Chapter 5

Labor Supply and Demand

5.1 Labor Supply

I will analyze labor supply as a choice that consumers face between two goods: leisure and good X, which represents all other goods in the economy. This will allow me to examine labor supply using the tools that I developed to study consumer demand. Let

- l denote leisure hours
- L denote labor hours
- w denote the wage rate
- X denote an aggregation of all goods in the economy except leisure
- P_X denote the price of good X
- Y denote my consumer's income

I shall assume throughout this chapter that $P_X = 1$. I want to explore how my consumer chooses between leisure and X. The first step is to determine my consumer's income Y. It depends upon the hours that she works L and her non-labor income N.

$$Y = wL + N \tag{5.1}$$

The first term on the right-hand side of equation 5.1 is my consumer's wage income: her wage rate w times her hours of work L. Her non-labor income N can come from any of the following sources: dividends, gifts, government transfers, etc.

My consumer can use her income to purchase good X. If she spends all of her income, the following must be true (since $P_X = 1$):

$$wL + N = X \tag{5.2}$$

Let me now define T as the total number of hours that my consumer has available in a day for labor and leisure. You can think of this as 24 hours or as 24 hours minus all hours spent doing things that aren't labor or leisure (e.g., sleeping). However you think about it, it is true that

$$T = l + L \Rightarrow L = T - l \tag{5.3}$$

I can rewrite equation 5.2, using equation 5.3, as

$$w(T - l) + N = X \Rightarrow wT + N = X + wl \tag{5.4}$$

The term on the left-hand side in the final expression is known as full income; it is the income that my consumer would earn if she worked all the time. The term on the right-hand side is her total expenditure on good X and on leisure. What does it mean to spend money on leisure? In this case, it means giving up the opportunity to make money by working. So the price of labor is my consumer's wage rate. Equation 5.4 can be thought of as my consumer's budget constraint; it is illustrated in figure 5.1.

Notice that the X-axis measures both leisure and labor. The intercept on the Y-axis, $wT + N$, occurs if my consumer spends all of her time working. The intercept on the X-axis occurs at T because, by definition, my consumer can't have more leisure than T. If her leisure equals T then she is not working, so her total income is her non-labor income N. The slope of her budget constraint is $-w$, the price of leisure over the price of good X.

To see this another way, I can rearrange the budget constraint to the form shown in equation 5.5. The Y-axis intercept is $wT + N$ and the slope is $-w$.

$$wT + N = X + wl \Rightarrow X = (wT + N) - wl \tag{5.5}$$

Having dervied my consumer's budget constraint, I would like to know where she will locate upon it. I will assume that she has well-behaved preferences over X and leisure so that I can draw her indifference curves as shown

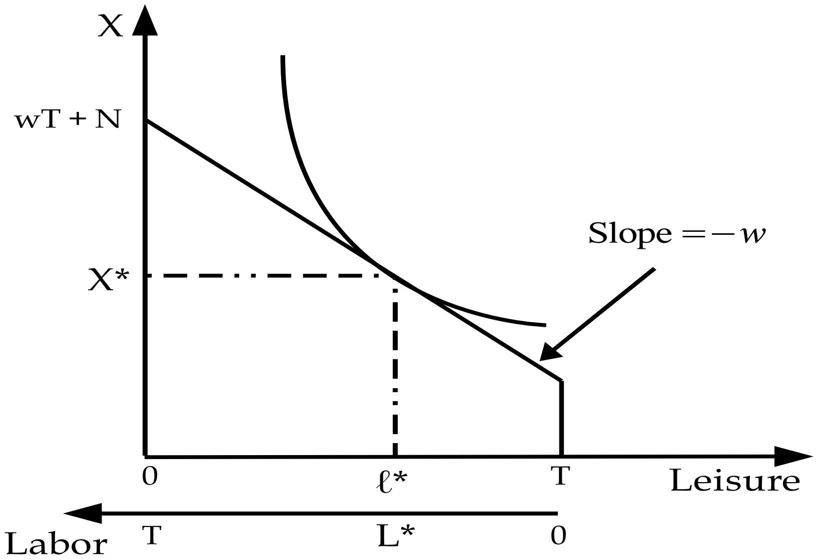

Figure 5.1: The Consumer's Budget Constraint

in figure 5.1. Her optimal consumption bundle, (X^*, l^*) occurs at the tangency of her indifference curve to her budget constraint. She will supply L^* hours of labor (note that $L^* + l^* = T$).

