

# AEA CONTINUING EDUCATION PROGRAM



## HEALTH ECONOMICS JONATHAN GRUBER, MIT

JANUARY 5-7, 2015

# Health Care in the U.S.: The Demand Side

Jonathan Gruber

AEA Continuing Education

# Insurance Coverage in the U.S. - Background

■ **TABLE 15-1**

## Americans' Source of Health Insurance Coverage, 2010

	People (millions)	Percentage of Population
Total population	301.5	100.0%
<i>Private</i>	201.0	64.0%
Employment-based	176.3	55.3%
Direct purchase	26.8	9.8%
<i>Public</i>	87.4	31.0%
Medicare	43.0	14.5%
Medicaid	42.6	15.9%
TRICARE/CHAMPVA	11.6	4.2%
<i>Uninsured</i>	46.3	16.3%

Source: U.S. Census Bureau. Income, Poverty, and Health Insurance Coverage in the United States: 2010. U.S. Government Printing Office, Washington, DC, 2011.

# Why is Most Private Insurance from Employers?

- Risk pooling and Economies of Scale
  - 99% of firms > 200 employees offer
  - 48% of firms <10 employees offer
- Tax-subsidy to employer-provided insurance
  - \$250 billion in foregone income/payroll tax
  - Subsidy to employees, not employers
- (Pre-ACA) Failure in non-group insurance market
  - Pre-existing conditions exclusions & rejection
    - Hendren: Can be optimal if private info correlated with costs
  - Risk rating
  - Experience rating
  - No dynamic insurance



# Medicare

- Insurance for post 65 (85%) and disabled (15%)
- Payroll tax of 1.45% each on employer/employee (uncapped)
- Ten year work requirement
- Part A: Hospital & LTC
  - Financed by payroll tax
  - Deductible for first 60 days & more thereafter
- Part B: Docs & outpatient
  - Voluntary – 25% of costs enrollee premium, rest from general revenues
  - Small deductible but uncapped coinsurance
- Part D: Drugs (since 2006)
  - Variety of plan designs & premiums – about 75% general revenues

# Medicaid

- Really two programs, administered by state
  - Variation in eligibility (lots), provider reimbursement (lots), benefits (little)
- First is for low income families
  - Very low income families
  - Pregnant women & kids up to 200% FPL or higher
  - (if state expands Medicaid) all up to 138% FPL
  - Free, comprehensive insurance
- Second is for low income elderly & disabled
  - Wraps around Medicare to cover cost sharing
  - Covers long term care costs
- 2/3 of folks in first, but only ¼ of costs

# Uninsured

- Why uninsured
  - Insurance market failure (selection & administrative costs)
  - Strategic underinsurance - EMTALA
  - Irrational underinsurance
    - Little empirical decomposition
- Why do we care?
  - Externalities: physical (small) & financial (large - \$50+ billion)
    - Decomposition/measurement of financial externalities
  - Inefficiencies of care delivery
  - Paternalism
  - Job lock & labor market efficiencies

# Labor market impacts of health insurance

- $U(\text{consumption, health insurance})$
- Two jobs:  $MP_1 > MP_2$
- Health insurance premium  $p$
- $U(MP_1 - p, 1) ?? U(MP_2, 0)$
- Existing evidence – Gruber & Madrian overview paper
  - Sizeable reduction in job to job mobility (25%)
  - Mixed evidence on entrepreneurship
  - Enormous increase in retirement
  - Welfare implications?
    - Interaction with completeness of insurance market

# The Health Insurance Problem

- Standard social insurance tradeoff
- Benefits of more generous insurance
  - Primary: better consumption smoothing
  - Secondary: better health
- Costs of more generous insurance
  - Ex-ante moral hazard (e.g. safety)
  - Ex-post moral hazard (e.g. overuse)

# Consumption Smoothing Benefits (I)

- Finkelstein & McKnight – introduction of Medicare
  - Use pre-existing variation in insurance coverage before 1965
  - 40% decline in OOP spending for top quartile
  - Input into expected utility function
  - Suggests welfare gains from risk reduction = 40% of program costs
- Engelhardt & Gruber – Introduction of Medicare Part D
  - Little impact on oop spending on average
  - Large reduction in tails
  - Argue that welfare gains equal to DWL of financing program

# Consumption Smoothing Benefits (II)

- Baicker, Finkelstein et al. – Oregon Health Insurance Experiment
  - Randomized lottery of 100,000 folks to 10,000 slots
  - Survey & administrative data for 12,000 treatments & controls
  - Lots of slippage due to takeup & dynamics of insurance
- Sizeable consumption smoothing effects
  - 35% decline in odds of any OOP medical expense (remember: very poor)
  - Significant decline in collection agency activity for medical debt
  - 40% decline in having to borrow money/skip paying bills for medical costs

