

3.2 – Marginal Productivity Theory

ECON 452 • History of Economic Thought • Fall 2020

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 [ryansafner/thoughtF20](https://github.com/ryansafner/thoughtF20)

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Outline



Second Generation Austrian Marginalists

Marginal Productivity Theory.

Product Exhaustion & The Morality of Marginal Productivity.

Second-Generation Marginalists

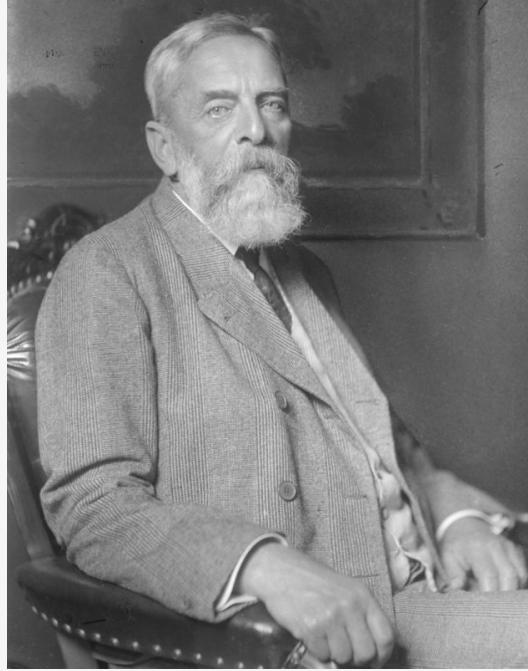


- Primarily extended and applied Jevons, Menger, & Walras' marginalist tendencies to more problems in economics
 - *especially*, the problem of pricing the factors of production
- In England: Alfred Marshall, Phillip Wicksteed, Francis Edgeworth, A.C. Pigou
- In Austria: Friedrich Wieser, Eugen von Böhm-Bawerk
- In Switz./Italy: Enrico Barone, Vilfredo Pareto
- In United States: John Bates Clark, Irving Fisher, Frank Knight, Frank Fetter
- In Sweden: Knut Wicksell



Second-Generation Austrian Marginalists

Friedrich von Wieser

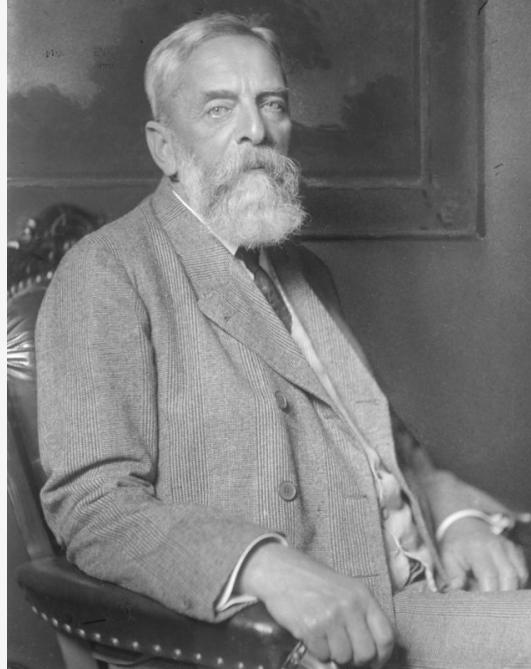


Friedrich von Wieser

1851–1926

- Student of Menger, ultimately replaced Menger as Professor of Political Economy at University of Vienna
- Coined the term “marginal utility” (*Grenznutzen*)
- Teacher to F.A. Hayek
- 1889, *Der natürliche Werth* (*Natural Value*)
- 1914, *Theorie der gesellschaftlichen Wirtschaft* (*Theory of Social Economy*),

Friedrich von Wieser: Alternative Cost Theory

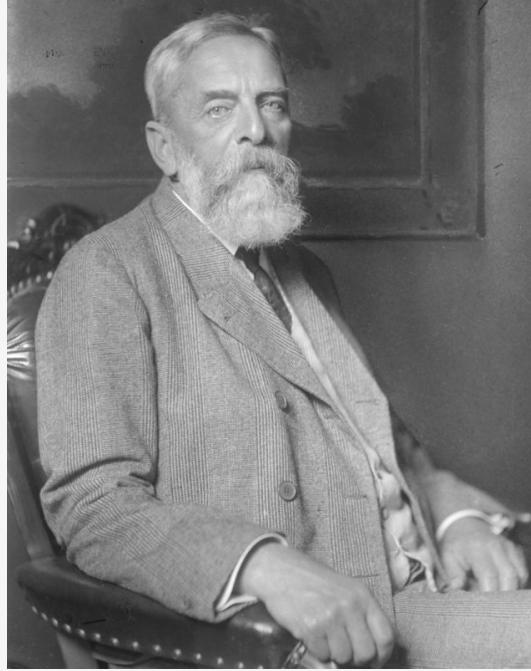


Friedrich von Wieser

1851–1926

- What role do costs of production (payments to factors) play in value of final goods?
- Costs are the values which are forgone in directing resources to a particular production process rather than other production processes
- In this sense, production costs are really a reflection of utilities elsewhere in the economy
- **Alternative cost theory** or **opportunity cost**

Friedrich von Wieser: Alternative Cost Theory

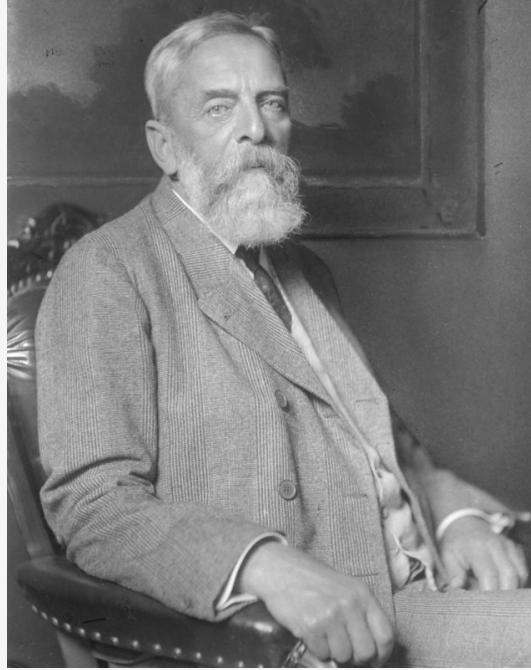


Friedrich von Wieser

1851–1926

- Beginnings of major disagreements:
- Jevons always thought costs were “real” in some sense, e.g. the *disutility* or pain of labor
 - utility of consumption vs. disutility of production; utility & disutility curves
- Marshall & Edgeworth would later argue you can derive an upward-sloping supply/cost curve for non-land factors by disutility of use

Friedrich von Wieser: Imputation Theory

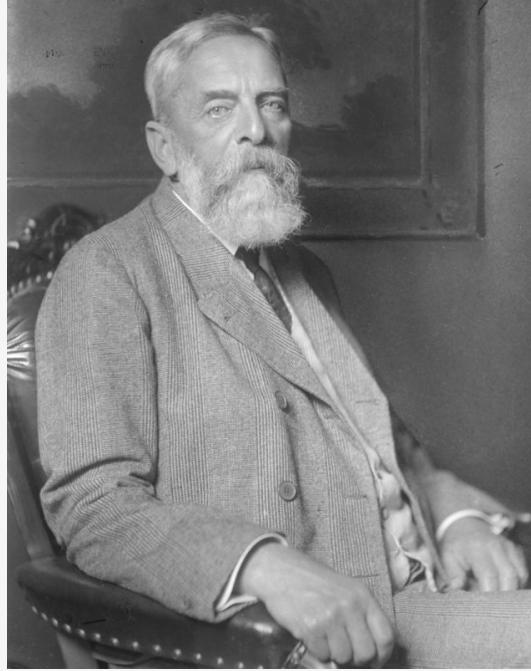


- Menger had clear insights about capital and production: goods of higher order, their complementarity and substitutability, etc.
- If we all agree that prices of final goods reflect their marginal utility, how do we price factor services (land, labor, capital)?
- Wieser, using a legal term, this is a “**problem of imputation**”

Friedrich von Wieser

1851–1926

Friedrich von Wieser: Imputation Theory



Friedrich von Wieser

1851–1926

- Wieser's solution was **linear programming** with simultaneous equations (no calculus)
- **Example:** consider a three-good society, factors in each good's production are x , y , and z , represented by three simultaneous equations:

$$\begin{aligned} x+y &= \$100 \\ 2x+3z &= \$290 \\ 4y+5z &= \$590 \end{aligned}$$

- Solve for x , y , and z (prices of each factor)
- Assumes prices for final goods are given, fixed production coefficients, and no substitution of factors

Eugen von Böhm-Bawerk



Eugen von Böhm-Bawerk

1851–1914

- Studied law at University of Vienna; exposed to Menger but never his direct student
- Friend & brother-in-law to Friedrich Wieser
- Became Minister of Finance of Austria-Hungary; ambassador to Germany
- Later became professor of political economy, teacher to Ludwig von Mises

Eugen von Böhm-Bawerk



Eugen von Böhm-Bawerk

1851–1914

- Direct critique of Marxism: 1896, *Karl Marx and the Close of His System*
- Famously wrote on capital theory and interest theory
 - We will dig into this next week
- *Capital & Interest* 2 volumes:
 - 1884, *History and Critique of Interest Theories*
 - 1889, *Positive Theory of Capital*

Eugen von Böhm-Bawerk



- Took a different approach to the imputation problem (factor pricing) than Wieser:
- Followed a phrase in Menger, “the loss principle” – applying to the price of the final good what would be lost if one of the factor services is withdrawn
- A good start, but in truth, marginal product operates at infinitesimally small changes (derivative)

Eugen von Böhm-Bawerk

1851–1914



Marginal Productivity Theory

The Ricardian Roots of Marginal Productivity Theory



- Ricardo's theory of rent applied marginal analysis ("doses" of L+K) to a fixed factor (land), concluding the fixed factor earns a residual surplus (gap between AP>MP) of variable factor (L+K)
- **Marginal productivity theory** takes the other side of the coin: any **variable factor must earn a payment equal to its marginal product** (holding all other factors fixed)

