Problem Set 1
Labor Markets: Supply, Demand and Equilibrium

Labor Supply
1. Consider a worker who earns $10 per hour. There are 168 hours in a week. Suppose that wages go up and this worker reduces labor supply.

   a. Illustrate (using a graph) the income effect and the substitution effect.
   b. In this case, is the elasticity of labor supply positive or negative? Explain.

   Elasticity of labor supply: Negative
   Income effect: Work less (dominates)
   Substitution Effect: Work more

2. Now suppose that after the wage increase, labor supply increases.

   a. Illustrate (using a graph) the income effect and the substitution effect.
   b. In this case, is the elasticity of labor supply positive or negative? Explain.

   Elasticity of labor supply: Positive
   Income effect: Work less
   Substitution Effect: Work more (dominates)

3. Linda’s hourly wage if she chooses to work is $5 per hour and she can work up to 168 hours in a week. Her utility function is \( U_L = \ln(C) + \ln(F) \) where \( C \) is consumption and \( F \) is leisure.

   a. First, draw Linda’s budget constraint in consumption-leisure space (leisure on the x axis) in the absence of a welfare program. Without any welfare, how many hours per week will Linda choose to work? How much income will she have?

   \( F^* = 84 \), Linda works 84 hrs per week.
   Income = \( W^*(Hours \ of \ Work) = 5*84 = 420 \)

   b. The government decides to set up a welfare program for all citizens. The program guarantees $150/week to everyone. The takeback rate on the program is 100 percent. Now draw Linda’s new budget constraint. How many hours does Linda choose to supply now? Over what range of hours should we never expect to see Linda working? How many hours must Linda work to be off of the welfare program?

   Linda still works 84 hrs per week.
Linda should never work from zero to 30 hours, which is how many hours it would take Linda to fully get off of the welfare program.

c. Now the government reduces the takeback rate from 100 percent to 60 percent. Draw Linda’s new budget constraint and determine how many hours Linda chooses to work now. Are there any ranges in which we should not expect to see Linda working at all? In reducing the takeback rate, how does the government affect the work incentives of different types of people? For example, people who chose to work zero hours per week when the takeback rate was 100 percent and people who chose to stay off of the program when the takeback rate was 100 percent.

Linda still works 84 hrs per week. If the takeback rate goes down (from 100 to 60 percent), workers working zero hours per week will be pulled into the market. Also, some workers who were previously off of the program will join. Linda was unaffected by the policy change.

4. Cindy’s indifference curves in leisure-consumption space (leisure on the x axis) are steeper than Mindy’s. True or False: Cindy must be offered higher wages than Mindy to work the same amount of hours?

TRUE

5. The government of a small country, Fairland, has decided to set up a program that mimics the EITC in the United States. The program will offer an initial wage subsidy of 30 percent and a takeback rate of 15 percent. The wage subsidy will apply to workers earning $100 or less per week. Once workers start earning over $300 per hour, the government will phase out the tax benefit until workers have fully paid off the subsidy. Workers in Fairland all earn $10 per hour and there are 168 hours in a week. Draw a carefully labeled budget constraint for workers in Fairland. In which directions do the income and substitution effects work on the different portions of the EITC budget constraint?

The slope of the BC should be (-13) for incomes from 0 to $100 using the original BC (0 to ten hours), slope of (-10) for incomes from $100 to $300 (10 to 30 hours) and (-8.5) over $300 per week and up to $500 (from hours 30 to 50).

6. Illustrate graphically the effect of an increase in wages on retirement age. Assume that all workers know that they will live to be 80 years old and that they can retire as early as age 60.
This will pivot the retirement budget constraint up, reflecting that the relative to returns to working have increased. The 0-years-of-retirement intercept will be higher than before.

7. Illustrate graphically the effect of an increase in pension benefits on retirement age. Assume that all workers know that they will live to be 80 years old and that they can retire as early as age 60.

The 0-years-of-retirement intercept will not change. The 20-years-of-retirement payout will go up. The slope of the budget constraint relating retirement years and income will flatten.

8. Reservation wages increase

9. Many reasons – wage growth up, reservation wages down (fertility down, value of time at household down because of technology), culture.

10. Labor supply would increase unambiguously (or, technically, either increase or not change) because there would be a substitution effect for hours above 40 but no income effect. If workers were working more than 40 hours per week already, there would be the standard income and substitution effects going in opposite directions.

11. 70*600 = 4200 utils. To get this person to continue enjoying 4200 utils worth at just 60 hours of leisure, we need 60*X = 4200. X in this case equals 700, so $100 would do the trick (you could also say $100 + epsilon where epsilon is some very, very tiny number).

