Macro module 11: Labor market practice problems

*Practice problems and illustrative test questions for the final exam*

(The attached PDF file has better formatting.)

This posting gives sample final exam problems. Other topics from the textbook are asked as well; these problems are just examples. All final exam problems are multiple choice; some practice problems are not multiple choice so that the solutions can be better explained.

*Question:* Why does Module 11 have so many practice problems, whereas Modules 6-10 have so few?

*Answer:* Barro develops the macroeconomic model for capital use and unemployment in Modules 6-11. The practice problems in Module 11 cover the material studied in Modules 6-11.

** Exercise 11.1: Labor Force (diamond workers)

Unskilled men in parts of the Congo either harvest crops by hand or search for diamonds by hand. All workers can do both tasks.

- Men do not search for diamonds on their own; they are hired by diamond firms, which pay an hourly wage.
- The Congo has limited land on which to search for diamonds. If more workers search for diamonds, each worker finds fewer diamonds.
- The number of diamond workers in the Congo does not affect the price of diamonds. (The Congo is a small part of the diamond market.)

In 20X9, a drought ruins the harvest, and the *demand for farm laborers falls*.

A. What happens to the supply curve for diamond workers?
B. What happens to the demand curve for diamond workers?
C. What happens to the equilibrium number of diamond workers?
D. What happens to the real wage rate for diamond workers?

*Part A:* The supply curve of diamond workers is the number of workers who want to search for diamonds at a given real wage rate. Suppose the real wage rate is $2 an hour for diamond workers

- When the harvest is bountiful, landowners pay more than $2 an hour for farm laborers. More workers find jobs on farms, and fewer workers hunt for diamonds.
- When the harvest is poor, landowners pay less than $2 an hour for farm laborers. Few workers find jobs on farms, and more workers want to hunt for diamonds.

A lower demand for farm workers causes a lower real wage rate for farm workers and a lower equilibrium number of farm workers. More workers are willing to search for diamonds at any given real wage rate. The supply curve for diamond workers shifts right. The supply curve is upward sloping, so the curve shifts down.

*Take heed:* The horizontal axis of the supply and demand curves is the quantity of the good (the amount of labor). The vertical axis is the marginal product of labor for the demand curve and the real wage rate for the supply curve. When the market clears, the real wage rate equals the marginal product of labor.

*Part B:* The demand for diamond workers is the number of workers that diamond firms want to hire, which depends on the marginal product of labor. The first worker has millions of acres of land (the Congo is huge), so his marginal product of labor is high. If a million workers search for diamonds, each one finds few diamonds their marginal product of labor is low. The marginal product of labor is downward sloping, so the demand curve for labor is downward sloping.

The capital stock, the technology level, and the price of the goods produced affect the marginal product of labor. If the capital stock increases, the marginal product of labor increases, and the demand curve shifts right – employers want more workers. In this scenario, if workers get tools with which to search for diamonds, their marginal product of labor rises, and employers want more workers. If the technology level rises, the marginal product of labor increases, and the demand curve curve shifts right. In this scenario, if people learn advanced methods of searching for diamonds, their marginal product of labor increases. If the price of diamonds rises, diamond workers produce more valuable goods, so their marginal product of labor rises and employers want more workers (the demand curve shifts right).

In this exercise, the capital stock, the technology level, and the market price of diamonds have *not* changed. Employers pay a real wage rate based on the marginal product of diamond workers' labor. The demand curve for diamond workers does not change.

*Take heed:* The horizontal axis of the supply and demand curves is the quantity of the good (the amount of labor). The vertical axis is the marginal product of labor for the demand curve and the real wage rate for the

supply curve. When the market clears, the real wage rate equals the marginal product of labor. The vertical axis of the demand curve sometimes has the marginal product of labor and sometimes the real wage rate. The vertical axis of the supply curve always has the real wage rate.

*Parts C and D:* The supply curve of diamond words shifts right and the demand curve does not change. The intersection of the supply and demand curves is at a *higher quantity of labor* and a *lower price for labor* (real wage rate).

** Exercise 11.2: Equilibrium business cycle model and labor markets

According to the equilibrium business cycle model

A. What causes economic fluctuations?
B. How does an economic boom affect the marginal product of labor?
C. How does an economic boom affect the demand curve for labor?
D. How does an economic boom affect the real wage rate?
E. How does an economic boom affect the amount of labor supplied?
F. How does the amount of labor supplied affect real GDP?

*Part A:* The equilibrium business cycle model says that economic fluctuations reflects shocks to the technology level A.

*Question:* Can you give examples of this?

*Answer:* For advanced, highly-diversified economies like the U.S. and western Europe, fluctuations in the technology level are sometimes hard to associate with economic fluctuations. For developing economies in Asia and Africa, the effects are clear. For example, changes in the technology level from genetically modified crops, cell phones that enable farmers to get weather reports and price information, and micro-finance led to agricultural or business booms.

*Question:* Is the relation of economic fluctuations and the technology level not true for the U.S.?

*Answer:* The relation is true for the U.S., but it is harder to see for the country as a whole. For individual cities, it is clear. A new invention may lead to a rapidly growing company and higher employment in a city, causing an economic boom. For example, advances in the technology level led to an economic boom in Seattle.

*Part B:* An economic boom reflects a higher technology level, so the marginal product of labor rises. For example, suppose each worker can harvest one acre of crops. If the technology level rises and farmers plant genetically modified crops, which produce a larger harvest, each worker produces more. If an engineer invents an inexpensive tractor, each worker can harvest more than one acre.

*Part C:* The demand curve for labor shows the relation of the marginal product of labor (on the vertical axis) and the amount of labor demanded (on the horizontal axis). The demand curve slopes downward, so a higher marginal product of labor causes the demand curve to shift right.

*Part D:* The real wage rate is at the intersection of the demand curve for labor and the labor supply curve. The supply curve slopes upward, so if the demand curve shifts to the right, the intersection is at a higher point. The real wage rate is on the vertical axis, so a higher point means a higher real wage rate.

*Part E:* The real wage rate is at the intersection of the demand curve for labor and the labor supply curve. The supply curve slopes upward, so if the demand curve shifts to the right, the intersection is at a point farther to the right, or a higher amount of labor.

*Part F:* The higher amount of labor further increases real GDP.