Let's now analyze the effect of a change in the wage rate w. Suppose in particular that w increases. Then the budget constraint's slope becomes steeper and the Y-axis intercept changes location, but I can't tell if l^* increases or decreases. To see why, consider figure 5.2, which shows the effect of an increase in the wage rate from W_1 to W_2.

All I know for sure is that the new l^* is somewhere between points A and B. If you think back to demand theory, you will remember that I had the same problem determining what happened to the demand for a good when its price changed. In this case the price that has changed is the price of leisure, w.

What is really going on here? Well, there are two opposite effects at work. The first is known as the income effect. The rise in the wage rate increases my consumer's income: if she works the same number of hours, she will earn more money. When income increases, demand for both l and X increases if both goods are normal goods—but more leisure means less work, so the income effect tends to decrease labor supply.

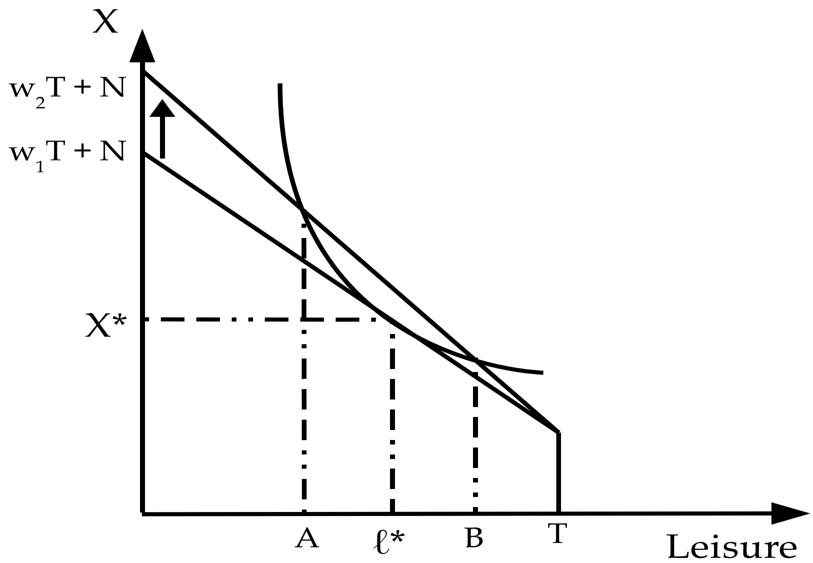

Figure 5.2: An Increase in the Wage Rate

The second effect is known as the substitution effect. If two goods are substitutes, when the price of one rises, demand for it falls. In this case, the price of leisure, w, has risen, so my consumer demands less leisure. Thus, the substitution effect tends to increase labor supply. Since the substitution and income effects work in different directions, I cannot tell how l^* will change when w changes.

5.2 Labor Demand

I now turn my attention to the demand for labor. Labor is demanded by firms, who use it as an input in the production of good X. I'll examine the short-run situation and assume that the firm's capital stock is fixed. The law of diminishing returns implies the relationship between labor and output shown in the left-hand pane of figure 5.3.

The left-hand pane shows that the slope of the total product of labor curve is the the change in output over the change in labor. This is known as the marginal product of labor. It is the change in output if the firm changes the amount of labor that it uses. The marginal product of labor multiplied by the price of good X is known as the value marginal product of labor, or

