Labor Demand

Downward-Sloping Labor Demand Curve

- A firm uses labor (L) and capital (K) to produce output (y). It takes factor prices (w and r) and output price (p) as given (no market power in either factor markets or output market).
- When prices are (w, r, p), it chooses (L^*, K^*, y^*).
- When prices are (w', r, p), it chooses (L', K', y').
- Revealed preference argument:
  - Both production plans are feasible (they are actually chosen under some circumstances)
  - First plan is better under first set of prices:
  $$py^* - wL^* - rK^* \geq py' - wL' - rK' \tag{1}$$
  - Second plan is better under second set of prices:
  $$py' - w'L' - rK' \geq py^* - w'L^* - rK^* \tag{2}$$
  - Add (1) to (2) to get
  $$(w' - w)(L' - L^*) \leq 0$$
  - When wage rises, employment falls

Substitution Effect

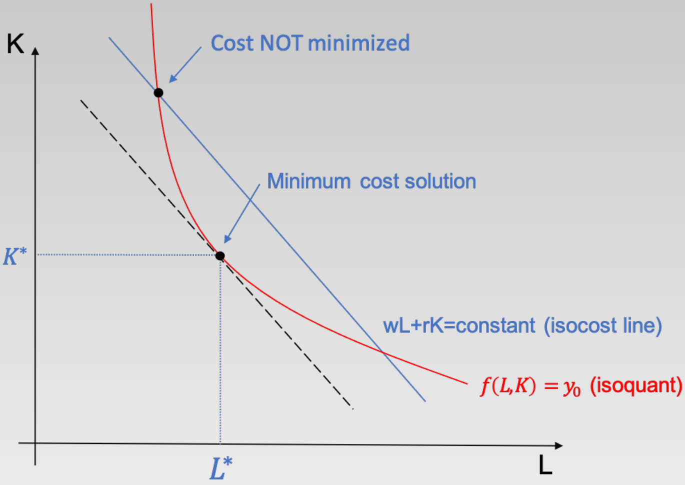
- Consider a production function, $y = f(L,K)$; output can be increased by either raising labor or capital input—these inputs are substitutable
- The marginal products of labor and capital are $f_L(L,K)$ and $f_K(L,K)$, respectively
- The marginal rate of technical substitution (slope of isoquant) tells us how much capital we can save by raising labor by 1 unit, while keeping output constant:

$$MRTS = -\frac{f_L(L,K)}{f_K(L,K)}$$

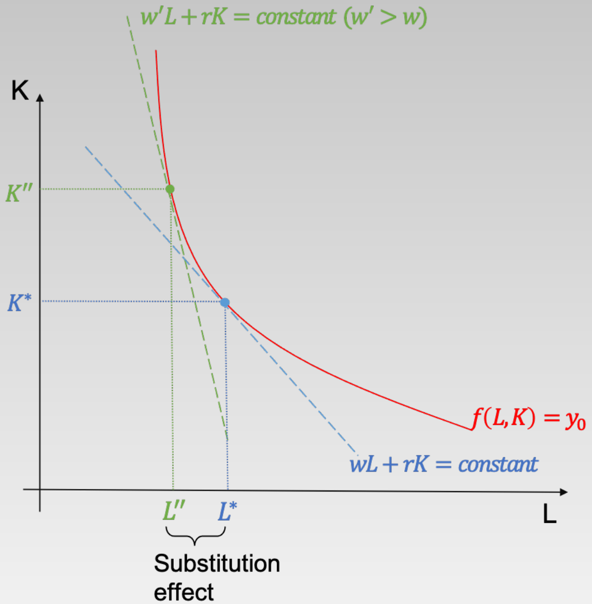
- The factor price ratio (negative slope of isocost line) tells us how much capital we have to cut when we raise labor by 1 unit, in order to keep total cost constant. It's equal to w/r.
- Cost minimization requires setting

