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At the Beginning There Were (Causal) Questions

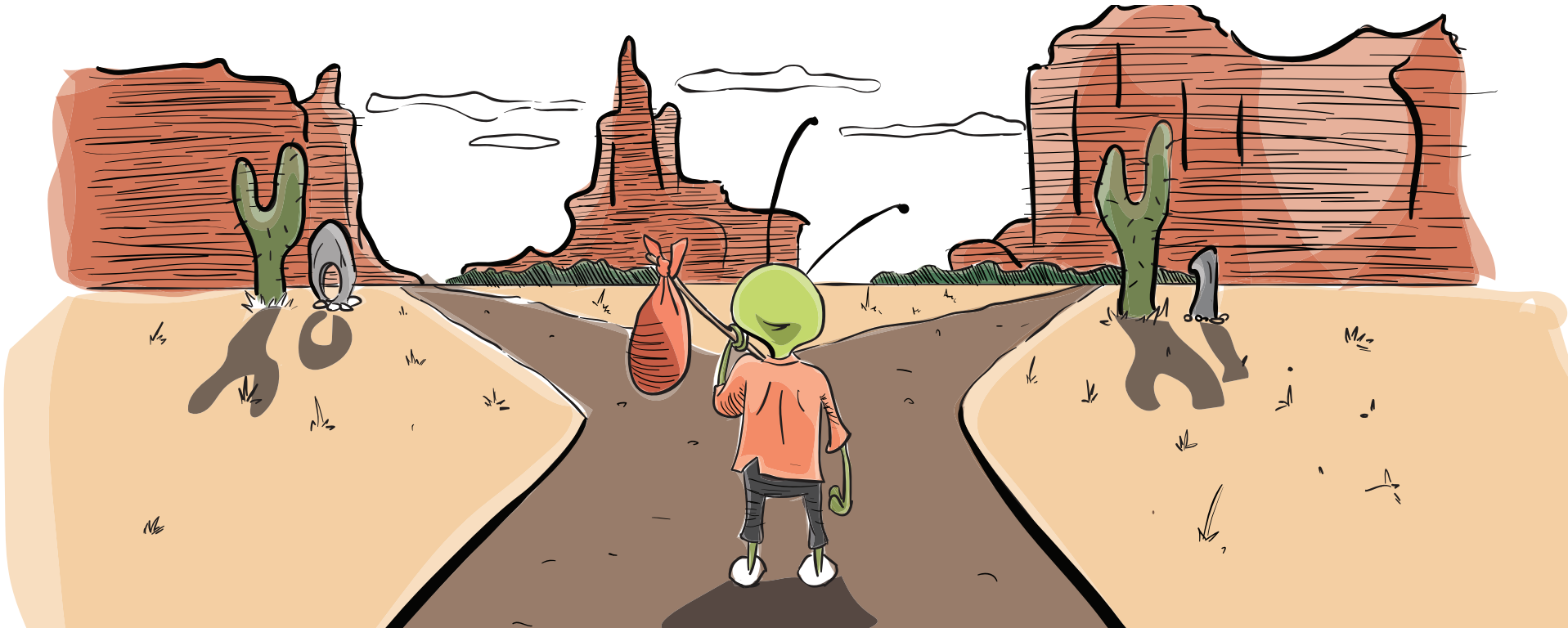
- Labor economists ask about the payoff of going to university
- Public finance economists ask about the consequences of health care expenditures and health insurance
- Education economists ask if school choice, education reform (like academies or charters), and school inputs (like computers) boost learning
- Many have asked recently: does expansionary monetary policy revive an ailing economy?
- Many business problems are causal questions:
  - Does a marketing campaing increase sales?
  - Does an incentive scheme raise employee performance?

Answers are crafted using the tools of the *'Metrics* trade: experiments, regression, IV, RD, and DD

Causality and Destiny: Potential Outcomes

Kwai Chang Caine: What happens in a man's life is already written. A man must move through life as his destiny wills. Old man: Yet each is free to live as he chooses. Though they seem opposite, both are true.

- Kung Fu Pilot



A Parable: Does Going to Hospital Improve Health?

- Average health (assigning a 1 to poor health and a 5 to excellent health), contrasting those who have been an inpatient in the past 12 months and those who have not (tabulated from the 2005 NHIS):

Group	Sample Size	Mean health status	Std. Error
Hospital	7774	3.21	0.014
No Hospital	90049	3.93	0.003

  This shows a large (and statistically precise) contrast in favor of the non-hospitalized
- Taken at face value, this comparison suggests that hospitalization makes people sicker. So why do so many go?
- Those who seek treatment were sicker in the first place (of course!)
  - A naive contrast, but not unusual

Selection Bias

Naive comparisons of means are plagued by selection bias:

$$\text{Difference in means} = \text{avg. causal effect} + \text{selection bias}$$

- Causal effect for individual i:

  i's health if going to hospital $-$ i's health if not going

- Selection bias:

  avg. health of those going to hospital *had they not gone*
  $-$ avg. health of those actually not going

Selection Bias is Everywhere

Every day we hear of comparisons linking behaviors, medications, or diet with outcomes related to health. Selection bias is pervasive in such comparisons.

- Breakfast is the most important meal of the day!
  - Many studies found that skipping breakfast leads to obesity.
  - Randomised clinical trials did not replicate this result and found no effect.
- Actions demolish their alternatives, but experiments reveal them: Random assignment ensures like for like comparisons

Rest Insured (True Story)

- Does *health insurance* make you healthier?
  - Many Americans have no health care coverage (like the NHS) or insurance. Compared to other rich countries, Americans are a bunch of sickos - cause and effect?
- The health of those with and without insurance

TABLE 1.1

Health and demographic characteristics of insured and uninsured couples in the NHIS

	Husbands			Wives		
	Some HI (1)	No HI (2)	Difference (3)	Some HI (4)	No HI (5)	Difference (6)
A. Health						
Health index	4.01 [.93]	3.70 [1.01]	.31 (.03)	4.02 [.92]	3.62 [1.01]	.39 (.04)

