

Part IIC: Labor Demand

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Labor Market Equilibrium

- Earlier: Developed theory of labor supply.
- But, policy analysis only considered one side of market!
- Many questions remain:
 - Where does the wage offered to workers come from in the first place?
 - How can we explain many real-world properties of labor markets?
 - Differences in wages due to (i) skills differences, (ii) irrelevant factors e.g. race
 - Unemployment: Why cant workers always find a firm willing to hire at the market rate? Etc.
 - Need a model of firm behavior to consider these questions.

The Firm's Objective

- What is the firm's goal?
 - To maximize **profit**: $\Pi = TR - TC$
- Assumption: The markets for inputs (e.g., labor & capital) and output (the product the firm is producing) are competitive
 - Firms are price takers
 - Market price of output is p
 - Market price of labor is w
 - Market price of capital is r

The Firm's Constraint

- Total costs: $TC = rK + wE$, where K is the stock of capital used and E is the number of employee-hours hired
- Total revenue: $TR = pq$, where q is the output quantity
- Firms produce output using labor (E) and capital (K) according to the firm's production function,

$$q = f(K, E)$$

The Firm's Constraint

- Assumptions about E :

- $E =$ We will generally simplify E to just be the number of workers hired by the firm
- E aggregates all different types of workers into one measure.
Ignores potential heterogeneity in productivity across workers.

The Production Function

- From the production function, we can define
 - ① **The marginal product of labor (MP_E)**: The change in output resulting from hiring an additional worker (holding K constant)
 - ② **The marginal product of capital (MP_K)**: The change in output resulting from a one-unit increase in the capital stock (holding E constant)
 - ③ **The average product of labor (AP_E)**: The amount of output produced by the typical worker. $AP_E = q/E$

The Production Function

- Assumptions:
 - $f(K, E)$ is increasing in K and E , so MP_K and MP_E are both positive.
 - MP_K and MP_E eventually decline (i.e., follow the **law of diminishing returns**)
- What is the relationship between MP_E and AP_E ?

Labor Demand in the SR

- **The short run:** A time span sufficiently short such that the firm cannot adjust its capital stock. $K = K_0$. The firm can adjust E .
- **The long run:** Capital and labor can both be adjusted by the firm.
- Implicitly, labor is more mobile than capital.

Labor Demand in the SR

- Short-run decision: Given a fixed level of capital K_0 , how many units of labor should the firm hire in order to maximize profits?
- Marginal cost of hiring an additional worker: $MC_E = w$
- Marginal benefit of hiring: The increase in revenue brought about from hiring an additional worker
- Per the usual, should hire until $MB = MC$

Labor Demand in the SR

- How do we define the marginal benefit?
- Because the firm is a price taker, $\Delta TR = p \times \Delta q$
- The marginal product of labor is given by

$$MP_E = \frac{\Delta q}{\Delta E}$$

- After a one unit increase in E ,

$$MP_E = \Delta q \Rightarrow \Delta TR = p \times MP_E$$

Labor Demand in the SR

- **Value of the Marginal Product of Labor (VMP_E):** The dollar value of what each additional worker produces (holding K constant).

$$VMP_E = p \times MP_E$$

- VMP_E is the change in revenue that results from a one unit increase in labor (holding K constant)
- **Value of the average product of labor (VAP_E):** The dollar value of output per worker.

$$VAP_E = p \times AP_E$$

Labor Demand in the SR

- Optimal hiring rule: Hire until $MB = MC \Rightarrow VMP_E = w$
- Additional condition: VMP_E must be declining.
- Moreover, the firm will only hire along points of the VMP_E curve that lie *below* the point where VMP_E and VAP_E meet.

Labor Demand in the SR

- This is referred to as the **marginal productivity condition**
- This condition is identical to the condition you have seen before where the firm produces until $MR = MC$
 - The condition telling firms when to stop producing output is the same as the condition telling firms to stop hiring workers.

