1.1-1.3 Readings

Wednesday, August 25, 2021 11:11 AM

As demand for one complement goes up, so does the other and labor is reallocated until even

- **Don't be too serious**
- **Impossible to draw a conclusion without a model/theory**
- **Don't be an accidental theorist**

Economics

- When productivity increases, employment *may* decrease
- "Reserve Army of the Unemployed" <– Karl Marx

	Manual	**Cognitive**
Routine	Industrial Revolution - Assembly line welders	Information Technology - Human calculator - Book keepers - Clerks
Non-Routine		

Externalities

- Little personal incentive

Word Cloud

- Negative
- Shame
- Selfish
- Spillovers
- Strategic substitutes
- Free riding
- Strategic complements

- "Property rights"
  - Property rights help free enterprise systems so that decision making about resources is aligned
- Free enterprise + private ownership

Public Goods

- Roads
  - Uncongested –> Non-rivalrous
  - Congested –> Rivalrous
- National defense

Pure Public Good

1. Non-rivalrous
2. Non-excludable

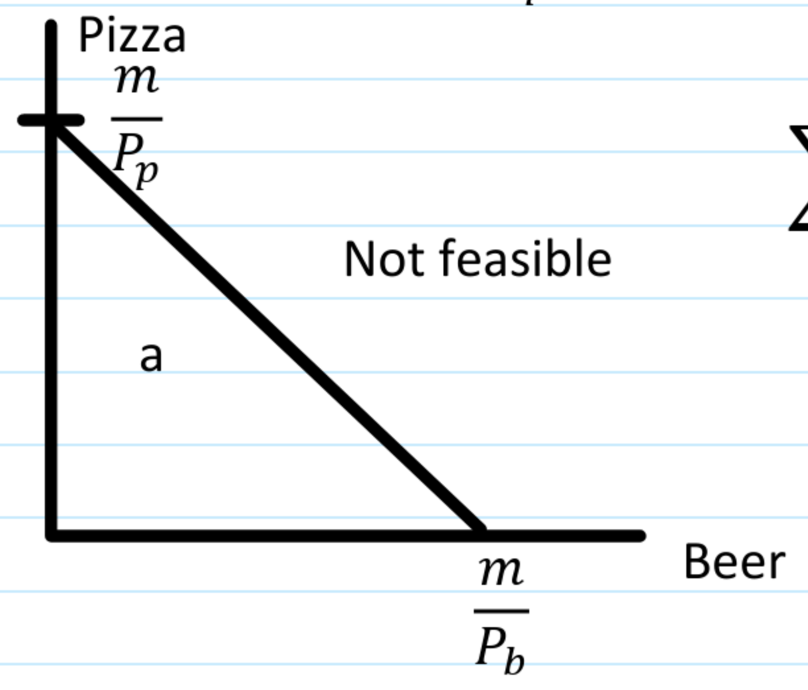
"Dispel the notion that economics is only about supply and demand and free trade"

Optimization

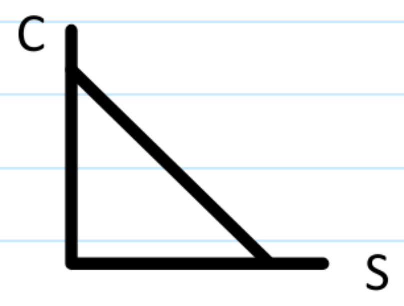
1. Math tool for finding choice to max objective
2. [find out later]

Consumer Optimization

$\max U(pizza, beer)$
$S.T.\ \ M - P_b Beer - P_p Pizza \geq 0$

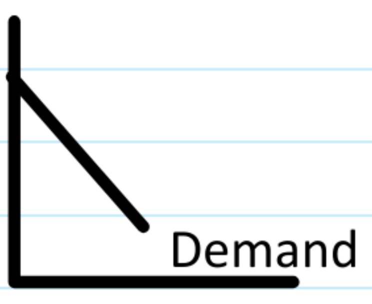


$$\sum_i P_i X_i + S = m$$



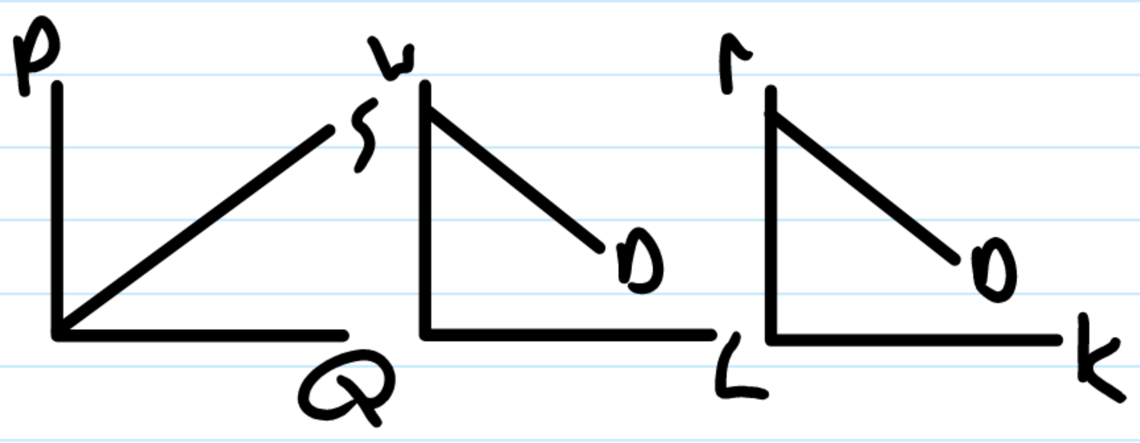
$$\sum_t \frac{\sum_i P_{it} X_{it}}{(1+r)^t} = \sum_t \frac{m_t}{(1+r)^t}$$

$\max u(x) s.t.\ m - \sum P_x \geq 0 \rightarrow x^D(m, p)$



Firm
$\max\ p * q(k, l) - wl - rk$
Price * quantity(capital, labor)-wage labor-return on capital

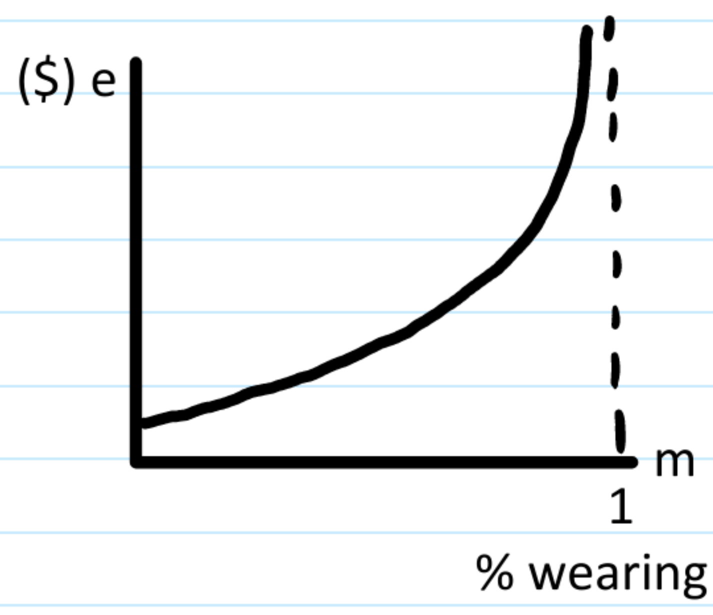
->
$L^D(w, r, p)$
$K^D(w, r, p)$
$q^S(w, r, p)$



Optimization applied to <u>mask mandates</u>

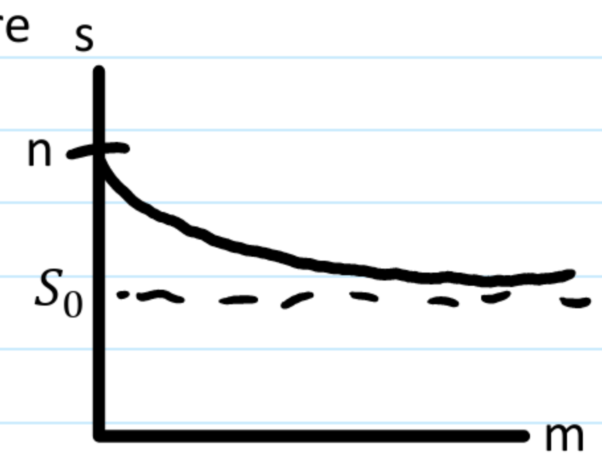
- n: # of people
- s: sick –> s_0 s_1
- h: healthy –> h_0 h_1
- m: # wearing
- e: enforcement
- c: cost of being sick

$\min c_s * s_1 + c_m m + e(m)$
s_1 depends on stuff



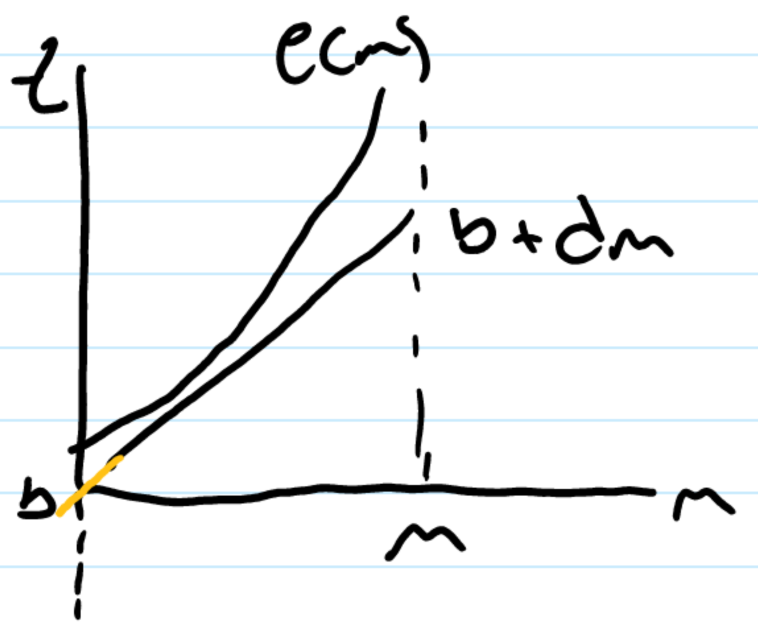
Ignore Cs if masks do not offer 100% protection. "They don't work anyways"
If we model at the exact point of the mandate, we can include s0 and s1 and h0 and h1
Don't use h because we can use n-s
Cs is a function of
protection ratio = m/n*(n-s)/n=m(n-s)/n2

