31E00700 Labor Economics: **Lecture 4**

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First Part of the Course: Outline

1. Supply of labor
   1. static labor supply: basics
   2. static labor supply: benefits and taxes
   3. intertemporal labor supply
2. **Demand for labor**
3. Labor market equilibrium

Introduction

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  - Firms hire workers and buy capital to produce goods and services that consumers want

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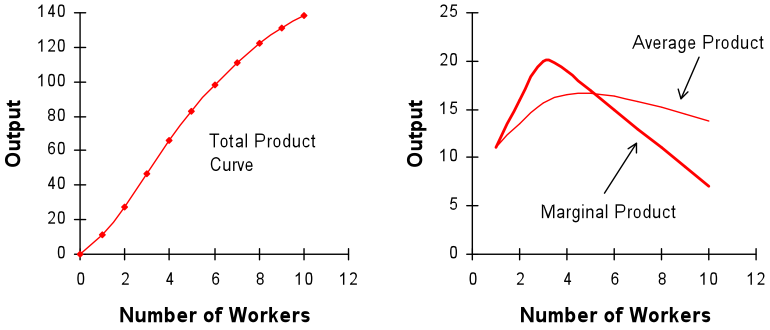
- Today we will study demand for labor in the
  - short-run (firms can adjust only labor inputs)
  - long-run (firms can adjust all inputs)
  - and the impact of maximum hours policy on employment

Labor and Capital

Decreasing Marginal Product of Labor (aka "André must go")

Marginal and average product



The total product curve gives the relationship between output and the number of workers hired by the firm (holding capital fixed). The marginal product curve shows the output produced by each additional worker, and the average product curve shows output per worker.

Labor Demand in the Short-Run

Firm's problem

$$\max_{\{E\}} pf\left(E, \overline{K}\right) - wE - r\overline{K}$$

where p the price of the output, $f\left(E, \overline{K}\right)$ is the production function, E is employee-hours, $\overline{K}$ the (fixed) capital stock, w wage rate and r rental rate of capital

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First-Order-Condition

$$pf_E\left(E, \overline{K}\right) = w$$

i.e. value of the marginal product of labor, $VMP_E = pf_e\left(.\right)$, equals the price of the unit of labor.

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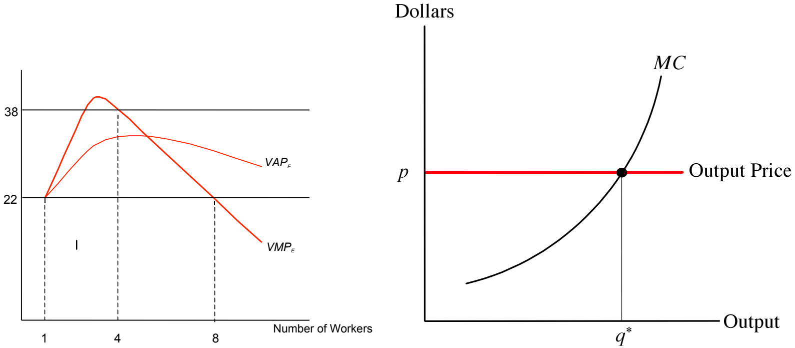
This yields the short-run labor demand curve for the firm

$$E^d_{sr} = E\left(w,p,\overline{K}\right)$$

Labor Demand in the Short-Run



A profit-maximizing firm hires workers up to the point where the wage rate equals the value of marginal product of labor (left panel). This corresponds to the marginal cost of production being equal to the output price (right panel).

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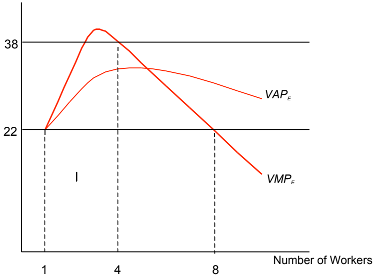
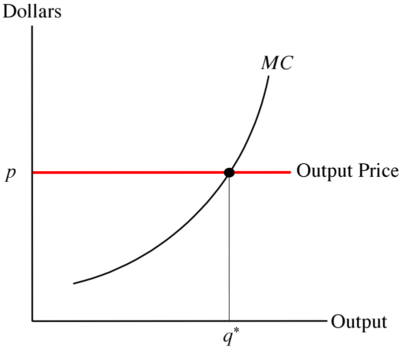
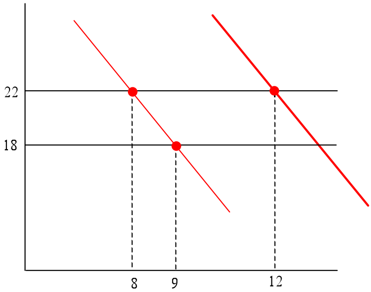




