MIT 14.01: Principles of Microeconomics
Sp 2025, Lecture 7: Consumer Theory (Part II)

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Plan for Today

- Continue with our deeper investigation of consumer theory from Lecture #6
- Main focus: how price changes affect demand (and the possibility of upward-sloping demand curves)

(Own) Price Elasticity of Demand

- Probably the most important question about consumer demand: how will consumer i's demand for a good (e.g. B_i) depend on that good's own price (e.g. p_B)?
  - Of course, demand for B_i also depends on p_A and y_i, but for the next few slides we'll suppress that and just write $D_i^B(p_B)$

- Recall the definition of this elasticity from Lecture #2:

$$\varepsilon_{D_i^B, p_B} \equiv \frac{p_B}{D_i^B} \frac{\partial D_i^B(p_B)}{\partial p_B} = \frac{\partial \ln D_i^B(p_B)}{\partial \ln p_B} \approx \frac{\%\text{ change in } D_i^B}{\%\text{ change in } p_B}$$

- And recall definitions from Lecture # 2 (though now they refer to the price elasticity that consumer i has, rather than the elasticity of aggregate demand):
  - Elastic good: $\varepsilon_{D_i^B, p_B} < -1$
  - Inelastic good: $\varepsilon_{D_i^B, p_B} \geqslant -1$

Back to the Cobb-Douglas Example

- Recall that we calculated the demand functions:

$$A_i^* = \left(\frac{\alpha}{\alpha+\beta}\right)\frac{y_i}{p_A} \quad \text{and} \quad B_i^* = \left(\frac{\beta}{\alpha+\beta}\right)\frac{y_i}{p_B}$$

- So what is the own-price elasticity of demand for good A_i? And what is it for B_i?

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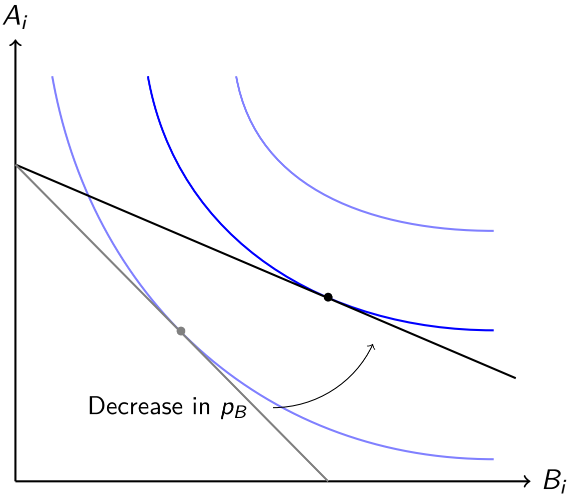
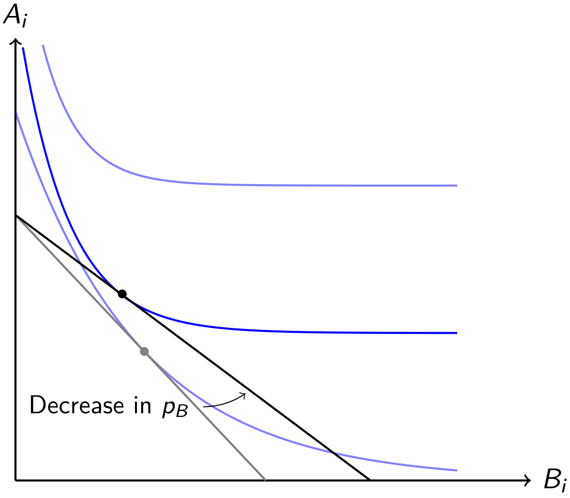
- So what is the own-price elasticity of demand for good A_i? And what is it for B_i?
- Take logs, differentiate, apply the definition, and we get $\varepsilon_{D_i^A,p_A} = \varepsilon_{D_i^B,p_B} = -1$. So both are inelastic.
  - NB: it is not at all generally the case that $\varepsilon_{D_i^A,p_A} = \varepsilon_{D_i^B,p_B}$! This is just one of many things that are special properties of the Cobb-Douglas case.