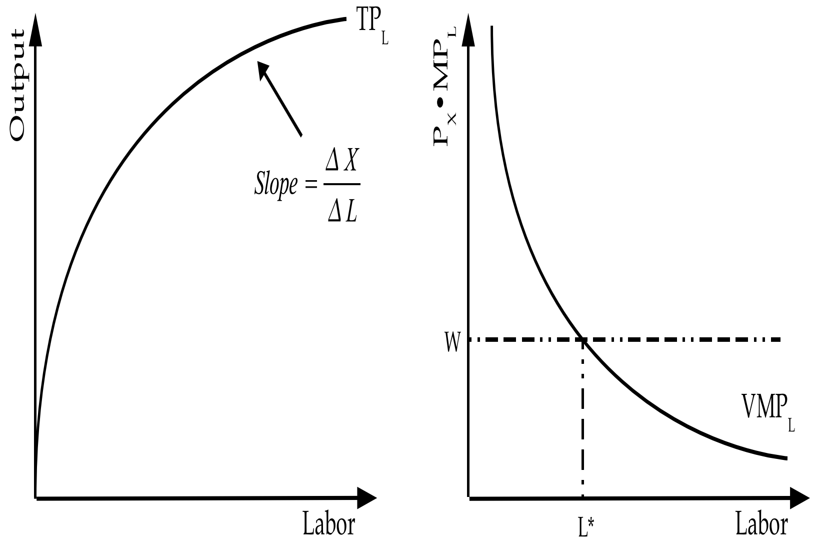

Figure 5.3: The Value Marginal Product of Labor

VMP_L. It is the amount by which the firm's earnings change if it changes the amount of labor that it uses.

$$VMP_L = P_X \frac{\Delta X}{\Delta L} \tag{5.6}$$

The right-hand pane shows the VMP_L and the total amount of labor used. As the amount of labor used increases, the VMP_L declines. This is because of the law of diminishing returns: increasing the variable input by equal increments (eventually) yields lower and lower increments of output.

The firm's profit maximizing point occurs when the VMP_L is equal to the wage rate. At this point, the cost of hiring an additional worker (w) equals the increase in earnings that worker will generate (VMP_L). I argued in chapter 4 that a firm should stop increasing production when price equals marginal cost. Does this decision rule result in the same output level as my new rule? The answer is yes. To see why, consider equation 5.7.

$$VMP_L \equiv P_X \frac{\Delta X}{\Delta L} = w \Rightarrow P_X = w \frac{\Delta L}{\Delta X} \equiv MC_L \tag{5.7}$$

So the two rules are two sides of the same coin—either one is sufficient to determine the amount of labor that a firm will demand given the wage rate.

5.3 Equilibrium

The previous two sections developed methods for determining the amount of labor supplied and demanded by individual consumers and firms, respectively. The next step is to aggregate individual consumers and firms to determine the supply and demand of labor for the entire economy. Aggregating the demand for labor is easy. When wages fall, firms will demand more labor; when wages rise, they will demand less labor.

Aggregating the supply of labor is more difficult. I can't say for sure how an individual consumer will respond to a change in the wage rate, so I certainly can't say what will happen at the aggregate level. Despite this, there is general agreement among economists that at low wage levels, increasing the wage rate will increase labor supply. In terms of the income and substitution effects, the substitution effect is larger than (or dominates) the income effect. There is no such consensus for higher wage rates alas, and the supply curves in figure 5.4 represent but two of the many possibilities.

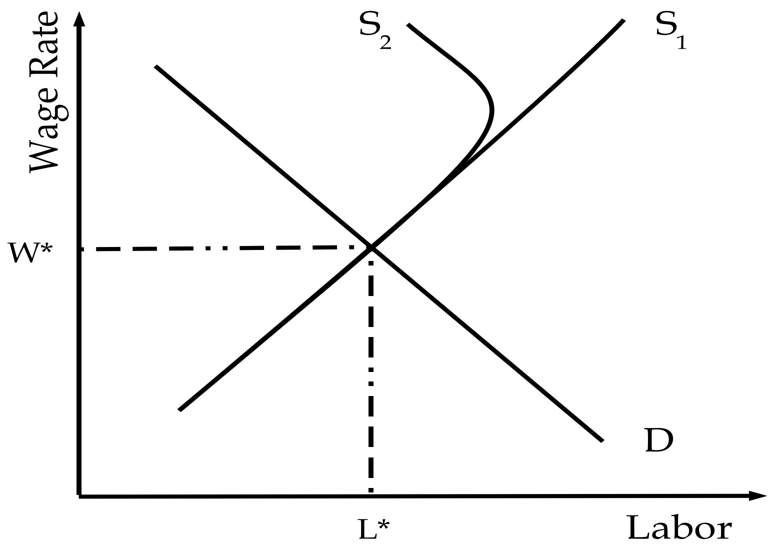

Figure 5.4: The Supply and Demand of Labor

5.4 Efficiency

Whatever the values of w^* and L^*, I would like to know whether the economy's allocation of labor is efficient. To answer this question, imagine that the economy produces two things: good X and leisure. The production possibilities frontier (PPF) for the whole economy is shown in figure 5.5. The line that is tangent to the PPF is an iso-profit line, defined by equation 5.8.