A profit-maximizing firm hires workers up to the point where the wage rate equals the value of marginal product of labor (left panel). This corresponds to the marginal cost of production being equal to the output price (right panel). For example, if the wage is $22, the firm hires eight workers. However, if the wage is $38, the value of average product of labor would be less than the wage $\rightarrow$ the firm does not hire anyone

Firm-level short-run labor demand curve

1. $\frac{\delta E_{sr}^{d}}{\delta w} < 0$ (downward sloping due to decreasing marginal cost)
2. $\frac{\delta E_{sr}^{d}}{\delta p} > 0$ (increase in output price $\rightarrow$ higher value of marginal product)
3. $\frac{\delta E_{sr}^{d}}{\delta \overline{K}} > 0$ (more capital $\rightarrow$ higher marginal product)



Short-run labor demand curve (industry)

If the wage rate falls, all the firms in the industry will increase their output. As a result, the price of the output will decrease and labor demand will adjust downwards

Labor Demand in the Long-Run

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$$\max_{\{E,K\}} pf(E,K) - wE - rK$$

[as before, but now the firm chooses the level of labor *and* capital]

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Equilibrium

The FOCs are $pf_E(E^*,K^*) = w$ and $pf_K(E^*,K^*) = r$, hence

$$\frac{f_E(E^*,K^*)}{f_K(E^*,K^*)} = \frac{w}{r}$$

i.e. the slope of the **isoquant** curve equals the slope of the **isocost** line

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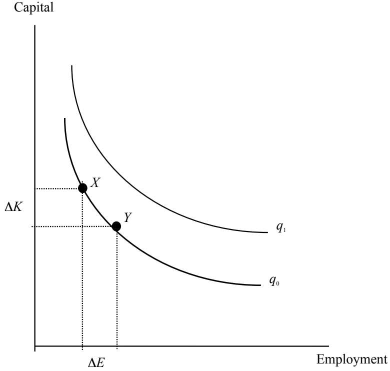
Duality: We get the same result from solving

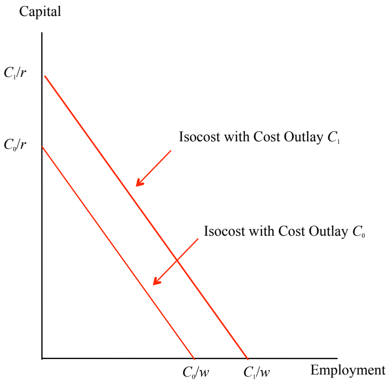
$$\min_{\{E,K\}} wE + rK \text{ s.t. } f_k(E,K) = q_0$$

Isoquant Curves



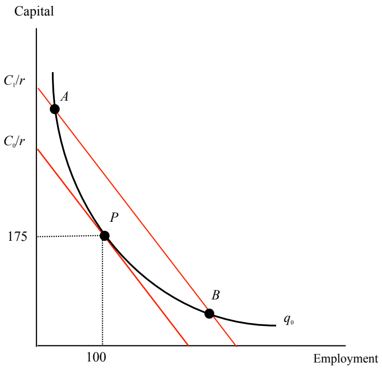
All capital-labor combinations that lie on a single isoquant produce the same level of output. The input combinations at points X and Y produce q_9 units of output. Combinations of input bundles that lie on higher isoquants must produce more output. The slope of the isoquant curve corresponds to the **marginal rate of technical substitution**

Isocost Lines



All capital-labor combinations that lie on a single isocost curve are equally costly. Capital-labor combinations that lie on a higher isocost curve are more costly. The slope of an isoquant equals the ratio of input prices $-\frac{w}{r}$.

The Firm's Optimal Combination of Inputs

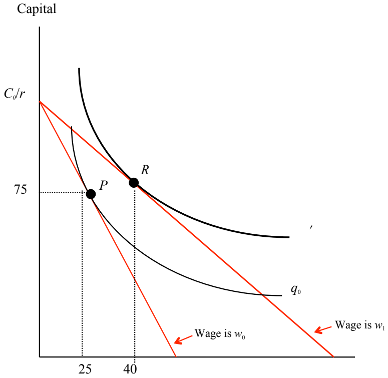


A firm minimizes the cost of producing q_0 units of output by using the capital-labor combination at point P, where the isoquant is tangent to the isocost. All other capital-labor combinations (such as those given by points A and B) lie on a higher isocost curve.