Labor Demand in the SR

Example

Suppose the hourly wage is \$10 and the price of each unit of capital is \$25. The price of output is constant at \$50. The production function is given by

$$f(E, K) = E^{1/2}K^{1/2},$$

which implies that $MP_E = (1/2)(K/E)^{1/2}$. If the current capital stock is fixed at 1,600 units, how much labor should the firm hire in the short run? How much profit will the firm earn?

Short-Run Labor Demand

- Recall that a labor demand curve gives the firms chosen level of employment as a function of the wage rate.
- Graphically, the short-run labor demand curve (E_{SR}) is just the downward-sloping portion of the VMP_E curve
- The “height” of the labor demand curve depends on the price (p) of the output
 - Positive relationship between short-run employment and p

Short-Run Labor Demand

- An important implication of the marginal productivity condition:
 - At the margin, workers are paid a wage equivalent to what they earn for the firm.
 - Workers are paid precisely what they're worth to the firm!
- This condition does not hold if labor markets are not competitive.
 - Competitive markets provide workers with high level of surplus.
 - Do we believe labor markets are competitive?
 - How can we reinterpret this condition in a non-competitive market?
 - More on this later.

Short-Run Labor Demand Elasticity

- Elasticity of labor demand: A measure of the responsiveness of employment to changes in the wage rate

$$\varepsilon_w^{D,SR} = \frac{\% \Delta E_{SR}}{\% \Delta w} = \frac{\Delta E_{SR}}{\Delta w} \times \frac{w_0}{E_{SR0}}$$

Readings

- Borjas 3.1-3.2

Labor Demand: Long versus Short-Run

- Recall that in the short-run, the firm's capital stock is fixed at $K = K_0$
- In the short-run, the firm chooses E to maximize profits since it takes K_0 as given:

$$\max TR - TC = pq - wE - rK_0 \text{ s.t. } q = f(K, E)$$

- Long-run: Firm is free to vary capital, hence it must choose **both** the optimal labor level and the optimal capital level:

$$\max TR - TC = pq - wE - rK \text{ s.t. } q = f(K, E)$$

Long-Run Optimality Conditions: Labor

- Should hire labor until $VMP_E = w$
- Same intuition as the short-run case: Hire an additional unit of labor if, and only if, the marginal benefit (VMP) outweighs the marginal cost (w)

Long-Run Optimality Conditions: Capital

- Optimal capital hiring must satisfy a similar condition:

$$VMP_K = p \times MP_K = r$$

- Intuition: Hire the next unit of capital if, and only if, the marginal benefit (VMP) outweighs the marginal cost (r)

Long-Run Optimality Conditions: MRTS Condition

- Combining the optimality conditions for labor and capital, we get that optimal bundles of labor must satisfy:

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

- The ratio of MP_E and MP_K is called the **marginal rate of technical substitution**.

Interpreting the MRTS Condition

- Thus, in the long-run optimal bundles of labor and capital must satisfy $MRTS_{E,K} = w/r$
- This condition is largely the reason long-run labor demand behaves differently than short-run labor demand
- The intuition behind the $MRTS$ condition can be seen by re-writing it as

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

Interpreting the MRTS Condition

- The condition essentially states that the last dollar spent on labor must yield as much output as the last dollar spent on capital
- How should we reallocate resources if $MRTS < w/r$?
- How should we reallocate resources if $MRTS > w/r$?