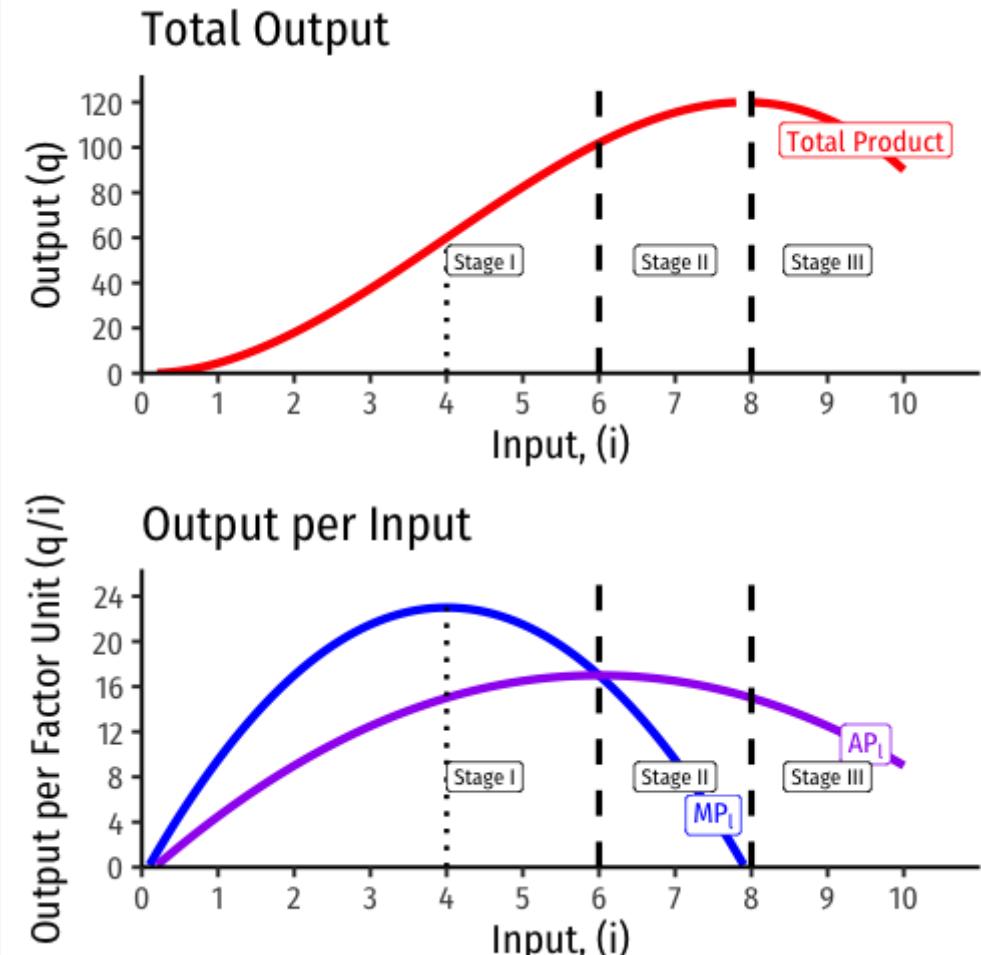
David Ricardo

1772-1823

Marginal Productivity Theory



- Applying Ricardian logic *beyond* agriculture, we arrive at the modern **law of diminishing returns**
 - “**Law of variable proportions**” or “**variation of returns**”
- For *any* one variable factor (holding all others constant), increasing use will eventually yield a diminishing marginal product
 - nothing special about land!



Diminishing Returns



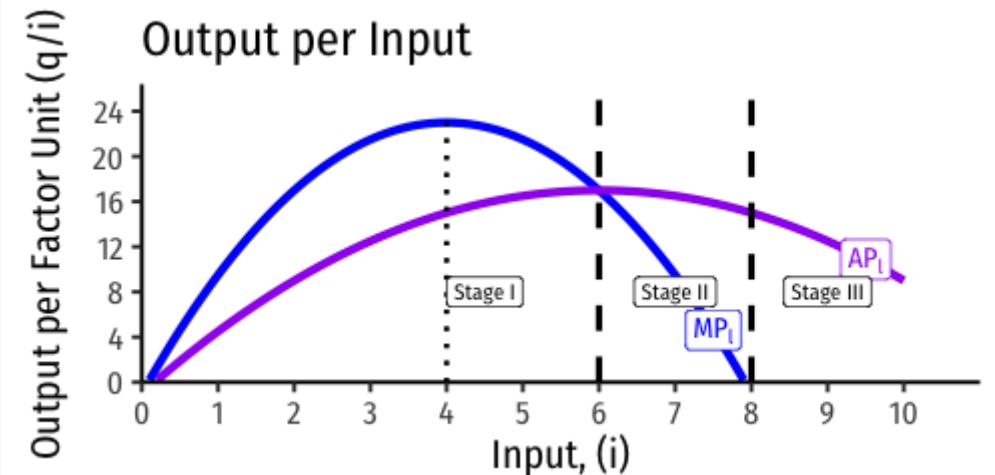
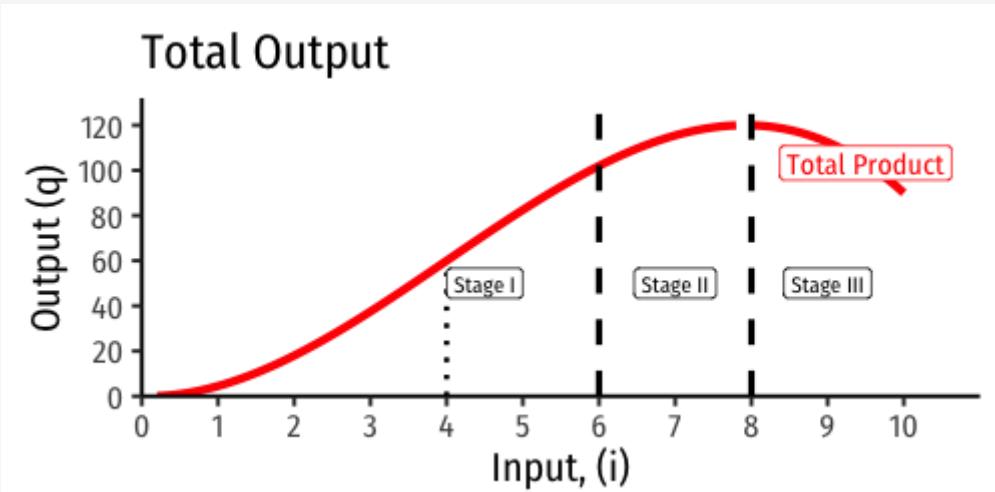
- **Marginal product of factor i, (MP_i)**: additional output produced by adding one more unit of factor i (holding all others constant)

$$MP_i = \frac{\Delta q}{\Delta i}$$

- MP_i is slope of TP at each value of i
- **Average product of factor i (AP_i)**: additional output produced by adding one more unit of factor i (holding all others constant)

$$AP_i = \frac{q}{i}$$

- AP_i is slope of a ray from the origin to the production function at any quantity of i



Derived Demand in Factor Markets



- Demand for factors (e.g. labor) is a “derived demand”:
 - Firm only demands inputs to the extent they **contribute to producing sellable output**
- Firm faces a **tradeoff** when **hiring more labor**, as more labor ΔL creates:
 1. **Marginal Benefit**: Increases output and thus revenue
 2. **Marginal Cost**: Increases costs



Marginal Revenue Product (of Labor)



- Hiring more labor increases output (i.e. labor's MP_L)
 - Recall: $MP_L = \frac{\Delta q}{\Delta L}$, where q is units of output
- Additional output generates (i.e. labor's $MR(q)$)
 - Recall: $MR(q) = \frac{\Delta R(q)}{\Delta q}$, where $R(q)$ is total revenue
- Hiring more labor, on the **margin**, generates a **benefit**, called the **marginal revenue product of labor, MRP_L** :

$$MRP_L = MP_L * MR(q)$$

- i.e. the number of new products a new worker makes times the revenue earned by selling the new products

Marginal Revenue Product for *Competitive Firms*



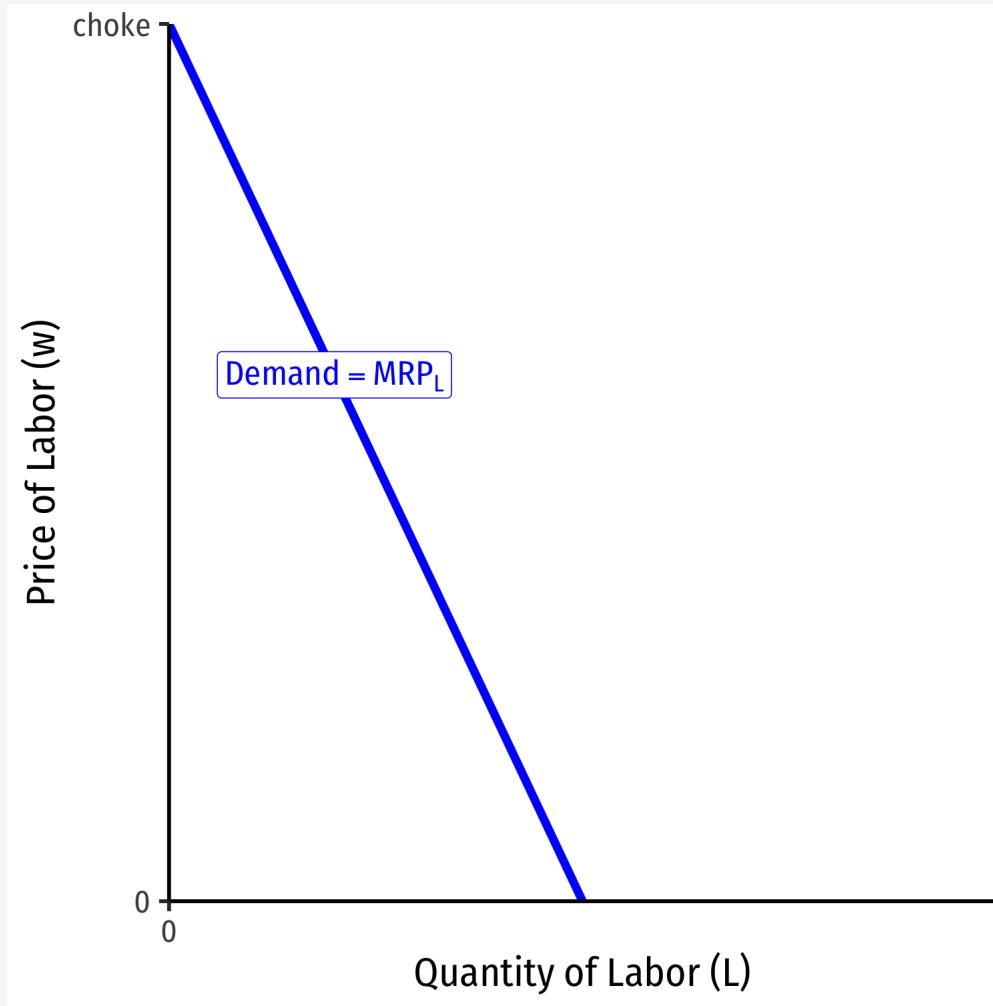
- This is the **Firm's Demand for Labor**:

$$MRP_L = MP_L * MR(q)$$

- For a firm in a **competitive (output) market**, firm's $MR(q) = p$, hence:

$$MRP_L = MP_L * p$$

where p is the price of the firm's *output*

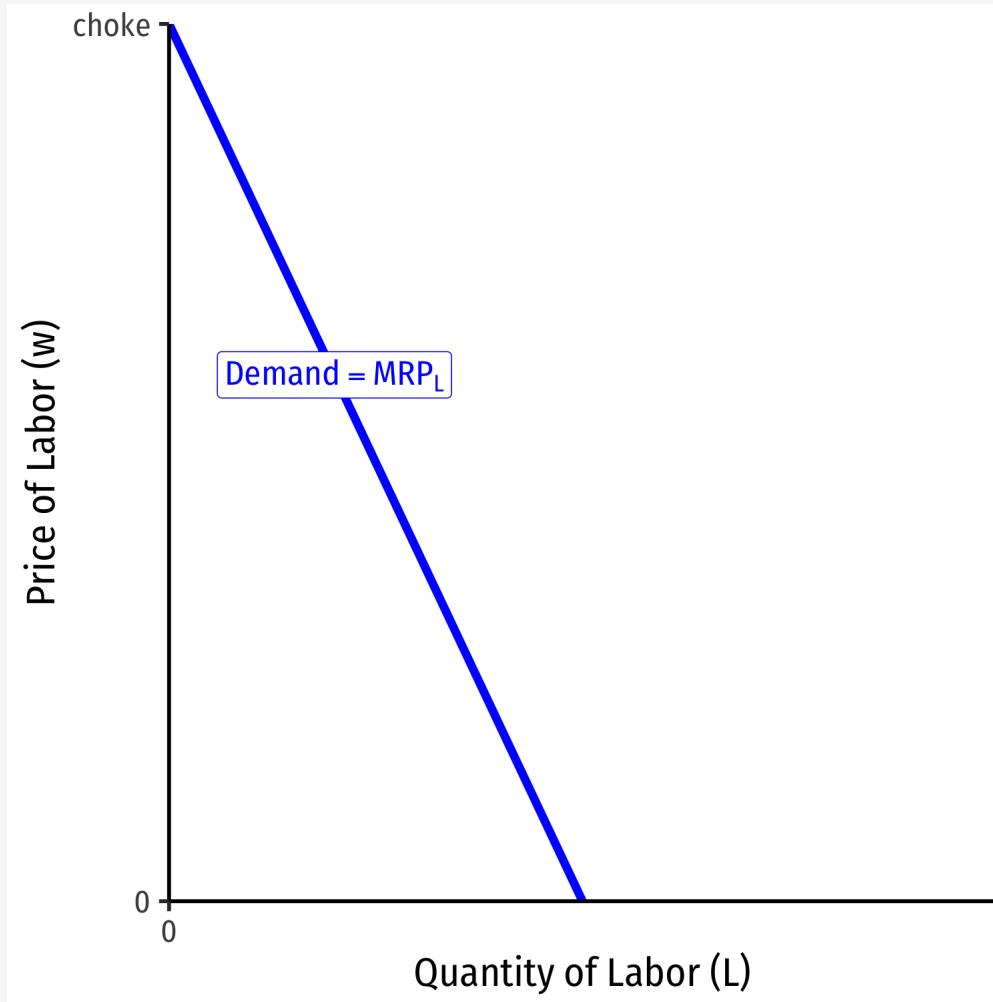


Marginal Revenue Product for *Competitive Firms*

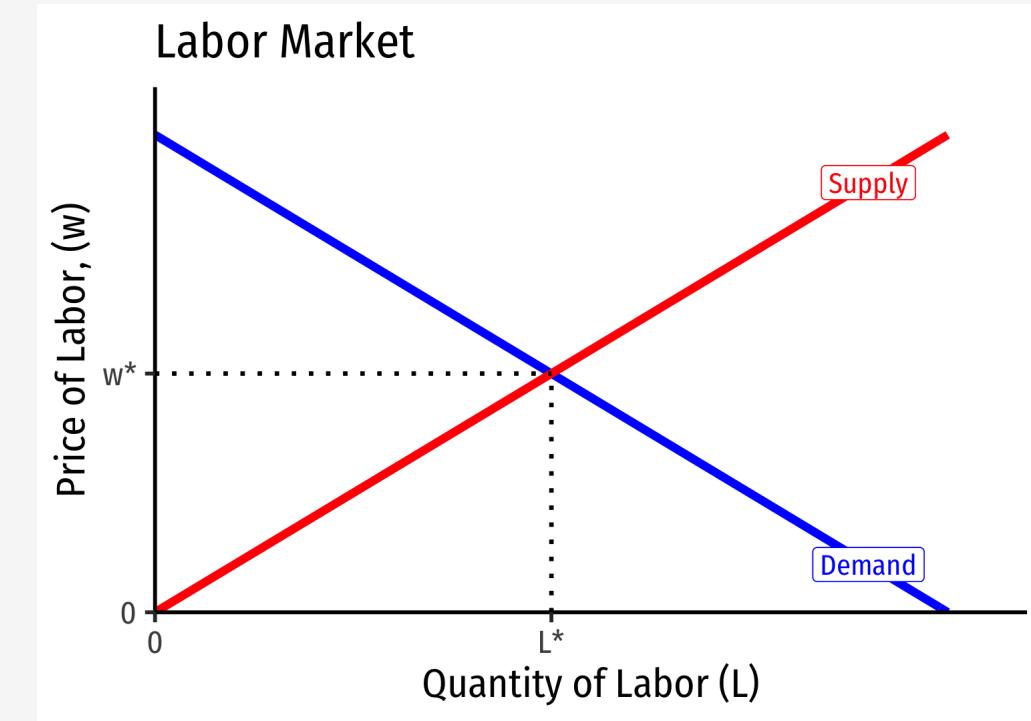
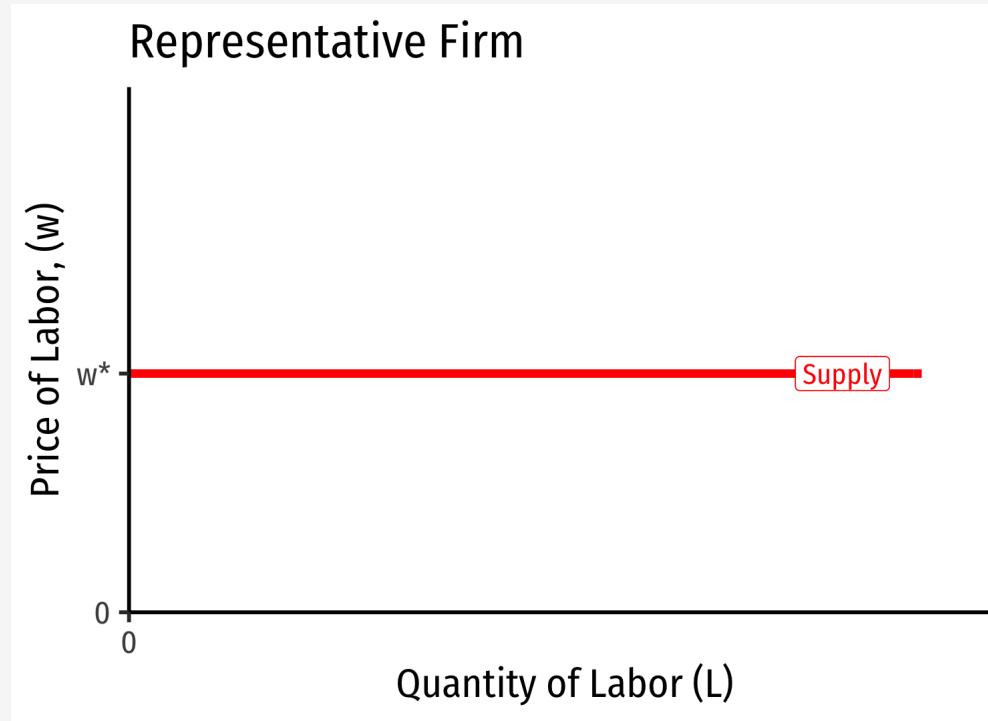


$$MRP_L = MP_L * p$$

- Marginal benefit of hiring labor, MRP_L **falls** with more labor used
 - production exhibits **diminishing marginal returns to labor!**
- **Choke price for labor demand:** price too high for firm to purchase any labor



A Competitive Factor Market

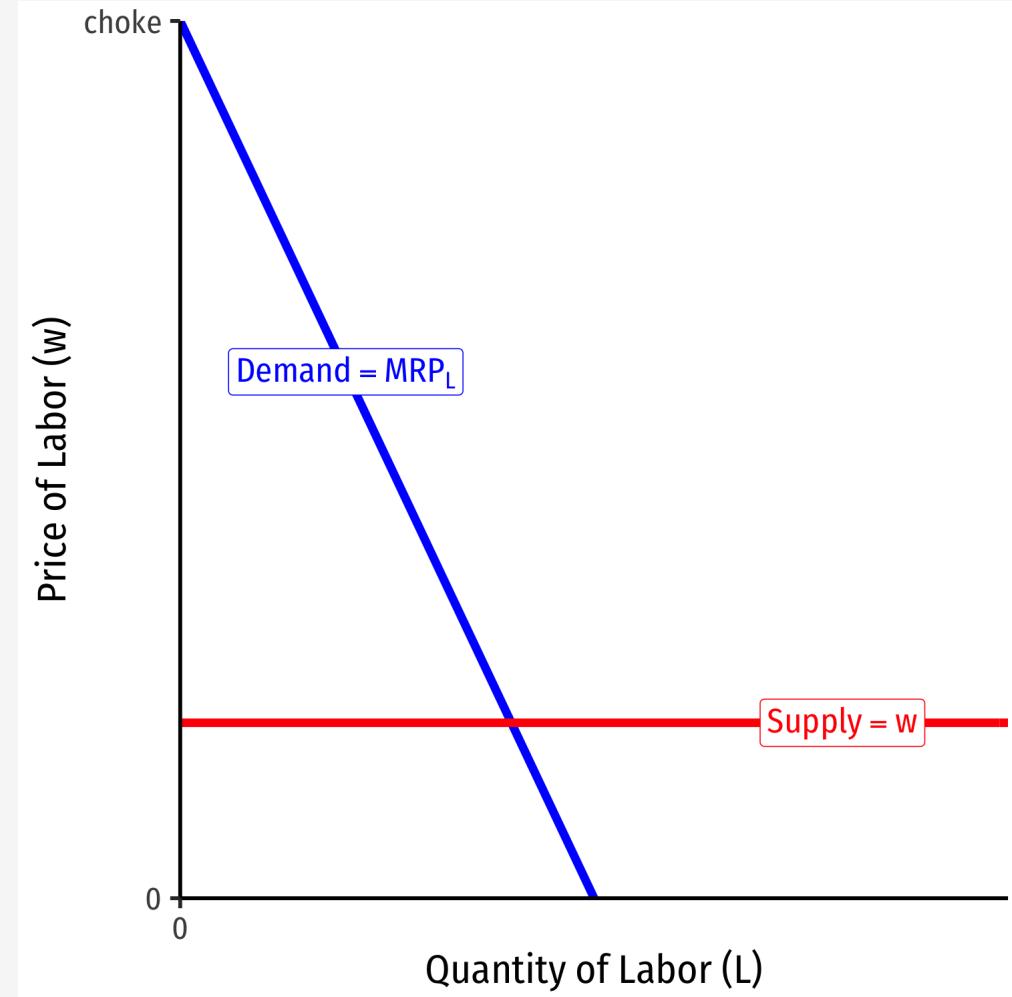


- If the **factor market is competitive**, labor supply for an individual firm is *perfectly elastic* at the market price of labor (w^*)