- me[0,1] –> fraction wearing
- E = ne(m)
- m_{min} is the number of people that will always wear a mask
- p is probability you don't get it from 1 exposure
- e = equation
  - $\frac{m - m_{min}}{1 - m} * a$
  - $s_1(m)$
  - $s_0 + h[1 - p^{s_0}]$
  - $s_0 + h[1 - p^{s_0} e^{rm}]$
- **<u>NOT QUITE RIGHT</u>**



- $\lambda = e^{rm}$
- $m * ln(\lambda) = rm$
- $\ln(\lambda) = r$

- Talk through the basic economics of what are the tradeoffs in a mask mandate. Diff in ask vs enforce.
- λ is making masks more or less effective



b = y intercept

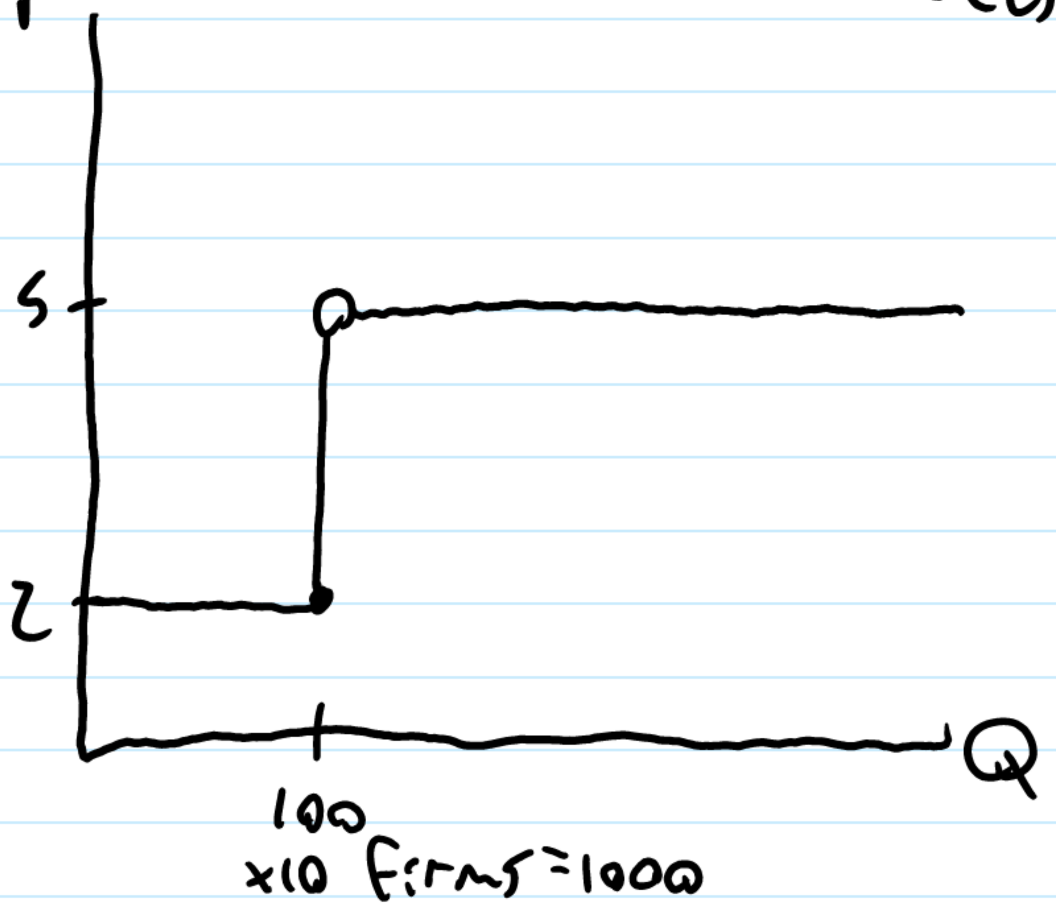
Optimization Review

$u = 10q - \frac{1}{2}q^2 - Pq$ 1000 customers
$\frac{du}{dq} = 10 - q - P$ at $P = 0$ $q = 10 - P \rightarrow q = 10 - 0 \rightarrow q = 10$
$Q = (1000 \cdot 10) - 1000P$

n = 10 firms $MC = 2$ $q \leq 100$, 5 $q > 100$ $F = 100$
market supply?

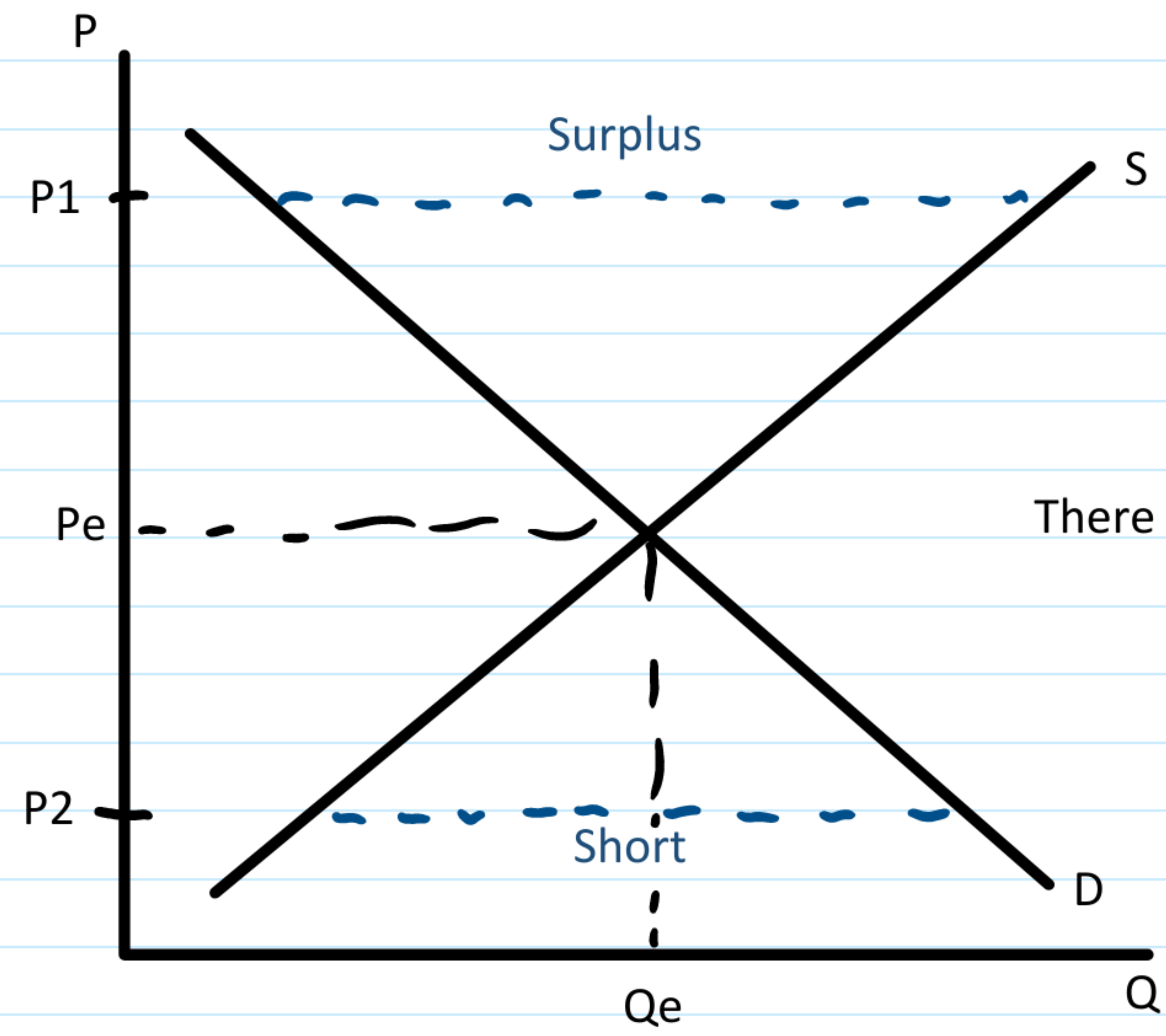
$c(q) = 100 + 2q$ $q \leq 100$
$100 + (100 + 2(100)) + 5(q - 100)$ $q > 100$
↳200