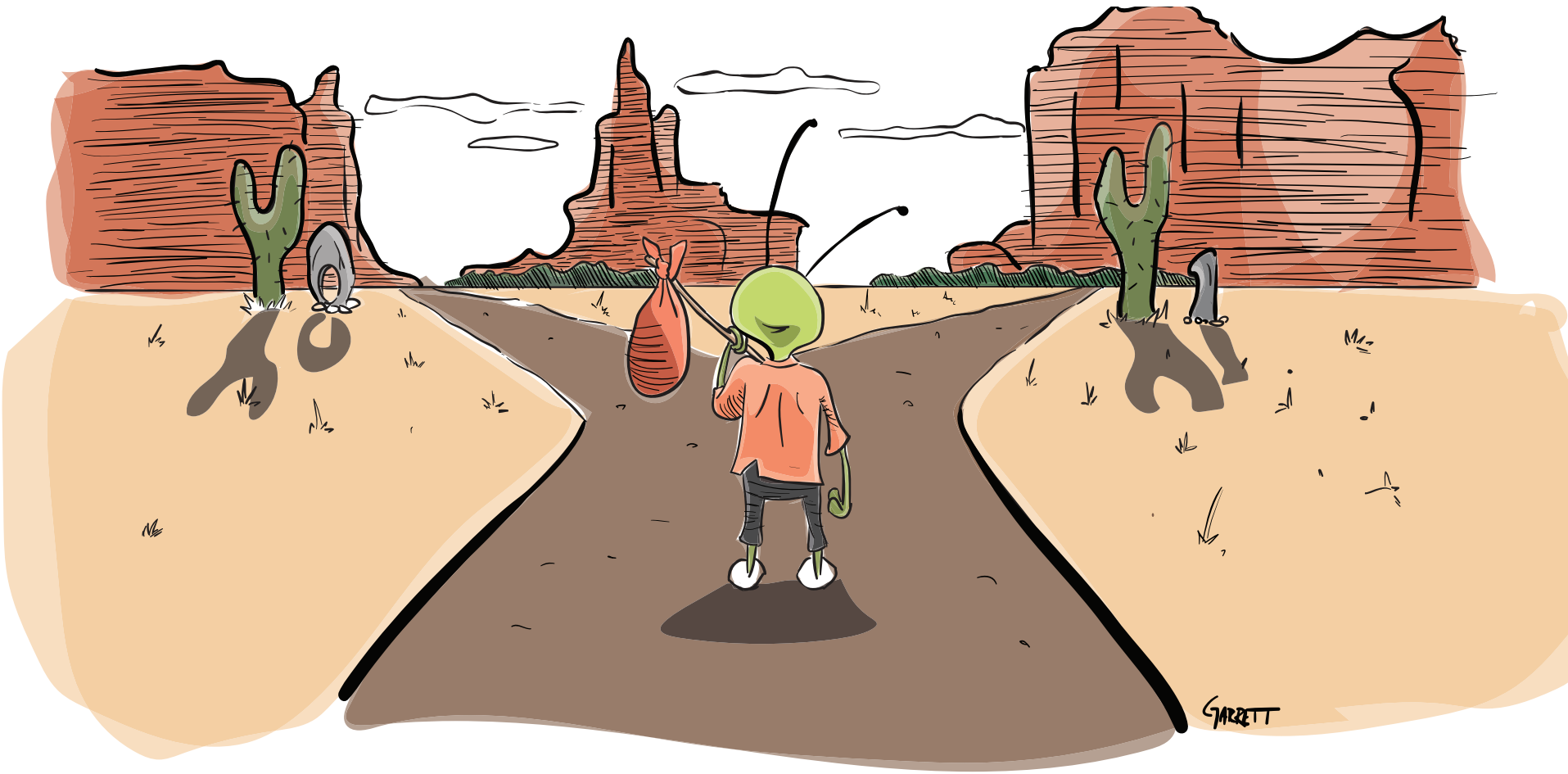
A large, statistically precise health gap in favor of the insured.

Are the Insured and Uninsured Similar?

TABLE 1.1
Health and demographic characteristics of insured and uninsured couples in the NHIS

	Husbands			Wives		
	Some HI (1)	No HI (2)	Difference (3)	Some HI (4)	No HI (5)	Difference (6)
B. Characteristics						
Nonwhite	.16	.17	−.01 (.01)	.15	.17	−.02 (.01)
Age	43.98	41.26	2.71 (.29)	42.24	39.62	2.62 (.30)
Education	14.31	11.56	2.74 (.10)	14.44	11.80	2.64 (.11)
Family size	3.50	3.98	−.47 (.05)	3.49	3.93	−.43 (.05)
Employed	.92	.85	.07 (.01)	.77	.56	.21 (.02)
Family income	106,467	45,656	60,810 (1,355)	106,212	46,385	59,828 (1,406)
Sample size	8,114	1,281		8,264	1,131	

Randomization Breaks Selection Bias



Just RANDomize

- Can you imagine ... a randomised trial on health insurance?
- Yes! From 1974-82, the RAND HIE randomly assigned 4,000 people to different health insurance plans
  - The RAND experiment was motivated by an interest in the elasticity of demand for health care, but looked at health outcomes too
  - We combine treatment groups: catastrophic only (no coverage up to a cap: control); partial coverage; full insurance (free care)

RAND Balance

TABLE 1.3
Demographic characteristics and baseline health in the RAND HIE

	Means	Differences between plan groups			
	Catastrophic plan (1)	Deductible – catastrophic (2)	Coinsurance – catastrophic (3)	Free – catastrophic (4)	Any insurance – catastrophic (5)
A. Demographic characteristics					
Female	.560	−.023	−.025	−.038	−.030
		(.016)	(.015)	(.015)	(.013)
Nonwhite	.172	−.019	−.027	−.028	−.025
		(.027)	(.025)	(.025)	(.022)
Age	32.4	.56	.97	.43	.64
	[12.9]	(.68)	(.65)	(.61)	(.54)
Education	12.1	−.16	−.06	−.26	−.17
	[2.9]	(.19)	(.19)	(.18)	(.16)
Family income	31,603	−2,104	970	−976	−654
	[18,148]	(1,384)	(1,389)	(1,345)	(1,181)
Hospitalized last year	.115	.004	−.002	.001	.001
		(.016)	(.015)	(.015)	(.013)

RAND Balance

TABLE 1.3
Demographic characteristics and baseline health in the RAND HIE

	Means	Differences between plan groups			
	Catastrophic plan (1)	Deductible – catastrophic (2)	Coinsurance – catastrophic (3)	Free – catastrophic (4)	Any insurance – catastrophic (5)
B. Baseline health variables					
General health index	70.9 [14.9]	−1.44 (.95)	.21 (.92)	−1.31 (.87)	−.93 (.77)
Cholesterol (mg/dl)	207 [40]	−1.42 (2.99)	−1.93 (2.76)	−5.25 (2.70)	−3.19 (2.29)
Systolic blood pressure (mm Hg)	122 [17]	2.32 (1.15)	.91 (1.08)	1.12 (1.01)	1.39 (.90)
Mental health index	73.8 [14.3]	−.12 (.82)	1.19 (.81)	.89 (.77)	.71 (.68)
Number enrolled	759	881	1,022	1,295	3,198