See Barro, Macroeconomics, Chapter 8, pages 146-147.

** Exercise 11.3: Labor markets

A firm invents a new crop that grows twice as quickly and an engineer develops a new tractor that costs half the price and enables farm laborers to be twice as productive.

A. The production function considers labor, capital, and the technology level. Which change in this scenario?
B. What is the effect on the marginal product of capital?
C. What is the effect on the marginal product of farm labor?
D. What is the effect on the demand curve for farm labor?
E. What is the effect on the demand curve for capital?
F. What is the effect on the supply curve for farm labor?
G. What is the effect on the employment rate for farm labor?
H. What is the effect on the real wage rate for farm labor?

*Part A:* The labor supply has not changed. The population has not changed and the same people are ready to work on farms. The technology level changes with the new crops and the new tractors.

*Part B:* Suppose a tractor costs $10,000. The old tractors could increase production by $2,000 at the margin, for a marginal product of capital of 20%. The new tractors are more efficient, so the marginal product of capital increases. Farmers buy more tractors, so the marginal product of capital will not be twice as great as before. But the new equilibrium takes a while.

Once farms buy more tractors, capital changes. Initially, just the technology level changes. Over time, workers migrate from cities to farms and more capital is invested in farm equipment.

*Part C:* With the new crops and new tractors, each worker can produce more, so the marginal product of labor increases. The labor supply in most countries changes slowly. In many countries, population is decreasing. In some countries, there are many unemployed persons willing to work on farms; in the United States and Europe, it is hard to find willing workers. With a stable or declining labor force and higher technology level, the marginal product of labor increases.

*Part D:* With a higher marginal product of labor, farms want to hire more workers, so the demand curve for farm labor shifts to the right. For a downward sloping demand curve, this is a shift upwards.

*Question:* Is this a shift of the demand curve or a movement along the demand curve?

*Answer:* This is a shift of the demand curve. The vertical axis is the real wage rate and the horizontal axis is the demand for labor. With the old technology level, at a real wage rate of $10 an hour, employers might want 10,000 farm workers. With the new technology level, they might want 20,000 workers. The demand curve shifts to the right.

*Part E:* The demand curve for capital shift to the right. With the old technology level, at a real rental price of 10% per annum, employers might want 1,000 tractors. With the new technology level, they might want 2,000 workers. The demand curve shifts to the right.

*Part F:* In the short run, the supply curve for farm labor does not change. Immigration from other countries and migration from farms to cities (or vice versa) affects the labor supply, but these changes are gradual.

*Part G:* The supply curve for farm labor does not change and the demand curve shifts to the right, so the intersection occurs at a greater supply of labor (more to the right). The employment rate for farm labor is low in many countries, though it is not well documented. In the United States, there are many Hispanic workers (some illegal immigrants, some legal immigrants, and many still living in Latin America) who will take jobs if offered. If the demand curve shifts to the right, more of these workers are hired.

*Part H:* The supply curve for labor is upward sloping. If the equilibrium quantity of labor moves to the right, the real wage rate moves up. One can also state this as: the demand curve for labor shifts up, so the intersection moves up. The real wage rate is the marginal product of labor. Since the marginal product of labor increases, the real wage rate increases.

*Question:* In the real world, the technology level for agricultural production has increased many-fold from better crops and better machines, but the percentage of people living on farms decreases each year. Doesn't this show that as capital increases, labor decreases?

*Answer:* First, the marginal product of farm labor may have increased 100% over the past generation, but the marginal product of industrial labor increased much more.

** Exercise 11.4: Technology level

Half the workers in Bangladesh sew clothes for sale as exports to Western Europe; the other half are farm workers. Bangladesh is a small country, and its exports are a tiny portion of the world clothes market. Workers are paid an hourly wage, which reflects the marginal product of labor.

- In 20X4, workers sew clothes with no machines.
- In 20X5, factories buy sewing machines that enable workers to sew clothes twice as efficiently.

A. How do the sewing machines affect the demand curve for workers who sew clothes?
B. How do the sewing machines affect the supply curve for workers who sew clothes?
C. How do the sewing machines affect the demand curve for clothes sewn in Bangladesh?
D. How do the sewing machines affect the supply curve for clothes sewn in Bangladesh?
E. How do the sewing machines affect the real wage rate for textile workers in Bangladesh?
F. How do the sewing machines affect the number of textile workers in Bangladesh?
G. How do the sewing machines affect the number of farm workers in Bangladesh?
H. How do the sewing machines affect the real wage rate for farm workers in Bangladesh?

*Part A:* Suppose a worker could sew five shirts in an hour without the new sewing machine, and firms would hire 1,000 workers at the going rate of $2 an hour. With the new sewing machine, workers sew 10 shirts an hour, and firms want to hire more workers at the rate of $2 an hour, so *the demand curve shifts to the right*.

*Part B:* The supply curve is the same workers as before. At a rate of $2 an hour, the same number of people want to work. If the real wage rate increases, more of these people take jobs sewing shirts. That is a shift in the quantity supplied, not a shift in the supply curve.

*Part C:* The international clothes market is competitive. A small country like Bangladesh has no market power. It faces a flat demand curve at the going international price for clothes. The demand curve does not change because it can produce clothes more efficiently.

*Part D:* Bangladesh can produce twice as many clothes with its workers, so its supply curve shifts to the right.

*Part E:* In a competitive market, the real wage rate equals the marginal product of labor. The new sewing machine doubles the marginal product of labor, so the real wage rate increases.

*Part F:* The real wage rate for textile workers rises, so the some farm workers come to work sewing clothes, and the number of textile workers increases. Graphically, the demand curve for textile workers moves to the right (increases) and the supply curve does not change.

- The intersection of the supply and demand curves occurs further to the right.
- The supply curve is upward sloping, so a point further to the right is higher.

Farther to the right mean a higher quantity of workers and a higher real wage rate.

*Part G:* The increase in textile workers is from farm workers who move to the city. The number of farm workers declines.

*Part H:* The marginal product of labor curve is upward sloping. If the number of farm workers decreases, their marginal product of labor increases, and their real wage rate increases.

*Question:* It seems that everyone gains: both textile workers and farm workers. Is that so?

*Answer:* Yes: capital deepening can raise wages for everyone. Capital investment is the best way to improve the conditions of workers in poor countries.