$P = 2 + 100/\frac{Q}{n}$



2.2 Supply and Demand

Friday, September 3, 2021 10:06 AM



Firms optimizing

There are many firms and many consumers

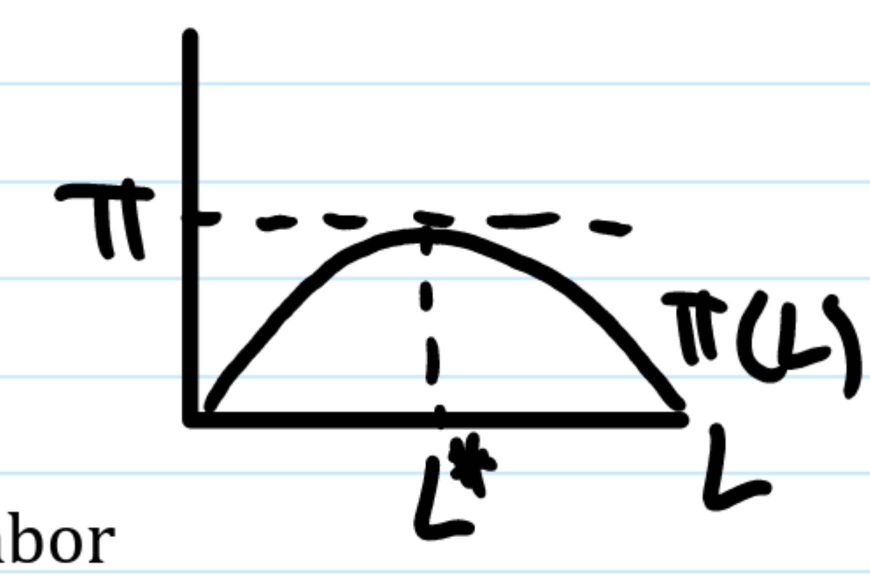
Consumer optimizing

Firm F

$$\pi_f = p q_f(L_f, K_f) - rK_f - WL_f$$

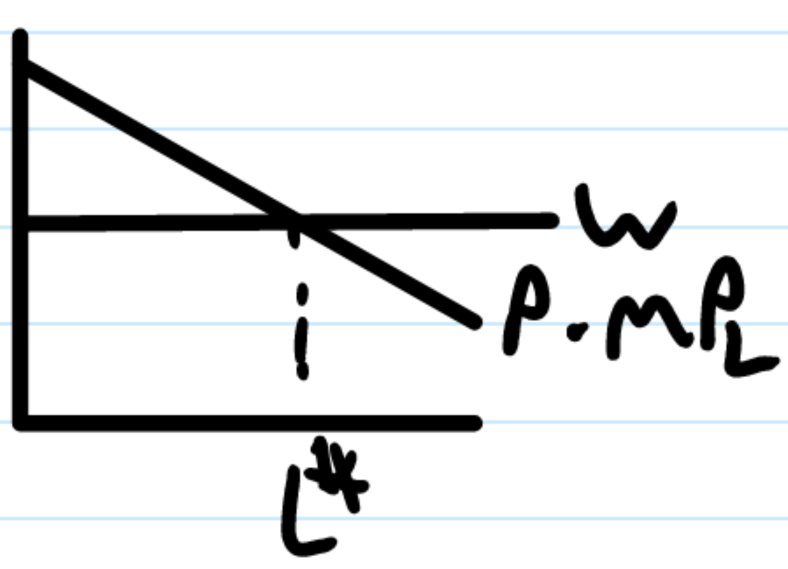
$$\frac{d\pi_f}{dL_f} = p\boxed{\frac{dq_f}{dL_f}} - W = 0$$