12. Elasticity of labor supply with respect to wages = ΔQ/Q / ΔW/W where Q is the hours of labor supplied, W is the wage and Δ stands for “change in”. Elasticity ≈ 0.75

13. 
   a. Bill will work less than Phil after age 35. The shapes of their work paths will still look the same.
   b. Bill will always work less – his work-profile will be a shifted down version of Phil’s

14. Pure income effect – people will retire later

15. 
   a. None, assuming that wages are also fully adjusted for inflation. If wages don’t adjust and retirement benefits do, retirement will occur earlier because the return to working will fall.
   b. This worker will retire later than originally planned, again assuming that wages are fully adjusted.
**Labor Demand**

1. Suppose that elasticity of substitution between workers and capital is very high in the production of insulin, and the price of machines suddenly goes up.

   a. What will happen to the demand for labor in the insulin industry? Keep in mind that the demand for insulin is highly inelastic. Be sure to discuss both the substitution and the scale effect.

   Demand for labor will rise. The substitution effect into labor will be large because the elasticity of substitution is large, and the scale effect, working in the opposite direction, will be small because the demand for insulin is inelastic.

   b. In this case, are capital and labor gross complements or gross substitutes?

   Gross substitutes: Cross-price elasticity is positive

2. A firm has the following production function $Q = (K^{1/3})(E^{2/3})$. It will produce 80 units of output and faces prices for labor and capital as follows: $w=10$, $r =15$. Find the cost-minimizing bundle of labor and capital, $(E^*,K^*)$.

**DETAILED ANSWER:**

Cost-minimizing condition:

$$\frac{MP_E}{MP_K} = \frac{w}{r}$$

Take derivatives of production function to get $MP_E$ and $MP_K$:

$MP_E = (2/3)(K^{1/3})(E^{-1/3})$

$MP_K = (1/3)(K^{-2/3})(E^{2/3})$

$$\frac{MP_E}{MP_K} = \frac{2K}{E}$$

$$\frac{2K}{E} = \frac{10}{15} \quad (w =10 \text{ and } r=15 \text{ per above})$$

$10E = 30K$

$E^* = 3K^*$

Now plug in $3K$ for $E$ into production function, and set $Q = 80$ as indicated in the problem:
80 = (K^{1/3})(3K)^{2/3}

Pull out the term “3^{2/3}” and add the exponents on the K-terms:

80 = (3^{2/3})(K)
K^* = 80/(3^{2/3}) = 38.46
E^* = 3K^* = 115.38

Informal check to make sure there are no silly errors:

80 = ((38.46)^{1/3})((115.38)^{2/3})

3. You are a monopsonist. The labor supply function in your industry is given by \( L_s = -50 + 5W \), where \( L \) is the labor supply, \( W \) is the wage and \( a \) and \( b \) are constants that are both greater than zero.
   a. Write down the “inverse labor supply curve” (\( W \) as a function of \( L \)).
      \[ W = L/5 + 10 \]
   b. If you wish to employ 20 workers, what wage must you pay?
      14
   c. What’s your total wage bill (Wages x Employment) if you employ 20 workers?
      280
   d. What is your marginal cost of hiring the 21\textsuperscript{st} worker? What does the 21\textsuperscript{st} worker earn in wages? What about the 22\textsuperscript{nd} worker?
      18.2, 14.2; 18.6, 14.4

4. Difference-in-Difference Estimation. A few years ago, an economist from MIT named Jonathan Gruber did a study of the effect of mandated maternity benefits on the wages of women between 20 and 40 years old. His study bears many similarities to the study we looked at in class that examined the effect of an increase in the minimum wage in New Jersey on employment levels of fast food workers in that state. Here is a brief outline of Gruber’s study:

In October 1978, the Federal Government passed a law mandating the provision of maternity benefits. However, this law only affected a subset of all states since many states had already passed state-level laws mandating maternity benefits (and so were unaffected by the passage of the Federal law). For simplicity, I will refer to the states that were affected by the law change as “treatment states” and states that were
unaffected by the law as “control states”. Gruber found that before the law change, the average wage of women in the control states was $3.90, and the average wage of women in the treatment states was $4.70. In addition, after the law change, the average wage of women in the control states was $4.04, and the average wage of women in the treatment states was $4.54.

a. A naïve analysis of the effect of the mandated maternity benefits on wages would compare the average wages of women in the treatment states before and after the law went into effect. This simple comparison indicates that the effect of the mandated maternity benefits on wages was -$0.16. Calculate the difference-in-difference estimate of the effect of the mandated maternity benefits. Does the simple comparison understate or overstate the effect? By how much? Why might the difference-in-difference estimate be preferred to the simple comparison?

\[ \text{Diff in Diff} = -0.3 \]
Simple comparison understates
Diff in diff uses a control group to remove the effects of other factors from your estimate
Labor-Market Equilibrium

1. Suppose that the government decides to levy a payroll tax on workers. Assume that the elasticity of labor demand is less than the elasticity of labor supply.
   a. Relative to when there are no taxes, use a graph to illustrate how this tax will affect the wage that firms pay workers, the amount that workers receive after taxes and the equilibrium employment level.