Impact of Wage Decreas on the Long Run Demand for Labor

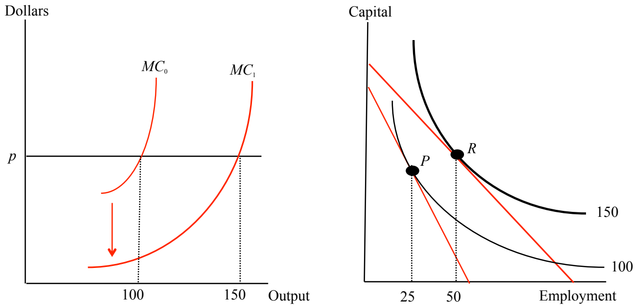
1. **Scale effect**: The firm takes advantage of the lower price of labor by expanding production
2. **Substitution effect**: The firm takes advantage of the wage change by rearranging its mix of inputs

The Impact of a Wage Reduction
(Holding Costs Constant)



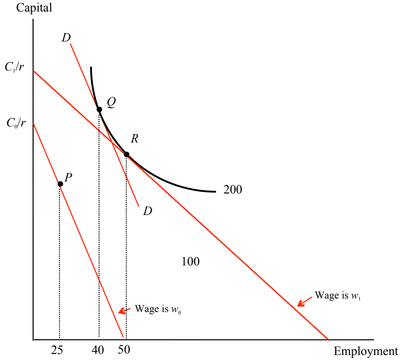
A wage reduction flattens the isocost curve. If the firm were to hold the initial cost outlay constant at C_0, the isocost would rotate around C_0 and the firm would move from point P to point R. A profit-maximizing firm, however, will not generally want to hold the cost outlay constant when the wage changes.

The Impact of a Wage Reduction on the Output and Employment of a Profit-Maximizing Firm



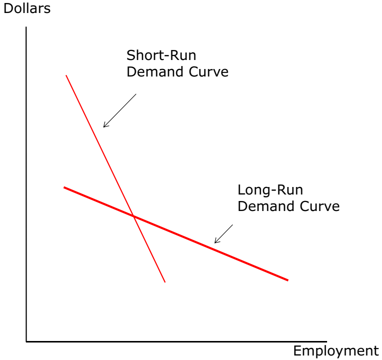
A wage cut reduces the marginal cost of production and encourages the firm to expand (from producing 100 to 150 units). The firm moves from point P to point R, increasing the number of workers hired from 25 to 50.

Substitution and Scale Effects



A wage cut generates substitution and scale effects. The scale effect (from P to Q) encourages the firm to expand, increasing the firm's employment. The substitution effect (from Q to R) encourages the firm to use a more labor-intensive method of production, further increasing employment.

Short- and Long-Run Demand Curves



In the long run, the firm can take full advantage of the economic opportunities introduced by a change in the wage. As a result, the long-run demand curve is more elastic than the short-run demand curve.

Elasticity of Substitution

The elasticity of substitution

$$\sigma = \left[\frac{\Delta\left(K/E\right)}{K/E}\right] / \left[\frac{\Delta\left(w/r\right)}{w/r}\right]$$

i.e. the percentage change in the capital to labor ratio given a percentage change in the price ratio (wages to real interest).

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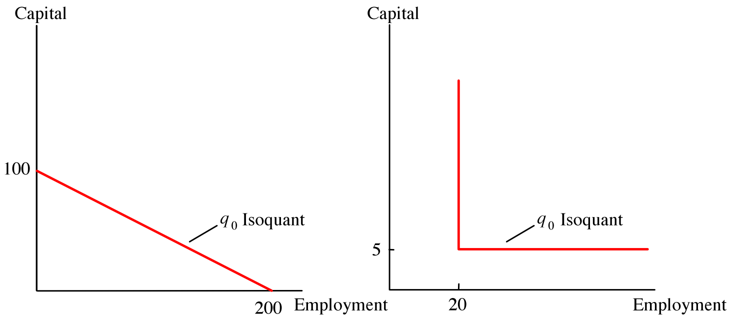
- Interpret as the percentage change in the capital–labor ratio given a 1% change in the relative price of labor to capital
- Example: If the elasticity of substitution is 5, then a 10% increase in the ratio of wages to the price of capital would result in the firm increasing its capital-to-labor ratio by 50%.

