Economics 448W, Notes on the Classical Supply Side

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(Updated for Spring, 2019)

These notes cover the basics of the first part of our classical model discussion. Review them in detail prior to the second class of the semester.

- The supply-side determines the economy's potential to produce output. The pieces of the supply-side consist of the resources available to the economy and the technology that transforms those resources into the goods and services that constitute final output (GDP).
- Firms are the location of production. Households supply labor.

A. Labor Demand

- Firms hire workers to produce final output. What motivates firm behavior in economic models? Answer: profit maximization. Firms hire workers with the objective of maximizing the profits that accrue to the owners of the firm.
    - More specifically for our purposes, firms choose how much labor to hire in order to maximize their profits.
- Define profits: Revenues – Costs
    - Revenue comes from the sale of real output (Y) at a price (p)
    - Labor costs consist of the number of hours of labor hired (N) at a uniform nominal money wage (w) per hour of worked. Labor demand is the number of hours actually hired by a representative firm.
    - Firms also use capital goods in the production of output (business equipment and machines, business structures where production takes place, and possibly some other items). The capital stock (K) is accumulated over time by business investment.
        - Be careful to note that business investment in this context means the purchase of newly produced capital goods. This is <u>not</u> the purchase of financial assets. (That is, we are not talking about "investment" in stocks, bonds, etc.)
        - The cost of capital (c) is the opportunity cost the firm incurs by using the capital stock for one period of production. Effectively, c can be thought of as the cost to the firm of "renting" the capital stock from itself. We may have more to say about what determines the period-by-period cost of capital later.
            - Example: Suppose the firm has a capital stock worth $100,000 at the beginning of the year. Capital depreciates at a rate of 10% per year and the interest rate the firm could earn on liquid financial assets is 4%. What is the

opportunity cost of using $100,000 in capital for the year? The firm gives up $4,000 of interest it could have earned by depositing $100,000 in a liquid financial account. Depreciation also implies the firm will have a capital stock worth just $90,000 at the beginning of the next year. So, the opportunity cost of tying up $100,000 in fixed capital for the year is $14,000 (or 14%).

- A simple version of the cost of capital is c = r + delta where r is the interest rate and delta is the depreciation rate. (In practice, this basic concept is modified for details of the tax treatment of business capital, but that issue is not important for our purposes at the moment.)

- We will assume initially that the economy is <u>perfectly competitive</u> in both input and output markets. This assumption implies that firms treat p, w, and c as given by the market. That is, the prices of output and inputs do not depend on the amount the firm actually produces.
    - With these definitions and the perfect competition assumption: Profits = pY – wN – cK
- To maximize profits with no constraints at all, firms would make Y arbitrarily large and set N and K to zero. But this strategy is obviously not feasible. To produce Y, firms need N and K.
    - Another way to state this point in more typical economic language is to say that firms are <u>constrained</u> by a production technology that maps inputs into outputs.
    - We will specify the technology by a <u>production function</u>: Y = F(N,K). The production function tells us the possible combinations of labor and capital inputs needed to produce a given amount of output Y.
    - If technology improves, the production function shifts so that less N and/or K will be necessary to produce a given amount of Y.
- We are now ready to specify formally the choice of labor input (labor demand) that maximizes profits for a representative firm, given the competitive prices for inputs and output.
    - We will make a simplifying assumption that the capital stock is given at a constant level for the purposes of short-run analysis. The idea is that it takes time to accumulate capital and over a relatively short period, the capital stock will not change in a significant way.
        - The period of time over which it is reasonable to approximate the capital stock by a constant value defines what we mean by the <u>short run</u> in the context of the classical model. The short-run assumption is quite sensible for one or two quarters, it might apply

to one or two years. Over a decade, however, most businesses would be able to make significant capital stock changes, so the short-run assumption would be implausible.

- We will denote the constant short-run level of the capital stock by $\bar{K}$ (K-bar).

- Profit maximization first-order condition:

$$\max_{N}(Profit) = pY - wN - c\bar{K} = p\,F(N,\bar{K}) - wN - c\bar{K}$$

- Note how substituting the production function for Y into the profit definition imposes the technological constraint on the relationship between inputs and outputs.