-> Marginal product of labor

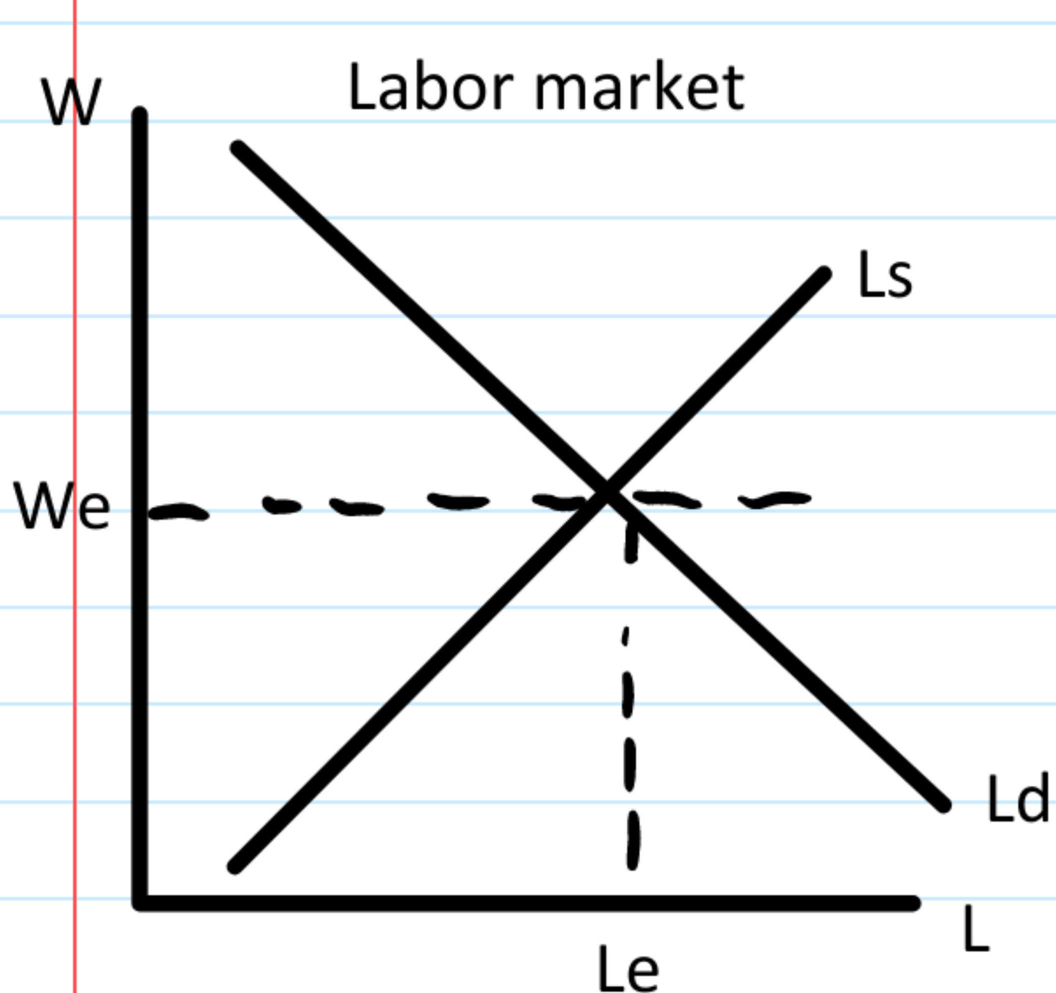


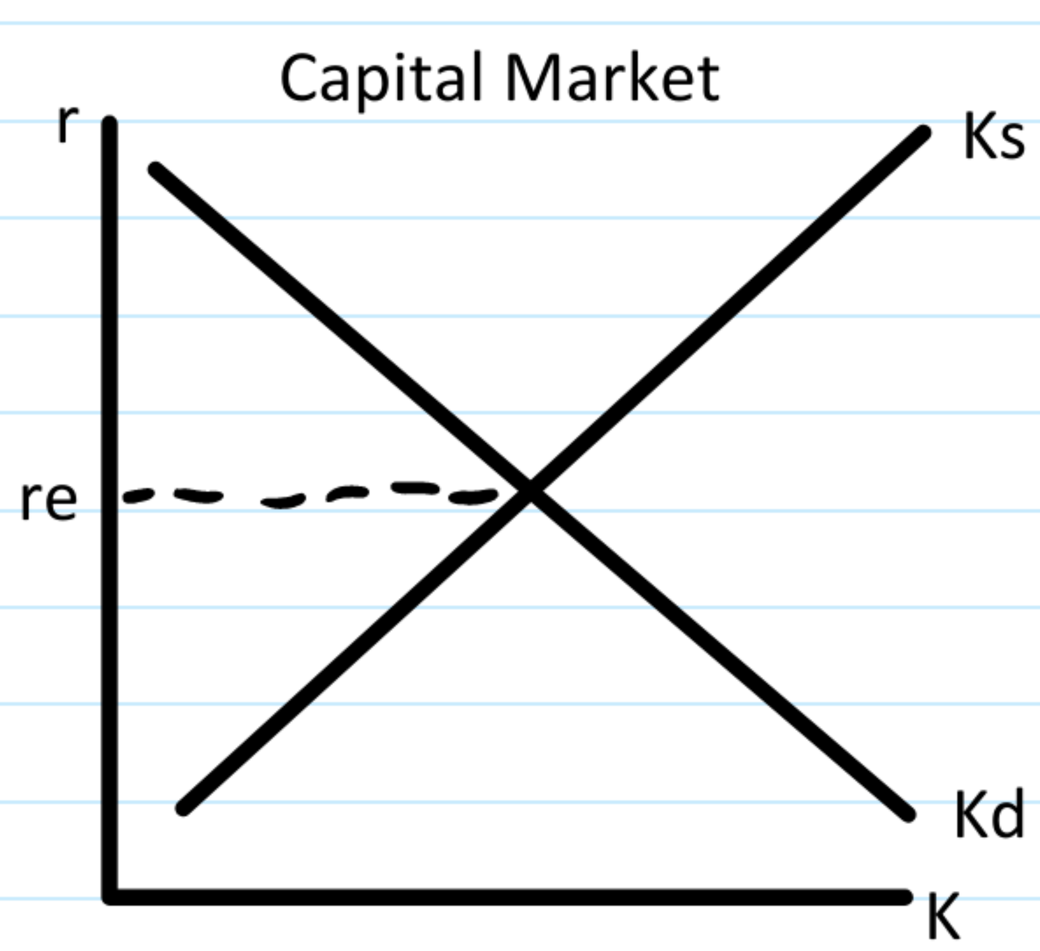
$p * Mp_L > w$

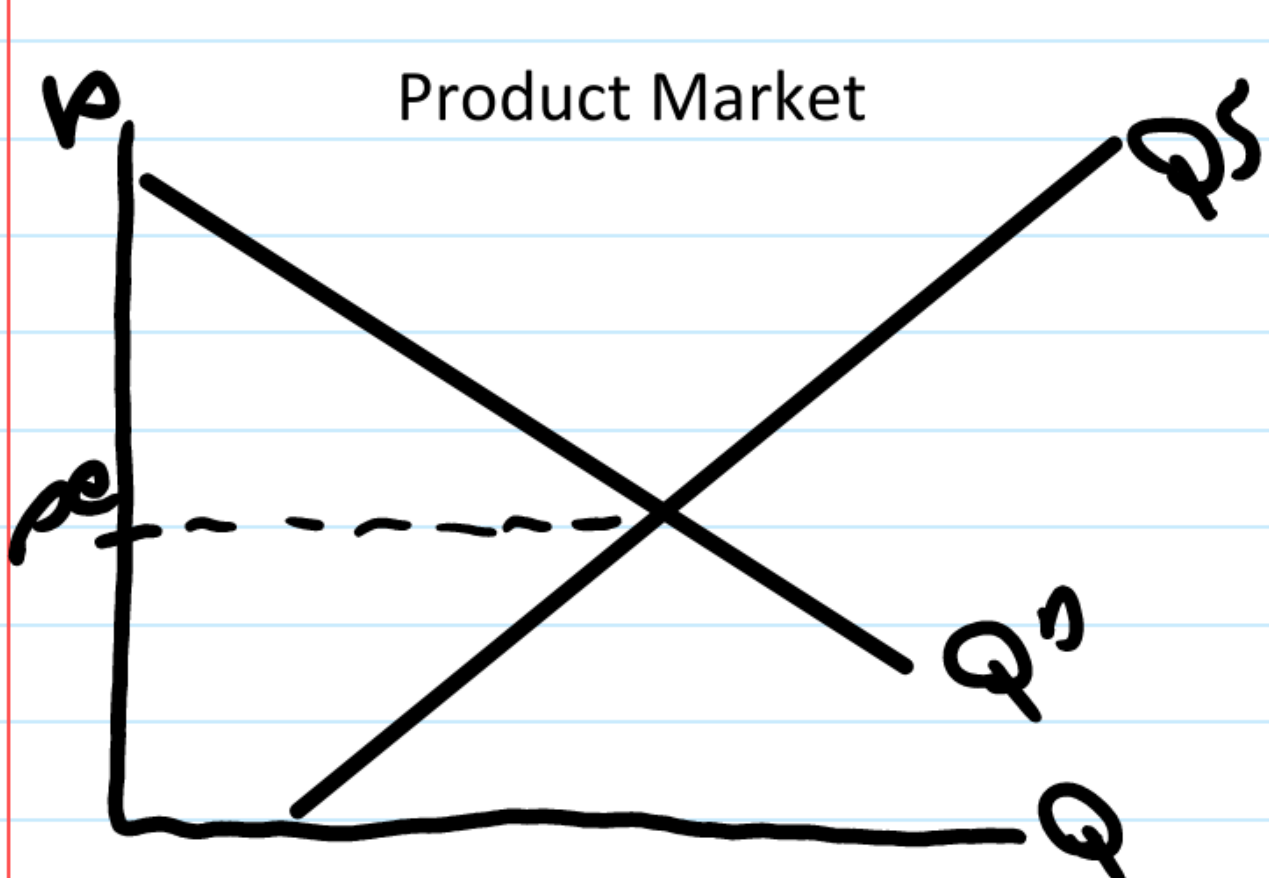
10*10 > 20



$$L^D = \Sigma_f L_f^D$$







2.3 Multiple Regression

Wednesday, September 8, 2021 10:01 AM

- Cont. Issues
- Economic analysis
- Game theory
- Econometrics: Causal inference, Panel + survey data

Credibility Revolution

1. Context. Why? – Hail
2. What was it? – Graham
3. Ill effects
   a. Not enough focus on external validity – Kori
   b. Too much focus on small questions – Jake
4. Rebuttal to #3 – Maverick

Regression

	Sandwiches	Sleep
Logan	8	7
Hail	2	8
Maverick	2	6
Gus	2	8
Kori	1	5
Nicole	1	6
Graham	5	7

Average Sandwiches:
- Females: 1.33
- Males: 4.25
- Total: 4

$min \sum_i (S_i - \hat{S})^2$

$2\sum(S_i - \hat{S}) = 0$

$\sum S_i = \sum \hat{S} = 7\hat{S} = n\hat{S}$

$\hat{S} = \frac{\sum S_i}{n}$

Split the prediction equation for males and females
Best predictor value is the average number for that group

Regression: Compute $E(y|x, x_1, x_2, x_3, \ldots, x_k)$

$\min_{\hat{Y}} \sum_{i \in g} (Y_i - \hat{Y}_g)^2 \rightarrow \hat{Y}_g = \bar{Y}_g = E(Y|g)$

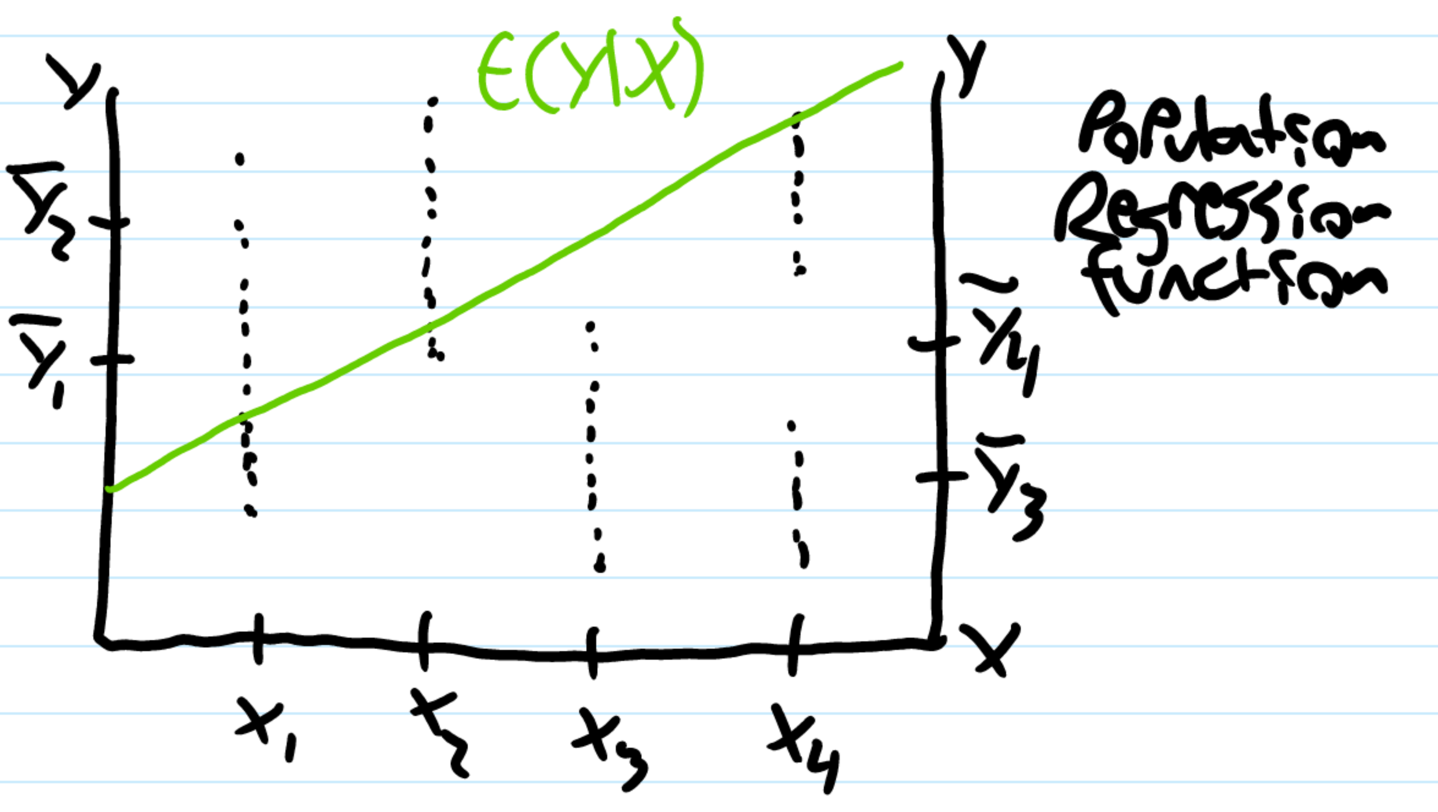
$\hat{Y}_i = \hat{\beta}_0 + \hat{\beta}_1 X_1 + \hat{\beta}_2 X_2 + \ldots + \hat{\beta}_k X_k$

Small # groups, Categorical vars

ANOVA

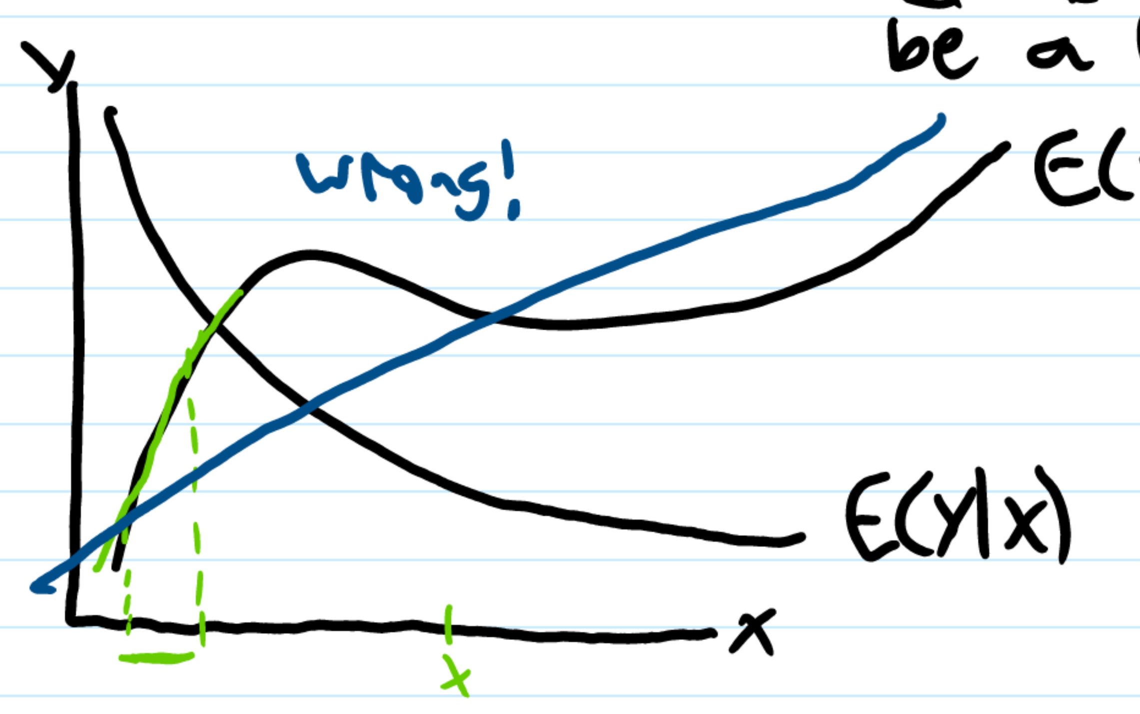
$E(Y|\underset{\text{vector of } x}{X}) = XB$ ← linear function of x