** Exercise 11.5: Capital Deepening

In 20X4, Arasia has many workers and few machines. The real interest rate is 5% per annum, the marginal product of labor is $10 per hour, and the marginal product of a machine (capital) is $20 per hour.

In 20X5, the country produces machines for all its workers and teaches workers to use the machines.

In 20X6, the country has more machines than workers. The technology level has not changed.

A. Does the marginal product of labor increase, decrease, or stay the same from 20X4 to 20X6?
B. Does the real wage rate increase, decrease, or stay the same from 20X4 to 20X6?
C. Does the marginal product of capital increase, decrease, or stay the same from 20X4 to 20X6?
D. Does the real rental rate increase, decrease, or stay the same from 20X4 to 20X6?
E. Does the real interest rate increase, decrease, or stay the same from 20X4 to 20X6?

*Part A:* The capital per worker increases. With more machines per worker, each worker accomplishes more, so the marginal product of labor increases.

*Part B:* In equilibrium, the real wage rate equals the marginal product of labor, so the real wage rate increases.

*Part C:* In 20X4, each additional machine could be used by several workers in the most efficient place, so the marginal product of capital is high. In 20X6, all workers already have machines. The value of an additional machine, which is the marginal product of capital, is lower.

*Part D:* In equilibrium, the real rental rate is the marginal product of capital, so the real rental rate decreases.

*Part E:* The real interest rate is the marginal value of capital. If workers already have enough machines, no one buys more machines, so no one has incentive to produce more machines. Firms no longer want to borrow money to produce machines, so the real interest rate falls.

*Question:* Can you generalize the implications of this exercise?

*Answer:* Know four cases:

- If capital increases with no change in the labor force, the marginal product of labor rises and the marginal product of capital declines. This scenario is most common, stemming from an open economy with foreign investment and strong birth control. China is the best example.

- If the population increases with no change in capital, the marginal product of labor declines and the marginal product of capital rises. This scenario is common in some African and Arab countries, stemming from a closed economy with no foreign investment, no domestic middle class, and high birth rates.

- If capital decreases with no change in the labor force, the marginal product of labor declines and the marginal product of capital rises. This scenario occurs after civil wars that destroy the country's assets and deter foreign investment but have a smaller effect on the work force. Cambodia and Vietnam were examples a generation ago; several African nations are examples now.

- If the population decreases with no change in capital, the marginal product of labor rises and the marginal product of capital declines. This scenario is *not* common, though a severe epidemic might cause this, such as AIDS in some countries of southern Africa.

** Exercise 11.6: Market for labor

In the equilibrium business cycle model, if the labor demand curve shifts right, what happens to each of the following?

A. The unemployment rate
B. The real wage rate
C. The job finding rate
D. The job separation rate
E. Job vacancies

*Part A:* If the labor demand curve shifts right, businesses want more workers at any given real wage rate. If the labor supply curve shifts left, workers supply less labor at any given real wage rate. Fewer people remain unemployed, so the unemployment rate decreases.

*Part B:* If the economy had much involuntary unemployment, more people might start working after the shifts in the labor supply and demand curves. But the equilibrium business cycle model assumes unemployment reflects the complexities of switching jobs. If the real wage rate does not change, the economy is not in equilibrium: business want to hire more workers. To clear the labor market, the real wage rate increases. At the higher real wage rate, businesses want fewer workers and workers supply more labor.

*Part C:* If the real wage rate increases, jobs become more attractive to unemployed workers.

*Illustration:* Suppose the real wage rate is $8 an hour, and unemployed workers get unemployment benefits of $5 an hour. If leisure is worth $4 an hour, unemployed workers have little incentive to return to work. If the real wage rate rises to $10 an hour, the same workers want to find jobs more than before.

The black market for labor has similar effects. Some persons work off the books; they are unemployed officially, but they may be earning $4 an hour in the black market. If the real wage rate increases to $10 an hour, they seek regular work.

*Part D:* If the demand curve for labor shifts to the right, employers want more workers. They are more reluctant to fire the workers they have, lest they be unable to find others. The job separation rate decreases.

*Part E:* With a higher demand for labor, more jobs are vacant, so job vacancies increase.

*Question:* What causes the demand curve for labor to shift right?

*Answer:* In the equilibrium business cycle model, the demand curve for labor shifts right or left because of changes in the technology level. If the technology level increases, the marginal product of labor increases, and businesses want to hire more workers.

*Illustration:* In 1800, an employer hires 10 workers to sew clothing by hand. Each worker makes one set of clothing a day, from which the employer earns $20. If someone invents a sewing machine, each worker can sew five sets of clothing a day. The employer wants to hire more workers, since the employer now earns $100 a day from each worker.

*Question:* Isn't it also true that as the technology level advances, fewer workers are needed because machines do all the labor?

*Answer:* That view is often heard: it was associated with the Luddites in 19$^{th}$ century England, and it is often expressed by populist politicians seeking to stir up anti-capitalist anger. When the technology level rises, some unskilled workers may not be able to find unskilled jobs, since all jobs require computer literacy and the ability to work with complex machines. But many more skilled jobs are created. A higher technology level increases

the marginal product of labor, so employer want to hire more workers. Similarly, more capital (such as more sewing machines in the factory) increase the marginal product of labor.

*Question:* Does the supply curve for labor shift right or left as the technology level changes?

*Answer:* The technology level does not have a direct effect on the supply curve for labor. Over the long-run, the supply curve for labor in most countries has been increasing as women enter the labor force. Women are now about 51% of the U.S. labor force, and they are a rising percentage in almost all developing countries.

*Question:* As the supply of labor increases, the supply curve shift right. If the demand curve for labor doesn't change, the real wage rate decreases. Has this been happening?

*Answer:* In almost all countries, women's participation in the labor force is accompanied by higher education and better health care, both of which raise the real wage rate. Finally, women tend to have higher skilled jobs than men (doctors, lawyers, actuaries, and other professionals), so the marginal product of labor and the real wage rate increase. There may be more male doctors, lawyers, and actuaries than female ones at the moment, but the numbers of new doctors, lawyers, and actuaries is skewed towards women.