Take the derivative with respect to labor input and set to zero:

$$\frac{\mathrm{d(Profit)}}{\mathrm{dN}} = p\frac{\partial F}{\partial N}(N,\bar{K}) - w = 0 \qquad (*)$$

- Note that the capital cost term drops out of the first-order conditions because of the short-run assumption that the capital stock is fixed. Fixed costs do not affect the choice of labor demand.
- But the capital stock matters indirectly because, in general, the partial derivative of the production function with respect to labor input depends on the level of the capital stock. It is standard to assume labor is more productive when workers have more capital to work with. Formally, $\frac{\partial F}{\partial N}(N,\bar{K})$ increases when $\bar{K}$ rises, that is, we usually assume:

$$\frac{\partial^2 Y}{\partial N \partial K} > 0$$

Re-write the first-order condition (*) from above as:

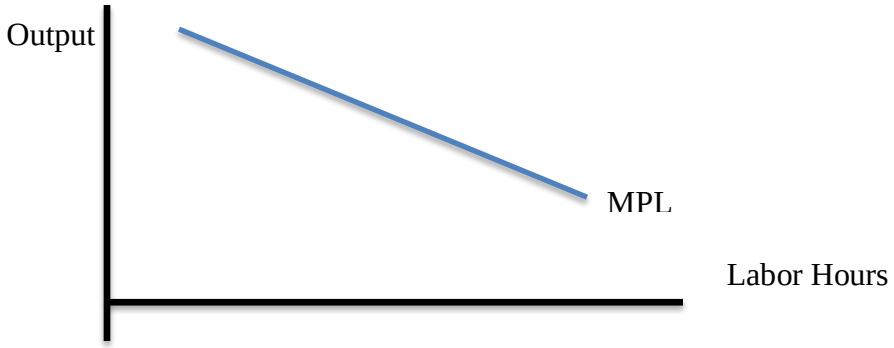
$$\frac{\partial F}{\partial N}(N,\bar{K}) = \frac{w}{p}$$

- This form for the first-order condition is often used in the basic micro theory of the firm. What is it's economic meaning?
  - The left-hand side is the <u>marginal productivity of labor</u>, the additional output a firm obtains by hiring one additional hour of labor. It varies with the levels of the labor and capital inputs.
  - The right-hand side is the real cost of labor, or the <u>real wage.</u>

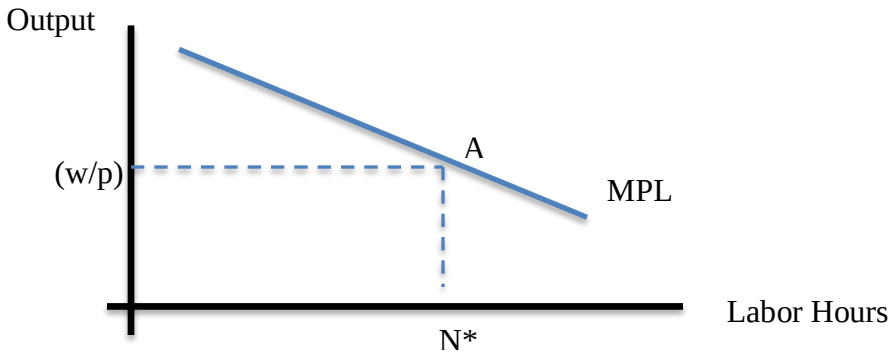
Intuition: if a firm obtains more real output from hiring an additional hour of labor than the real cost of that hour of labor, profits will rise by

increasing labor input. Therefore, firms keep increasing labor input up until the point when the marginal product of labor equals the real wage. (And the opposite effect, reduce labor input if $\frac{\partial F}{\partial N}(N, \bar{K}) < \frac{w}{p}$ until $\frac{\partial F}{\partial N}(N, \bar{K}) = \frac{w}{p}$.

- Graphical interpretation. The marginal product of labor (MPL) is determined entirely by the production function. The usual assumption is that the MPL declines as the amount of labor hired rises (diminishing marginal returns to labor). Therefore, we can graph the MPL like this:



  - Note that both the MPL and the real wage are measured in units of output. So we can put the given) real wage on the vertical axis:



(Note that the real wage is "given" for a representative firm because we assume perfect competition for now. So the firm takes w and p as given.)