$$\pi = P_X X + wl \Rightarrow X = \frac{\pi}{P_X} - \frac{wl}{P_X} \tag{5.8}$$

The slope of the iso-profit line is equal to $-w$ since $P_X = 1$. This means that at the tangency point, the slope of the PPF is also equal to $-w$.

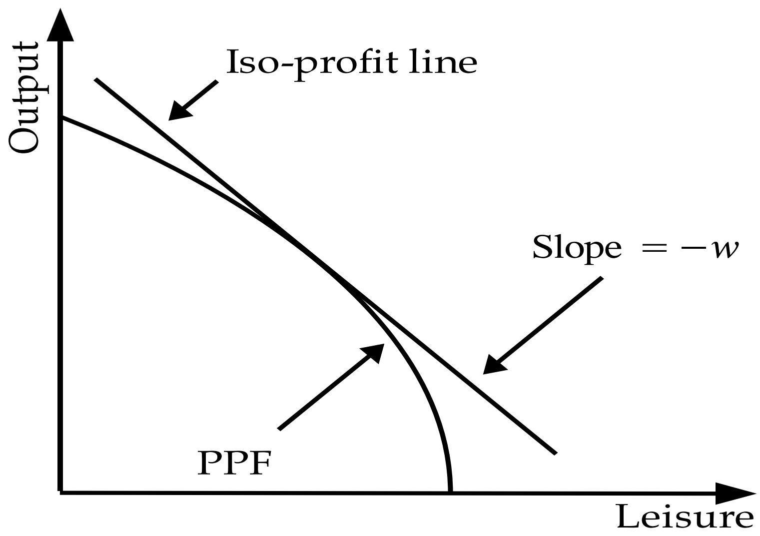

Figure 5.5: The PPF for Output and Leisure

A glance back at figure 5.1 shows that the slope of every consumer's indifference curve at the point of consumption is $-w/P_X$. Since the PPF and all of the indifference curves have the same slope, no advantageous trades can be made and the allocation of leisure—and hence labor—is efficient.

5.5 Problems

1. My model of labor supply assumes that consumers can choose the number of hours that they work.

   (a) Assume instead that a consumer can only work 0, 20, or 40 hours per week and draw her budget constraint under this assumption.

   (b) Depict an increase in the wage rate on your diagram. How will full-time workers, part-time workers and the unemployed respond?

2. Suppose that the government decides to give all consumers with an income below Y_{min} a lump-sum payment of \$A to help alleviate poverty (assume for this question that non-labor income N is equal to zero.

   (a) Draw the resulting budget constraint for consumers.

   (b) What effect will this program have on labor supply?

   (c) Can you design a better program (there is no correct answer here so use your imagination)?

3. The government decides to implement a minimum wage w_{min} to help low-income workers. How will the minimum wage affect the demand for labor and what does this imply about the success of the government's initiative?

4. Due to a series of new inventions, the productivity of labor increases across the board.

   (a) How will this increase in productivity affect the demand for labor in the short-run?

   (b) If the labor market was originally in equilibrium, what do you think will happen in the long-run? (The discussion here is informal—use your intuition.)

5.6 Solutions

1. (a) Begin by letting T represent hours in a week. I can then draw the consumer's budget constraint as shown in figure 5.6.