See Barro, Macroeconomics, Chapter 8, page 136, Figure 8.8

** Exercise 11.7: Minimum wage

Chicago raises the minimum wage from $5.50 to $8.50 an hour so that all employees earn a living wage. Chicago has many pizza shops and restaurants that hire teen-age workers and small shops that hire part-time sales clerks at the minimum wage. How does the higher minimum wage affect each of the following?

A. The quantity *demanded* of unskilled labor
B. The quantity *supplied* of unskilled labor
C. The use of capital vs unskilled labor
D. Unemployment of teen-age workers
E. Workers whose marginal product of labor is less than the new real wage rate

Answer 11.7: D

*Part A:* Unskilled labor costs more after the increase in the minimum wage, so less is demanded. A pizza shop may pay an unskilled teen-ager $5.50 an hour because the hour's work is worth $5.50. If the pizza shop must pay $8.50 an hour, it prefers to hire a skilled older worker with a higher marginal product of labor.

*Part B:* If wages for unskilled labor increase, more unskilled workers apply for jobs. The labor supply curve does not change, but if employers pay higher wages, more workers apply. In practice, employers won't pay wages higher than the marginal product of unskilled labor. If teen-age workers and sales clerks find that fewer jobs are offered, some of them give up looking for work.

*Part C:* Unskilled labor costs more, so firms substitute capital for labor. Instead of hiring check-out clerks, supermarkets may install self-checkout lanes with machines (capital) for reading the prices of goods.

*Illustration:* Many factories in France are highly automated: machines do the work, with few human workers. The French say they are more intelligent that other nations, so they more easily automate their factories. Economists say that restrictions on labor in France, such as the 35 hour work week, the difficulty of firing unneeded workers, and the high benefits, reduce the relative value of labor. Firms substitute capital for the high-priced labor. The French are not more intelligent that other nations. Rather, French politics prevents the optimal use of labor.

*Part D:* Many teenagers work at the minimum wage, since their marginal product of labor is low. If demand for teen-age labor falls, the unemployment rate *increases*.

*Part E:* The equilibrium real wage rate is the marginal product of labor. In free labor markets, workers with a marginal product of labor of $5.50 an hour receive $5.50 an hour in wages. If the minimum wage is $8.50 an hour, firms do not hire these workers.

The effects of minimum wage laws are best seen by a comparison with consumer products. Suppose beef costs $5.00 a pound on free markets, and 40 farms produce 10,000 pounds of beef apiece. Legislators fear that farmers are not earning a living wage, so they decree that beef be sold for not less than $10.00 a pound.

Consumers substitute cheaper foods for beef. They eat more fowl or fish and less beef. The quantity of beef demanded declines from 400,000 pounds to 100,000 pounds.

Of the 400,000 pounds that farmers supply, only 100,000 are bought. The other 300,000 pounds that farmers supply but can not sell are like unemployed labor: people who want to work but no firm wants to hire them.

*Question:* Does this happen in the real world?

*Answer:* The real world is worse. Farm price supports in the U.S. and Western Europe give farmers extra income through transfer payments. Consumers pay more for food and farmers produce too much, which is

sold to third world countries. Farmers in third world countries can not compete with government subsidized crops. Everyone loses – except the farmers in the U.S. and Western Europe.

*Illustration:* Farmers in Africa produce 200 bushels of wheat a year and sell them for €200. Farmers in France produce 1,000 bushels of wheat a year and sell them for €1,000. A French farmer makes 5 times as much as an African farmer, because the French farmer works with more equipment (capital) and has a higher marginal product of labor.

The European Union creates a farm subsidy that pays French farmers an additional €0.25 for each bushel of wheat. French farmer produce more: 1,200 bushels of wheat. They sell 1,100 bushels at €0.75 in Europe. The other 100 bushels are sold in Africa at €0.75 a bushel. African farmers can't produce wheat at €0.75 a bushel, so they sell just the remaining 100 bushels.

In sum, African farmers go hungry, EU taxpayers subsidize French farmers, and French farmer are happy.

*Take heed:* The terms differ among economists. The natural unemployment rate reflects the time needed to search for jobs and workers. Some economists say the higher minimum wage raises the unemployment rate above its natural level. Other economists (like Barro) do not distinguish among causes of unemployment. The higher minimum wage reduces the job finding rate and raises the natural unemployment rate.

** Exercise 11.8: Minimum Wage and Pizza Shops

A city has pizza shops and restaurants that employ waiters, busboys, and cooks.

- Pizza shops cater to blue collar consumers and hire teen-age staff earning $6 an hour.
- Restaurants cater to white collar consumers and hire skilled staff earning $12 an hour.

The city has 50 pizza shops and 50 restaurants. Each store serves 1,000 people a week.

To reduce income inequality, the city set a minimum wage of $12 an hour.

A. What is the effect of the new minimum wage on the demand demanded of teen-age labor?
B. Because of the new minimum wage, pizza shops move to other cities. Some consumers who previously ate pizza now eat at restaurants. What is the effect on the demand curve for skilled restaurant staff?
C. What happens to the real wage rate for skilled restaurant staff?
D. Who gains from the minimum wage law?

*Part A:* Pizza shops can not afford to pay $12 an hour for teen-age labor, so the quantity demanded declines.

*Part B:* The restaurants need more workers, so the demand curve shifts to the right.

*Part C:* The higher demand causes the equilibrium wage to rise; restaurant workers get paid more in the short run. In the long-run, more restaurants open and more workers are trained. Eventually, the wages of skilled restaurant staff fall back to their previous level.

*Part D:* Restaurant workers gain.

- Teen-age workers are now unemployed; they lose.
- Restaurant workers are paid more and work more; they gain.
- Reduced competition hurts consumers; they lose.
- Pizza shop owners have to close and move to other cities; they lose.
- Income inequality increases, since teen-age workers are unemployed and restaurant workers earn more.

** Exercise 11.9: Job finding rate cyclicality

The job finding rate is pro-cyclical: higher in prosperous years than in recessions.

A. What is the definition of the job finding rate?
B. How is the job finding rate often measured?
C. Why does this measurement over-state the true job finding rate?
D. How do job vacancies affect the job finding rate?
E. How does the real wage rate affect the job finding rate?

*Part A:* The job finding rate is the percentage of unemployed persons who accept new jobs.

*Part B:* One measure is the number of new hires divided by the number of unemployed persons.