- The firm will choose labor input to satisfy the first-order condition for profit maximization. That is, choose the optimal amount of labor to hire (N*) to equate the real wage to the marginal product of labor, as represented by point A on the diagram.

- Technological determination of labor demand
    - The downward sloping curve in the diagram above is a "demand curve" in the sense that it shows how the "quantity" of an item purchased (in this case, the number of hours of labor hired by firms) is a function of a "price" (in this case, the real wage).
    - Therefore, the labor demand curve is the marginal productivity of labor curve. The assumptions that firms operate in perfectly competitive markets, firms produce output with a conventional production function, and firms maximize profits lead to this result.
    - In this case, the demand for labor is determined entirely by technology. The MPL is a characteristic of the production function. If you know the production function (that is, the "technology"), you know the MPL. Nothing else affects classical labor demand.
    - In particular, sales expectations of firms do not affect labor demand in the classical model. Perfectly competitive firms behave as if they can sell as much as they want at the market price of output.
- Aggregate labor demand
    - Think of labor demand in the economy as a whole as the sum of all the labor demands of individual firms.
    - If the individual firm labor demand curves are all determined by the firm technologies, aggregate labor demand will also be technologically determined.

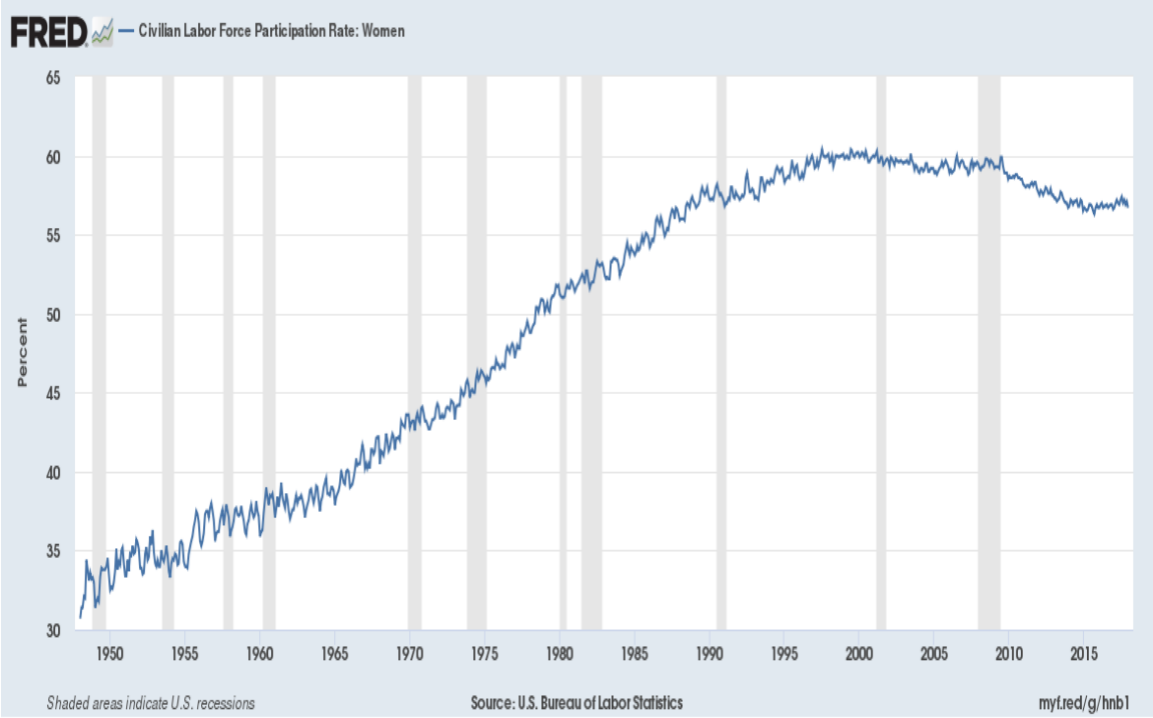
B. Labor Supply

- To complete the classical labor market we consider labor supply, the choice of workers in the economy to offer hours of labor time for sale.
- The central emphasis of classical labor supply theory is the preferences of workers, usually analyzed as a trade-off between work and leisure. That said, it may be more useful to think of the fundamental trade-off as between consumption and leisure.
    - People enjoy leisure time when they are not constrained by the requirements of work. But they also like to consume goods and services produced by the market economy. To purchase market output, people need income which they obtain by working, that is, by supplying their labor to the market.
    - In this framework, labor supply is determined by the how much people desire consumption versus leisure, that is, by their preferences for the two goods.
- Preferences in standard economic models are usually modeled formally with a utility function that links an overall level of individual satisfaction (utility) to the

amounts of market output and leisure the individual consumes. A key result from a formal analysis of labor supply choices that comes from utility maximization is the understanding of what happens to labor supply when the real wage rate changes.

- As you hopefully remember from your intermediate micro class, the effect of a change in price on individuals' consumption choices can be decomposed into a substitution effect and an income effect.
- In the labor supply context the substitution effect describes how a change in the real wage induces substitution between leisure and consumption goods purchased with labor income.
- Suppose the real wage rises. An hour of labor would then purchase more consumption goods. The cost of consumption has gone down relative to leisure, or, equivalently, the opportunity cost of leisure has increased. This change in the relative "price" of consumption and leisure encourages individuals to substitute toward the relatively cheaper good: more consumption and less leisure, and more consumption implies more work to generate the money to buy consumption in the market. This substitution effect generates an unambiguous positive relation between labor supply and the real wage.