How Demand Depends on Own Price: An Ordinary Good



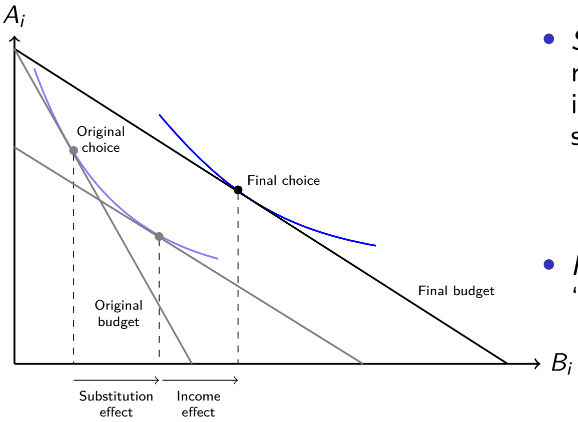
- Consider a reduction in p_B (holding p_A and y_i constant) and ask: what will happen to B_i?
- Since the slope of the BC is $-\frac{p_B}{p_A}$, a reduction in p_B will rotate the BC outwards (can also think about it as shifting the x-axis intercept, which is given by $\frac{y_i}{p_B}$, outwards).
- Drawn here: the amount of B_i that consumer i demands will go up. This means i's demand curve slopes downwards (i.e. $\varepsilon_{D_i^B, p_B} < 0$).
- When $\varepsilon_{D_i^B, p_B} < 0$ we say that B is an *ordinary good* for consumer i

How Demand Depends on Own Price: A Giffen Good



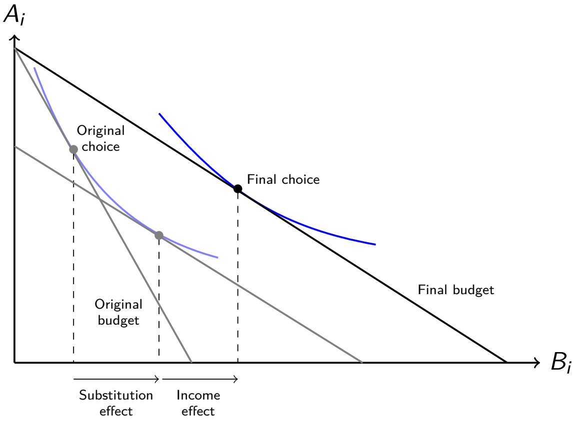
- Continue to consider a reduction in p_B (holding p_A and y_i constant) and again ask: what will happen to B_i?
- Drawn here: the amount of B_i that consumer i demands will go *down*, so their demand curve *slopes upwards* (i.e. $\varepsilon_{D_i^B, p_B} > 0$)
- When $\varepsilon_{D_i^B, p_B} > 0$ we say that B is a *Giffen good* for consumer i
- How is this possible?!

Substitution Effect (SE) and Income Effect (IE)



- We can *decompose* the effect of a change in p_B (on B_i) into two effects...
- *SE*: Imagine that we lower p_B and also reduce income such that the BC "rotates" in a way that keeps the consumer on the same IC as initially (i.e $\Delta U = 0$)
  - Clearly B_i has to rise
  - So SE is always positive (for falling p_B)
- *IE*: Now increase income so as to shifft the "rotated" BC to the final BC
  - This is exactly like an income shock (so it depends on the income elasticity $\varepsilon_{D_i^B,y}$ we studied in Lecture #6)
  - IE captures the fact that a drop in p_B makes this consumer *effectively* richer (even though y_i is constant)

SE, IE, and Giffen Goods

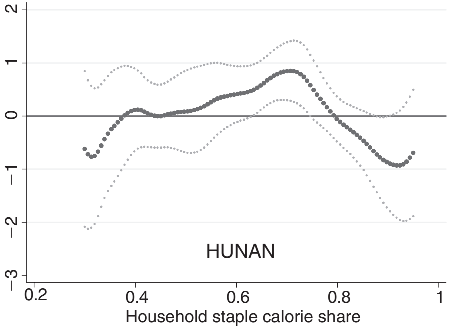


- Recall that for a normal good, $\varepsilon_{D_i^B,y} > 0$, so $IE > 0$
  - So (since $SE > 0$ too) we see that the good is definitely an ordinary good (as drawn here)
- But recall that for an inferior good, $\varepsilon_{D_i^B,y} < 0$, so $IE < 0$
  - So if inferior good then it's *possible* (but not at all guaranteed) to be a Giffen good
  - It's a Giffen good when $IE + SE < 0$ (i.e. highly negative IE beats out positive SE)

When Can We Expect Big (in Absolute Value) Income Effects?