Labor Supply and Firm's Demand for Labor



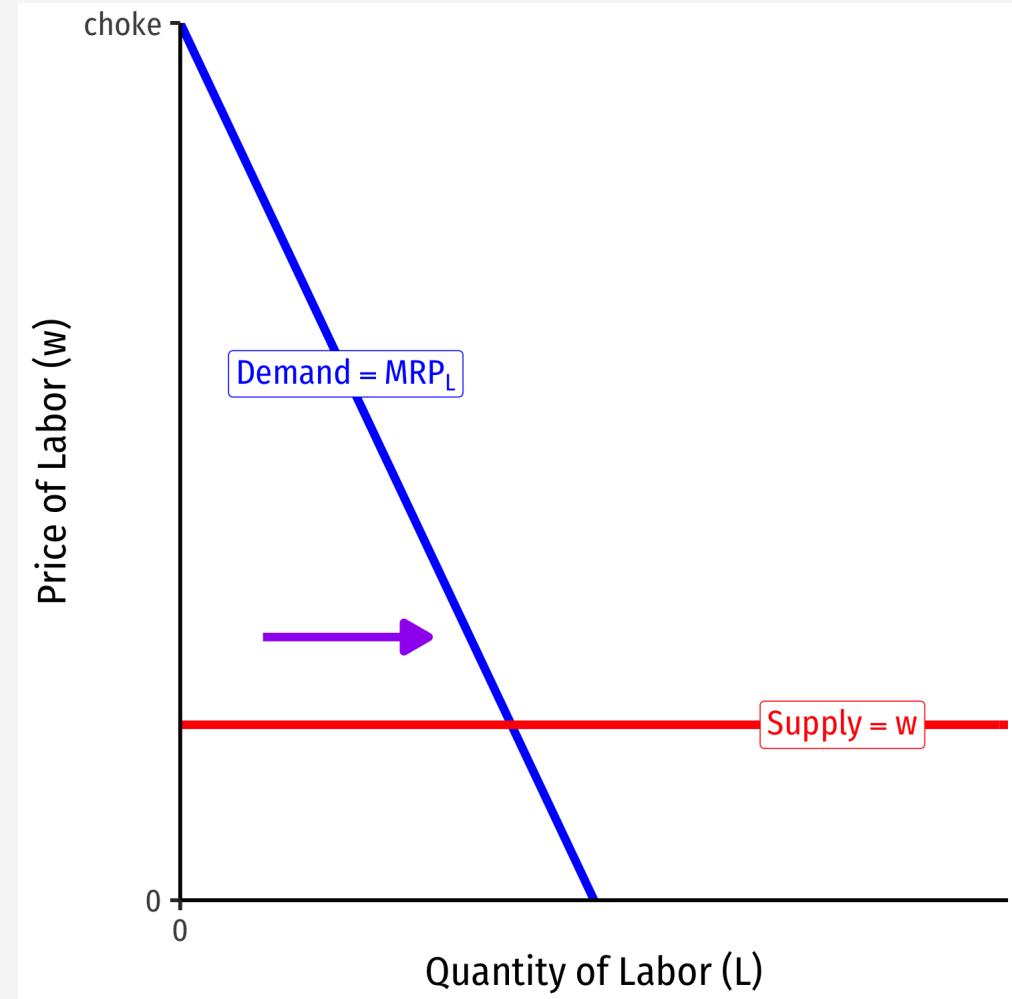
- We've seen a falling MRP_L , the marginal benefit of hiring labor
- **Marginal cost of hiring labor**, w , remains constant
 - so long as firm is not a big purchaser (has no market power) in the labor market



Labor Supply and Firm's Demand for Labor



- At low amounts of labor, marginal benefit (MRP_L) < w marginal cost
- Firm will hire more labor



Labor Supply and Firm's Demand for Labor



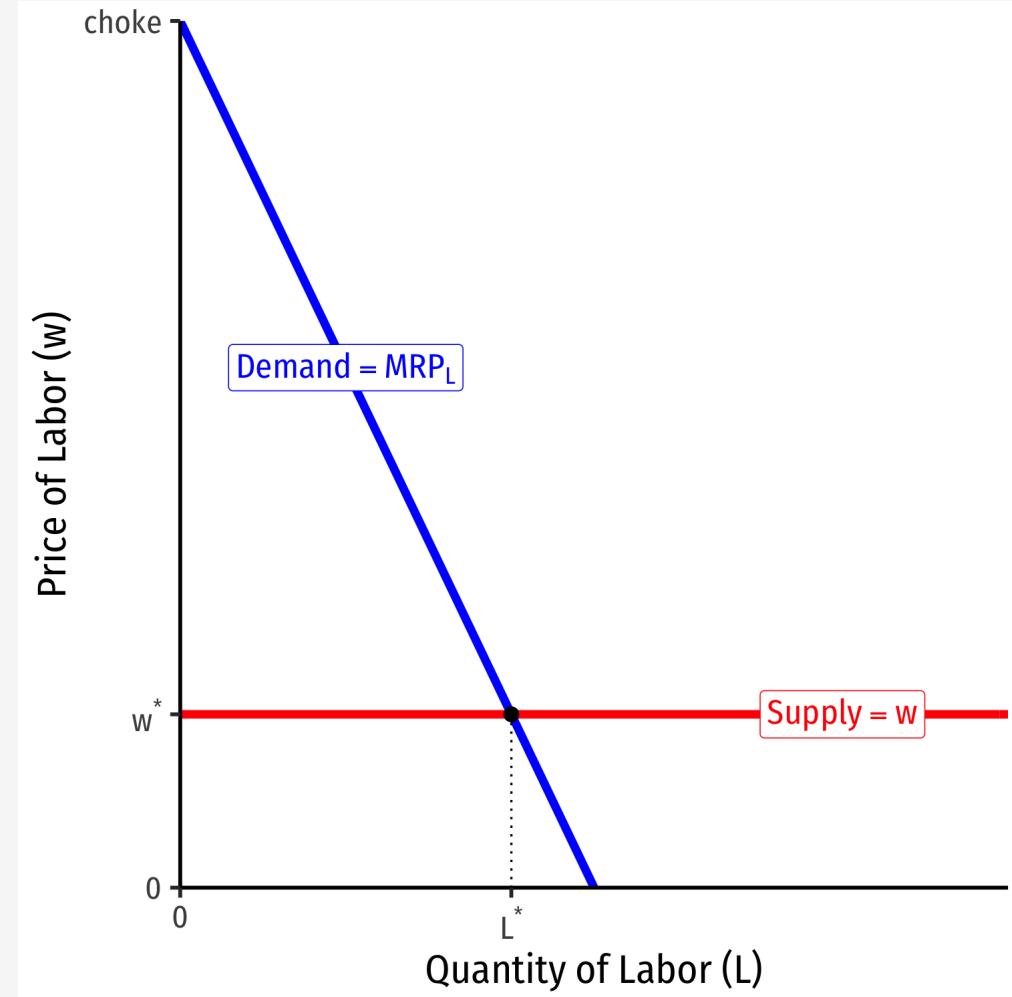
- At high amounts of labor, marginal benefit (MRP_L) < w marginal cost
- Firm will hire less labor