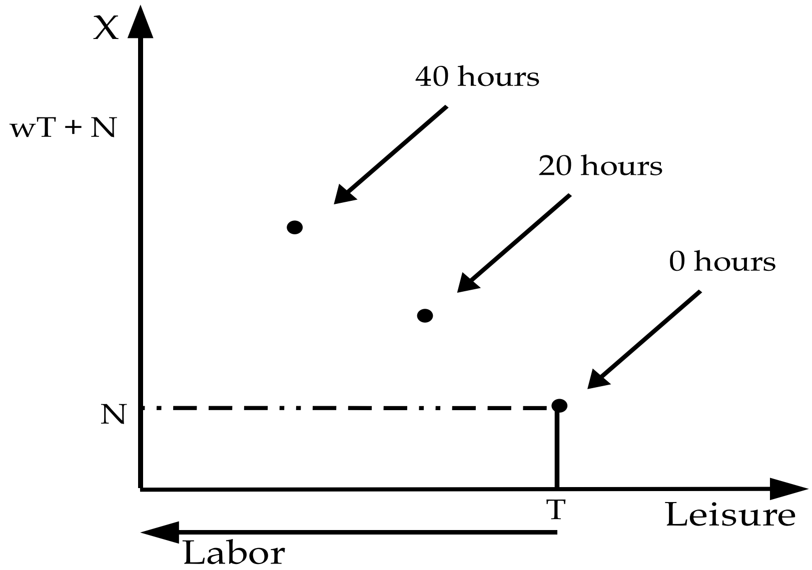

Figure 5.6: The Consumer's Budget Constraint

(b) Figure 5.7 shows the effect of the change on the budget constraint (the best way to get this diagram correct is to draw a new, continuous budget constraint and then erase all but the points directly above the old dots). Notice that the 0 hours point doesn't change. If you draw indifference curves for these consumers who were working 0 hours, you will see that the increase in the wage rate may increase their hours worked (if the new 20 or 40 hour points are inside their original indifference curves). Consumers who were working 20 hours will not decrease their hours. Their old highest indifference curve was above the 0 hours point so the new one must as well. They may increase their hours worked if their new highest indifference curve intersects the new 40 hours per week point. This situation is illustrated in figure 5.8. Consumers who were working 40 hours a week cannot increase their hours but they may remain at 40 hours a week or decrease to 20 hours a week. They cannot decrease to 0 hours per week because their original highest indifference curve was above the 0 hours per week point. Figure 5.9 shows them remaining at 40 hours per week.