Long-Run Labor Demand

- Consider the dynamics of labor demand in response to $\uparrow w$.
- Short-run: $VMP_E = w \Rightarrow \uparrow w \Rightarrow \downarrow E$
- Long-run: Free to vary capital. Because $\uparrow w$, now we have:

$$\frac{MP_E}{MP_K} < \frac{\uparrow w}{r}$$

so the firm must decrease E even further in order to re-balance the $MRTS$ condition

Long-Run Labor Demand Elasticity

- Long-Run Labor Demand elasticity is the percentage change in the firm's labor level (E) which results from a one percent increase in the wage rate (w), while the firm is free to vary capital:

$$\varepsilon_w^{D,LR} = \frac{\% \Delta E_{LR}^*}{\% \Delta w} = \frac{\Delta E_{LR}^*}{\Delta w} \times \frac{w_0}{E_{LR0}^*}$$

Long-Run versus Short-Run Labor Demand Elasticity

- In the long-run, firm's have the option of substituting between labor and capital
- Hence, the firm can effectively replace some of its labor with capital if the wage rate rises.
- Implication: $|\varepsilon_w^{D,LR}| > |\varepsilon_w^{D,SR}|$

Long-Run versus Short-Run Labor Demand Elasticity

- In words: Firms are more able to adjust their level of employment in response to changes in wages in the long-run
- Effect of policy changes may be different in long-run than short-run. E.g. The minimum wage
 - Data indicate that firms do not significantly reduce E in short-run.
 - Possible that firms do reduce E in the long-run.

Readings

- Borjas 3.3-3.4

The Minimum Wage

- Introduced by the Fair Labor Standards Act (FSLA) in 1938
- Coverage was initially small (~45% of nonsupervisory work), but now most workers are covered by the legislation
- The minimum wage is updated at irregular intervals and is not indexed to inflation or productivity growth
 - Implication: The *real* minimum wage declines between the time it is set and the next time it is raised

Federal Minimum Wage, 1938-2012

Shown in adjusted 2012 dollars and unadjusted dollars



Note: Wage rates adjusted for inflation using implicit price deflator for personal consumption expenditures.

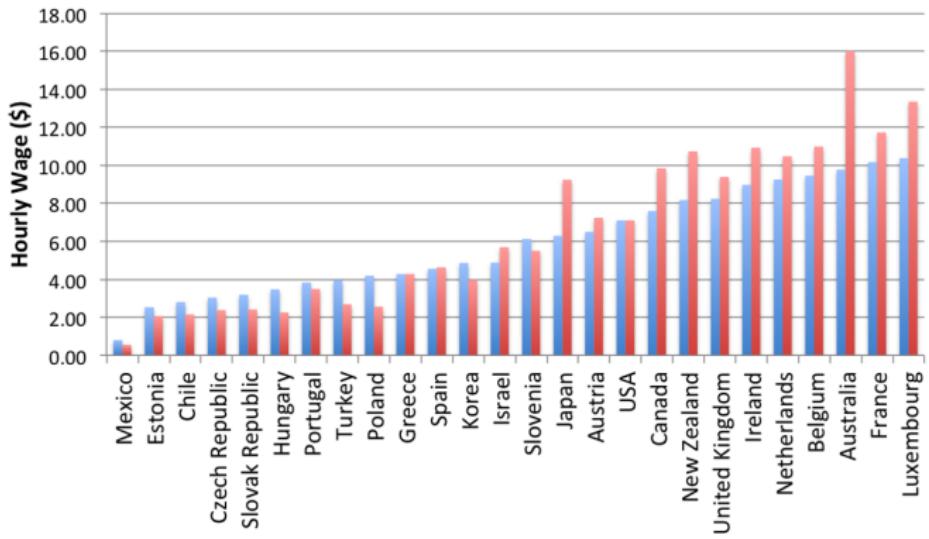
Source: Labor Department, Bureau of Economic Analysis, Pew Research Center analysis

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Minimum Wages Around the World 2012

Source: OECD StatExtracts, Real Minimum Wages

■ PPP Exchange Rate (US\$) ■ Ordinary Exchange Rate (US\$)



The Minimum Wage: Universal Coverage

- Standard analysis under universal coverage: A minimum wage set above the equilibrium wage leads to a surplus of labor (i.e., unemployment)
 - Firms demand less labor at the hire wage
 - Some workers are displaced from their current job and become unemployed
 - The higher wage increases the quantity of labor supplied
 - These additional workers enter the labor market, but cannot find jobs and so increase unemployment