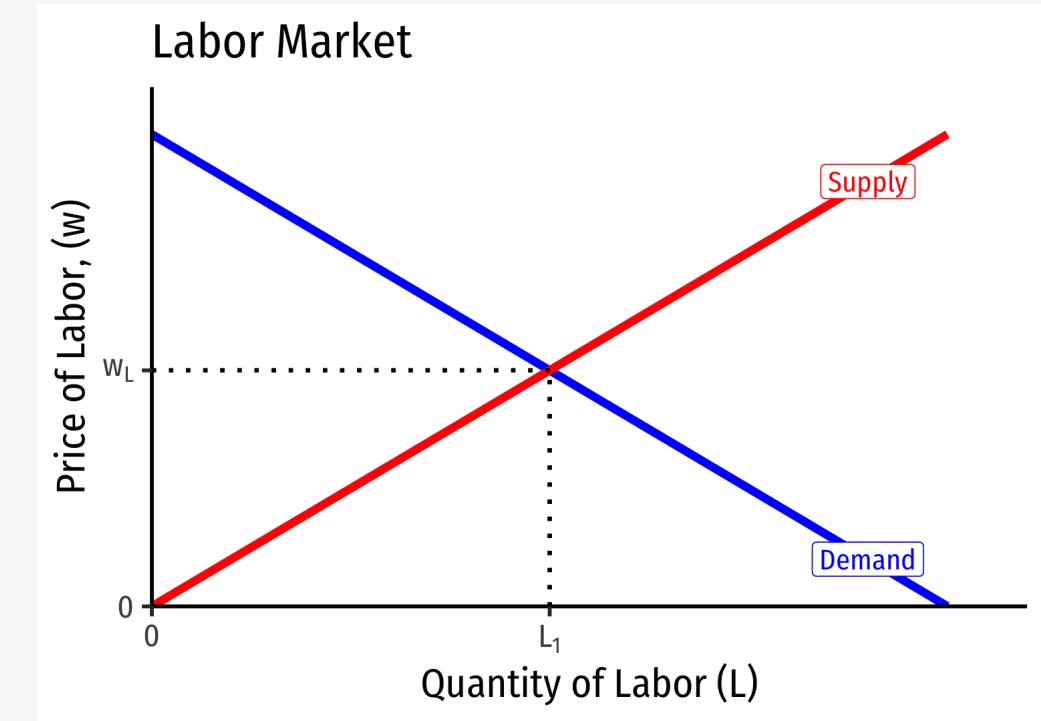
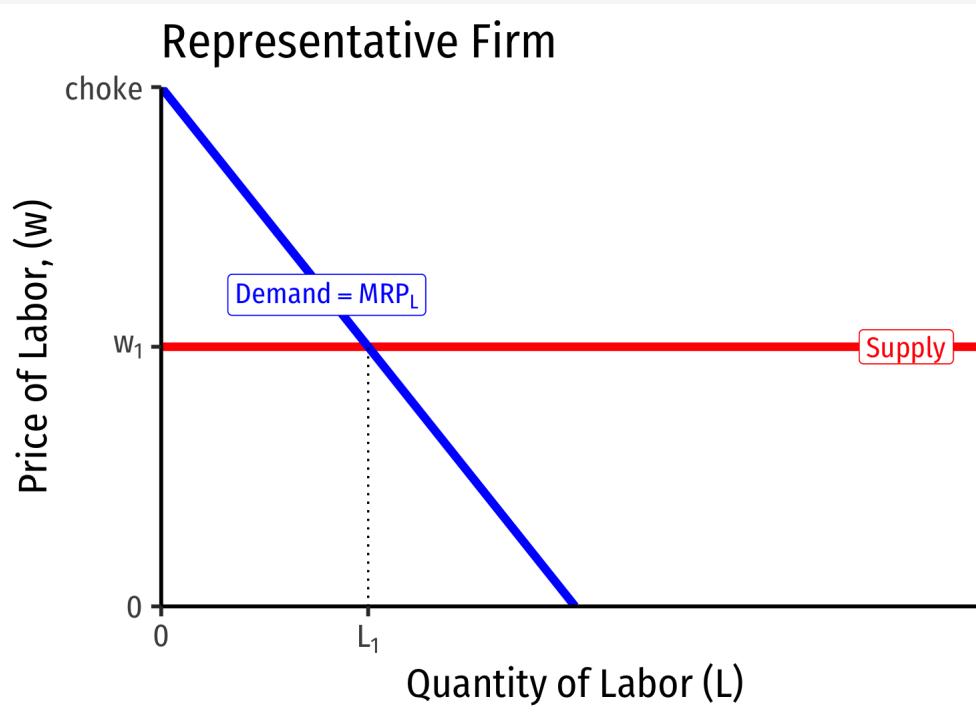
Labor Supply and Firm's Demand for Labor



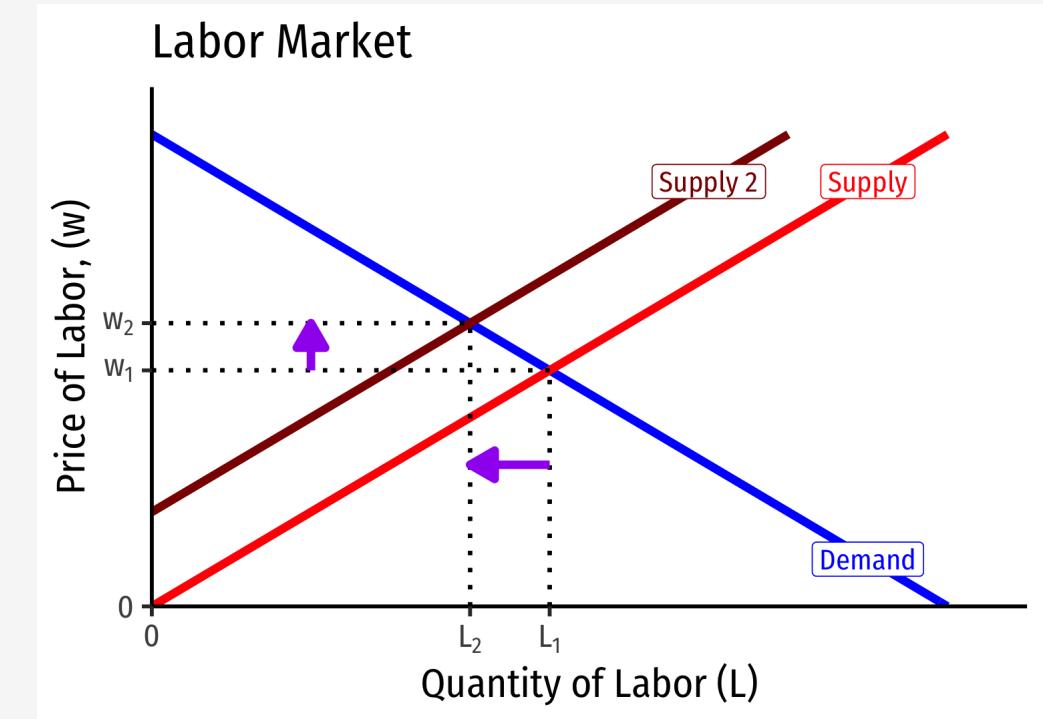
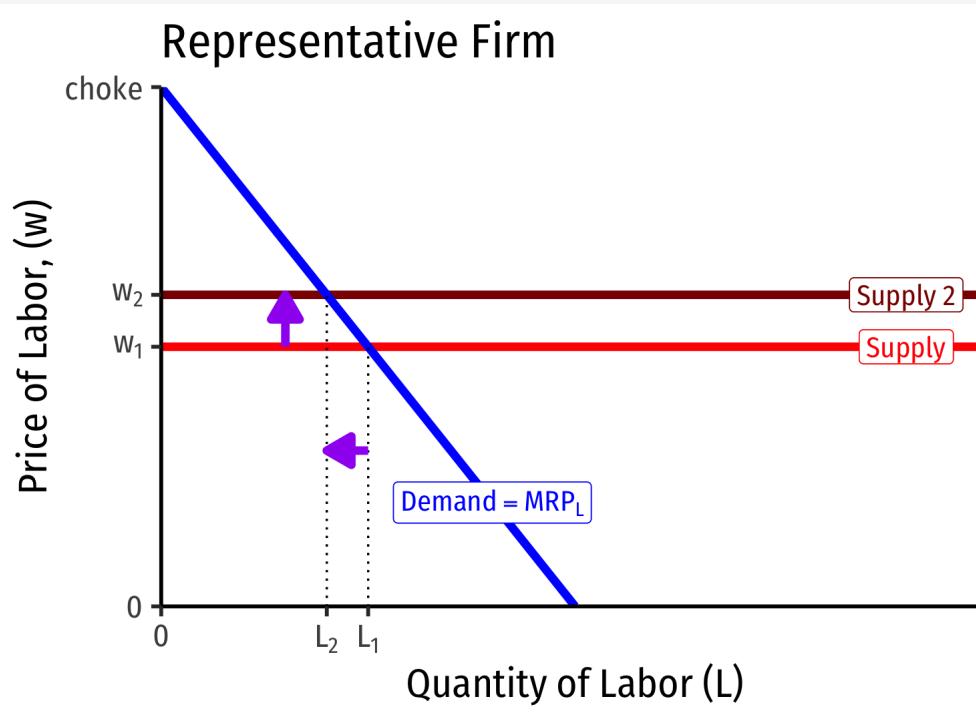
- Firm hires L^* optimal amount of labor where $w = MRP_L$
- i.e. marginal cost of labor = marginal benefit of labor



Labor Supply and Firm's Demand for Labor



Labor Supply and Firm's Demand for Labor



- If market supply of labor decreases, firms hire fewer workers, at higher wages (and vice versa)

Multiple Inputs and Cost Minimization



- But firms produce with many factors, what is the more general rule for hiring the optimal combination of factors?
- Assume three factors: land, labor, capital
- Optimal hiring condition is the **equimarginal rule** (Gossen's Second Law} again:

$$\frac{MP_l}{p_l} = \frac{MP_k}{p_k} = \frac{MP_t}{p_t} = \dots = \frac{MP_n}{p_n}$$

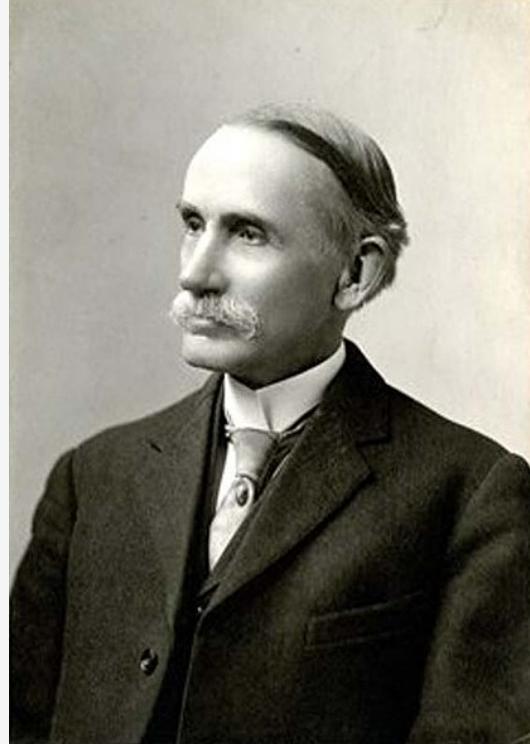
- Cost of production is minimized where the **marginal product per dollar spent** is **equalized** across all n possible inputs
 - the “last dollar spent” on each input provides the same marginal product