- The IE for a good scales (in absolute value) with the *budget share* of the good (i.e. the share of spending on that good in the consumer's total expenditure)
- Intuition:
  - Think of something you don't buy at all (budget share $= 0$). If the price of that good were to fall, would you feel richer? No! So no IE.
  - Imagine you only buy one thing, A_i (budget share $= 1$). Then clearly demand is $A_i^* = y_i/p_A$. If the price of that good (i.e. p_A) were to fall, the entire reason you buy more A_i is because of the IE. (There is nothing to substitute to, so no SE.)
- Implication: Giffen goods must be inferior goods (as we saw above), but among inferior goods they are more likely for things that have large budget shares.
- Any ideas about where we might see Giffen goods?

Price Elasticities of Demand for Rice in Hunan, China



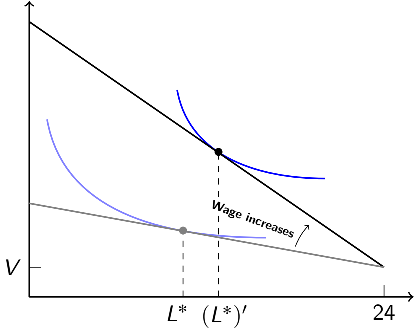
Jensen and Miller (*Am. Econ. Rev.*, 2008)

- RCT of rice subsidies offered to ≈ 500 households in 2006
- Shown here:
  - x-axis: households' calorie share for staple foods (mostly rice) prior to the RCT
  - y-axis: estimate of average treatment effect of (log) p_{rice} on (log) D_i^{rice} (i.e. an estimate of avg. $\varepsilon_{D_i^{\text{rice}}, p_{\text{rice}}}$), for households i that are at the given value of the x-axis
- So rice is a Giffen good among households that initially had a "medium-sized" staple food share.
- Replicated with wheat (in bread/noodles) in predominantly wheat-growing (rather than rice-growing) region of Gansu

The Labor Supply Decision: Work Hard or Play Hard?

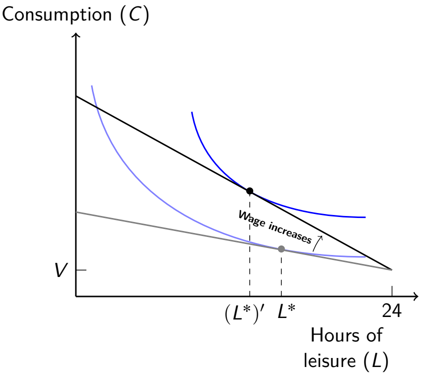
- Now consider a different model of choice
- The two goods are: total consumption (C) and hours of leisure time per day (L), and you have some $U(C, L)$ over these goods
- Your budget constraint follows from the following simple logic:
  - Say you work H hours and only have 24 hours a day. Then $L = 24 - H$.
  - Say you earn a wage of w per hour and consumption C costs p_C per unit
  - Say you also have some potential non-wage income (lucky you!) of $V \geqslant 0$
  - And you spend all of your income on consumption
  - Then your BC is $p_C C = wH + V = w(24 - L) + V$
  - Which we can write as $y(w) = p_C C + wL$, if $y(w) \equiv 24w + V$
- This is like the usual BC for two goods (C and L) but with the unusual feature that income $y(w)$ depends on the price w of one of the goods
- Note how the price of leisure is w, which is an example of *opportunity cost*.
  - Leisure is not literally costly, but because $L = 24 - H$ and H is paid w, every unit of L effectively costs w because is prevents the opportunity of earning w.

The Labor Supply Decision: Suppose w Increases...