*Part C:* This measure over-states the true job finding rate for two reasons:

- Some new jobs are taken by people not in the labor force, such as students and retirees
- Some new jobs are taken by people currently employed, who switch jobs without being unemployed

*Part D:* A higher technology level raises the marginal product of labor and the marginal product of capital, and real GDP rises (prosperous years). Employers want more workers and advertise more job vacancies, so more unemployed persons find jobs (the job finding rate increases).

*Part E:* A higher marginal product of labor causes a higher real wage rate. More unemployed persons accept job offers, since the real wage rate offered is higher (the job finding rate increases).

*Question:* In recessions, people are more likely to accept jobs, since they don't have other work. Doesn't this make the job finding rate anti-cyclical?

*Answer:* Barro has an ingenious argument to show why this is not true.

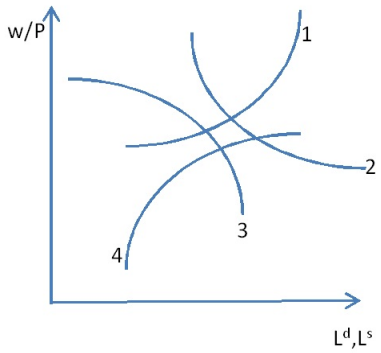
Suppose that the real wage rate is $10 an hour in prosperous years and people take 50% of job offers. Their likelihood of accepting a job depends on (i) the income from unemployment benefits, welfare payments, and other government transfers, (ii) work in the black market, and (iii) the value of leisure time. Leisure does not mean sleeping all day. Leisure time is most valuable if it is used for education. For example, a student who graduates from college in August (after summer classes) may spend September and October studying for actuarial exams and not begin looking for work until mid-November.

Suppose the real wage rate declines to $8 an hour in a recession. If the value of unemployment benefits, welfare payments, other government transfers, work in the black market, and leisure time also declines 20%, the job finding rate should not change. In practice, these other items do not change much in recessions. (In the United States, the duration of unemployment benefits sometimes lengthens during recessions.) The job finding rate declines in recessions: fewer jobs offers are made by employers (who have fewer job vacancies), and the real wage rate for these jobs is lower.

See Barro, Macroeconomics, chapter 9,page 169

** Exercise 11.10: Supply and demand curves

Four curves are drawn on the graph below. The four curves differ by their slope and convexity.




A. What are the axes for the labor supply and demand curves?
B. Which curve is the labor supply curve? Assume the substitution effect is stronger than the income effect.
C. Which curve is the labor demand curve?

*Part A:* The axes are labeled on the graph. The vertical axis is the real wage rate, w/P, for both curves. The horizontal axis is the amount of labor supplied $L^s$ for the labor supply curve and the amount of labor demanded $L^d$ for the labor demand curve.

*Part B:* The substitution effect causes the labor supply curve to slope upward, and the income effect causes it to slope downward.

Substitution effect: a higher real wage rate makes labor more valuable relative to leisure, so people want to work more: the supply curve slopes upward.
Income effect: a higher real wage rate makes people wealthier. They have less need to work, and they want more time for leisure, so the supply curve slopes downward.

The exercise assumes that the substitution effect is stronger than the income effect, so the labor supply curve is either Curve #1 or Curve #4.

Wages have decreasing marginal utility on the supply of labor.

- If a person works 6 hours a day, a one dollar increase in the wage rate may elicit another hour of work.
- If a person works 16 hours a day, a ten dollar increase in the wage rate may elicit another hour of work.

The decreasing marginal utility causes the labor supply curve to be convex, so Curve #1 is the supply curve.

*Question:* Could you explain the last part in plain English?

*Answer:* Even at low wages, people work to buy food. Even at high wages, people don't work more than 16 hours a day, since they need about 8 hours to sleep.

- Curve #4 says that at low wages, people don't work at all. As the real wage rate increases people work more at increasing rates. That is not correct at either end.
- Curve #1 says that at low wages, people work enough some minimum amount. As the real wage rate increases people work more at decreasing rates, capped at a maximum. That is correct at both ends.

*Part C:* The demand curve for labor slopes downward.

- As the real wage rate increases, employers want to hire fewer workers.
- As the real wage rate decreases, employers want to hire more workers.

*Question:* Is this related to the marginal product of labor?

*Answer:* Labor has decreasing marginal utility: the first hour of labor produces a lot and the last hour of labor produces little. The real wage rate equals the marginal product of labor. The first hours of labor produce a lot, so employers would pay a lot. The last hours of labor produce little, so employers would pay little.

*Question:* Do employers pay different amounts for the first and last hours of labor?

*Answer:* No: the real wage rate is the marginal product of labor at the last hour.

** Exercise 11.11: Labor equilibrium

In the *Macroeconomics* textbook, Barro draws the labor demand curve.

A. What do the vertical and horizontal axes represent on the labor demand curve?
B. Does the labor demand curve slope up or slope down?
C. Is the labor demand curve convex or concave?
D. In Chapter 6. how is the equilibrium real wage rate determined?

*Part A:* Barro draw the labor demand curve in Figure 6.4 on page 104.

- The vertical axis is the marginal product of labor.
- The horizontal axis is the amount of labor demanded.

*Part B:* The law of decreasing marginal product says that as labor increases, the marginal product of labor decreases, so the labor demand curve slopes down. This downward slope is true for all demand curves.

*Part C:* The rate of decrease in the marginal product of labor slows as labor increases, so the labor demand curve is convex.

*Part D:* In Chapter 6, the supply of labor is fixed, so the labor supply curve is a vertical line. The equilibrium labor is the fixed amount. The real wage rate equals the marginal product of labor at equilibrium, so the real wage rate is the marginal product of labor where the supply and demand curves intersect.

See Barro, Macroeconomics, Chapter 6, market prices supply demand, pages 104-105, figures 6.4 and 6.5

*Question:* Why does this exercise say “in chapter 6 …”?

*Answer:* In Chapter 6, the labor supply is fixed. In Chapter 9, Barro explains how the labor supply depends on the real wage rate by the substitution effect and the income effect. The vertical axis of the supply and demand curves for labor is the real wage rate. The marginal product of labor can not be the vertical axis on the supply curve for labor, since it does not affect the amount of labor supplied. The answer for Part D also differs. The amount of labor is not fixed; rather, it is derived from the intersection of the supply and demand curves.