Product Exhaustion & The Morality of Marginal Productivity

John Bates Clark



John Bates Clark

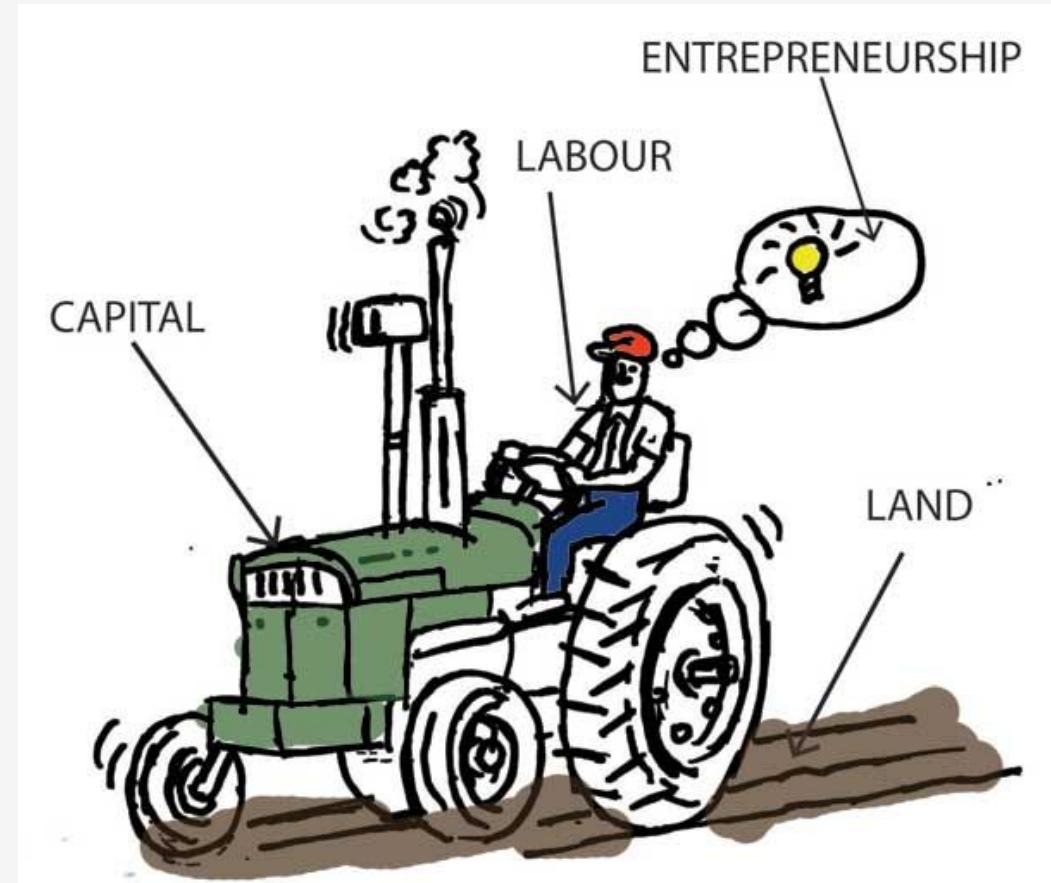
1847–1938

- Initially a German Historicist (studied under Karl Knies) in Germany; a Christian socialist
- Became professor at Columbia, independently derived his own version of marginal utility theory
- Main popularizer of marginal productivity theory, virtues of market competition; opponent to American Institutionalists (see later)
- 1886, *The Philosophy of Wealth*
- 1889, “Possibility of a Scientific Law of Wages” paper at AEA; generalized in 1899 *The Distribution of Wealth*

Product Exhaustion



- Ricardian rent theory defined rent as a residual, will always adjust to fill the gap between output price and wages & profits
 - $\text{output price} = \text{wages \& profits} + \text{rent}$
- Thus, the payments to all factors of production (land, labor, capital) “**fully exhaust the product**”
 - i.e. the sum of factor payments (costs to firm) equals the price

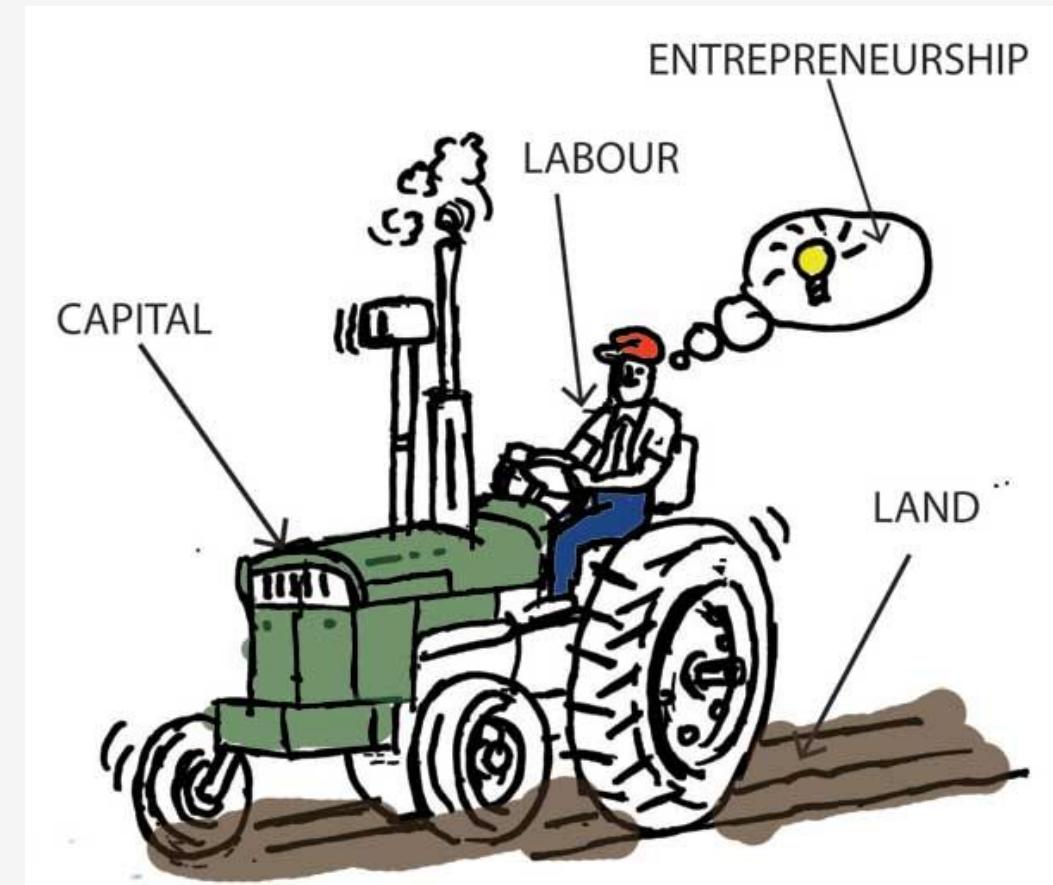


Product Exhaustion

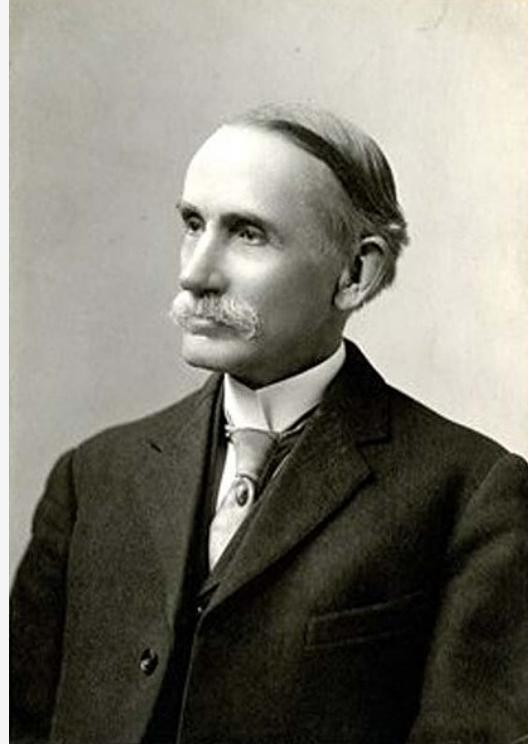


- On a competitive market, each product is paid its marginal (revenue) product
- Does the sum of these marginal products exactly equal the market price of the output?
 - “Product Exhaustion” debate:

$$Q = ? MP_L \times L + MP_K \times K + MP_T \times T$$



John Bates Clark

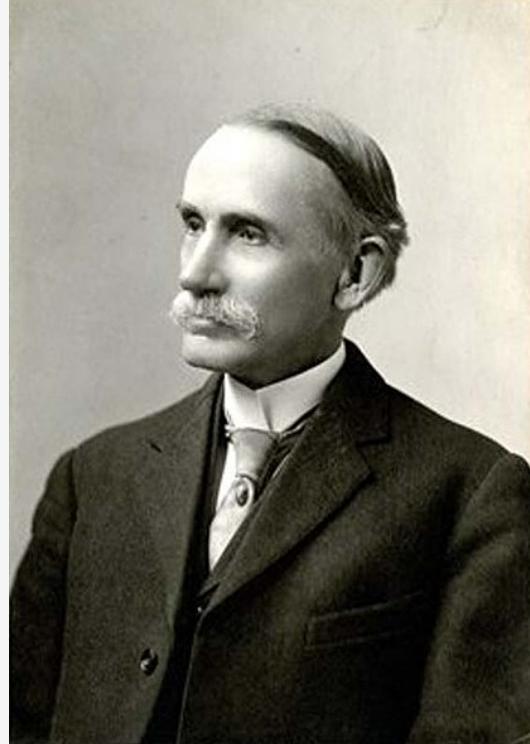


John Bates Clark

1847–1938

- Clark famously argued that on a competitive market, each factor is paid its marginal product, and that this exactly exhausts the product
- Viewed this as a *moral* virtue of markets: each factor is paid for its contribution to society
 - factor prices are not only efficient, they are just
- Offered no *proof* that this is true

John Bates Clark: The Morality of Marginal Productivity

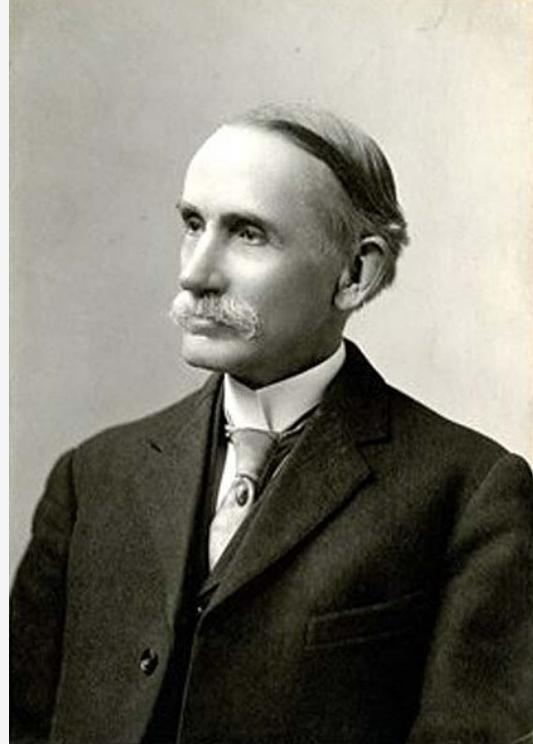


John Bates Clark

1847–1938

- Meant this as a critique of both Karl Marx and Henry George
- Georgists believed rent was undeserved, unearned income of landowners: should go to government
- Marxists believed profit was exploitative and undeserved (surplus value): belonged to workers
- Clark's *Distribution of Wealth* argues that marginal productivity theory shows that under competitive markets, each factor is paid its just due
 - Labor and land and capital are *all* necessary for production, and are paid for their productive contributions