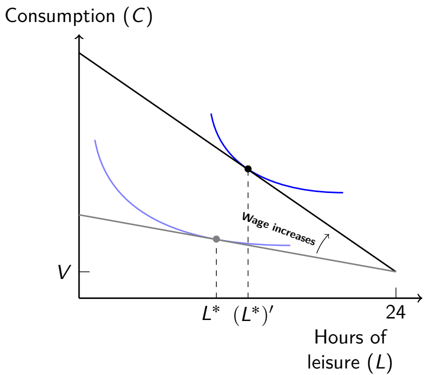
- Demand for leisure (and hence negative of supply of labor, H) is $L = D^L(w, p_C, y(w))$
- Now w has two channels of impact: $\frac{dL}{dw} = \frac{\partial L}{\partial w} + \frac{\partial L}{\partial y}\frac{\partial y}{\partial w} = \frac{\partial L}{\partial w} + 24\frac{\partial L}{\partial y}$
  - $\frac{\partial L}{\partial w}$: the usual own-price effect (which can be decomposed into the SE and IE that we saw earlier)
  - $\frac{\partial L}{\partial y}\frac{\partial y}{\partial w}$: an "endowment valuation" effect, since w is part of income $y(w)$. But this is different from the IE! The IE is "when a price falls I am effectively richer" but here "when w rises I am literally richer, since $y(w) = 24w + V$".

The Labor Supply Decision: Suppose w Increases...



- Recall w has two channels of impact:
  $\frac{dL}{dw} = \frac{\partial L}{\partial w} + \frac{\partial L}{\partial y}\frac{\partial y}{\partial w} = \frac{\partial L}{\partial w} + 24\frac{\partial L}{\partial y}$
- Suppose that leisure is a normal good, as we saw from the lottery studies in Lecture #6
  - So $\frac{\partial L}{\partial y} > 0$ (by definition of normal)
  - But also $\frac{\partial L}{\partial w} < 0$ (normal, so not Giffen)
- So very possible to have $\frac{dL}{dw} \lesseqqgtr 0$ depending on which effect wins between $\frac{\partial L}{\partial w} < 0$ and $24\frac{\partial L}{\partial y} > 0$
- Drawn here: the case when $\frac{dL}{dw} < 0$
- NB: since $\frac{dH}{dw} = -\frac{dL}{dw}$, and hence $\frac{dH}{dw} > 0$ here, and H is labor supplied by this person, we call this the *upward-sloping labor supply* case.

The Labor Supply Decision: Suppose w Increases...



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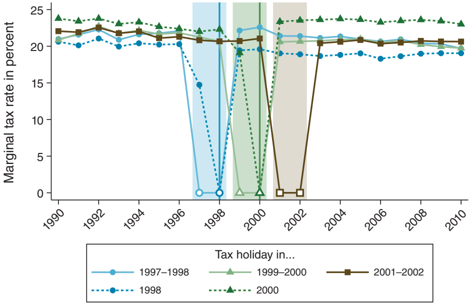
  - So $\frac{\partial L}{\partial y} > 0$ (by definition of normal)
  - But also $\frac{\partial L}{\partial w} < 0$ (if normal, not Giffen)
- So very possible to have $\frac{dL}{dw} \lesseqqgtr 0$ depending on which effect wins between $\frac{\partial L}{\partial w} < 0$ and $24\frac{\partial L}{\partial y} > 0$
- Drawn here: the case when $\frac{dL}{dw} > 0$, which we call the *downward-sloping labor supply* case

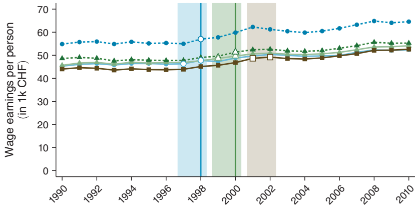
Is Labor Supply Downward-Sloping or Upward-Sloping?



Martinez et. al. (*Am. Econ. Rev.*, 2021)

- The Swiss income "tax holiday" took place at different times in Swiss provinces
  - 1 or 2 years without income tax, big impact on after-tax incomes
  - Think about it as an increase in w in our model
- To estimate causal effect on leisure, can use a *difference-in-differences* analysis:
  - Compare evolution of "treated" provinces with that of "control" provinces at same time (e.g. blue is treated in 97-98, but brown is not treated in 97-98, so could serve as the control group)
  - Assumption: ("parallel trends") had the treated group not been treated, it would have continued to evolve exactly like the control group did

Is Labor Supply Downward-Sloping or Upward-Sloping?