- The income effect is somewhat more subtle. When the real wage rises, the individual has more resources overall to allocate to all things that generate utility. In this context, there are two things entering the utility consumption goods and leisure. The way increased resources are allocated to these different things, again, depends on an individuals' preferences.
    - If wages and income rise, the quantity consumed of "normal goods" increases. These goods are called "normal," because this is the most intuitive case. (When you have more money, you usually expand your purchases of most things.)
    - It is possible, however, for goods to be "inferior." These are things that you purchase because your resources are limited, but you would really like to have something better, so when your income rises, you reduce consumption of inferior goods. (An example could be cheap beer or wine. When you get richer, you buy less of the "inferior" product.)
    - In our specific context, it seems entirely reasonable to assume that both the bundle of consumption goods bought in the market and leisure time are normal goods. As you get richer, you will certainly want to buy more market goods, but you probably also will want to use some of your higher income to allow less work.

        - International and historical evidence strongly supports the idea that people work fewer hours as their income rises. This effect may be less obvious for affluent Americans, however.
    - If leisure is a normal good, then when real wages rise, the income effect implies that leisure hours increase. The only way to increase leisure is to reduce labor. So, the income effect implies that higher real wages reduce labor supply, the opposite of the substitution effect.
- So, what does theory tell us about how real wages and labor supply are related? It says the effect is ambiguous. If the substitution effect dominates, then the labor supply curve that relates hours of labor offered for sale to the real wage is upward sloping. If the income effect dominates, the labor supply curve is downward sloping. It's even possible that the curve bends back on itself, starting with a positive slope at low real wages and a negative slope at high real wages.
    - What does the evidence tell us? It is mixed, but as a first approximation it seems that the income effect and substitution effect roughly cancel each other out. This makes labor supply rather insensitive (inelastic) to real wages.
    - For women, at least historically, income effects seemed more important, for men, substitution effects seem to dominate empirically.
- We will follow standard practice and assume an aggregate upward sloping supply of labor, that is, the substitution effect dominates the income effect. But we should keep in mind that labor supply, in reality, is likely rather insensitive to changes in real wages.
- Before combining labor supply with labor demand, we should note, despite the emphasis on the relationship between the real wage and labor supply in typical economic discussions, other factors are important, perhaps more important, in determining how much people choose to work (or what constrains their choices). These factors are especially relevant over longer periods of time. Here are some examples:
    - Social norms: the society in which individuals are embedded undoubtedly shapes preferences about many things, especially about work. Examples:
        - Female labor force participation rose significantly and steadily from the 1950s through the late 1990s (see the graph below). A dominant factor in this trend was undoubtedly changes in the perception of gender roles in the family and changes in the perception of women in the workplace.