The Minimum Wage: Universal Coverage

- For a given minimum wage, the level of employment depends on the elasticity of labor demand
- The level of unemployment depends on the elasticity of labor demand and the elasticity of labor supply
- The greater the elasticities of each curve, the greater impact the minimum wage will have on the labor market
 - Implication: The effect of the minimum wage will be greater in the long run

The Minimum Wage: Evidence

- Card & Krueger, "Minimum Wages and Employment: A Case Study of the Fast-Food Industry in NJ and PA," AER (1994)
- New Jersey increased their minimum wage in 1992
- Pennsylvania (a neighboring state) kept the minimum wage at the federally mandated level

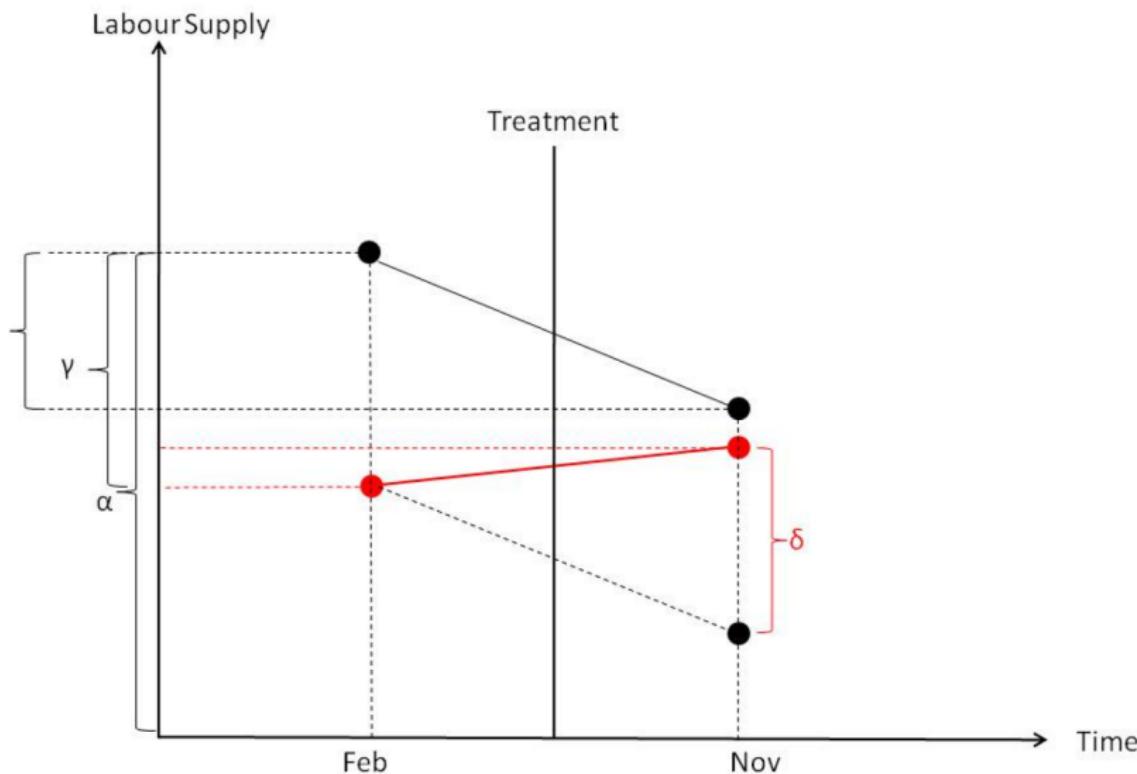
The Minimum Wage: Evidence

- Control group: Fast food establishments in PA
- Treatment group: Fast food establishments in NJ (same franchises)
- Strategy: Difference-in-differences