Martinez et. al. (*Am. Econ. Rev.*, 2021)

- Find very small increase in total pre-tax earnings (which are mostly affected by hours worked) – so $\frac{dH}{dw} > 0$ (but small)
- So labor supply seems (very weakly) upward-sloping here
- In paper: slightly larger effect for those who are self-employed
  - Perhaps they have more control over their hours over a two-year horizon
  - But concern that their tax earnings are more "avoidable" (or evadable)
- NB: one concern of interpretation is that this policy affected the taxes of everyone in a province, so unlikely that p_C is constant (like it is in our model)

Cross-Price Elasticity of Demand

- The final thing to consider is how consumer i's demand for a good (e.g. B_i) depends on the *other* good's price (i.e.. p_A), which we call the *cross-price elasticity of demand* (when only 2 goods)
  - Of course, demand for B_i also depends on p_B and y_i, but for the next few slides we'll suppress that and just write $D_i^B(p_A)$
- The definition of this elasticity follows all of our previous definitions:

$$\varepsilon_{D_i^B, p_A} \equiv \frac{p_A}{D_i^B} \frac{\partial D_i^B(p_A)}{\partial p_A} = \frac{\partial \ln D_i^B(p_A)}{\partial \ln p_A} \approx \frac{\text{\% change in } D_i^B}{\text{\% change in } p_A}$$

- Definitions:
  - Good B is a *gross substitute* for good A: $\varepsilon_{D_i^B, p_A} > 0$
  - Good B is a *gross complement* for good A: $\varepsilon_{D_i^B, p_A} < 0$
  - Good B is both a gross complement and a gross substitute for good A: $\varepsilon_{D_i^B, p_A} = 0$
  - Careful: the property of complements/substitutes is not symmetric (and $\varepsilon_{D_i^B, p_A} \neq \varepsilon_{D_i^A, p_B}$ in general)

Back to the Cobb-Douglas Example

- Recall that we calculated the demand functions:

$$A_i^* = \left(\frac{\alpha}{\alpha+\beta}\right)\frac{y_i}{p_A} \quad \text{and} \quad B_i^* = \left(\frac{\beta}{\alpha+\beta}\right)\frac{y_i}{p_B}$$

- So what is the cross-price elasticity of demand for good B_i (i.e the elasticity of demand for B with respect to the price of good A_i)?

Back to the Cobb-Douglas Example

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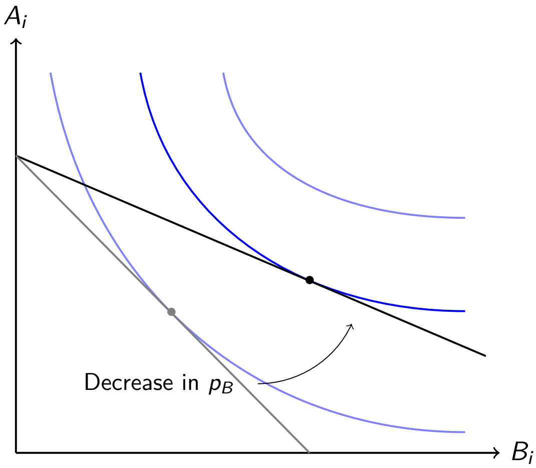
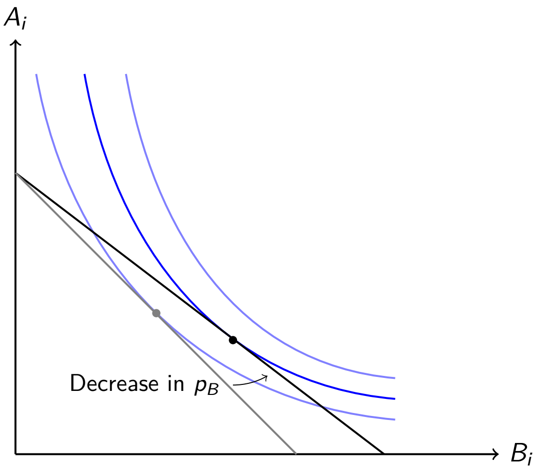
- So what is the cross-price elasticity of demand for good B_i (i.e the elasticity of demand for B with respect to the price of good A_i)?
- We get $\varepsilon_{D_i^B, p_A} = 0$. So good B is both a gross complement and a gross substitute for good A.
- Of course, by symmetry, we also have $\varepsilon_{D_i^A, p_B} = 0$, so in this case the cross-price elasticities are actually symmetric. (Another case where Cobb-Douglas can give special results!)