$$\frac{f_L(L,K)}{f_K(L,K)} = \frac{w}{r}$$

Graphical Treatment



Labor Becomes More Expensive



Another Revealed Preference Argument

- You choose (L^*, K^*) to produce y^* units of output when factor prices are (w, r).
- You choose (L'', K'') to produce the same amount y^* of output when factor prices are (w', r)
- Both production plans are feasible
- The first plan must be cheaper under the first set of prices:

$$wL^* + rK^* \leq wL'' + rK''$$

- The second plan is cheaper under the second set of prices:

$$w'L'' + rK'' \leq w'L^* + rK^*$$

- Adding up these two equations gives

$$(w' - w)(L'' - L^*) \leq 0$$

Scale Effect

- $L'' - L^*$ is the substitution effect
- But why should you keep output unchanged at y^* when labor becomes more expensive?
- Higher wages raise the cost of production. They (typically) shift up the marginal cost curve. Meanwhile, output price remains unchanged at p
- For profit maximization, the optimal response is to reduce output (say, from y^* to $y' < y^*$)
- If you want to produce less output, you (typically) need less input: labor demand falls further from L'' to (say) $L' < L''$ (when we are holding wage fixed at the high level w')
- $L' - L''$ is the scale effect
- Both effects go in the same direction: overall effect ($L' - L^*$ is larger in magnitude than each effect alone)

Industry-Level Scale Effect

- The above refers to the "scale effect" for an individual firm, holding output price fixed
- At the industry level, higher wage leads to higher average cost of production. If the industry is competitive and price equals average cost, output price will rise
    - more generally, higher cost reduces industry supply of output and will raise output price
- Higher output price causes output demand to fall, leading to reduction in labor demand

Intensive and Extensive Margins

- Higher wages can reduce employment through two channels:
  - intensive margin: an individual firm hires fewer workers (or cutting down hours worked per worker)
  - extensive margin: some firms become unprofitable and leave the industry

Lessons for Managers

- Labor demand is "homogeneous of degree 0" is prices
  - maximizing $py - wL - rK$ is is the same as maximizing $(\lambda p)y - (\lambda w)L - (\lambda r)K$ for any $\lambda > 0$
  - it is the real wage (w/p) rather than the nominal wage (w) that matters for labor demand decisions
- Cheaper workers are not always better
  - Let's say young workers are cheaper than old workers, $w_y < w_o$
  - but if older workers are more productive, in the sense that $\frac{MP_o}{MP_y} > \frac{w_o}{w_y}$, you should hire the older workers
  - Example: Day's Inn switched from young minimum wage workers to senior citizens to staff its reservation center. This turns out to be a good move despite senior citizens are more expensive workers. Calls take longer to complete (bad) but they are more likely to result in a reservation (good). Also turnover is much lower and this reduces training costs
  - Example: In international trade, countries with cheaper labor need not be more competitive if their workers are less productive

More Lessons

- Marginal product of labor depends on the quantity and quality of other factors of production
  - $f_L(L,K)$ depends on K
  - Example: more productive firms (better managers, more intellectual capital) are larger (hire more workers) than less productive ones
  - Example: Suppose a more able legal assistant has a 1% smaller chance of making a mistake in writing a legal document. A mistake may cost $1000 in a small claims court but it may cost $10 million in a merger and acquisition deal $\rightarrow$ better lawyers hire better legal assistants
- Hiring risky workers has option value
  - Johnson is an experienced salesman and you are sure he can deliver $1 million of sales each year
  - Wilson is brash woman just laid off from Hollywood. She has the potential to deliver $1.5 million of annual sales, but she may equally likely deliver 0 dollars every year
  - Their yearly wage is the same, which one would you hire?