Y	X1	X2	X3	X4	X0	B
	1	40	3		1	B1
	0	90	8		1	B2
	0	75	12		1	B3
	1	66	8		1	B4
	1	12	7		1	B5
	1	11	9		1	B6
	0	103	6		1	B7
	1	41	5		1	B8
	0	52	4		1	B9



$\bar{Y}$ = Averages

If I drew it right, there would be a line for the regression



$\ln Y = B_0 + B_1 \ln X$

$Y = B_0 + B_1 X_1 + B_2 X^2 + B_3 X^3$

$Y = B_0 + B_1 \, 1/X$

B is the unknown

$\min \sum (Y_i - \hat{B}_0 - \hat{B}_1 X_1 - \ldots - \hat{B}_k X_k)^2 \rightarrow \min \sum e_i^2$

↳ $\min \sum (Y_i - \hat{Y}_i)^2$

$\hat{B} = (X^T X)^{-1} X^T Y$

$\frac{dSS_i}{d\hat{B}_1} = -2\sum \underbrace{(Y_i - \hat{B}_0 - \hat{B}_1 X_{1i} - \ldots)}_{\text{Residual}} X_{1i} = 0$

$\sum (X_{ki} e_i) = 0 \quad \forall k$

Picks the line so there's no correlation between the explanatory + unpredicted part

$Y_i = \hat{Y} + \hat{e}_i$

$E(\hat{B}) = \sum \; \xi(XB + \epsilon) = (\cancel{X^T X^{-1}}) \cancel{X^T X} B + (X^T X)^{-1} X^T \epsilon =$

$B + \underbrace{(X^T X)^{-1} X^T \epsilon}_{=0}$

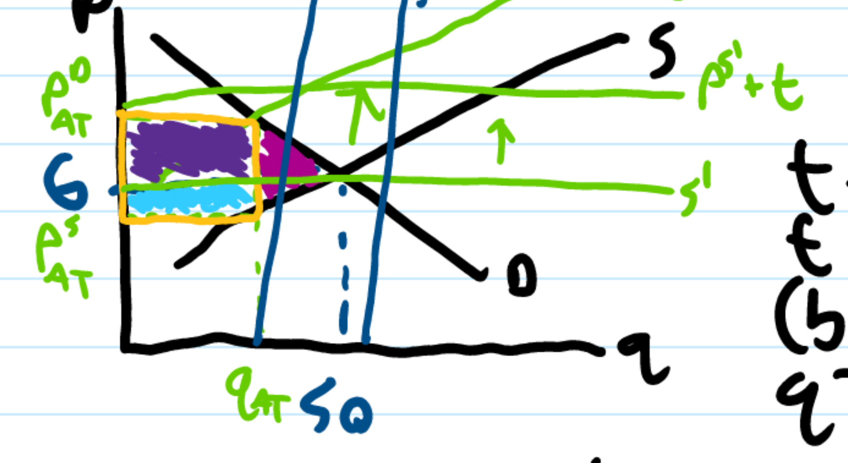
$Sandwich_i = B_0 + B_1 sex_i + B_2 sleep_i + B_3 Income + \epsilon_i$

$= B_0 + B_1 sex_i + B_2 sleep_i + B_3 Income_i + B_4 Ad_i + \epsilon_i$

For causation, need sleep, sex, income, and uncorrelated with ϵ_i

↳ ϵ_i: combined effect of other causes

$P^S = c + dq^S$ → supply
$P^D = a - bq^D$ → demand
for iced coffee → $P^S = P^D$ → $q^S = q^D = q$