*Question:* Do the final exam problems use the scenario in Chapter 6 or Chapter 9?

*Answer:* The final exam problems use the Chapter 9 assumptions: the labor supply depends on the real wage rate by the substitution effect and the income effect. This exercise is in the Chapter 9 section to remind you that the assumption in Chapter 6 is changed later in the text.

** Exercise 11.12: Job vacancies

A. How does the technology level affect the marginal product of labor?
B. How does the marginal product of labor affect job vacancies?
C. What other items affect job vacancies?
D. Are job vacancies pro-cyclical, anti-cyclical, or a-cyclical?

*Part A:* A higher technology level raises the marginal product of labor.

*Part B:* A higher marginal product of labor for any given amount of labor shifts the labor demand curve right. Employers want to hire more workers, so they post more job openings.

*Part C:* Two other items affect job vacancies:

- The real wage rate: if employers must pay workers more to take a job, they post fewer jobs.
- Cost of searching for workers: a lower cost of interviewing and finding workers induces employers to post more job openings. Internet search firms reduce the cost of finding workers, so employers post more jobs.

The relations assume that firms know the marginal product of workers, the real wage rate required to attract workers, and the cost of searching for new workers.

*Question:* Doesn't a higher real wage rate raise the job finding rate (acceptance of job offers)?

*Answer:* A higher real wage rate needed to attract job candidates reduces the demand for labor; a higher real wage rate offered for jobs raises the supply of labor. These relations reflect the slopes of the supply and demand curves: the supply curve slopes upward and the demand curve slopes downward.

*Part D:* The technology level is pro-cyclical, so job vacancies are pro-cyclical.

*Question:* In a recession, there are fewer employed workers; doesn't that mean there are more job vacancies?

*Answer:* Job vacancies decline for two reasons: there is less work to be done and so fewer job openings, and workers still employed are working fewer hours, so they can do any work left over.

** Exercise 11.13: Labor Market Cyclicality

For Barro's textbook, real GDP is above its trend in prosperous years and below its trend in recessions. In practice, recessions are periods with decreasing real GDP, not just real GDP below its trend, but Barro's use of above or below trend is a better description.

Are the following pro-cyclical, counter-cyclical, or acyclical?

A. Labor force
B. Job vacancies
C. Job finding rate
D. Job separation rate
E. Natural unemployment rate
F. Average hours per worker
G. Marginal product of labor
H. Real wage rate

*Part A:* Barro assumes a constant labor force in much of his textbook. The labor force is people working plus people looking for work. During recessions, some people become discouraged and stop looking for work, so the labor force is smaller. But during recessions, some people who had not been in the labor force take jobs or look for work. Empirical data do not show a strong pro-cyclical or counter-cyclical pattern.

*Question:* If a person wants a job, but is too discouraged to look for one because no jobs are available, why do we exclude that person from the labor force?

*Answer:* We really should not exclude people too discouraged to look for jobs, but we don't have any way of distinguishing people not looking for work because they don't want to work (e.g., retired persons, students in school, parents taking time off to raise children) from those who are simply discouraged.

*Question:* Do the final exam problems ask if the labor force is pro-cyclical or counter-cyclical?

*Answer:* Final exam problems ask if the labor force has weak or strong correlation with GDP. (Answer = weak)

*Part B:* Job vacancies are pro-cyclical. In prosperous years, firms expand and post new jobs. In recessions, have too many workers and don't post new job offers.

Job vacancies are pro-cyclical because firms do not like to fire workers and they don't want to be understaffed. In recessions, firms eliminate unfilled positions before firing workers (which is expensive). Firms do not post help wanted ads during recessions.

*Part C:* The job finding rate is pro-cyclical. When firm have more job vacancies, people find new jobs more quickly.

*Part D:* Barro does not assume the job separation rate is pro-cyclical or counter-cyclical. The job separation rate includes people who are fired and those who voluntarily leave their jobs. During recessions, more people are fired but fewer people voluntarily leave their jobs.

*Question:* During prosperous years, job vacancies increase. Don't many people switch jobs for now offers?

*Answer:* Switching jobs has a high cost. One has to move, one's spouse may have to find a new job, one's children may have to attend a new school. Some young people switch jobs for new opportunities. Most people switch jobs when they are forced to.

*Part E:* The natural unemployment rate is counter-cyclical. If more people lose their jobs and fewer people find new jobs, the unemployment rate increases. The natural unemployment rate is the job separation rate divided by the sum of the job separation rate and the job finding rate.

*Question:* If the job separation rate is not pro-cyclical or counter-cyclical, why is the natural unemployment rate counter-cyclical?

*Answer:* The job finding rate is strongly pro-cyclical. In recessions, people can't find new jobs; in prosperous years, many people find new jobs.

*Part F:* Average hours per worker is pro-cyclical. During recessions, hourly workers work fewer hours. In prosperous years, many workers work overtime.

*Illustration:* Construction is a highly cyclical industry. During recessions, many workers work only a few days a week. During prosperous years, the same workers may work 60 hours a week.

*Part G:* The marginal product of labor is pro-cyclical. Barro's macroeconomic model assumes prosperity stems from technological progress and recessions stem from adverse shocks. This statement is an over-simplification, but it highlights the relations. Technological progress makes workers more productive and causes prosperity: that is, prosperity reflects the rising marginal product of labor. This rising marginal product of labor may reflect better education or more equipment (human or physical capital).

*Part H:* The real wage rate is pro-cyclical, since it reflects the marginal product of labor. Some other models say the real wage rate is counter-cyclical; Barro discusses these models in the last two chapters of the text.

*Question:* Why is cyclicality so important?

*Answer:* In physics, chemistry, or biology, we do experiments. We vary one factor and examine the effects on other variables. In economics, we have no laboratory to conduct controlled experiments. Not only do people disagree on the details, they have opposite views on the major effects.

*Illustration:* In 2009-10, the U.S. government use deficit spending to finance an enormous stimulus program. Democrats say this program saved the U.S. economy; Republicans say it destroyed the U.S. economy.

Each macroeconomic model implies certain correlations. We compare the empirical data with the predictions of the model. Barro shows that his model agrees well with empirical data.