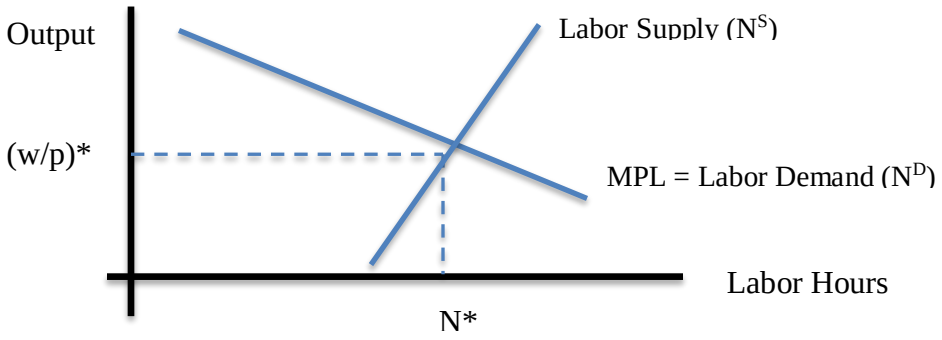
- Consumption norms might also affect female labor force participation. Dual-earner households have higher incomes and can afford higher consumption. As it becomes more common for both partners to work, rising consumption by dual-earner families may nudge more labor supply from single-earner households. Both partners in a household may feel pressure to work to "keep up" with prevailing consumption norms that are socially determined.
- Differences across time and countries in normal age profiles of work might affect labor supply. Europeans take longer vacations and typically retire somewhat earlier than Americans.

- Note that while most mainstream economic models assume that work preferences are an "exogenous fundamental" factor grounding the predictions of the model, these points suggest that preferences are in fact endogenous in a broader social context. (This is one place where the disciplines of sociology and economics intersect.)
- Government policy also affects labor supply. Examples:
  - Tax policy that affects the "take-home" real wage
  - Work requirements for social assistances
  - Eligibility age rules for Social Security and Medicare
- The 40-hour full time work week norm is a particularly interesting case. There are some government regulations that mandate overtime pay for employees who work more than 40 hours, but the regulation doesn't formally apply to many people. Nonetheless, most jobs expect about 40

hours per week for a full time worker. (At WU, many full-time staff employees are paid for 37.5 hours per week. For some job categories, WU requires payment of 150% of hourly wages for work beyond 37.5 hours in a week.)

C. Labor Market Equilibrium and Full Employment

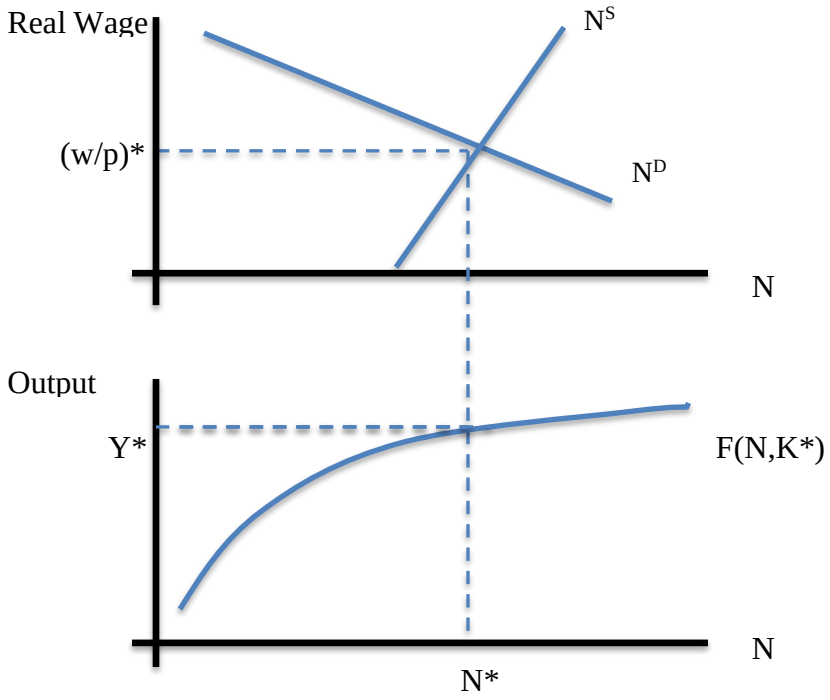
- The equilibrium between labor demand and labor supply jointly determines the real wage and the level of employment (number of labor hours actually employed)