John Bates Clark: The Morality of Marginal Productivity

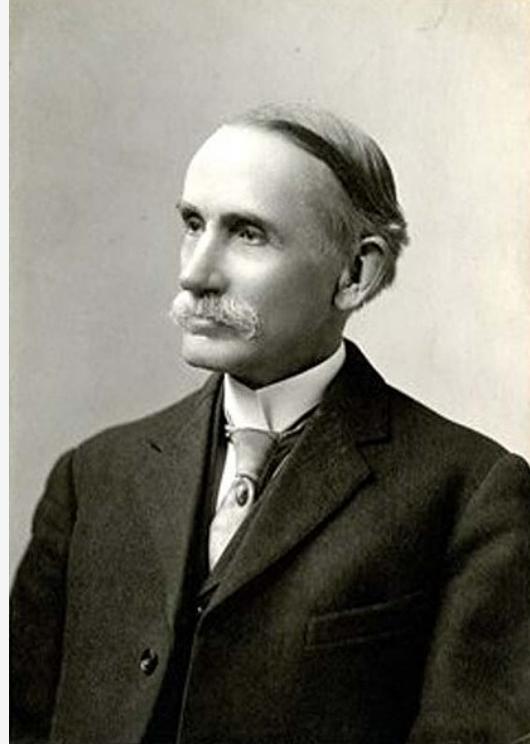


John Bates Clark

1847–1938

- Furthermore, argues that the distribution of income (under competitive markets) is *just* and *deserved!*
- Heavily criticized for this normative theory
 - Problems: not perfectly competitive, monopolies, labor unions, etc.
 - His student, Thorstein Veblen reached the opposite conclusion!
- Hume's is-ought gap

John Bates Clark: The Morality of Marginal Productivity

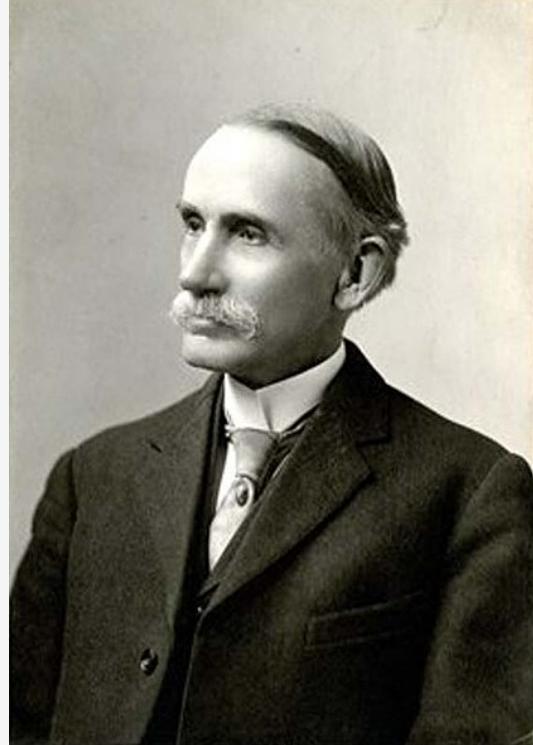


John Bates Clark

1847–1938

- Several flaws with marginal productivity theory as a theory of distribution
- MPT is primarily **a theory of factor pricing**, not about **distribution of relative shares**
- Also an incomplete theory of factor pricing! Considers only demand side of factor market (firms), not the supply side!
- Biggest problem: impossible to observe and measure an individual factor's marginal product!

John Bates Clark: The Morality of Marginal Productivity



- MPT describes the outcome to which we are always *approaching* (i.e. perfect competition), it is an equilibrium state of rest
 - *actual* prices in real world are not equilibrium prices, we are not in perfect competition
- A scarce factor will command higher prices, may be efficient, but is that moral?

John Bates Clark

1847–1938

Phillip Wicksteed



Phillip Wicksteed

1844–1927

- A British economist and unitarian minister
- Learned economics from Jevons, and got inspired to write about political economy after reading Henry George
- 1894, *An Essay on the Co-Ordination of the Laws of Distribution*
 - tries to solve the product exhaustion problem of marginal productivity theory
- 1910, *The Common Sense of Political Economy: Including a Study of the Human Basis of Economic Law*

Phillip Wicksteed



- Uses Euler's Theorem of homogeneous functions to prove product exhaustion under specific conditions:
 - production functions must be linearly homogenous (degree 1)
 - we would say: **constant returns to scale**
 - $cY = f(cL, cK, cT)$

Phillip Wicksteed

1844–1927

Returns to Scale



- The **returns to scale** of production refers to the change in output when all inputs are increased *at the same rate*
- **Constant returns to scale:** output increases at same proportionate rate as inputs increase
 - e.g. if you double all inputs, output doubles
- **Increasing returns to scale:** output increases *more than* proportionately to the change in inputs
 - e.g. if you double all inputs, output *more than* doubles
- **Decreasing returns to scale:** output increases *less than* proportionately to the change in inputs
 - e.g. if you double all inputs, output *less than* doubles

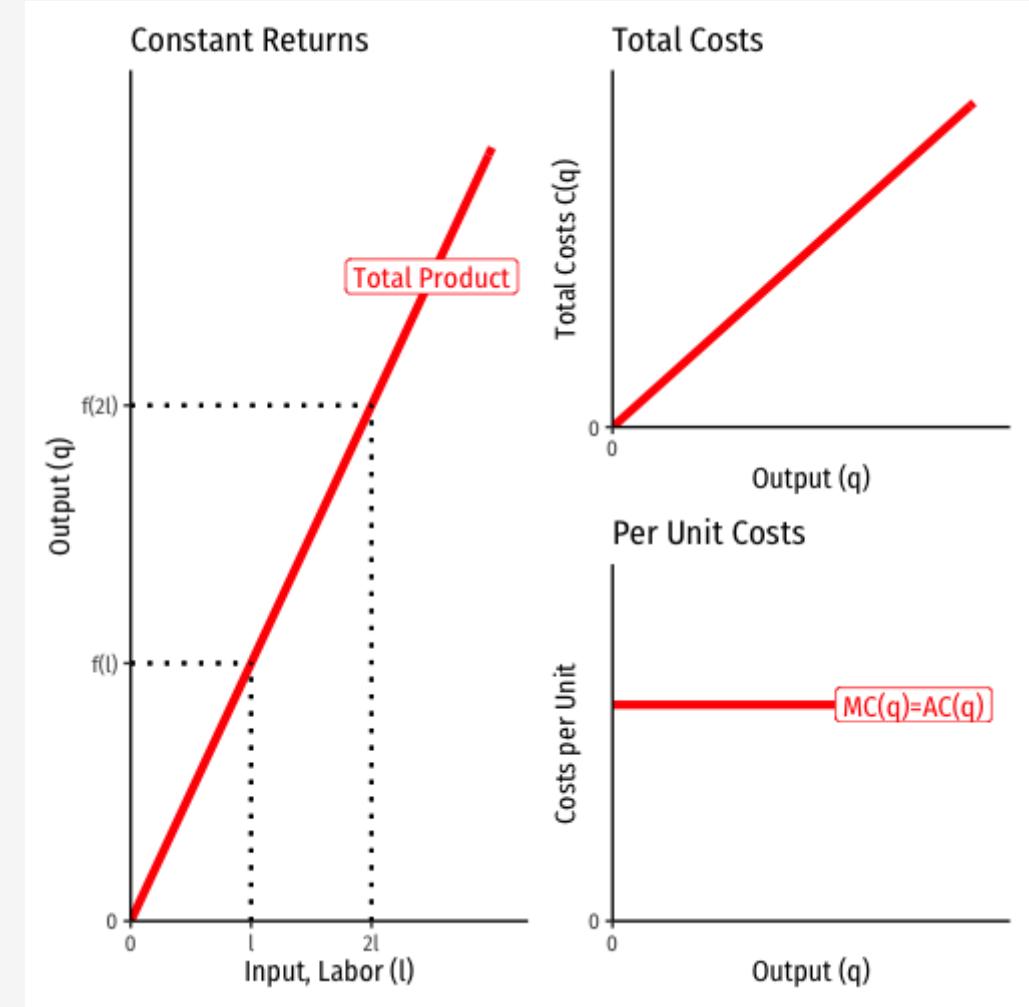
Constant Returns to Scale



- **Constant returns to scale:** doubling all inputs
⇒ double output

$$f(cl, ck, ct) = cf(l, k, t) \quad \forall c > 1$$

- **Constant economies of scale:** average and marginal costs (are equal and) do not vary with output
- Total revenues are completely exhausted by the payments to factors (costs to firm)



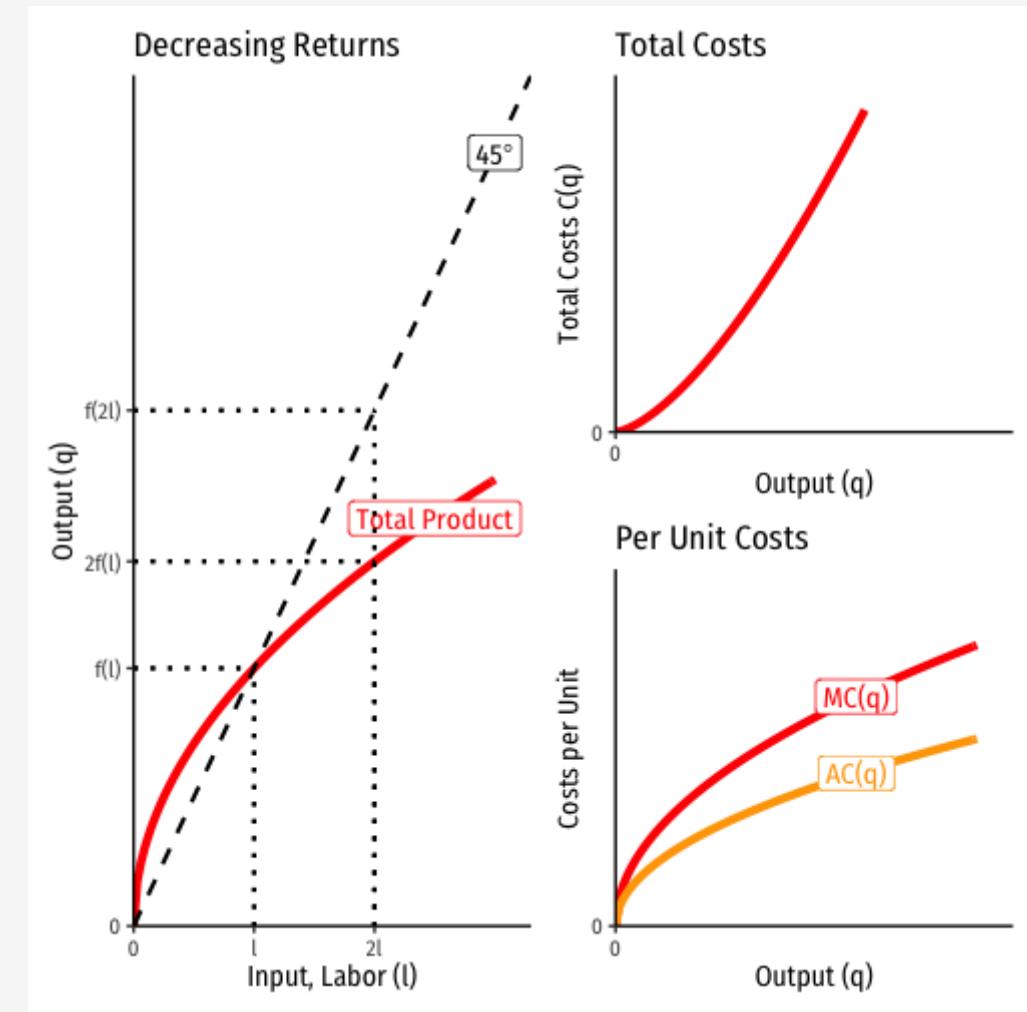
Decreasing Returns to Scale



- **Decreasing returns to scale:** doubling all inputs
 \implies less than double output