** Exercise 11.14: Labor Markets

The labor supply measured by total *worker hours* is the labor force × employment rate × average work hours per employee.

A. How does the labor force vary with real GDP?
B. How does the employment rate vary with real GDP?
C. How does average work hours per employee vary with real GDP?
D. Which element is most strongly pro-cyclical and which is least pro-cyclical?

*Part A:* The labor force are people working or willing to work but unemployed. More people join the labor force in prosperous years: older, semi-retired people, young people who leave school to work, and spouses who place children in child care and join the labor force. Some people leave the labor force in recessions: some work "off-the-books," some go back to school, some retire and live on savings, and some are too discouraged to look for work.

*Part B:* The employment rate is people working as a percentage of the labor force. Firms seek more workers in prosperous years, so the demand curve for labor shifts right. The supply curve doesn't change much: for a given real wage rate, people are still ready to accept a job offer. The supply curve is upward sloping (if the substitution effect dominates the income effect), so if the demand curve shifts right, the intersection of the supply and demand curves is at a higher real wage rate and a higher employment rate.

*Part C:* The real wage rate is higher in prosperous years, so average hours per employee rise, especially for self-employed persons, consultants, and blue-collar labor.

*Part D:* The employment rate is the most strongly pro-cyclical. In prosperous years, firms hire more workers, and in recessions, they lay off workers. The unemployment rate better shows the cylicality: if unemployment changes from 5% in prosperous years to 10% in recessions (a 100% increase), the employment rate changes from 95% to 90% (a 5% decrease).

The labor force is the least pro-cyclical. For some analyses, Barro assumes it is constant, since the slight cyclicality is not material. Average hours worked is moderately cyclical. For self-employed persons, blue-collar labor, and consultants, the cyclicality is strong; for employees paid by salary, the cyclicality is weak. (Some jobs – mostly blue-collar – have much over-time work in prosperous years. Salaried employees have pre-set number of hours, such as 8 hours a day.)

** Exercise 11.15: Recessions and labor

What happens during recessions to each of the following?

A. The labor force
B. The marginal product of labor
C. The demand curve for labor
D. Job vacancies
E. The job separation rate
F. The job finding rate
G. The real wage rate
H. The employment rate and the unemployment rate

*Part A:* The labor force doesn't change much in recessions. The labor force is people working plus people looking for work (available for work). During recessions, some unemployed people are too discouraged to look for work or go back to school or retire or work in the black market and don't look for regular jobs, all of which reduce the labor force. Other people leave school or come out of retirement during recessions because they need money, which increases the labor force. The labor force is slightly pro-cyclical, but (for simplicity) Barro sometimes treats the labor force as constant.

*Part B:* An increase in the technology level above its trend raises the marginal product of labor and leads to booms (prosperous years); a decline in the technology level below its trend reduces the marginal product of labor and leads to recessions. The marginal product of labor is lower in recessions.

*Part C:* The higher marginal product of labor causes the demand curve for labor to shift right.

*Question:* Is this a shift of the demand curve or a movement along the demand curve?

*Answer:* This is a shift of the demand curve itself. The higher technology level causes a higher marginal product of labor at each amount of labor, so the demand curve shifts up. The demand curve slopes down, so a shift up is a shift right.

*Question:* Fewer people are working during recessions. Labor has decreasing marginal utility, so the decrease in labor during recessions should lead to higher marginal product of labor.

*Answer:* You are describing the movement along the demand curve for labor. The change in the technology level shifts the demand curve itself right (in prosperous years) or left (in recessions) by the change in the marginal product of labor at a given number of people working. The shift in the demand curve with no change in the supply curve causes a higher (in prosperous years) or lower (in recessions) number of workers, which partly (not fully) offsets the original change in the marginal product of labor.

*Part D:* The lower demand for labor in recessions causes employers to post fewer job openings. Job vacancies decrease during recessions.

*Part E:* The job separation rate is slightly anti-cyclical: more workers are fired (or otherwise leave their jobs) in recessions than in prosperous years. But this relation is weak, and Barro assumes the job separation rate is pretty constant. In recessions, many workers avoid leaving their jobs, since they won't be able to find new jobs. In prosperous years, many workers leave their jobs to find better ones.

*Part F:* The real wage rate is at the intersection of the supply and demand curves for labor. In prosperous years, the demand curve shifts right and the real wage rate increases; in recessions, the demand curve shifts left and the real wage rate decreases.

*Part G:* The job finding rate is strongly pro-cyclical, because of more job vacancies and higher real wage rates in prosperous years. In recessions, the job finding rate is lower.

*Part H:* The employment rate decreases during recessions and the unemployment rate increases.

** Exercise 11.16: Reservation wage

People searching for work evaluate jobs by (i) the wage income from the job vs the income from not working, (ii) non-wage income and other assets, (iii) the value of leisure time, and (iv) the likelihood of better job offers.

A. How do unemployment benefits affect the reservation wage?
B. How do non-wage income and other assets affect the reservation wage?
C. How does the value of leisure time affect the reservation wage?
D. How does the likelihood of better job offers affect the reservation wage?

*Part A:* Unemployment benefits are income from not working. Higher benefits raise the reservation wage.

*Question:* If a person receives unemployment benefits of $100 a week, is the reservation wage always more than $100 a week?

*Answer:* Unemployment benefits have two drawbacks. First, they are temporary. People consider the present value of the remaining unemployment benefits, which depend on the duration of the benefits. Benefits which continue for long durations, such as two years, encourage people to remain unemployed; benefits which end quickly encourage people to find job. Second, benefits may stop if a person refuses a suitable job.

*Question:* What else is income from not working?

*Answer:* Some countries have black markets for labor, which are especially attractive if the marginal tax rate on labor is high. A large black market for labor, a high marginal tax rate on reported income, and lax regulation of unreported income raise the reservation wage.

*Illustration:* A person can get a job as a construction worker for $30,000 a year and pay taxes of one third of the income. Alternatively, the person can work “off-the-books” as a handyman doing interior modeling and extending homes, making $20,000 a year and not paying taxes. The after-tax values are the same.

*Part B:* Non-wage income and other assets make working less attractive; debts, liabilities, and expenses make working more attractive. Students who graduate college with outstanding loan liabilities have lower reservation wages than students who graduate with no loans. An unmarried person has a higher reservation wage than a single mother with two children.