after tax… $t + P^S = P^D$

$t + P^S = a - bq$

$t + c + dq = a - bq$

$(b + d)q = a - c - t$

$q = (a - c - t)/(b + d)$

$q_{AT} = \frac{a - c}{b + d} - \frac{t}{b + d}$

Consumer surplus
Producer surplus
Deadweight loss
Government revenue

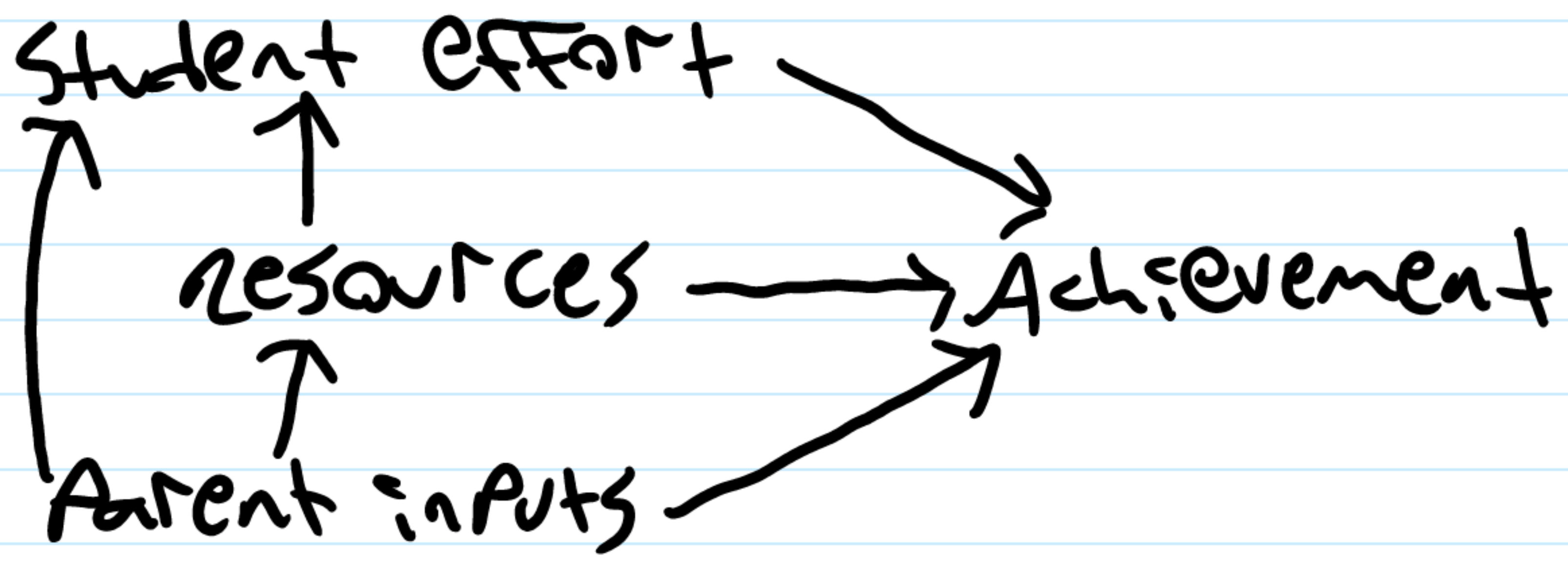
4.1 Directed Acyclic Graphs

Wednesday, September 22, 2021 10:06 AM

School resources —> Academic Achievement

Regress A R

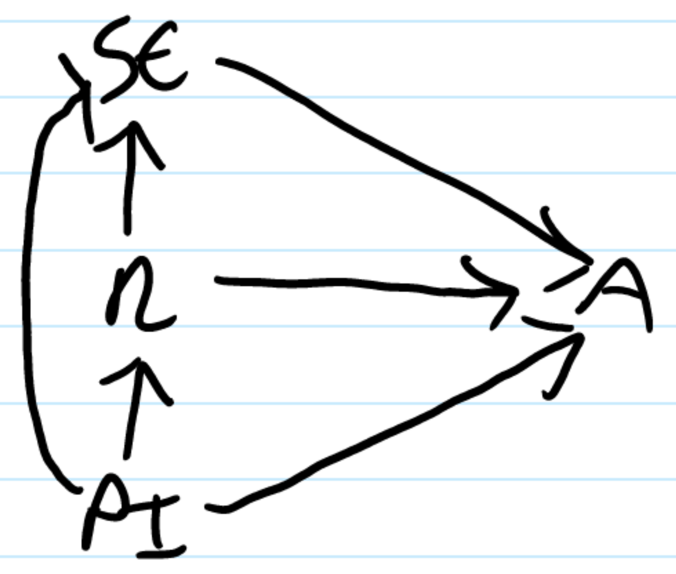
$A = B_0 + B_1 R$



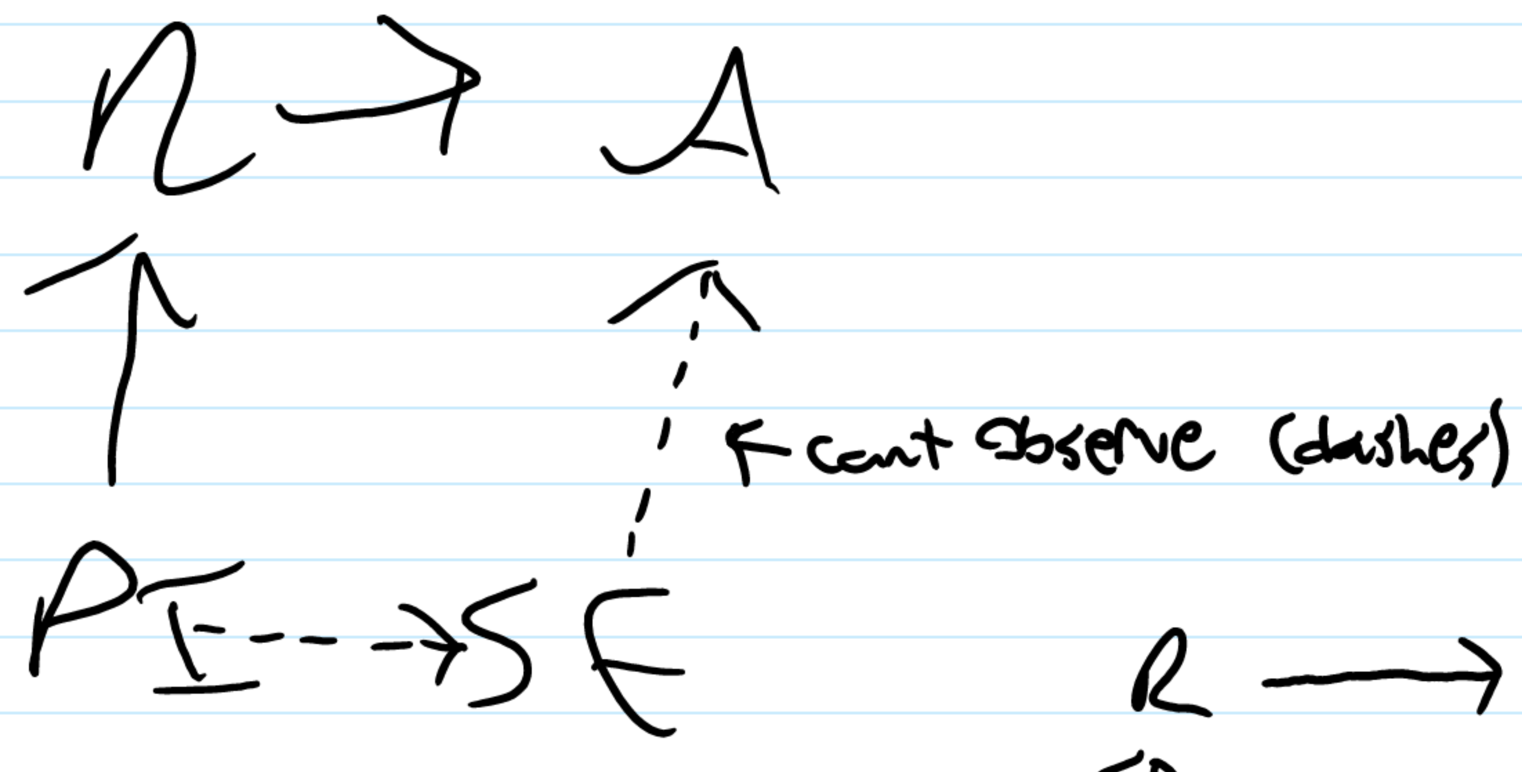
$R \to A$

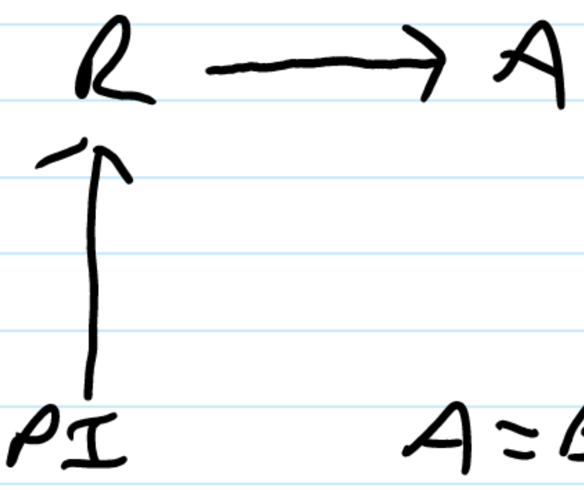
$A \leftarrow PI \to R \to SE \to A$

$R \to A$



$A = B_0 + B_1 R + B_2 PI + B_3 SE$





$A = B_0 + B_1 R$

$A = B_0 + B_1 R + B_2 PI$

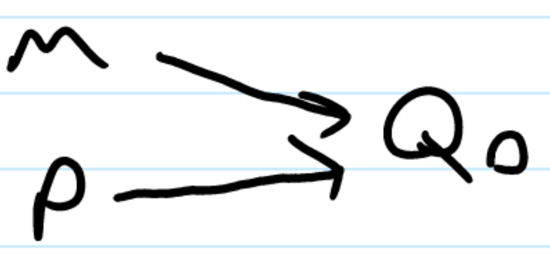
$A = B_0 + B_1 R + B_2 PI$

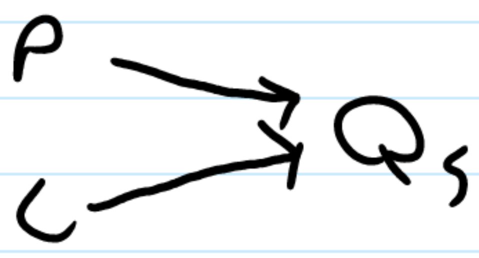
~~$A + B_1 R$~~

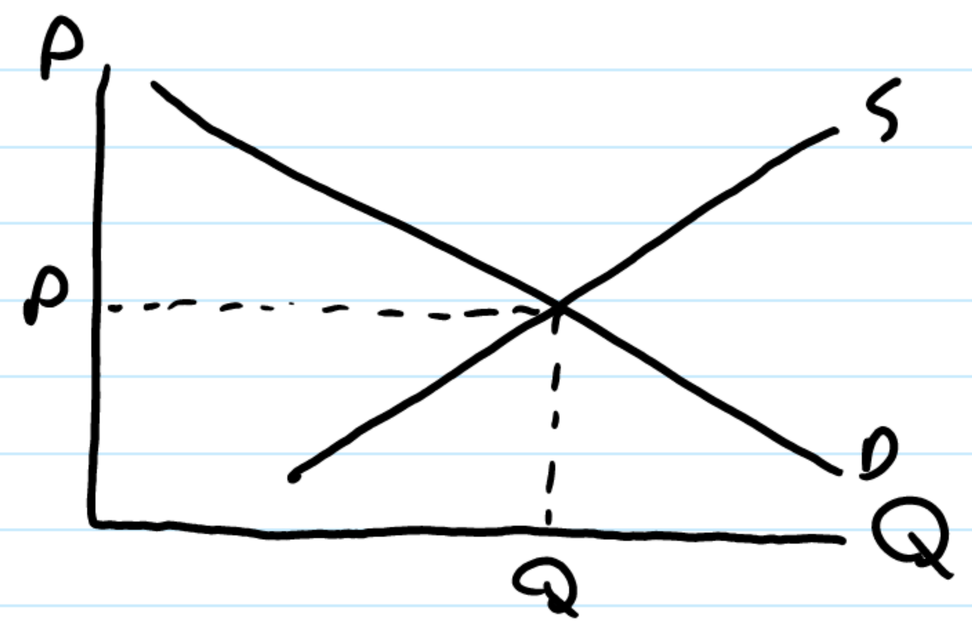
$R \to A$

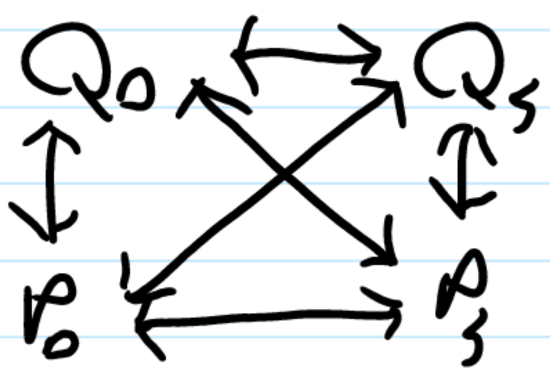
$R \leftarrow PI \to SE \to A$

Simultaneous Relationships - Simultaneity

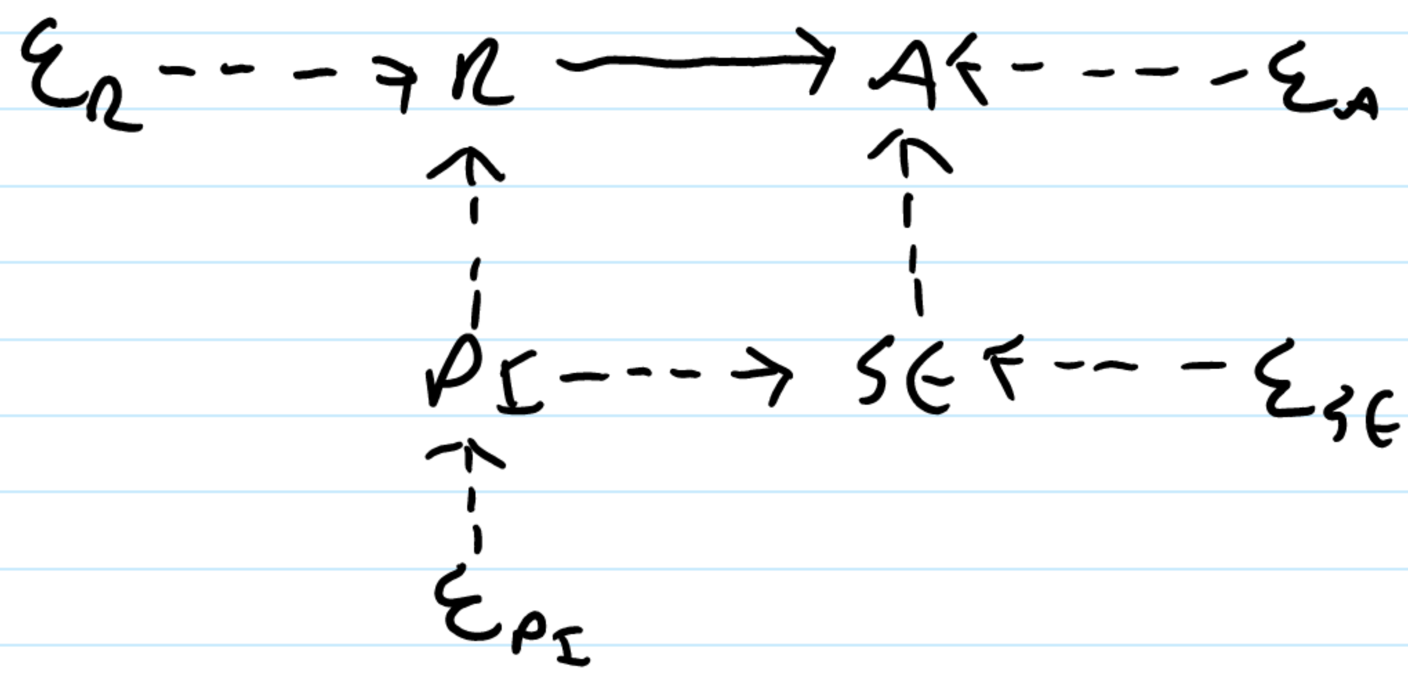


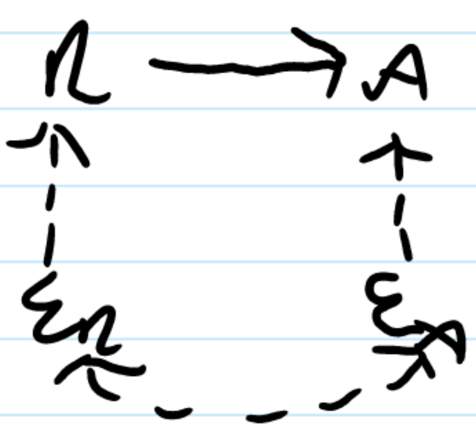


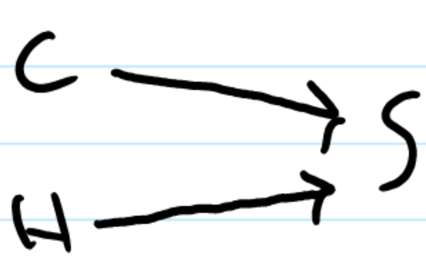




Unknown Unknowns

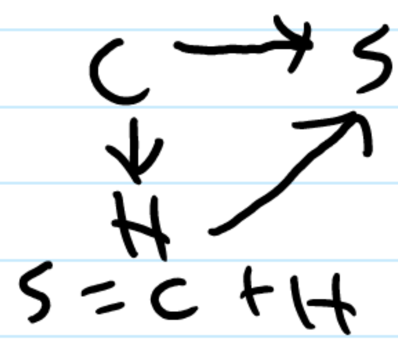


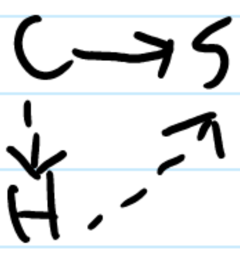


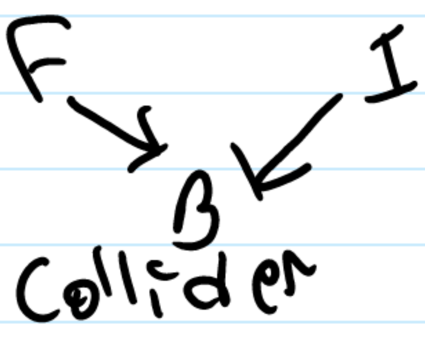


$S = C \quad (S = B_0 + B_1 C)$

$S = C \qquad H$







$F = I$

no corr

$F = B \quad I$

$\mathrm{corr}(F, I)$

$X \quad Y$

$Z = X + Y$

$X = Z \quad Y$

$Z = X + Y$

$X = Z - Y$

$X = Y$

no corr

$X = \varepsilon_X$

$Y = \varepsilon_Y$

4.2 The Rubin Causal Model

Friday, September 24, 2021 10:39 AM

Counter Factual Framework

	Yes Coffee	No Coffee	Treatment Effect (Yes - No)	Ta	Yes	No	TT	TU
Hail	89	75	14	1	89		14	
Gus	87	91	-4	0		91		-4
Jake	91	26	65	0		26		65
Kori	84	57	27	1	84		27	
Nicole	92	94	-2	1	92		-2	
Graham	84	90	-6	0		90		-6
Maverick	89	40	49	1	89		49	