RAND Outcomes

TABLE 1.4
Health expenditure and health outcomes in the RAND HIE

	Means	Differences between plan groups			
	Catastrophic plan (1)	Deductible – catastrophic (2)	Coinsurance – catastrophic (3)	Free – catastrophic (4)	Any insurance – catastrophic (5)
A. Health-care use					
Face-to-face visits	2.78 [5.50]	.19 (.25)	.48 (.24)	1.66 (.25)	.90 (.20)
Outpatient expenses	248 [488]	42 (21)	60 (21)	169 (20)	101 (17)
Hospital admissions	.099 [.379]	.016 (.011)	.002 (.011)	.029 (.010)	.017 (.009)
Inpatient expenses	388 [2,308]	72 (69)	93 (73)	116 (60)	97 (53)
Total expenses	636 [2,535]	114 (79)	152 (85)	285 (72)	198 (63)

RAND Outcomes

TABLE 1.4
Health expenditure and health outcomes in the RAND HIE

	Means	Differences between plan groups			
	Catastrophic plan (1)	Deductible – catastrophic (2)	Coinsurance – catastrophic (3)	Free – catastrophic (4)	Any insurance – catastrophic (5)
B. Health outcomes					
General health index	68.5 [15.9]	−.87 (.96)	.61 (.90)	−.78 (.87)	−.36 (.77)
Cholesterol (mg/dl)	203 [42]	.69 (2.57)	−2.31 (2.47)	−1.83 (2.39)	−1.32 (2.08)
Systolic blood pressure (mm Hg)	122 [19]	1.17 (1.06)	−1.39 (.99)	−.52 (.93)	−.36 (.85)
Mental health index	75.5 [14.8]	.45 (.91)	1.07 (.87)	.43 (.83)	.64 (.75)
Number enrolled	759	881	1,022	1,295	3,198

But the Chance to Do Experiments Is Rare, Isn't It?

- Another health insurance experiment: the Oregon health insurance lottery
- More and more experiments in academic research, business, government, etc.
  - Development economics
  - For example, Google AdWords will randomise different ads and you can see which gets more hits
- Even when we don't do an experiment it is useful to think about one: experiments as a benchmark for non-experimental methods.
  - How can we best mimic the ideal experiment?
- There are questions even experiments can't answer
  - If you come across such an answer it won't come from the data

Where'd You Go to School?

- Starting salaries of LSE economics graduates are £35,000, City University of London grads make £23,000.
- Causal effect of a better education or selection?
- Large differences in selectivity and fees of US universities (1976):

University	Private/Public	SAT score	Fees
Yale University	Private	1360	3744
Rice University	Private	1316	1753
University of Michigan	Public	1110	1517
Washington University	Private	1180	3245
University of North Carolina	Public	1080	541
Tulane University	Private	1080	3269

Matchmaker, Matchmaker . . . Find Me a College!

Applicant group	Student	Private			Public			1996 earnings
		Ivy	Leafy	Smart	All State	Tall State	Altered State	
A	1		Reject	Admit		Admit		110,000
	2		Reject	Admit		Admit		100,000
	3		Reject	Admit		Admit		110,000
B	4	Admit			Admit		Admit	60,000
	5	Admit			Admit		Admit	30,000

Make Me a Match . . . Run Me a Regression

Dependent Variable: Log of Earnings

TABLE 2.2
Private school effects: Barron's matches

	No selection controls			Selection controls		
	(1)	(2)	(3)	(4)	(5)	(6)
Private school	.135	.095	.086	.007	.003	.013
	(.055)	(.052)	(.034)	(.038)	(.039)	(.025)
Own SAT score ÷ 100		.048	.016		.033	.001
		(.009)	(.007)		(.007)	(.007)
Log parental income			.219			.190
			(.022)			(.023)
Selectivity-group dummies	No	No	No	Yes	Yes	Yes