Competitive Firm

- The profit-maximization problem can be written as

$$\max_{L,K} \quad pf(L,K) - wL - rK$$

- The first-order conditions are $pf_L(L,K) - w = 0$ and $pf_K(L,K) - r = 0$
- $pf_L(L,K)$ is the value of marginal product of labor. The general rule is to set

$$VMP = \text{factor price}$$

  for every factor of production
- The VMP curve is also the labor demand curve

Market Power

- Now suppose a firm has market power in the output market. It does not take p as given. Instead, p falls whenever this firm produces more output.
- Let $R(y)$ be total revenue (it's equal to $P(y)y$, where $P(y)$ is the inverse product demand curve)
- The profit maximization problem is

$$\max_{L,K} \quad R(f(L,K)) - wL - rK$$

- The first-order conditions are $R'(f(L,K))f_L(L,K) - w = 0$ and $R'(f(L,K))f_K(L,K) - r = 0$
- $R'(f(L,K))f_L(L,K)$ is the marginal revenue product of labor. The general rule is to set

$$MRP = \text{factor price}$$

Monopsony Power

- Now suppose a firm has market power in the input market for labor.
- The more workers it hires, the higher the wage it has to pay to attract these workers. This firm faces an upward-sloping labor supply curve: $w = S(L)$ where $S'(L) > 0$
- The profit maximization problem is

$$\max_{L,K} \quad pf(L,K) - S(L)L - rK$$

- The first-order conditions are $pf_L(L,K) - (S(L) + S'(L)L) = 0$ and $pf_K(L,K) - r = 0$
- When you have L workers and want to hire one more, you pay this worker $w = S(L+1)$. But you also have to raise the wage for all the workers from $S(L)$ to $S(L+1)$. The increase in total wage bill is $S(L+1) + (S(L+1) - S(L))L$
- $S(L) + S'(L)L$ is the marginal factor cost of labor
- The general rule is to set VMP (or MRP) equal to MFC for the input which the firm has monopsony power.

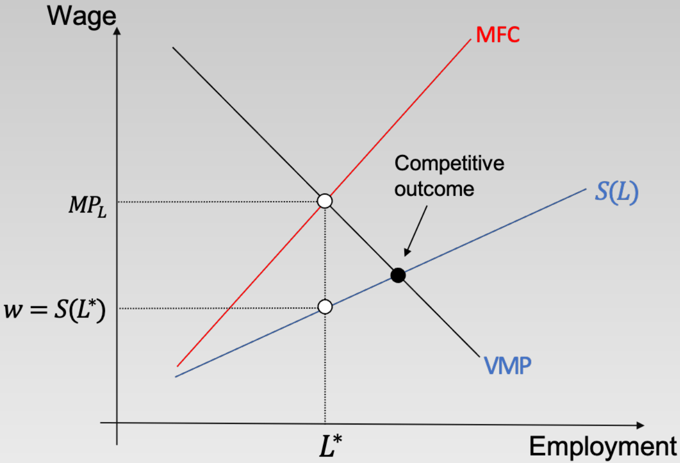
Elasticity Formula

- $MFC = S(L) + S'(L)L = w + \frac{\mathrm{d}w}{\mathrm{d}L}L = w + w\frac{\mathrm{d}w}{\mathrm{d}L}\frac{L}{w} = w(1 + 1/e)$, where e is the elasticity of labor supply (to the monopsony firm)
- So the optimality condition for the monopsony can be written as $MRP = w(1 + 1/e)$, or equivalently:

$$\frac{MRP - wage}{MRP} = \frac{w/e}{w(1 + 1/e)} = \frac{1}{1 + e}$$

- Workers can be "underpaid" (relative to their MRP) by about 9% if the elasticity of labor supply to the firm is 10.