Cross-Price Elasticity of Demand

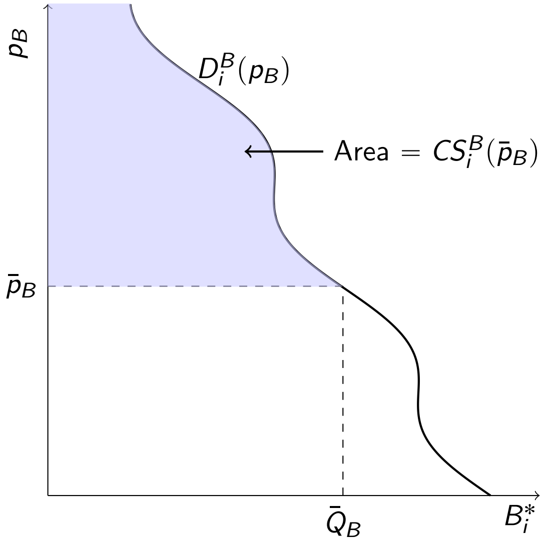


Good A is a *gross complement* for good B:
$\varepsilon_{D_i^A, p_B} < 0$



Good A is a *gross substitute* for good B:
$\varepsilon_{D_i^A, p_B} > 0$

Individual-Level Consumer Surplus (As Before, but Now for the Case of a Continuous Good)



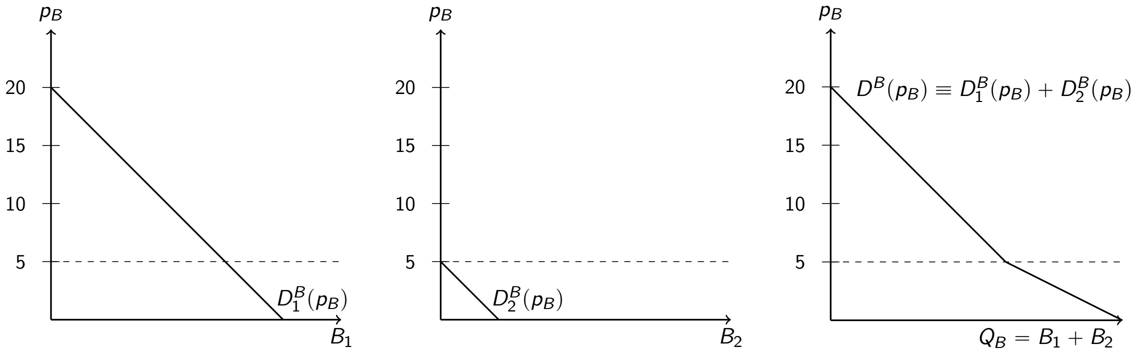
- Can define *individual-level CS* from good B (at some $\bar{p}_B$) as:

$$CS_i^B(\bar{p}_B) \equiv \int_{\bar{p}_B}^{\infty} D_i^B(p)dp$$

- When i's income effect for good B is zero, can show that $CS_i^B(\bar{p}_B)$ has nice interpretation:
    - *Question:* if good B were removed from the market, how much would we need to pay i to hold their utility constant?
    - *Answer:* $CS_i^B(\bar{p}_B)$.

- But in settings with big income effects, this is no longer true (so it's not used)

Aggregate Demand Function



- As in Lecture #1, we define the *aggregate demand function* as $D^B(p_B) \equiv \sum_{i=1}^{N_C} D_i^B(p_B) = Q_B$. In the above example, $N_C = 2$.
- Aggregate demand (like individ. demand) can slope upwards, but it's less likely to happen than for individ. demand (because of what we saw in Lecture #1: heterogeneity of preferences is a force that pushes towards downward-sloping aggr. demand)

Concluding Remarks

- **Key concepts from today's lecture:**
  - Own price elasticity of demand (ordinary goods vs Giffen goods)
  - Decompose effect of price change into substitution effect and income effect
  - Demand can slope up! (Giffen case). Happens only for inferior goods, and more likely when budget share is high (big negative income effect overcomes positive substitution effect).
  - Upward-sloping and downward-sloping labor supply in the leisure-consumption choice model of labor supply. Different from Giffen case due to the endowment valuation effect.
  - Cross-price elasticity of demand
  - Individual-level consumer surplus (valid when income effect is small)
  - New method for estimating causal effects: difference-in-differences

- **Next lecture:**
  - Revisit our model of supply from Lecture #3 and make it more realistic