- Labor market equilibrium determines full employment. Full employment prevails when all workers who choose to work at the market real wage are employed. This condition is satisfied at N*.
    - Note that full employment doesn't mean "everybody has a full-time job." Some people may not choose to work at all. Others may prefer part-time work. Some people might assert that they want to work, but do not consider the wage high enough to make taking a job worthwhile.
    - If the economy operates a N*, there may be measured unemployment, but unemployment is basically voluntary.
        - The unemployment rate is measured by a large national survey every month. Respondents are asked if they are employed or, if they are not employed, if they looked for work in recent weeks.
        - If you are not employed, but you looked for work recently, you are counted as unemployed. But it could be that you are not willing to accept jobs available at the prevailing market wages. This is why we can reconcile some measured unemployment with a "full employment" labor market in the sense of the equilibrium in the graphical model shown above.

D. Potential Output (Y*): Tastes, Technology, and Resources

- Given the pre-determined level of the capital stock ($\bar{K}$) and the equilibrium level of employment (N*), the aggregate production function determines the level of output the economy is capable of producing: $Y^* = F(N^*, \bar{K})$
- Using the typical graph of a production function, we can show these relationships in a pair of diagrams:



- The output level Y* is a benchmark for good economic performance. If the economy operates at Y*, resources are fully utilized and labor choices are realized.
- Economists often assert that Y* represents the underlying "fundamentals" of an economy that we can classify into three categories:
    - Tastes: Another word for preferences, most obviously represented by the labor supply choices embodied in the N^S curve.
    - Technology: How inputs are transformed into consumable output, represented by the production function. Because labor demand is technologically determined, it can also be linked to technology.
    - Resources: What one might call the endowment of the economy. In the analysis so far the inherited capital stock represents an important "resource" for the economy. You could also think of the economy's population, which obviously affects labor supply, as a resource. In an extended model, you might include natural resources like oil deposits and agricultural land as well.

- In the classical model, output equals potential Y* and is determined ultimately by the fundamentals of tastes, technology, and resources.
- In this sense, the classical model is often associated with "supply-side" economics. Output is determined by the characteristics of "supply, the ability of the economy to produce as driven by its input supplies and its technology.

(Notes beyond this point are likely relevant for class #3)

E. How Do We Know Y* Will Be Sold? Say's Law and the Classical Model Demand Side

- The notes to this point show how the economy's potential output (Y*) is determined by tastes, technology, and resources. The classical model asserts that actual output in the economy will equal Y*. Therefore, there must be some economic process to assure Y* will actually be sold. (Firms will not produce output unless they believe they can sell it.)
- The key concept here is Say's Law, usually simply stated as "supply creates its own demand." If Say's Law holds, then the ability of an economy to supply Y* implies there will be enough demand to purchase Y*.
    - Say's Law is not an assumption, but rather a result of the classical model. We need to explain the economic processes that generate the result.
- Say's Law in a non-monetary economy
    - To motivate the ideas, consider a stylized simple tribal economy without money. Suppose the people in this economy produce a single good, corn.
    - Will the people demand all the corn they can produce given their tastes, technology, and resources?
        - The simple answer is yes as long as their welfare is improved by eating more.
        - The more general point is that if people want to consume more of what the economy produces they will demand as much output as can be produced. So, there will always be enough demand to justify production of Y*.
    - What about saving? It might make sense for the tribe not to consume all the corn they produce because they need some to provide seed for the next season. This point suggests that consumption might not equal Y*.
        - But what will they do with corn that is "saved?" They will put it in some kind of warehouse to keep it for next season's planting.
        - The accumulation of corn seed for further use is an act of <u>investment</u>. It is an alternative source of demand for the corn.

- Corn that is not consumed will be invested, so there is still demand for all of Y*. Say's Law holds in this non-monetary economy.