Graphical Illustration



Imperfect Labor Market

- Monopsony exercises market power by restricting employment (to avoid raising wages) → employment is too low compared to competitive outcome
- Possible sources of monopsony power
  - worker mobility is limited: switching a job is tougher than switching the brand of toothpaste you use
  - people have locational preferences and preferences over job characteristics (e.g., co-workers, company culture, tasks and responsibilities) that may be difficult to replicate in another company
  - sunk investments in human capital
  - search frictions and informational problems

Application: Employer Mandate

- In 1976, Illinois, New Jersey and New York required employer-provided health insurance to cover pregnancy costs (costs were about 4% of earnings)
- VMP (net of additional insurance cost) fell
- Reduced demand led to lower wages for female workers, and the burden on workers (relative to the burden on employers) is larger whenever supply is more inelastic
- Female workers in these states fell by about 4% relative to
  - male workers in these states
  - female workers in other states
- The burden of the mandate was mostly paid by the workers themselves

Application: Overtime Regulation and Labor Demand

- California required female workers to be paid 1.5 times the wage for any hours worked in excess of 8 hours per day, even if the worker worked fewer than 40 hours during the week
- In 1980, this rule applied to male workers as well

TABLE 3-2 Employment Effects of Overtime Regulation in California

Source: Daniel S. Hamermesh and Stephen J. Trejo, "The Demand for Hours of Labor: Direct Estimates from California," *Review of Economics and Statistics* 82 (February 2000): 38–47.

	Treatment Group	Control Group	
	Men in California (%)	Men in Other States (%)	Women in California (%)
Workers working more than 8 hours per day in			
1973	17.1	20.1	4.0
1985	16.9	22.8	7.2
Difference	−0.2	2.7	3.2
Difference-in-differences	—	**−2.9**	**−3.4**

Lesson for Causal Inference

- Just looking at before-and-after (time series difference) comparison may not be enough (i.e., -0.2% may not reflect the pure effect of the regulation)—many other things changed between 1973 and 1985
- But if these other things that changed across time also apply to other states, then we can estimate the "time effects" by looking at other states (the estimate is $+2.7\%$)
- Subtracting the "time effects" from the observed effect gives $-0.2\% - (2.7\%) = -2.9\%$ to be the estimated effect of the regulation

Difference in Differences

- Another way of looking at this is:
  - comparing California after the regulation to other states (without the regulation) (cross section difference) gives an estimate of −5.9%—but there are many other things that differ across these two sets of states
  - If these other things did not change over time, then we can estimate the "state effects" by looking at the comparison when the regulation was the same across them (the estimate is −3.0%)
  - Subtracting the "states effects" from the observed effect gives $-5.9\% - (-3.0\%) = -2.9\%$
- This is known as a difference in differences estimate
- The key assumptions for this method to work are:
  - the "time effects" do not vary across states
  - the "state effects" do not vary over time
- it is useful to use multiple control groups—male workers in other states; women workers in California

DID in Regression Framework

- You have panel data on a group of individuals $i = 1, \ldots, I$ in each period $t = 1, \ldots, T$
- Assign dummy variable Treat_{it} equal to 1 if individual i receives treatment in period t (and equal 0 otherwise)
- Run a regression of the form

$$\text{outcome}_{it} = \beta \text{Treat}_{it} + \gamma_i + \delta_t + \text{controls}_{it}$$

  - γ_i are individual fixed effects
  - δ_t are time fixed effects
- Suppose for time $t < t_0$ nobody receives treatment; and for $t \geq t_0$ the treatment group receives treatment (but the control group does not)

DID Estimate

- Predicted outcome for individual i in period t:

	$t < t_0$	$t' \geq t_0$	Diff
$i \in$ Treatment group	$\gamma_i + \delta_t$	$\beta + \gamma_i + \delta_{t'}$	$\beta + \delta_{t'} - \delta_t$
$i' \in$ Control group	$\gamma_{i'} + \delta_t$	$\gamma_{i'} + \delta_{t'}$	$\delta_{t'} - \delta_t$
Diff	$\gamma_i - \gamma_{i'}$	$\beta + \gamma_i - \gamma_{i'}$	β

- The estimated β gives you the DID estimate of the treatment effect