2. (a) The left-hand pane of figure 5.10 shows the old budget constraint

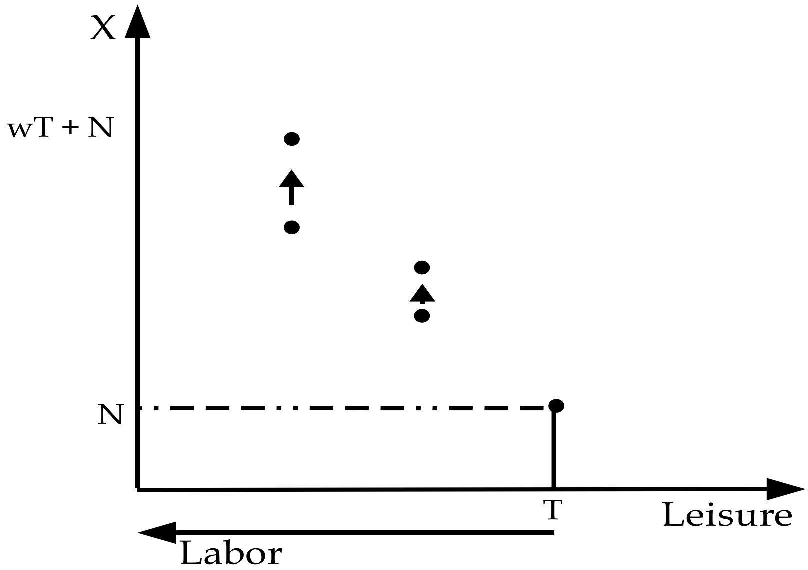

Figure 5.7: The Consumer's New Budget Constraint

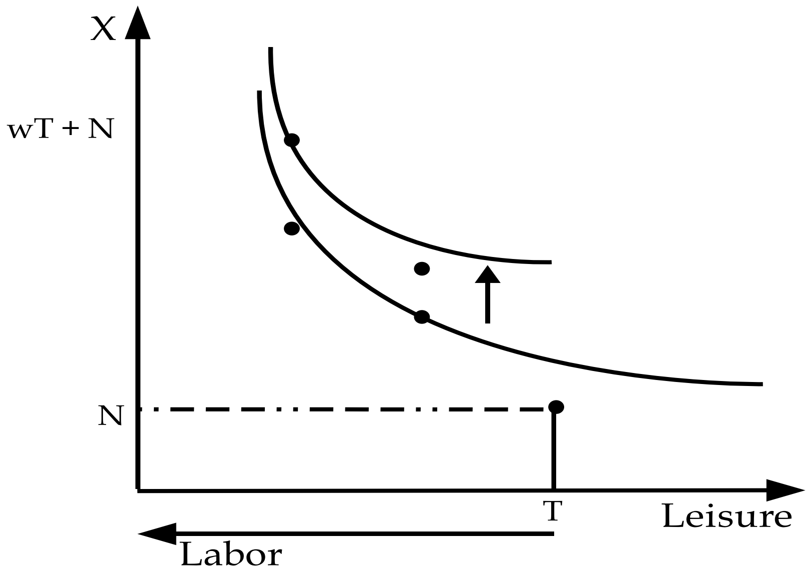

Figure 5.8: An Increase in Hours Worked

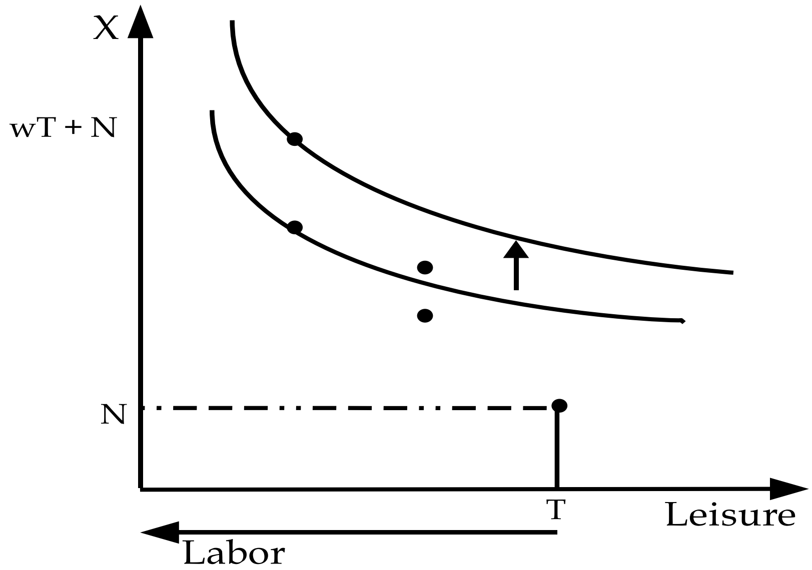

Figure 5.9: No Change in Hours Worked

and how the lump-sum transfer affects the budget constraint for those whose original income was below Y_{min}; it shifts it upward by \$A. The right-hand pane shows the new budget constraint. Notice the discontinuity at the number of hours that earns Y_{min}.

(b) Overall, it isn't clear what effect the policy will have; but for some consumers, the new policy creates an incentive to reduce hours worked. Figure 5.11 shows an example of a consumer who will reduce her hours of labor supply—her new highest indifference curve implies less hours of labor and more hours of leisure. Note though that the consumer is better off than she was—the program has improved her well–being.

(c) Figure 5.12 shows a program that pays a lump-sum transfer of \$A to consumers who currently have no income (the left-hand pane shows the effect, the right-hand pane shows the resulting budget constraint). The amount of the lump-sum transfer decreases as the income of the consumer rises so that there is no discontinuity in the budget constraint. This program design will mitigate the incentive for consumers to reduce their hours of labor. It has its own problems though—notice that the reduction in the lump-sum