$$f(cl, ck, ct) < cf(l, k, t) \quad \forall c > 1$$

- **Diseconomies of scale:** average and marginal costs are increasing with output
 - $AC < MC \implies$ marginal cost pricing is always profitable
 - $Total\ Costs < Total\ Revenues \implies \pi > 0$
- Total revenues are *not* exhausted by the payments to factors (costs to firm); residual leftover!



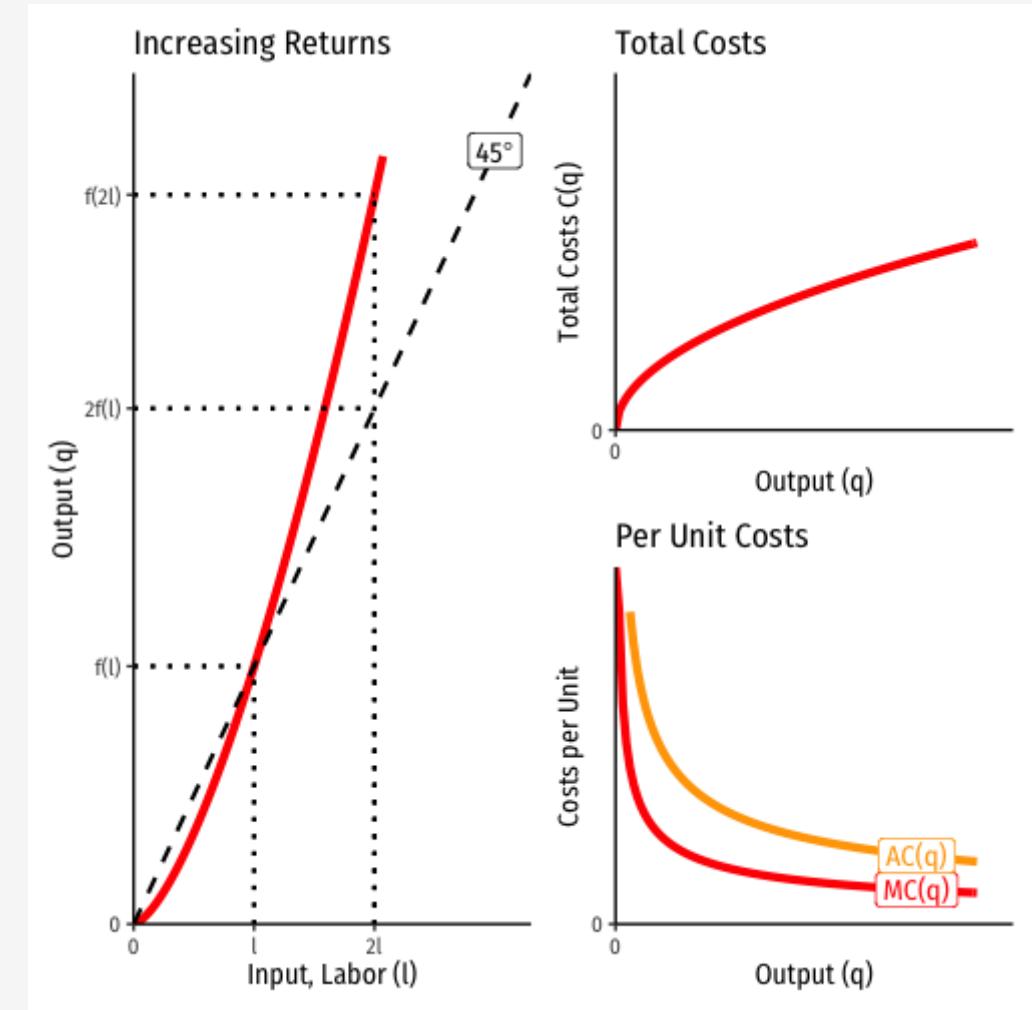
Increasing Returns to Scale



- **Increasing returns to scale:** doubling all inputs
 \Rightarrow more than double output

$$f(cl, ck, ct) > cf(l, k, t) \quad \forall c > 1$$

- **Economies of scale:** average and marginal costs are decreasing with output
 - $AC > MC \Rightarrow$ marginal cost pricing is always loss-inducing
 - $Total\ Costs > Total\ Revenues \Rightarrow \pi < 0$
- Total revenues are *insufficient* to cover the payments to factors (costs to firm); losses!



Knut Wicksell



Knut Wicksell

1851–1926

- Swedish economist at University of Stockholm
- Another supposed independent discoverer of marginal productivity theory
- Made key contributions to capital and interest theory, influence Austrian & Keynesian schools of macroeconomics
 - we'll explore more next week
- 1898, *Interest and Prices*

Wicksell and Product Exhaustion



- Most economists believed that an industry would always be either constant, increasing, or decreasing returns
- Wicksell showed that most **firms actually go through all three phases of returns to scale**
 - developing a **long-run U-shaped average cost curve** for a firm
 - would take a few decades for neoclassical economists to derive and understand shape of AC curve

Knut Wicksell

1851–1926

Wicksell and Product Exhaustion



Knut Wicksell

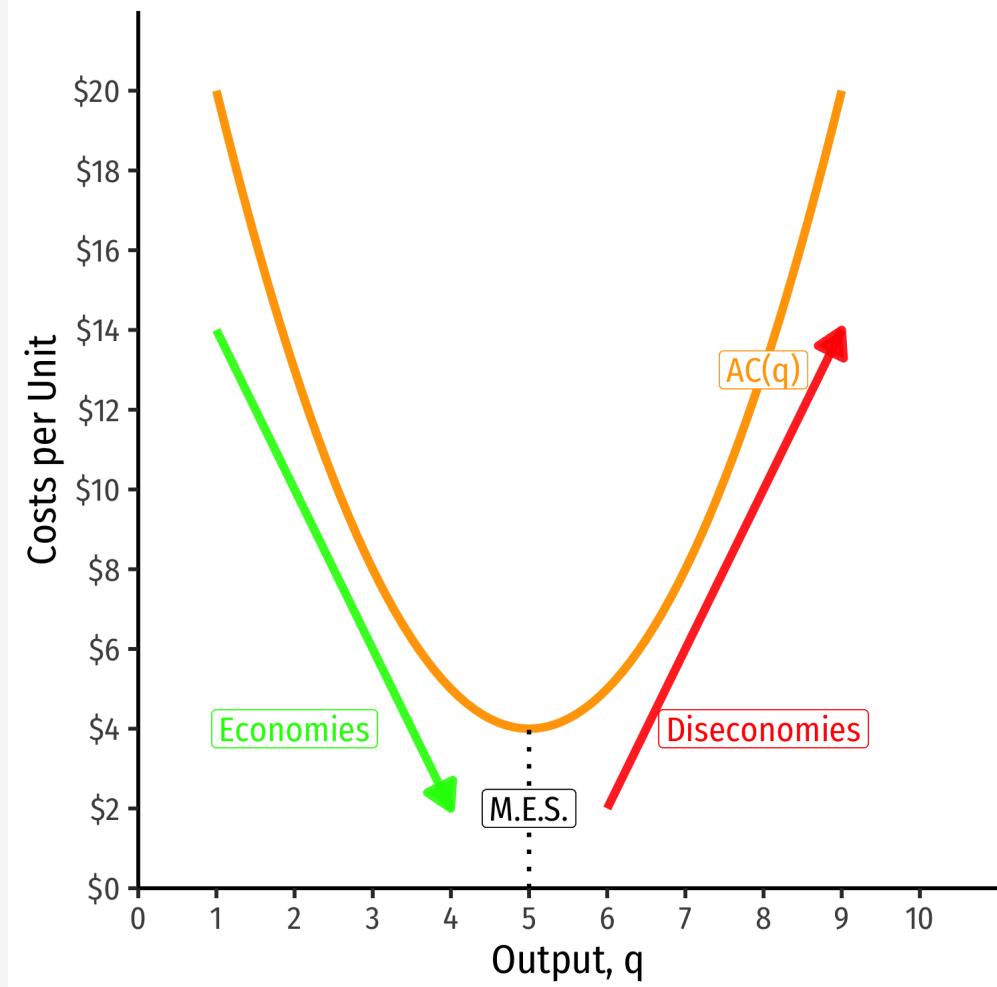
1851–1926

- Thus, it is *not* necessary (as Wicksteed did) to assume constant returns to prove product exhaustion
- Competition would ensure that in the long run, firms are producing at their least-cost combination
 - $p = MC = AC_{min}$
 - $\pi = 0$
 - “product exhaustion”

Wicksell and Product Exhaustion



- **Minimum Efficient Scale:** q with the lowest $AC(q)$
 - constant returns to scale
- **Economies of Scale:** $\uparrow q, \downarrow AC(q)$
 - increasing returns to scale
- **Diseconomies of Scale:** $\uparrow q, \uparrow AC(q)$
 - decreasing returns to scale



Wicksell and Product Exhaustion



- Think about what you learn in microeconomics
- In perfect competition, in the long run, as profits attract entrants and losses force exits, price settles on the break-even point, where profit is 0
 - $p = MC = AC_{min}$
- We still haven't gotten to the famous model of perfect competition, but this is where everything is heading

