with the following production information.

Number of Workers	Number of Cars Washed per Day
0	0
1	15
2	35
3	60
4	75
5	85
6	80

(a) With which worker is marginal product maximized?
(b) Identify and define the economic principle that explains why marginal product eventually decreases.
(c) Explain why Sparkle would never hire the sixth worker.
(d) If Sparkle charges $6 for washing a car, what is the maximum daily wage that Sparkle would be willing to pay the fourth worker?

Sample answer:

(a) Marginal product of labor may be defined as the addition to output generated by additing one more worker. Hence, the marginal product of the first worker is simply the output of the firm when only one worker is employed, that is 15. The marginal product of the second worker is the difference between the output of the firm when two workers and one worker is hired, which equals 35 -15 = 20 cars per day. Using the same logic we calculate marginal product of each successive worker and present the result in the last column of the table:

Number of Workers	Number of Cars Washed per Day	Marginal Product of Labor
0	0	-
1	15	15
2	35	20
3	60	25
4	75	15
5	85	10
6	80	-5

As one can see, marginal product of labor attains its maximum when the third worker is hired and is equal to 25.

(b) The economic principle responsible for the eventual decrease in marginal product is called the law of diminishing returns. In general, it says that if we use more of one factor of production while holding other factors fixed then after some point each successive increment of this variable factor will generate a smaller increase in output than the previous one. If there are two factors of production, namely, capital and labor, then taking on an additional worker means that each worker will have less capital to work with. When only a few workers are hired this will only partially offset the gains from specialization, but as the amount of labor input increases the negative effect will begin to dominate finally making marginal product fall.

(c) The firm would never take on the 6^{th} worker because his marginal product is negative. Any profit-maximizing business will only hire a worker if the value of his marginal product (i.e. the revenue generated by adding this worker) is more or at least equal to his wage. With a negative marginal product nothing can ever induce the firm to hire this worker unless the wage rate is also negative (which is hard to conceive). Instead of raising the firm's revenues to compensate for the increase in costs the 6^{th} worker actually reduces them, so that there is nothing except losses to hiring him.

(d) As has already been mentioned, the most a firm would be willing to pay to its workers is the value of their marginal product. If it costs \$6 to wash a car, then the marginal value product of the 4^{th} worker will be \$6 * 15 = \$90, which is the maximum daily pay he can get.

Problem 7 (APT'95, P1)

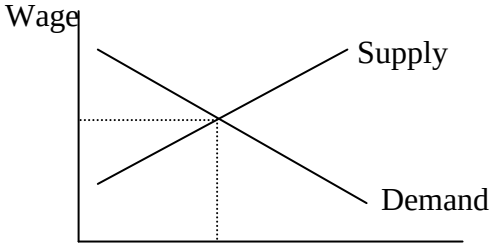
Peaches and nectarines are substitute goods, and both are produced under conditions of competitive long-run equilibrium.

(a) Joyce, a producer in the peach industry, discovers a technological breakthrough that only reduces the cost of producing peaches. Explain how the change in technology will affect each of the following for Joyce.
   (i) Quantity of peaches produced
   (ii) Price of peaches
   (iii) Short-run profits

(b) Now assume that all other peach-producing firms adopt the new technology. Explain how the adoption of the new technology will affect each of the following in the peach-producing industry.
   (i) Price of peaches
   (ii) Quantity of peaches produced

(c) This new technology is not applicable to the production of nectarines. Explain how the changes that occurred in the peach industry will affect each of the following in the nectarine industry.
   (i) Price of nectarines
   (ii) Quantity of nectarines

LABOR MARKET FOR NECTARINE WORKERS

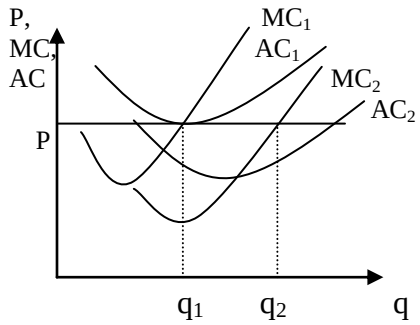


(d) The graph above depicts the supply and demand curves for workers in the nectarine industry before the technological breakthrough in the peach industry.

Explain how the technological breakthrough in the peach industry will affect each of the following in the labor market for nectarine workers.
   (i) Wage rate for nectarine workers
   (ii) Number of nectarine workers hired

Sample answer:

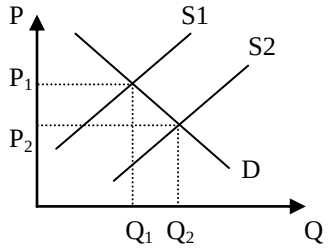
(a) (i) With the price being the same and the costs reduced by the technological innovation, the new profit-maximizing level of production (where P=MC) will occur at a higher level of output than before the discovery (see the graph below).



(ii) Suppose that the technological breakthrough is not so radical as to give Joyce a substantial advantage in the production of peaches and enable him to monopolize the industry. Let us consider that the increase in output of this single firm will be too small to influence the market price since it is difficult to expect this in this kind of production.

(iii) As one can see from the above diagram, Joyce will be making positive economic profits in the short run (as $P>AC_2$ at the new optimal point), in contrast to the initial situation, when he was just breaking even.

(b) If the new technology is adopted by all firms in the industry, the reduction in costs it brings about will increase each single firm's, and, therefore, the whole industry's supply of peaches. As a result, the price of peaches will go down, while the quantity of peaches produced will increase (see the graph below).



(c) Since peaches and nectarines are substitutes, the fall in the price of peaches, we identified above, will reduce the demand for nectarines. As a result, taking into account that the supply of nectarines is not affected by the discovery of the new technology, both the price and the quantity of nectarines will decrease:

(d) The decrease in the price of nectarines will reduce the marginal revenue product of labor in this industry, and, hence, the firms' demand for workers producing nectarines. As depicted in the diagram below, this will cause both the number of nectarine workers hired and their wage rate to go down.