		ATE	20.4286		88.500	69.0000		
				OSD	19.5			
						ATT	22	
						ATU		18.3333

	Yes Coffee	No Coffee	Treatment Effect (Yes - No)	Ta	Yes	No		TT	TU	T	Score
Hail	89	75	14	1	89			14		1	89
Gus	87	91	-4	0		91			-4	0	91
Jake	91	26	65	1	91			65		0	26
Kori	84	57	27	1	84			27		1	84
Nicole	92	94	-2	0		94			-2	1	92
Graham	84	90	-6	0		90			-6	0	90
Maverick	89	40	49	1		89		49		1	89
		ATE	20.4286							Combs	35
				OSD	88.25	91.6667	ATT	38.75			
					-3.4167		ATU		-4		

$E(Y^1|T=1)$ obs $\quad T \in (0,1)$

$E(Y^1|T=0)$ unobs

$E(Y^0|T=1)$ unobs

$E(Y^0|T=0)$ obs

$$OSD = E(y^1|T=1) - E(Y^0|T=0)$$

$$OSD = E(y^1|T=1) - E(y^0|T=1) + E(y^0|T=1) - E(y^0|T=0)$$
$= ATT +$ selection bias

$$ATE = \frac{n^1}{n} ATT + \frac{n^0}{n} ATU$$

$$\frac{n^1}{n} ATT = ATE - \frac{n^0}{n} ATU$$

$$ATT = \frac{n^0 + n^1}{n^1} ATE - \frac{n^0}{n^1} ATU = ATE + \frac{n_0}{n_1}(ATT - ATU)$$

$OSD = ATT +$ selection bias $+ \frac{n_0}{n_1}(ATT - ATU)$
heterogeneity

Fisher's Sharp Null

→ exact test
exact p-value

H_0: No causal effect
H_a: Causal effect

Regression Discontinuity Designs

4.4 Panel Data

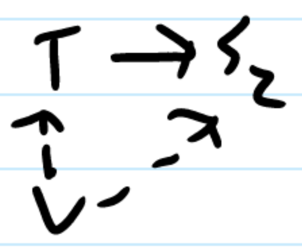
Monday, October 18, 2021 10:29 AM

$i = 1, 2, \ldots N$ cross section
$t = 1, 2, \ldots T$ time series

Usually:
small T
large N

$NT \rightarrow N = nT$

$S_1 \; S_2$ (T) $\quad Avg(S_2 | T=1) - Avg(S_2 | T=0)$



$Avg(S_2 - S_1 | T=1) - Avg(S_2 - S_1 | T=0)$

	Time 1	0
1	Y_1^1	Y_1^0
2	Y_2^1	Y_2^0

$\rightarrow (\hat{Y}_2^1 - \hat{Y}_1^1) - (\hat{X}_2^0 - \hat{Y}_1^0)$

ind. t

Ind	Exam	Score	Coffee	Study
1	1	80	0	4
2	1	70	0	7
3	1		0	6
4	1		0	
1	2		1	
2	2		0	
3	2		1	
4	2		0	

$Y_{it} = B_0 + B_1 Treat_{it} + B_2 X_{it} + V_{it}$ OLS

$Y_{it} = B_0 + B_1 Treat_{it} + B_2 X_{it} + u_i + \gamma_t + \varepsilon_{it}$

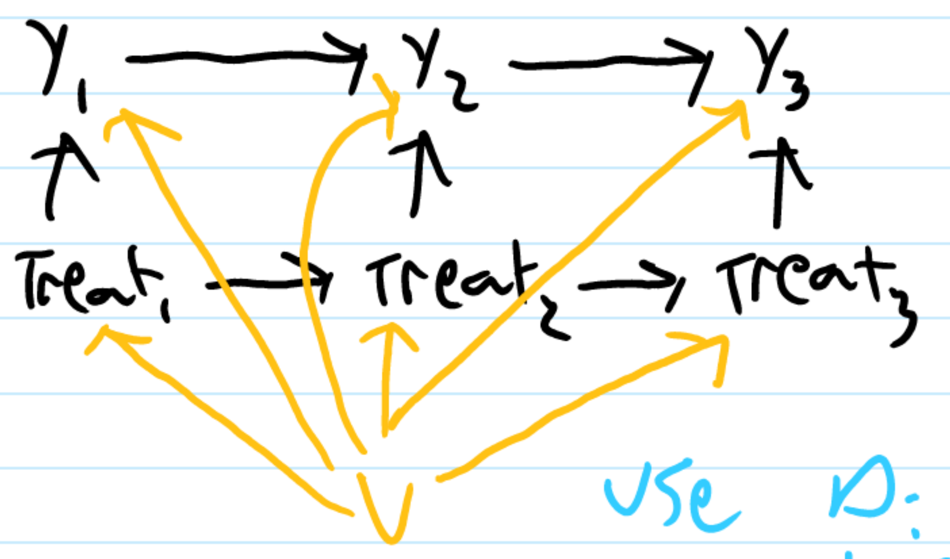
$\hookrightarrow V_{it} = u_i + \gamma_t + \varepsilon_{it}$