   Firms pay workers a wage that is higher after the tax. However, workers will take home less than before. See Figure 5.5 in text

   b. On your graph, show tax revenue and deadweight loss.
   c. In what sense are firms worse off because of the tax, even though the tax is levied on workers?

   Firms are worse because now they have to pay more to workers – they pay some of the tax. Also, you should be able to show in your graph that firm surplus falls.

   d. Who will bear the burden of the tax? Explain.

   Both sides will share the burden, but firms will bear a larger burden because labor demand is more inelastic in this case

2. Suppose that the government decides to levy a payroll tax on firms. Assume that the elasticity of labor demand is greater than the elasticity of labor supply.
   a. Relative to when there are no taxes, use graph to illustrate how this tax will affect the amount firms pay for a worker after taxes, the amount that workers receive and the equilibrium employment level.

   b. On your graph, show tax revenue and deadweight loss.
   c. In what sense are workers worse off because of the tax, even though the tax is levied on firms?
   d. Who will bear the burden of the tax? Explain.

   Similar to #1. See notes.

3. Suppose that the government mandates that firms provide their employees with healthcare. Suppose that the value of the healthcare to each worker is $1 per hour and that the cost to the firm of providing the healthcare to each worker is $1 per hour.
   a. Using a supply and demand graph illustrate the effect of this government mandate on the equilibrium wage and employment level.

   Wage will fall by the value of the healthcare, $1 per hour. Employment will be unchanged
b. Are workers made better off or worse off as a result of this program? Explain.

Workers are indifferent to the program - they value the benefit at the cost firms pay for it.

c. Now imagine that workers have difficulty obtaining healthcare on their own because of adverse selection. So, instead of valuing employer-provided healthcare at $1, they value it at $1.50 per hour. The cost to firms is still $1 per hour. Are workers made better off or worse off as a result of the program? Are firms made better off or worse off? What happens to labor supply?

Workers and firms are both better off. Labor supply shifts down (to the right) more than labor demand shifts down (to the left) so total employment increases.

4. Suppose that migration from Mexico has caused an increase in the number of migrant workers available to harvest the grape crop in California.

a. You are a farm worker who picks grapes. How do you feel about the migration of workers from Mexico? Explain using a graph.

Immigrant labor is a substitute for your labor. You are unhappy because wages will fall.

b. You are a Yuppie and love to drink wine. How do you feel about the migration of workers from Mexico? Explain using a graph.

You will be happy, the price of wine will fall because the marginal costs of production will fall, meaning output will rise, meaning industry supply will shift right.

c. You own stock in a company that makes machinery that is designed to help harvest grapes. How does the migration of workers into this country affect the demand for harvesting machinery? How does your answer depend upon the scale effect and the substitution effect?

The substitution effect means that firms will use less machinery and more workers now that workers are cheaper. The scale effect means that output will increase because costs have gone down, per the answer in (b). The demand for your machinery depends on which effect dominates – scale or substitution.

5. Recently, a group of American civilians called the Minutemen has begun patrolling the U.S.-Mexico border in an attempt to stop illegal immigrants from entering into the United States. Suppose that the Minutemen are successful at reducing the number of Mexican immigrants in the United States. Assume that Mexican immigrants and U.S. workers have different skill levels, so that Mexican immigrants and U.S. workers can be thought of as separate inputs in production.
a. How would a reduction in the number of Mexican immigrants affect the wages and employment levels of U.S. workers? How does your answer depend upon the scale effect and the substitution effect?

A reduction in immigrant labor will raise the price of immigrant labor, and firms will want to substitute into native labor. However, rising immigrant-labor costs will result in less output, so the scale effect implies firms will hire less native labor. Depending on which effect is bigger, the demand for native labor could increase or decrease.

b. Suppose that the elasticity of demand in the output market tends to be very low. How will this influence your answer to part a?

This implies the scale effect will be small – the overall demand for native workers should increase.