The Minimum Wage: Evidence

Variable	Stores by state		
	PA (i)	NJ (ii)	Difference, NJ – PA (iii)
1. FTE employment before, all available observations	23.33 (1.35)	20.44 (0.51)	-2.89 (1.44)
2. FTE employment after, all available observations	21.17 (0.94)	21.03 (0.52)	-0.14 (1.07)
3. Change in mean FTE employment	-2.16 (1.25)	0.59 (0.54)	2.76 (1.36)

The Minimum Wage: Evidence



The Minimum Wage: Evidence

- Neumark & Wascher (2000) performed the same exercise, but used (probably better) pay-roll record data
- Finding: Minimum wage increase lead to a small decrease in employment in NJ relative to PA

The Minimum Wage: Evidence

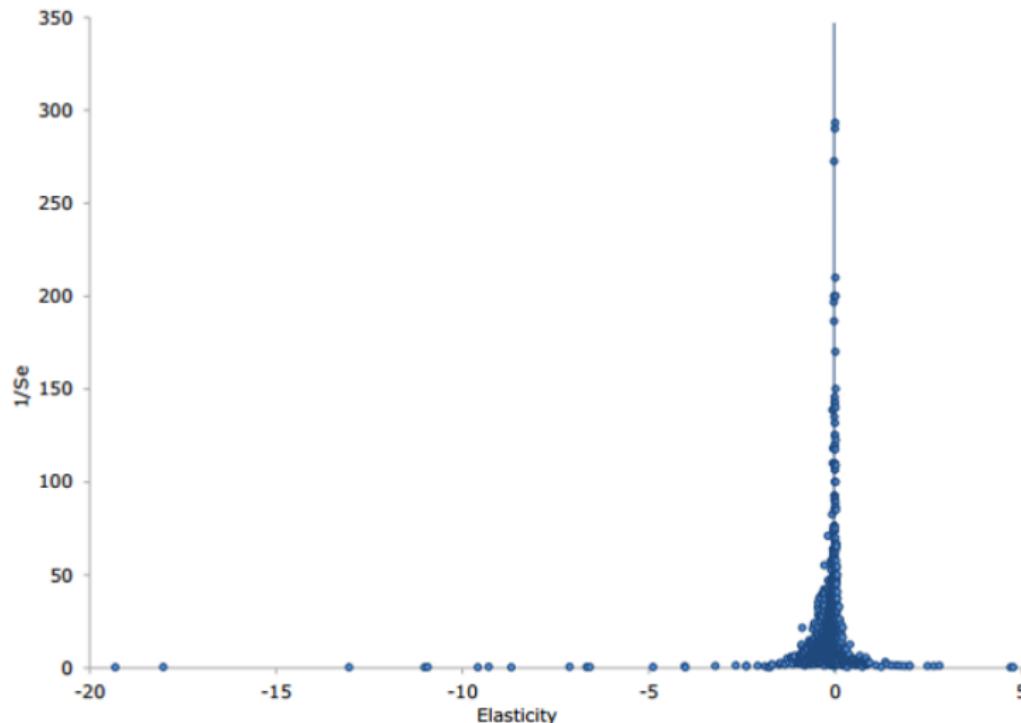
- Card & Krueger (2000) performed the same exercise, again, but used even more detailed data from BLS
- Finding: “The increase in New Jersey's minimum wage probably had no effect on total employment in New Jersey's fast-food industry, and possibly had a small positive effect.”

The Minimum Wage: Evidence

- Caveats:

- ① Long-run vs. Short-run labor demand
 - Long-run impacts may be larger if firms are more able to adjust inputs from labor to capital
- ② Magnitude of minimum wage changes
 - Most minimum wage changes are small, so its estimated effects on employment are likely small and difficult to estimate with precision
- ③ Inconsistency of evidence
 - Lots of “noise” in estimates. On average, estimates probably indicate that there is a fairly small disemployment effect

The Minimum Wage: Evidence

FIGURE 1**Trimmed Funnel Graph of Estimated Minimum-Wage Effects (n = 1,492)**

Source: Doucouliagos and Stanley (2009).

Readings

- Borjas 3.10