Regression Discontinuity Designs: Exam Schools

FIGURE 4.6
Enrollment at BLS

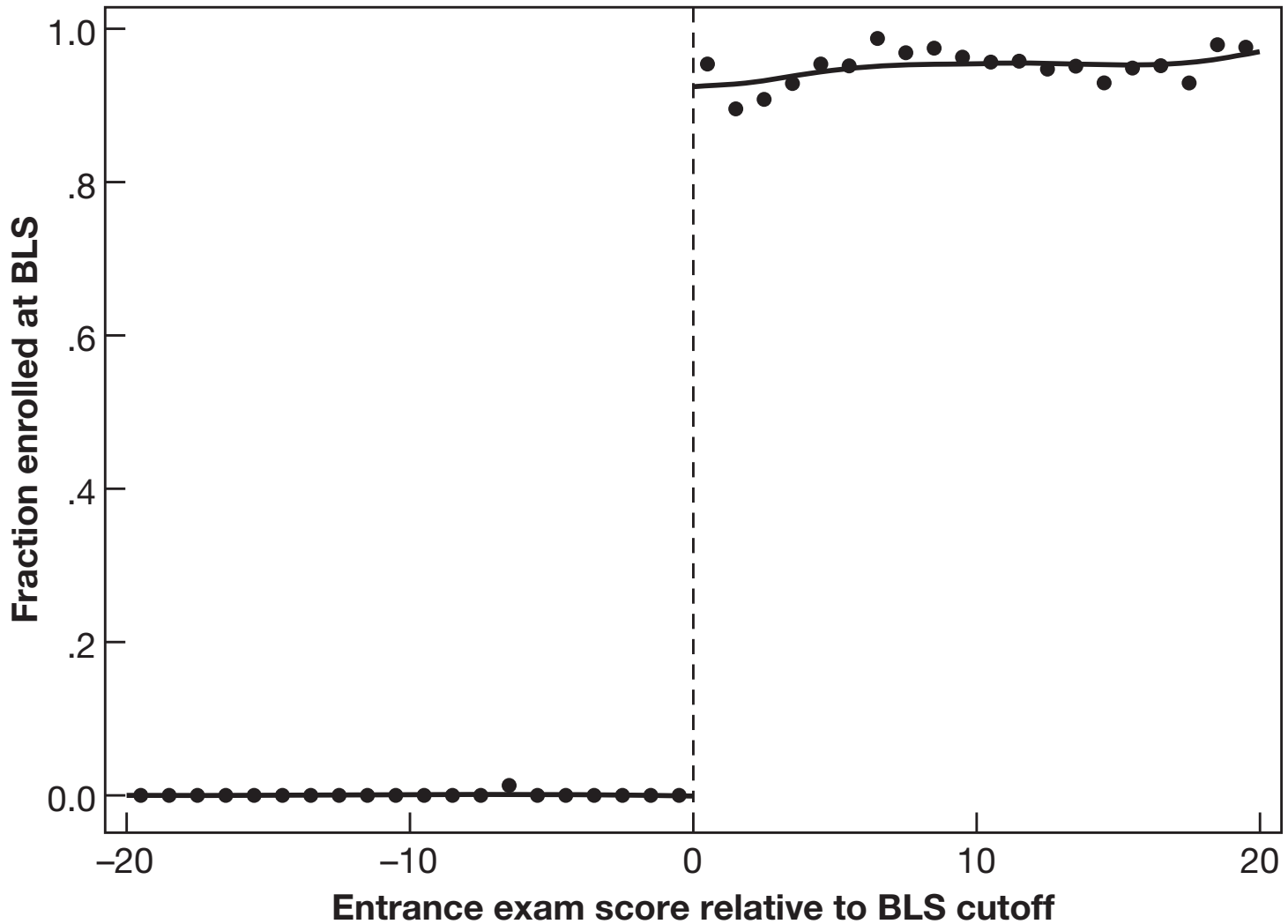


FIGURE 4.8
Peer quality around the BLS cutoff

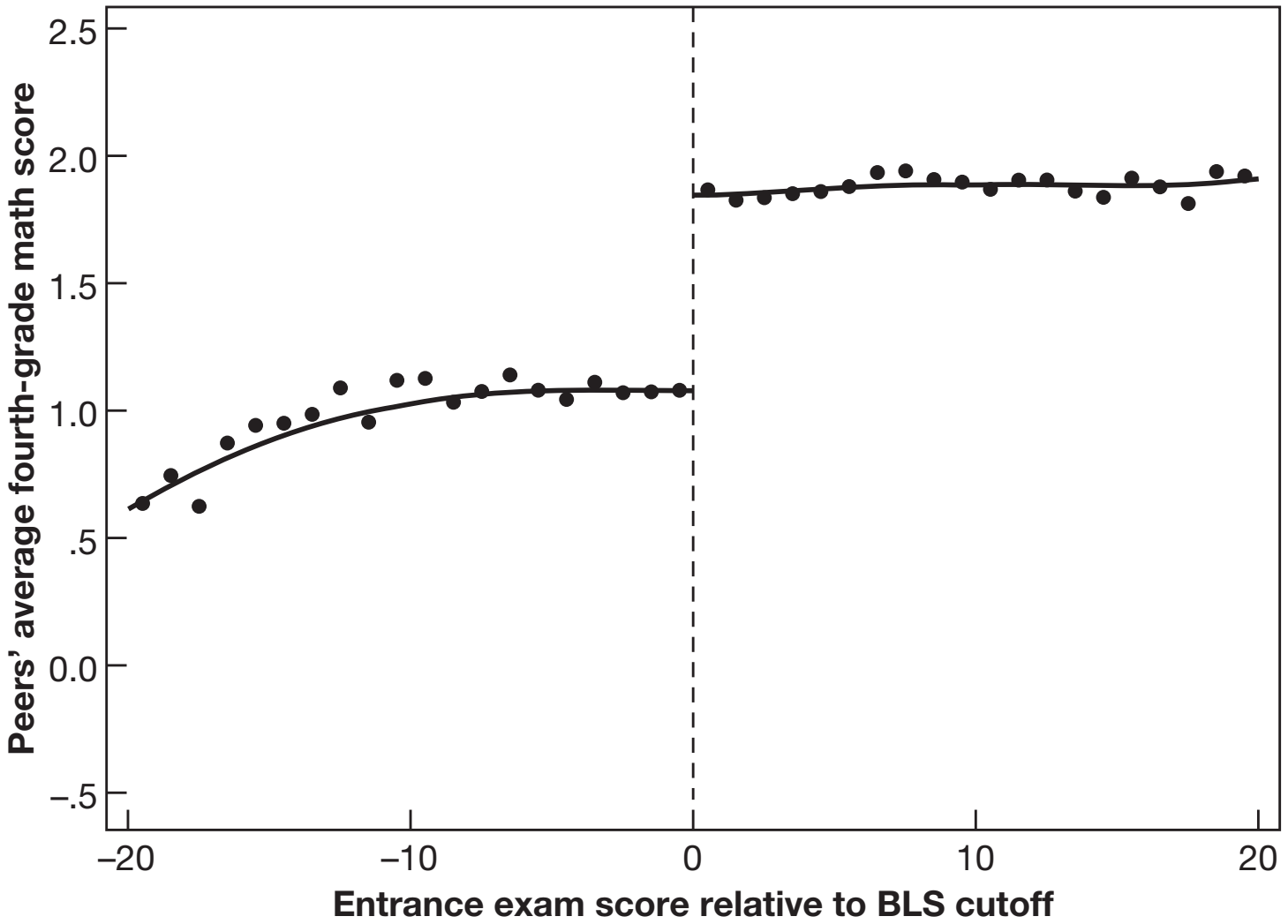
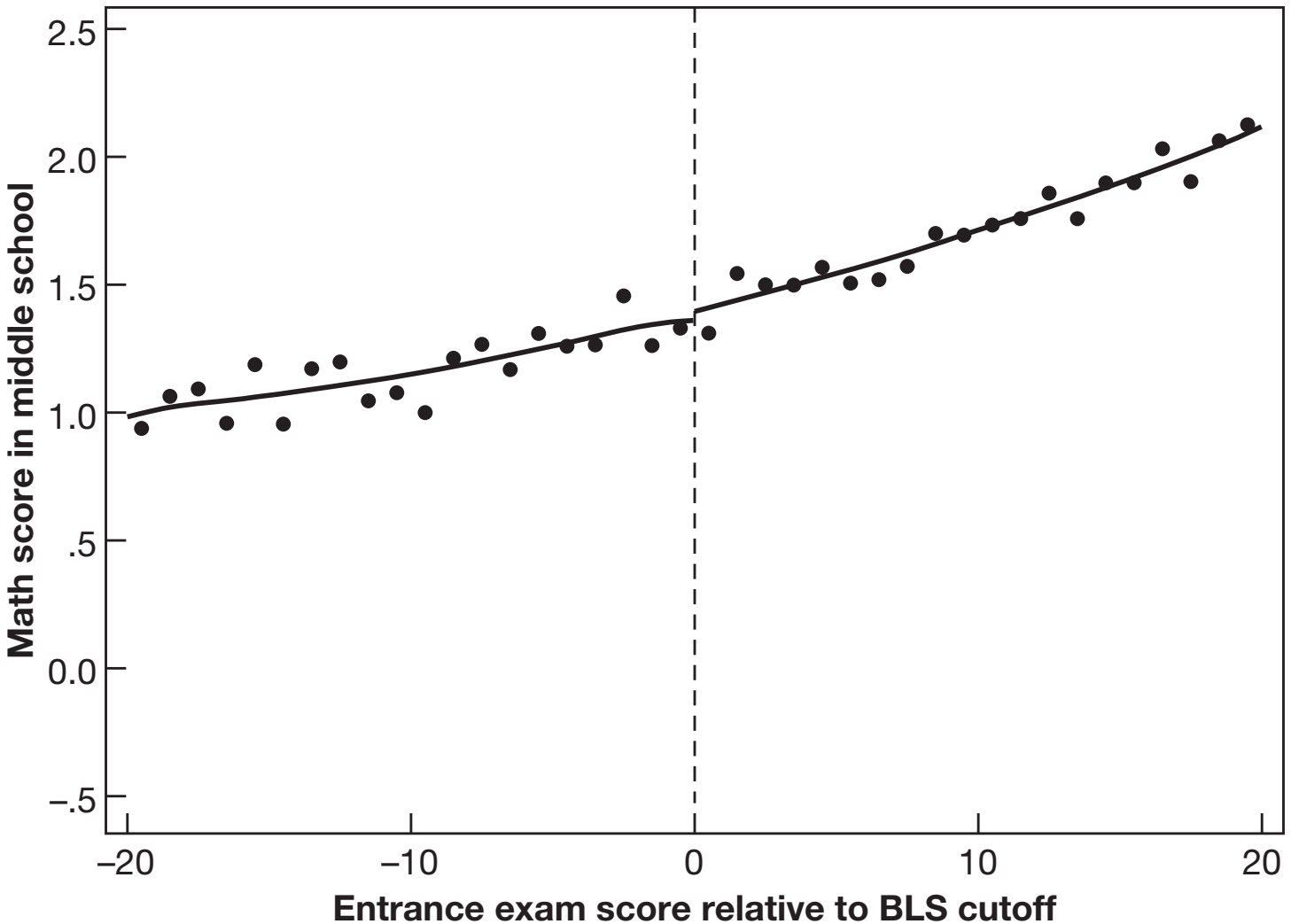
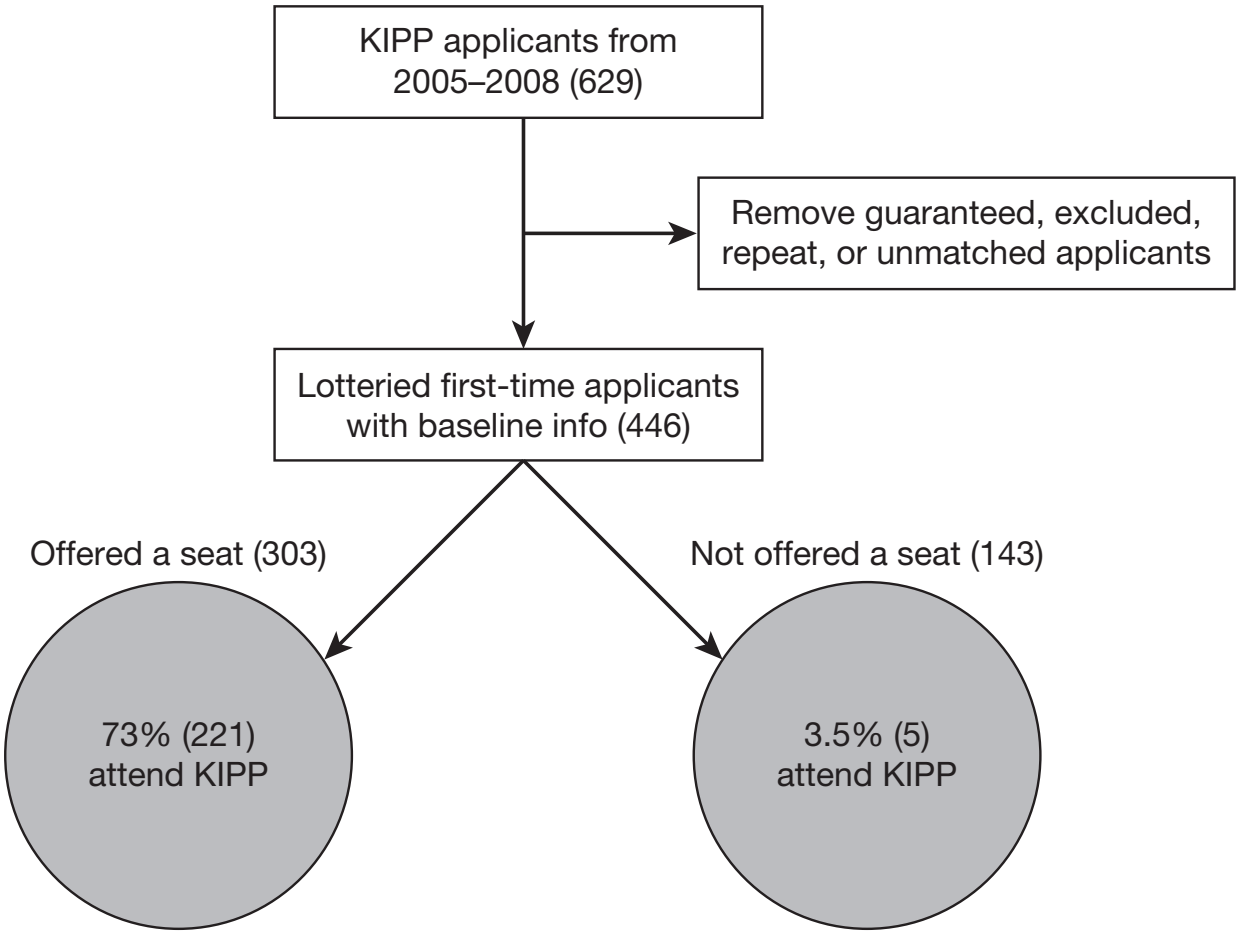


FIGURE 4.9
Math scores around the BLS cutoff



Charter School Applicants Play the Lottery

FIGURE 3.1
Application and enrollment data from KIPP Lynn lotteries



Note: Numbers of Knowledge Is Power Program (KIPP) applicants are shown in parentheses.