*Part C:* Leisure time may be more valuable than work. Leisure does not mean sleeping late; it includes study time and other ways of acquiring skills and education. A student who graduates in April with a finance major may study in May for the CFA exams in June and begin a job search after the exam. A person laid off and receiving unemployment benefits may spend two semesters at a community college before looking for a job.

*Part D:* Job offers are compared with the likelihood of better offers. Persons with college degrees have higher reservation wages than those with just high school diplomas.

** Exercise 11.17: Actuarial Labor

Actuarial candidates want to study in September and October for their Fall exams. In June and July, they want to work. Insurers have the same need for actuarial work in June-July as in September-October.

A. How does the supply curve for actuarial labor differ in June-July vs September-October?
B. How does the demand curve for actuarial labor differ in June-July vs September-October?
C. How does the reservation wage of actuarial candidates differ in June-July vs September-October?
D. How does the job finding rate of actuarial candidates differ in June-July vs September-October?
E. How does the natural unemployment rate of actuarial candidates differ in June-July vs September-Oct?

*Part A:* The supply curve shows the labor supplied for a given real wage rate. In September-October, fewer actuarial candidates work at any given real wage rate, so the supply curve shifts left. The supply curve is upward sloping, so a shift left is a shift upward: to induce a given amount of labor, one needs a higher real wage rate.

*Part B:* The need for actuarial labor doesn't differ in June-July vs September-October, so the demand curve doesn't shift.

*Part C:* Actuarial candidates are less likely to accept a job offer in September-October than in June-July for a given real wage rate, implying that their reservation wage is higher in September-October.

*Part D:* The job finding rate is lower in September-October. More actuarial candidates are not working and fewer are accepting job offers.

*Part E:* The natural unemployment rate is the job separation rate / (job separation rate + job finding rate). The natural unemployment rate for actuarial candidates is higher in September-October.

*Question:* This exercise confuses the inability to find a job with the decision not to accept a job or not to even look for a job. Similarly, it confuses people who are laid off with people who don't want to work.

*Answer:* Some economics textbooks distinguish involuntary unemployment from voluntary unemployment. This distinction is forced: most unemployed persons could get minimum wage jobs waiting on tables or picking grapes or cleaning houses. Barro sees unemployment as the natural result of job searches. People decide whether to take a job based on many considerations, including the value of leisure time to study for exams.

** Exercise 11.18: Marginal product of labor

Suppose all markets for labor and goods are perfectly competitive.

- A firm produces bread using raw material (flour), workers (bakers), and capital (ovens).
- Workers produce 20 loaves of bread each hour.
- Each loaf of bread sells for $2.50.
- The firm uses $1.00 of flour for each loaf of bread.
- No bread remains unsold each day, and all consumers can buy the bread they want.
- The price level is 1.00, and the wage rate is $10 an hour.
- Firms pay for the capital (ovens, stores) they use to make bread.
- Firms earn an *accounting* profit of $0.50 on each loaf of bread.

A. How do firms decide how many workers to hire as bakers of bread?
B. Why does the accounting profit over-state the value of making bread?
C. What is the marginal product of labor for baking bread?
D. What would change the marginal product of labor for baking bread?

*Part A:* Firms hire workers as long as the marginal product of labor is more than the real wage rate.

*Question:* What changes as the firm hires more workers?

*Answer:* The marginal product of labor declines as more workers are hired. If the firm has one oven, the first worker has a high marginal product of labor. The second baker might work a night shift and also have a high marginal product of labor. More bakers have a low marginal product of labor, since they don't have ovens.

The same is true for an industry. If the bread industry now makes 1,000 loaves of bread a day, each loaf sellls for $1.00. If more workers are hired and the industry makes 2,000 loaves of bread a day, each loaf may sell for only $0.50, since consumers don't want so much bread. The marginal product of labor is lower, since each loaf is worth less.

*Part B:* Accounting profit does not consider the real rental price of capital owned by the firm or the value of owner's time. Economic profit considers all costs, including the implicit rent on capital owned by the firm.

*Part C:* The marginal product of labor is the real wage rate. The price level is 1.00, and the wage rate is $10 an hour, so the real wage rate is also $10 an hour.

*Part D:* A higher technology level, more capital, or a higher demand for bread would raise the marginal product of labor.

** Exercise 11.19: Capital utilization and labor supply

Businesses choose the demand for capital services and the demand for labor to maximize profits. The capital stock K is fixed in the short run, but the capital utilization rate κ and labor are not fixed.

A. What are business profits in terms of output, labor costs, and costs of capital?
B. Using the symbols above, what are nominal profits of business firms?
C. Using the symbols above, what are real profits of business firms?

*Part A:* The output of the economy is the production function; labor costs are the wage rate times labor; cost of capital are the rental price times capital services. Capital services are the capital utilization rate times the capital stock.

*Part B:* The production function is $A \times F[K, L]$.

- Business firms can vary the capital utilization rate, so we use $\kappa K$ instead of K.
- Business firms choose their demand for capital services and labor, so we use $(\kappa K)^d$ and $L^d$.
- The production function is in real terms; to convert to nominal terms, we multiply by P.

Nominal output as a function of the demand for capital services and labor is $P \times A \times F[ (\kappa K)^d, L^d) ]$.

Nominal labor costs are the nominal wage rate times the labor demanded, or $w \times L^d$.

Nominal costs of capital are the nominal rental price times the capital services demanded, or $R \times (\kappa K)^d$.

Nominal profits are

$$\pi = P \times A \times F[ (\kappa K)^d, L^d) ] - w \times L^d - R \times (\kappa K)^d$$

*Part C:* For real profits, divide each term by P:

$$\pi/P = A \times F[ (\kappa K)^d, L^d) ] - (w/P) \times L^d - (R/P) \times (\kappa K)^d$$

*Question:* Why does the equation have quantities demanded instead of quantities supplied?

*Answer:* Businesses determine how much labor and capital to demand based on the expected profits from using the capital and labor to produce goods.

- $A \times F[ (\kappa K)^d, L^d) ]$ is the real revenue from producing goods.
- $(w/P) \times L^d + (R/P) \times (\kappa K)^d$ is the real expense of capital and labor.

See Barro, macroeconomics, chapter 9, equation 9.2 on page 150