Elasticity of Substitution: The Extreme Cases



Capital and labor are perfect substitutes ($\sigma = \infty$) if the isoquant is linear (two workers can always be substituted for one machine). The two inputs are perfect complements ($\sigma = 0$) if the isoquant is right-angled (the firm then gets the same output when it hires 5 machines and 20 workers as when it hires 5 machines and 25 workers)

Marshall's Rules of Derived Demand

Long-run elasticity of labor demand

$$\delta_{LR} = \frac{\Delta E_{LR}/E_{LR}}{\Delta w/w} = \frac{\Delta E_{LR}}{\Delta w} \times \frac{w}{E_{LR}}$$

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- elasticity of substitution is greater (see above)
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  (if production is labor intensive, even a small increase in wages substantially increases marginal cost of production)

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- the labor's share in total costs of production is greater
  (if production is labor intensive, even a small increase in wages substantially increases marginal cost of production)
- the supply elasticity of other factors of production is greater
  (more expensive to substitute workers to capital if the price of capital is very responsive to demand for capital)

Factor Demand with Many Inputs

Many different inputs

- Skilled and unskilled labor, old and young workers, old and new machines...

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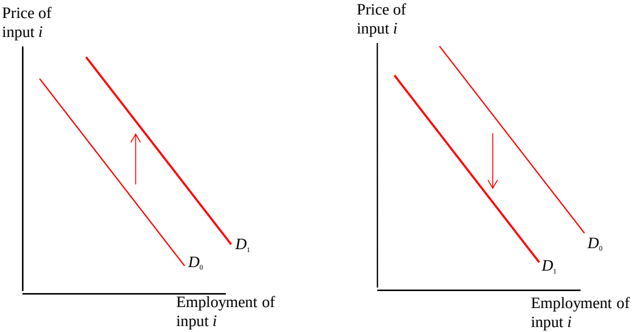
Cross-elasticity of factor demand

$$\frac{\Delta x_i / x_i}{\Delta w_j / w_j}$$

i.e. the percent change in the demand for input i given a percentage change in the price of input j

- Substitutes: cross-elasticity positive
- Complements: cross-elasticity negative

The Demand Curve for a Factor of Production is Affected by the Prices of Other Inputs



The labor demand curve for input i shifts up if the price of a substitutable input rises (left panel) and down if the price of a complement rises (right panel)

Work-Sharing

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  - Takeaway: (a) hours $\downarrow$, (b) wages $\uparrow$, (c) statistically insignificant estimates for employment effect

Background

- German unions negotiate industry level minimum wages, regular hours, vacations...
  (agreements also bind non-union members)
- After a IG Metall strike in 1984 regular hours for metalworkers reduced from 40 to 38.5 starting from 1985
- Other unions followed
  (and IG Metall pushed metalworkers hours to 35 by 1995)
- Hours cuts accompanied with "full wage compensation"
  (not clear what this means)

Model

Firm's problem

$$\max_{\{h,N,K\}} g\left(h, N, K\right) - whN - fN - pw\left(h - h_s\right) N - rK$$

where $g\left(.\right)$ is the production funtion, h hours per worker, N number of workers, K capital, w wages, f a fixed-cost of hiring a worker, p overtime premium, h_s standard hours (anything above this is overtime) and r rental rate of capital.

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Marginal costs of an extra worker and hour

$$\begin{aligned} MC_N &= wh^* + f + pw(h^* - h_s) \\ MC_H &= (1+p)\,wh^* \end{aligned}$$

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$$\begin{aligned} MC_N &= wh^* + f + pw(h^* - h_s) \\ MC_H &= (1 + p)\, wh^* \end{aligned}$$

The impact of an reduction in h_s (Fig. 1)

1. $h^* > h_s$: $N \downarrow$ (substitution from workers to hours, scale effect, substitution from labor to capital)
2. $h^* < h_s$: $N \uparrow$ (substitution from hours to workers, scale effect, substitution from capital to workers)

Identification

Three estimation equations (Sect VI)

$$\ln y_{it} = \beta_2 h_{s_{it}} + \beta_3 h_{s_{it-1}} + u_i + v_t + \epsilon_{it}$$

where y_{it} is employment or hours at industry i at period t, , $h_{s_{it}}$ is standard hours hours at this industry at period t, u_i is a set of industry-level fixed-effect, v_t is a set of time effects

Identifying assumptions (dif-in-dif)

- **timing** of standard hours reduction independent of time-specific unobservables $\rightarrow$ deviations from common time-effects (after conditioning on time-invariant industry-effects) caused by the treatment
-
-