Lottery Balance

TABLE 3.1
Analysis of KIPP lotteries

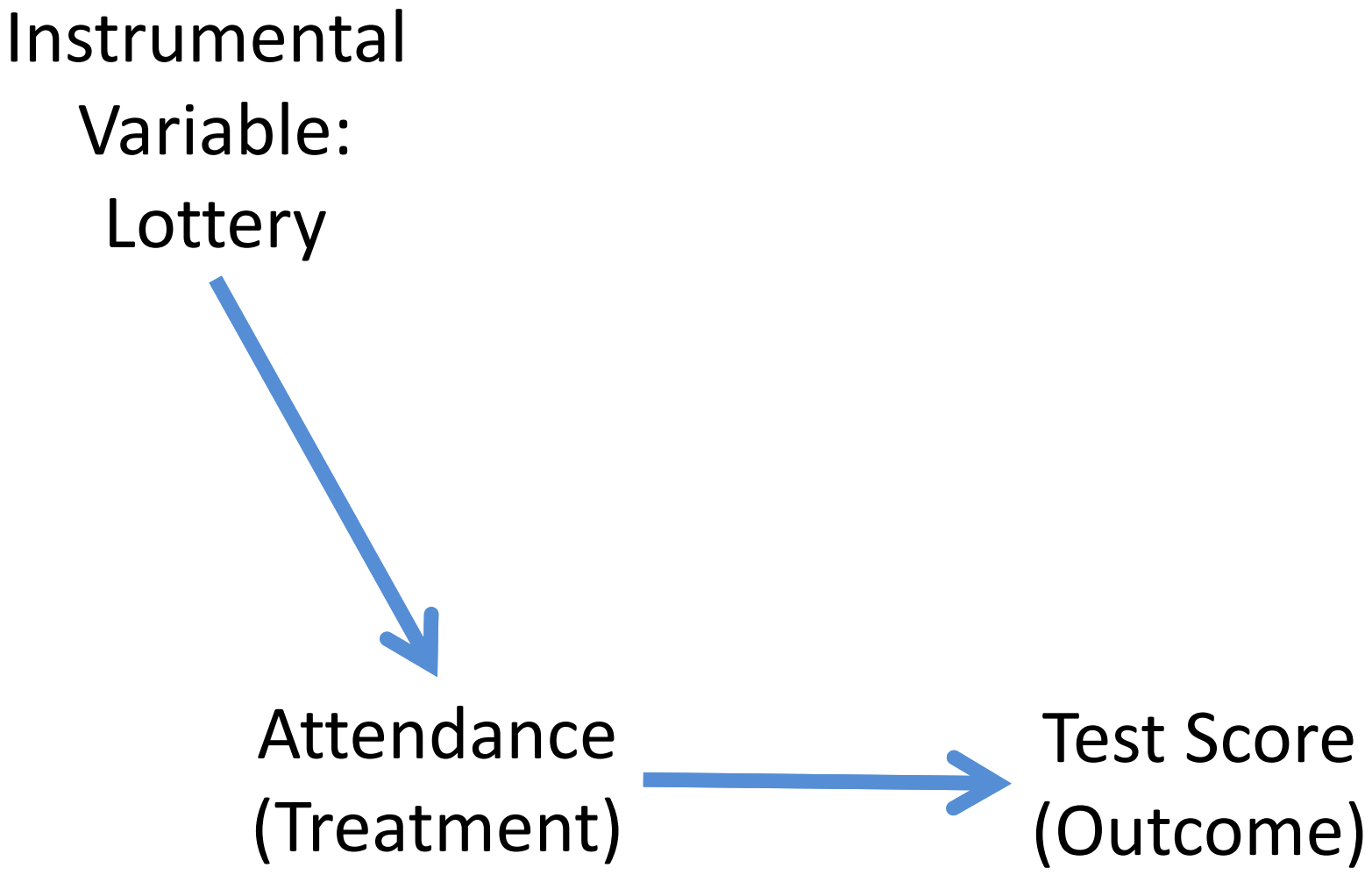
		KIPP applicants			
	Lynn public fifth graders (1)	KIPP Lynn lottery winners (2)	Winners vs. losers (3)	Attended KIPP (4)	Attended KIPP vs. others (5)
Panel A. Baseline characteristics					
Baseline (4th grade) math score	−.307	−.290	.102	−.289	.069
			(.120)		(.109)
Baseline (4th grade) verbal score	−.356	−.386	.063	−.368	.088
			(.125)		(.114)

Lottery Outcomes

TABLE 3.1
Analysis of KIPP lotteries

		KIPP applicants			
	Lynn public fifth graders (1)	KIPP Lynn lottery winners (2)	Winners vs. losers (3)	Attended KIPP (4)	Attended KIPP vs. others (5)
Panel B. Outcomes					
Attended KIPP	.000	.787	.741 (.037)	1.000	1.000 —
Math score	−.363	−.003	.355 (.115)	.095	.467 (.103)
Verbal score	−.417	−.262	.113 (.122)	−.211	.211 (.109)
Sample size	3,964	253	371	204	371