$\hookrightarrow$ seasonal effect

$Y_{it} = B_0 + B_1 Treat_{it} + B_2 X_{it} + \underbrace{\alpha_i + \gamma_t}_{\text{fixed effects}} + \varepsilon_{it}$

$Y_{it} = B_0 + B_1 Treat_{it} + B_2 X_{it} + \sum_{i=2}^{N} \alpha_i D_{it} + \sum_{t=2}^{T} \gamma_t Z_{it}$

Int for Nicole @ $t=2$ $\quad B_0 + \alpha_{Nicole} + \gamma_2$



Use D_i to measure U
$\hookrightarrow$ Dummy

Difference in Difference

"Parallel Trends"

	After	Before	delta
Treat	80	70	10
Non-treat	82	80	2
		delta|delta	8

Confidence Interval: 8+-15
Control for X to decrease standard errors

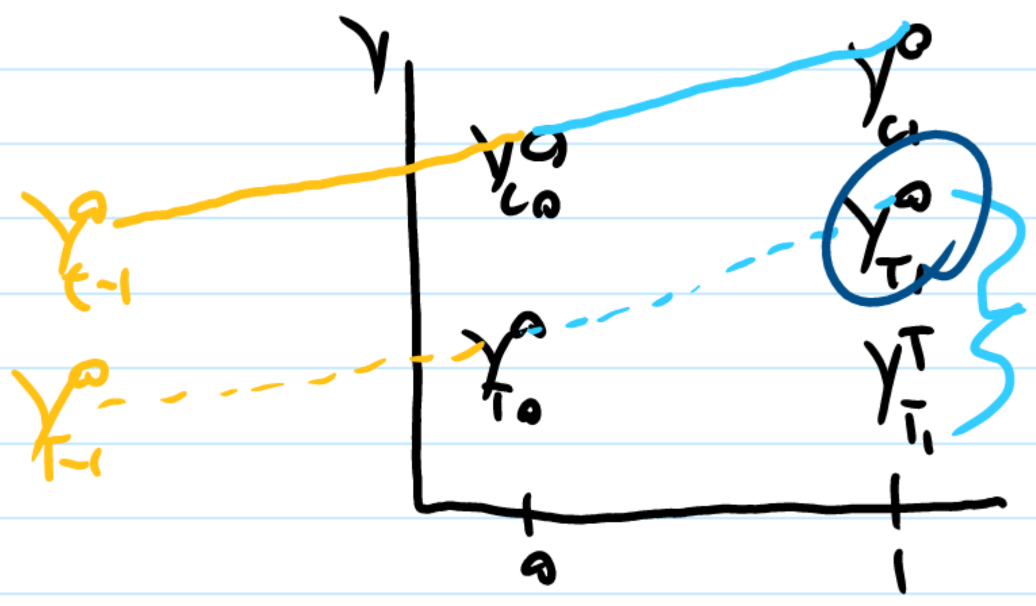
2. Variable treatment timing

Simple 2x2

t = linear time

$Y_{it} = \alpha_0 + \sum_i B_i D_i + \sum_t \gamma_t D_t + \delta Treat_{it}$ $(+ B X_{it})$ Not simple 2x2
$t \in 0, 1$

If trends diverge pre-treatment $+ \theta D_i t$



Counter factual

LATE / δ

Internal vs External

↓

Addictive → Implications for rational modelling

Use today - cost of γ tomorrow
use T days in a row - $\gamma(1+g)^T$

tomorrow worth $\delta < 1$, δ is small, use today even
if $\gamma + g$ is large

If quit, incur cost w

Payoff $(-w - \gamma(1+g)^T$ → $\gamma + g$ large
tomorrow (V)

don't quit today, $V - \gamma(1+g)^T$, tomorrow $V - \gamma(1+g)^T$

Variant: (a) prob addicted
$(1-a)$ prob not addicted

Some addicts: $\{$ once quit, stay quit

lifetime value < 0 if $a = 1$, > 0 if $a = 0$

8 People → everyone wants 5 slices

A) 1 each

B) 4 get 3, 3 get 2, 1 gets Ø

c) 3 get 5, 2 get 3, 1 gets 2, 2 get Ø

Average Pizza → Max(min(v_i)) "Kaldor Hicks" → highest average

A) 1

B) $[(4 \cdot 3) + (3 \cdot 2)]/8 = 18/8 = 2.25$

c) $[(3 \cdot 5) + (2 \cdot 3) + (1 \cdot 2)]/8 = 23/8 = 2.875$

Starving People

A) Ø B) 1 C) 2

Answer: I choose B. While people get slightly less pizza on average, fewer people go hungry

John Rawls "veil of ignorance"

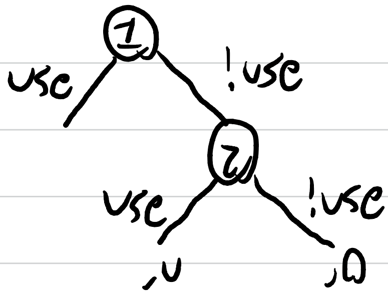
$$C = WL \qquad \left.\begin{array}{l} awL - b(wL)^2 + Z(T-L) \\ 2(wL - b(wL)^2) + Z(T-L) \\ awL - b(wL)^2 - \frac{1}{2}Z(T-L) \end{array}\right\} \text{variants}$$

effort ↓

$$ae - de^2 \rightarrow \left.\begin{array}{l} P > 1 \;\; Pae - de^2 \\ ae - \frac{d}{P}e^2 \end{array}\right\} \text{same thing}$$

Time: 0 → $v - \delta^f D$, $\delta < 1$, $v > 0$, $D > 0$ → $0 + \delta^f v$

1 → $\delta^f v - D$, $\delta < 1$, $v > 0$, $D > 0$ → $\delta^f D + v$



$v - \delta^f D > \delta^f v$

$(1-\delta^f)v > \delta^f D$ →

Average(0, 1) → $\frac{1}{2}[(1+\delta^f)v - (1+\delta^f)D]$

$< \frac{1}{2}(v + \delta^f v)$, < 0

↳ should !use at $t=0$

↳ would choose no access over use at $t=1$

6. Economics of Mask Mandated During Covid-19

$q(1-gm)(1-hm) \rightarrow$ how many people an infected person infects

$1 > g > h \geq 0$

$\downarrow$

$i \, q(1-gm)(1-hm) \rightarrow$ share of population infected today

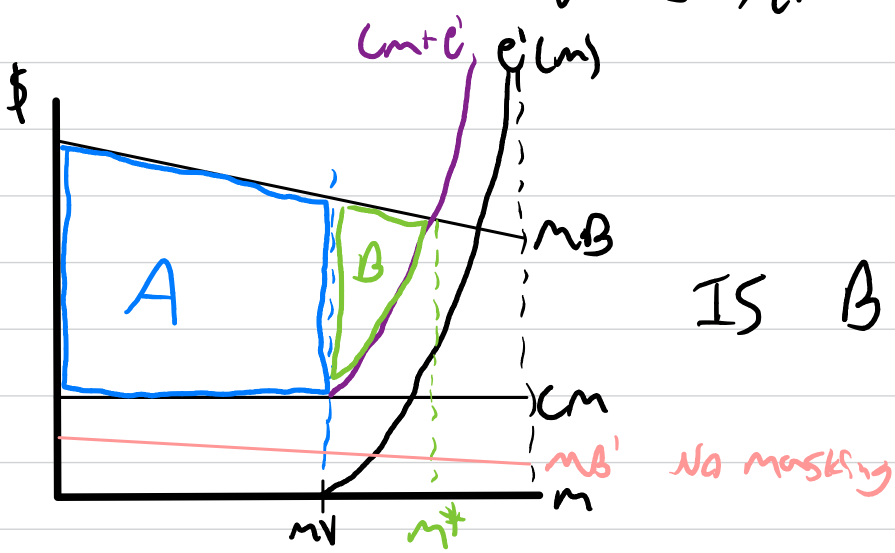
$b_i i_0(1-i_0)q(1-gm)(1-hm)c_s + c_m M + Ek + e(m; m_v; \bar{m})$

$E \in \{0,1\}$, $\bar{m} \rightarrow 1$

$q(1-hm)(1-gm)i_0(1-i_0)c_i + c_m M + EF + e(m) \rightarrow e'_m$

derive... $-\frac{d}{dm} = h(1-gm)q_i(1-i)c_i + g(1-hm)q_i(1-i)c_i$

$= (h+g-2hgm)q_i(1-i)c_i$



IS $B > F$

SIR models

$$r_t = r_{t-1} + x\, i_{t-1} \qquad x = \frac{1}{T}$$

$$s_t = s_{t-1} - q(1-hm)(1-gm)\, i_{t-1} s_{t-1}$$

$$qT = \frac{q}{x} = R_0$$

$i_0 = .0001 \quad s_0 = .9999 \quad r_0 = 0$

SIR + Masks + congestion

$\tilde{i}$: above $i = \tilde{i}$, congestion $C_t = 1$ if $i_t > \hat{i}$

$$c_{i_t} = \alpha + C_t \beta\left(\frac{i}{\tilde{i}} - 1\right)^2$$

$$i_t = i_{t-1} + q(1-gm)(1-hm)\, i_{t-1} s_{t-1} - x\, i_{t-1}$$

$$\alpha + C_t \beta\left(\frac{i_t}{\tilde{i}} - 1\right)^2 = c_{i_t}$$

↳ congested ↳ costs

$$E_t\left[F_t\, \gamma\left(\frac{m_t - m_v}{\bar{m} - m_t} + \ln\left(\frac{\bar{m} - m_t}{\bar{m} - m_v}\right)\right)\right] + c_m M_t$$

Endogenous behavior social distancing

$W_{it} = f($skill req.,
ability,
job appeal$)$

"Greedy jobs"

Max π, $MC = MB$

US Growth vs World growth