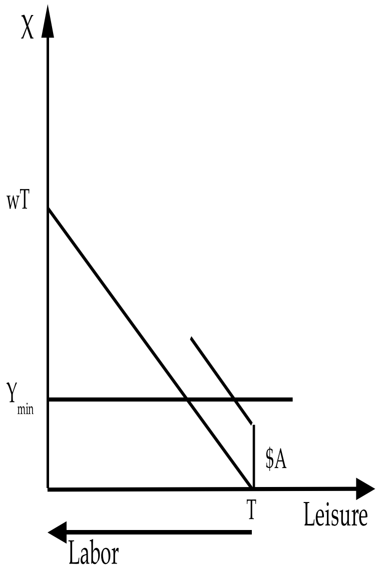

Figure 5.10: Consumers' Budget Constraints Under the New Program

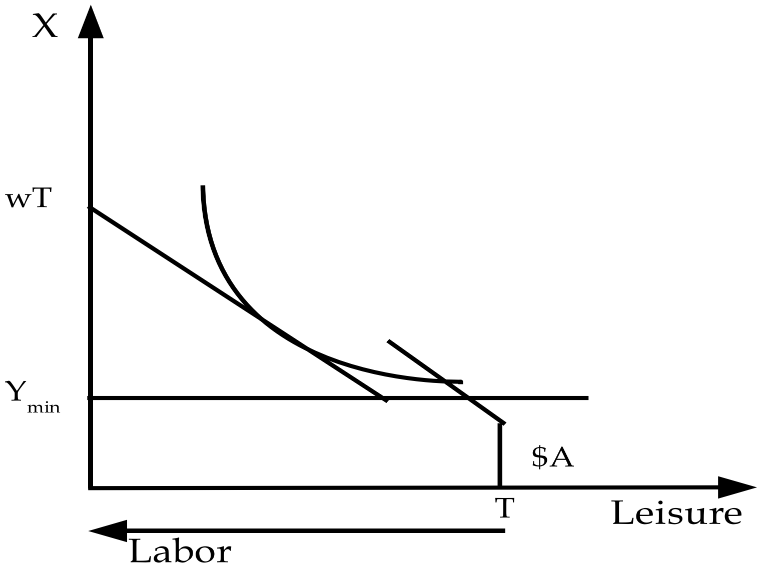

Figure 5.11: A Reduction in Hours Worked

transfer amounts to a reduction in the wage rate for consumers who earn less than Y_{min} (i.e., the budget constraint is less steep).

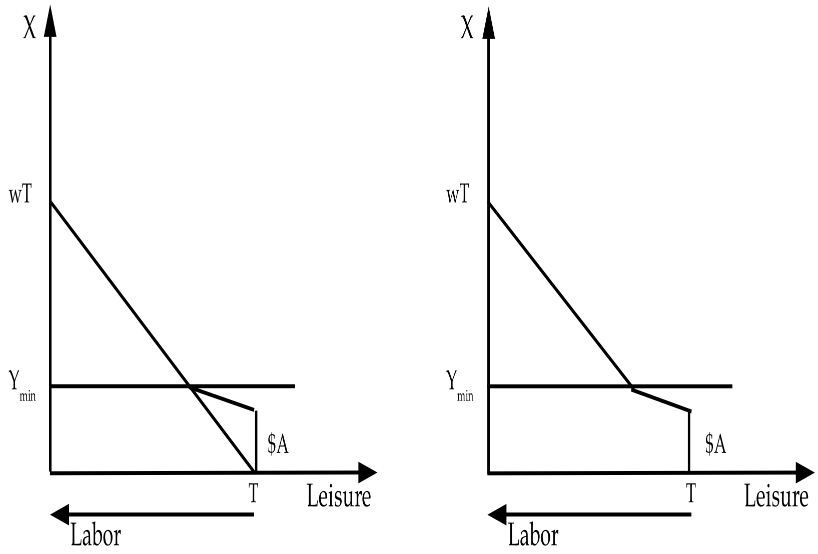

Figure 5.12: Consumers' Budget Constraints Under a Modified Program

3. The minimum wage will not affect the demand for labor if w_{min} is below the current wage rate w^*. As the left-hand pane of figure 5.13 shows, in this case, the policy is ineffectual because low-wage workers were already earning more than the minimum. Essentially, the minimum wage isn't binding—firms already pay more than w_{min}—so there is no effect on labor demand.