The IV Chain Reaction



The IV Chain as Algebra

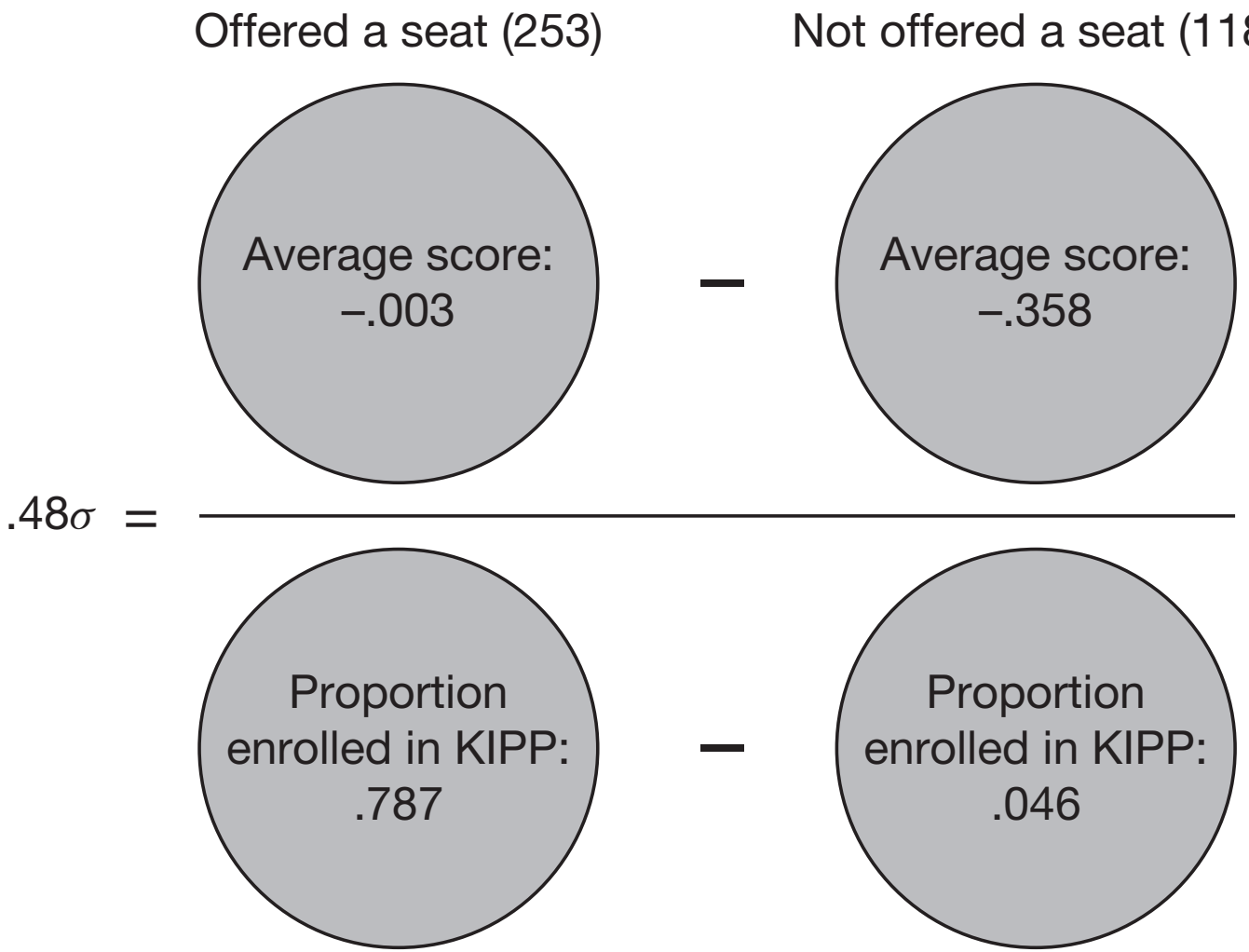
$$\text{Effect of offers on scores} = \{\text{Effect of offers on attendance}\} \times \{\text{Effect of attendance on scores}\}$$

Rearrange this

$$\text{Effect of attendance on scores} = \frac{\{\text{Effect of offers on scores}\}}{\{\text{Effect of offers on attendance}\}}$$

For Whom the School Bell Really Does Toll

FIGURE 3.2
IV in school: the effect of KIPP attendance on math scores



"We Bank on the South"

- Caldwell and Company, based in Nashville, Tennessee, was the largest banking chain in the US South in the 1920s.
- In November 1930, Caldwell faltered due to a combination of corruption, mismanagement, drought, and the economic slump of the Great Depression.
- The Caldwell demise precipitated a bank run in Mississippi in December 1930. Following a slow drain on deposits at first, five banks closed on 19 and 20 December. A banking panic started with 29 banks folding during the next six months.

How Should Central Banks React to Banking Panics?

Two views of how a central bank should behave when faced with a banking crisis:

- **Act as a lender of last resort to the banks:** Withdrawals drain cash assets from the banks. Nobody wants to be the last to get their money out, a bank run feeds on itself. In order to continue operating, the banks will have to liquidate their liabilities, withdrawing credit from the economy or other banks. A vicious circle ensues, where one bank's troubles spill over on others and the real economy.
- **Do nothing or even withdraw credit from banks:** Who says a crisis is just a liquidity crisis? The real economy was doing poorly during the Great Depression, and many bank loans may therefore have gone bad. Injecting more liquidity into banks simply amounts to throwing good money after bad. It also absolves bank managers from potentially poor decisions they made in the past, and possibly encourages more profligate behaviour in the future.