Identification

Three estimation equations (Sect VI)

$$
\begin{aligned}
\ln y_{it} &= \beta_2 h_{s_{it}} + \beta_3 h_{s_{it-1}} + u_i + v_t + \epsilon_{it} && (1)\\
\ln y_{it} &= \beta_2 h_{s_{it}} + \beta_3 h_{s_{it-1}} + u_i + v_t + \beta_1 t + \epsilon_{it} && (2)\\
\ln y_{it} &= \beta_2 h_{s_{it}} + \beta_3 h_{s_{it-1}} + u_i + v_t + \beta_1 t + \beta_4 w_{it-1} + \epsilon_{it} && (3)
\end{aligned}
$$

where y_{it} is employment or hours at industry i at period t, , $h_{s_{it}}$ is standard hours hours at this industry at period t, u_i is a set of industry-level fixed-effect, v_t is a set of time effects, $\beta_1 t$ captures industry-specific trends and w_{it-1} is the nominal bargained wage in the previous quarter

Identifying assumptions (dif-in-dif)

- Spec. 1: **timing** of standard hours reduction independent of time-specific unobservables → deviations from common time-effects (after conditioning on time-invariant industry-effects) caused by the treatment
- Spec. 2: as 1, but allowing for industry-specific trends
- Spec. 3: as 2, but also conditioning on industry-level bargained wages (probably should not do this as wages likely affected by standard hours)

Impact on Employment (Table V)

- Col 1, last row
  - point estimate: one hour decrease in standard hours decreases employment by 3.8 percent
  - however, standard error is 3.6 percent → no statistically significant effect
- Cols 2 and 3: similar results
  - IV is used here to correct for attenuation bias due to measurement error (not selection)
  - note that measurement error always leads to a bias towards zero
  - but this can be corrected if one has two independent measures of the same thing (one measure used as an instrument for the other)
- Cols 4 and 5: weighting by industry size reduces the estimates
  - not clear why to weight (treatment is at industry-level)
  - the difference between unweighted and weighted results simply tells you that less was going on in larger industries
  - .... and the difference between the results from alternative specifications are not statistically significant anyways

Impact on Employment (Table VI)

- Point estimates on col 1–2 suggest that one hour reduction in standard hours decreases employment by 5–6 percent among men (statistically significant)
    - Hunt: this is too large to be plausible
    - As we discussed in the first lecture, underpowered studies produce either insignificant or very large estimates (see Gelman, Weakliem (2009): Of Beauty, Sex and Power, *American Scientist 97*)
- Some point estimates for women (col 5–6) suggest positive employment effects, but these are not significant

Impact on Actual Hours (Table VII)

- Benchmarks
  - one hour reduction from 40 hours is 2.5 percent $\rightarrow$ a coefficient of 0.025 for standard hours implies one-for-one reduction in actual hours
  - a coefficient of zero would imply no effect on actual hours (i.e. full shifting to overtime)
- Results (cols 1–3): 0.024 (s.e. 0.003)
- Estimates for men smaller implying some shifting to overtime (consistent with employment results)

Impact on Actual Hours (Tables I and II)

- These estimates based on individual-level panel data
- y =actual hours or overtime dummies, D =standard hours
- Cols 1–3: $\beta = 0$ implies no effect on actual hours (full shifting to overtime); $\beta = 1$ complete "pass-through" to actual hours
  - Col 1: Cross-sectional variation
  - Col 2: Within-individual variation
  - Col 3: Within-individual variation + IV to correct for measurement error in reported standard hours
- Col 4: $\beta < 0$ implies an increased likelihood to work overtime as h_s decreases, $\beta = 0$ implies no effect
- Col 5: $\beta < 0$ implies an increased likelihood to work undertime as h_s decreases, $\beta = 0$ implies no effect

Takeaway: One hour reduction in standard hours reduces actual hours by 0.88–1 hours

Impact on Wages (Table III)

- Here no claims for causality
  - Wages and hours jointly determined
  - Future reductions in standard hours may be anticipated in bargaining process
- Still informative about correlation between standard hours and wages
- Results: One hour reduction in standard hours associated with 2–2.4 percent increase in hourly wage $\rightarrow$ monthly pay remains roughly constant (for a person not working overtime)

Conclusions

- Hours
  - most/all reduction in standard hours transfered to actual hours
- Wages
  - hourly wages increase when standard hours decrease

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- Employment
  - This study does not have enough data to really tell what happens
  - Nevertheless, a reasonable working hypothesis is that work-sharing does not increase employment
  - Additional evidence: Crépon, Kramarz (2002, JPE) conclude that an one-hour reduction of the workweek decreases employment by 2–4%