   If w_{min} is above w^* then the minimum wage will reduce the demand for labor (see the right-hand pane). The policy will cause some low-wage workers to become unemployed. Those who keep their jobs, however, will be better off as their incomes will have risen. The wage that firms have to pay increases, so they decrease their demand for labor to keep the wage rate equal to the value of the marginal product of labor.

4. (a) The increase in the productivity of labor will increase the marginal product of labor at every level of labor input. Thus, the value of

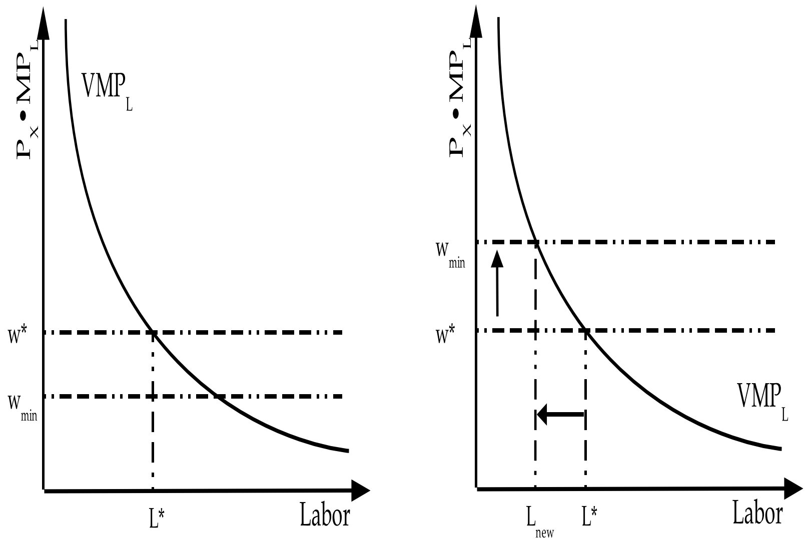

Figure 5.13: The PPF for Output and Leisure

the marginal product of labor will also increase at every level of labor input, shifting the VMP_L curve to the right. This will increase the demand for labor, as shown in figure 5.14.

(b) If the labor market is in equilibrium, there is no surplus labor supply. If firms want to increase their use of labor as an input, they must find a way to increase the supply of labor. One strategy is to increase the wage rate. This strategy might not work since the labor supply curve could be backward bending. If it does work, it will cause a decrease in the amount of labor demanded since the wage rate will have increased.

An alternative strategy would be to offer overtime wages. This will increase the supply of labor and led to a smaller decrease in the amount of labor demanded (since the increased wages are only paid on overtime hours and not all hours as in the previous strategy).

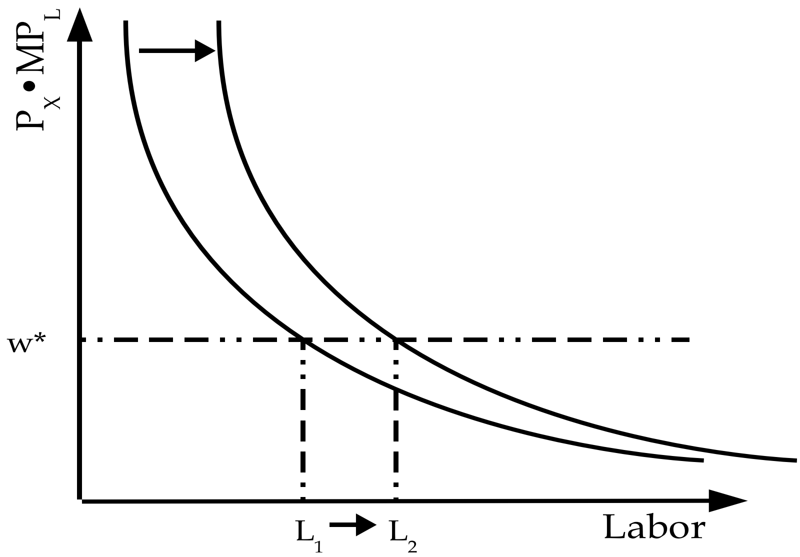

Figure 5.14: The PPF for Output and Leisure