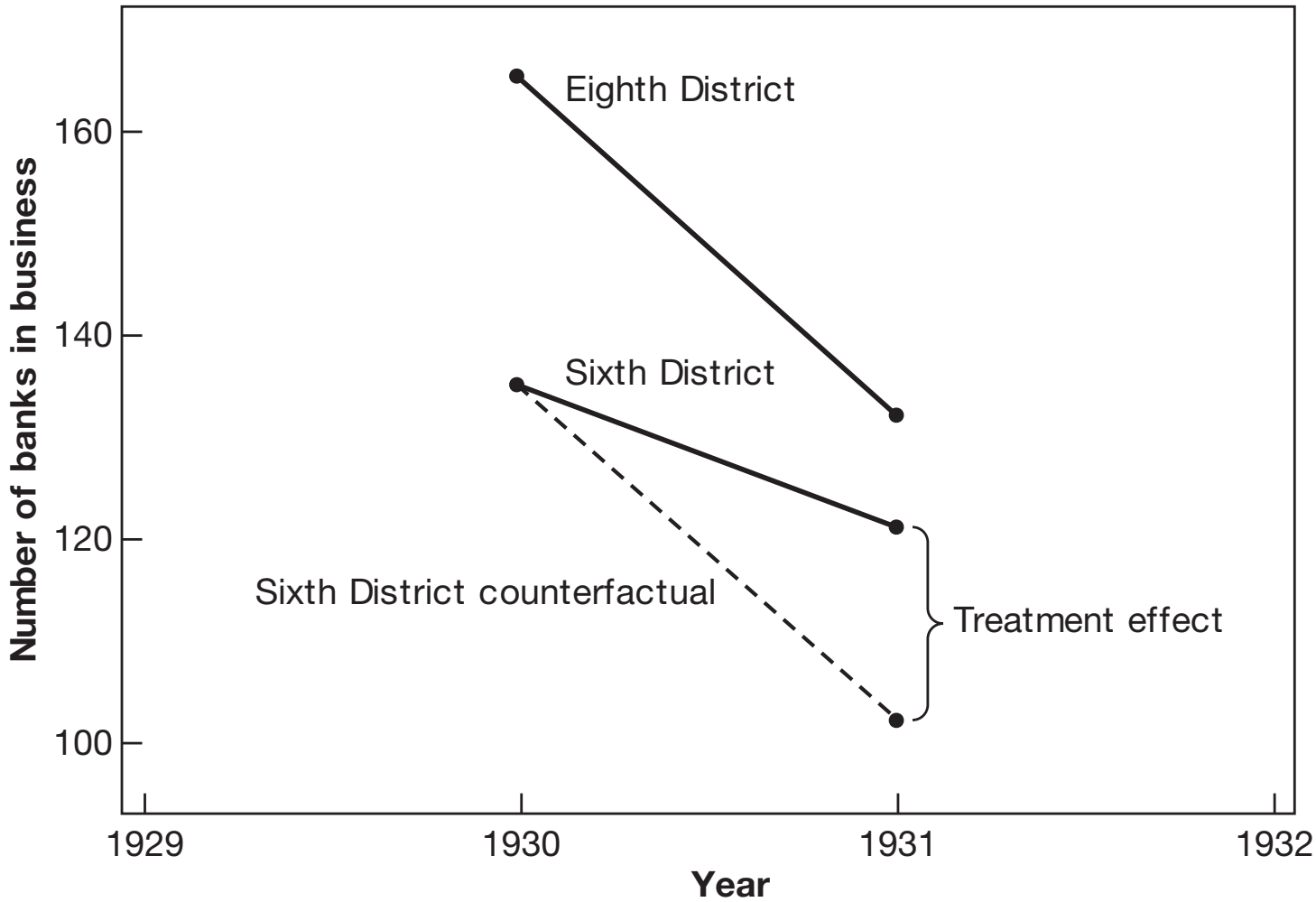
A Mississippi Experiment

Who is right? The Mississippi banking crisis of 1930/31 provides an experiment:

- The US Federal Reserve System (the central bank) is organised into 12 districts, operating with a lot of autonomy during the period of the Great Depression.
  - The Atlanta Fed, running the 6th District, favoured lending to troubled banks. Within four weeks of Caldwell's collapse, the Atlanta Fed increased bank lending by about 40%.
  - The St. Louis Fed, running the 8th District, behaved according to the Real Bills Doctrine, mandating that the central bank should restrict credit in a recession. Bank lending by the St. Louis Fed fell almost 10% during the Caldwell crisis.
- The border between the 6th and 8th district ran smack through the middle of the state of Mississippi.

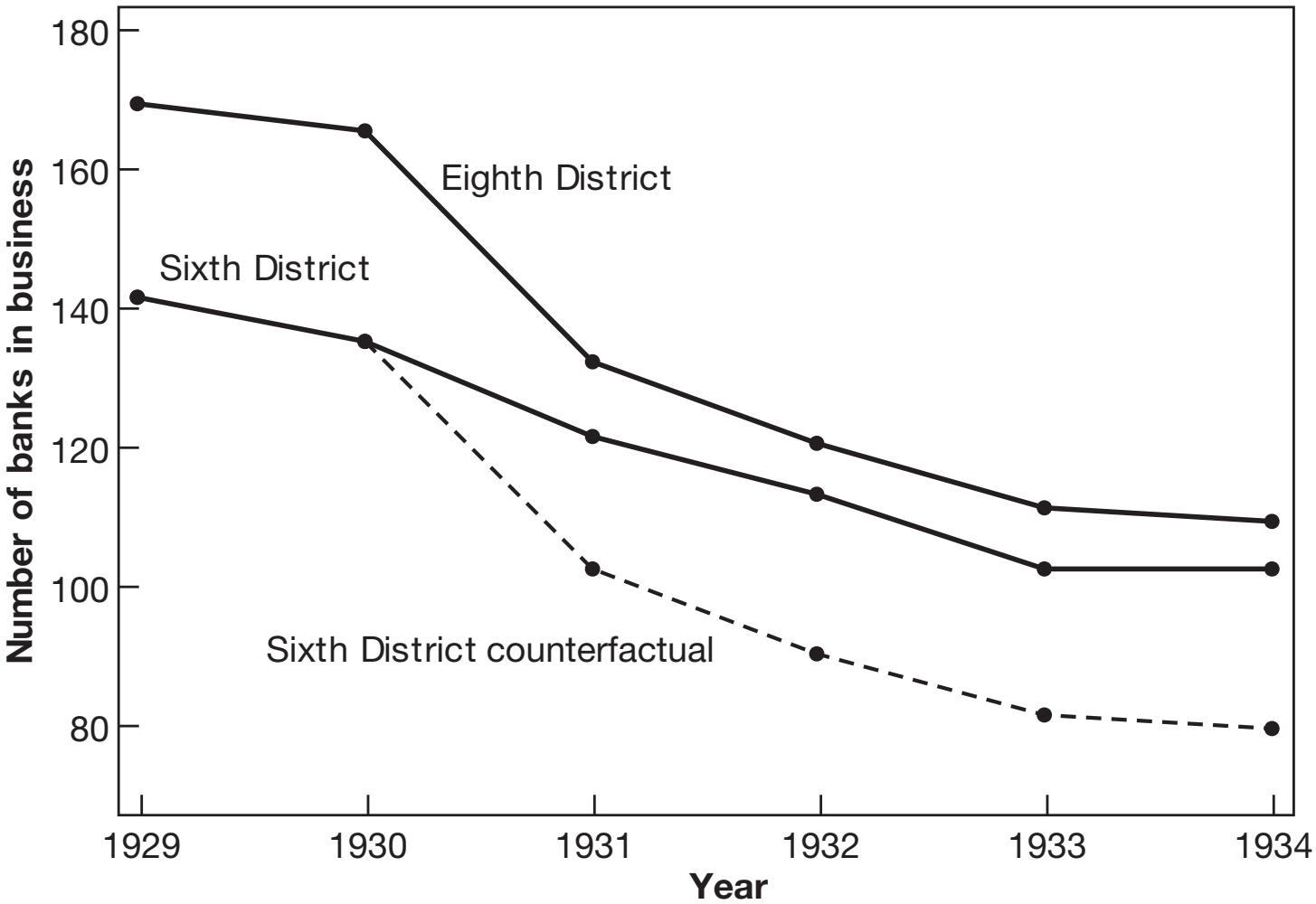
The Differences-in-Differences Design

FIGURE 5.1
Bank failures in the Sixth and Eighth Federal Reserve Districts



Common Trends

FIGURE 5.3
Trends in bank failures in the Sixth and Eighth Federal Reserve Districts, and the Sixth District's DD counterfactual



Lessons Learned

- Causal confusion abounds: naive scholars, dogmatic do-gooders, and interested parties weave evocative tales around plausible theories
  - In matters of medicine, nutrition, education, and economic policy: *caveat emptor*!
- Masterful 'metrics puts social, economic, and business policy on a firm evidence-based foundation
  - Success is rarely decisive, yet evidence accumulates
    - Monetary policy and *No Excuses* charter schools matter
    - No less important, many promising interventions–regular breakfast and elite schools–do not
- Master's wield 'metrics tools effectively with the help of clear thinking, but fruitful application does not demand extraordinary mathematical sophistication

You Can Master 'Metrics Too!