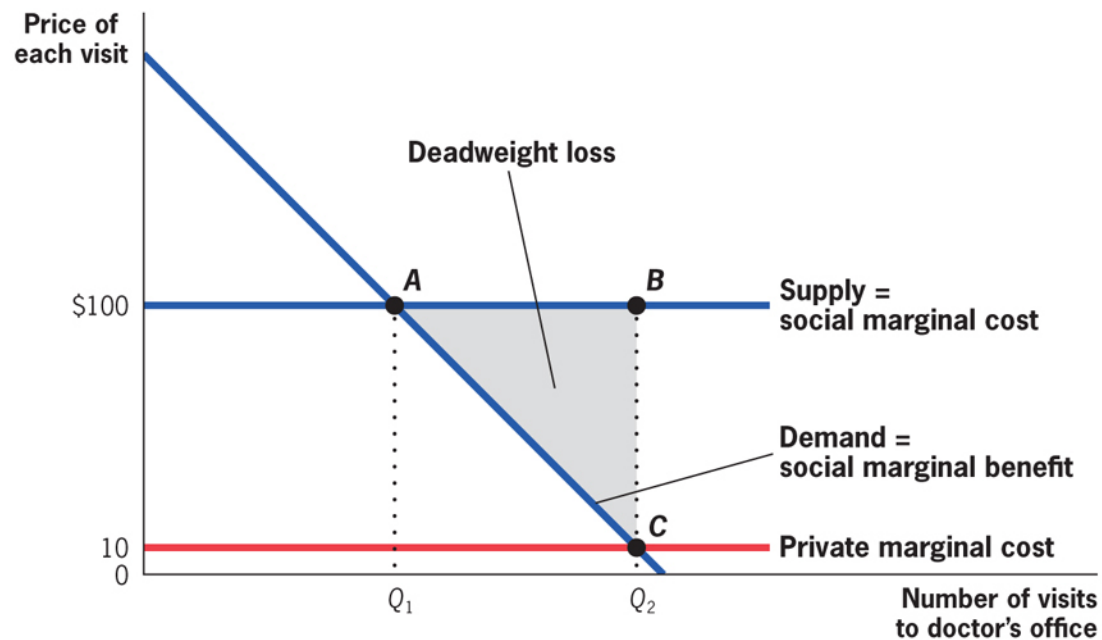
# Ex-ante Moral Hazard

- Very little evidence on this front
- Spenchuck (2012) – expansion of HI in Mexico leads to reduced preventive care
  - Hard to distinguish ex-ante moral hazard from capacity constraints
- OHIE – no impact of health insurance on risky behaviors like smoking and drinking
  - Huge increase in preventive care
  - But this could be price effect
- Bottom line: no evidence that this is significant issue



# Ex-Post Moral Hazard

■ FIGURE 15-3



**Patient-Side Moral Hazard** • With no insurance, at a cost of \$100 per visit, individuals would consume  $Q_1$  doctor's office visits, where marginal costs and benefits are equal. With only a \$10 copayment, however, individuals consume  $Q_2$  worth of visits, where private marginal costs equal social marginal benefit; this overconsumption of health care leads to a deadweight loss of ABC.

# Ex-Post Moral Hazard – RAND HIE (I)

- RAND Health Insurance Experiment
  - Began in 1974
  - 2000 families across 6 locations
  - Randomized into five health insurance options
    - Free Care
    - Three varying coinsurance rates
    - Individual deductible for outpatient care only

**Table 1: Summary of RAND HIE Findings**  
**Sample Means for Annual Use of Medical Services Per Capita, By Plan**  
 (standard errors in parentheses)

	Free Care	25%	50%	95%	Individual Deductible
Probability of Any Medical (%)	86.8 (0.82)	78.8 (1.38)	77.2 (2.26)	67.7 (1.76)	72.3 (1.54)
Face-to-Face Visits (#)	4.55 (0.17)	3.33 (0.19)	3.03 (0.22)	2.73 (0.18)	3.02 (0.17)
Outpatient Expenditures (1984 \$)	340 (10.9)	260 (14.7)	224 (16.8)	203 (12.0)	235 (11.9)
Probability of Any Inpatient Admissions (%)	10.3 (0.45)	8.4 (0.61)	7.2 (0.77)	7.9 (0.55)	9.6 (0.55)
Total Admissions (#)	0.128 (0.0070)	0.105 (0.0090)	0.092 (0.0116)	0.099 (0.0078)	0.115 (0.0076)
Inpatient Expenditures (1984 \$)	409 (32.0)	373 (43.1)	450 (139)	315 (36.7)	373 (41.5)
Total Expenditures (1984 \$)	749 (38.7)	634 (52.8)	674 (143.5)	518 (44.8)	608 (46.0)

# Ex-Post Moral Hazard – RAND HIE (III)

- Other interesting lessons from RAND HIE
- No evidence for offsets
  - Inpatient utilization lower with outpatient deductible
- Relatively consistent (percentage) impacts across services
- Reduction in both “appropriate” and “inappropriate” care
  - In particular, immunizations & pap smears reduced
- But also criticism
  - Finkelstein: linear elasticity not well identified with dynamic structure
  - Suggests that need structural simulations to estimate impact on spending

# Ex-Post Moral Hazard – Post HIE

- HIE remains the gold standard – but others have confirmed
- Subsequent studies of outpatient care find similar elasticities
- Large volume of studies on prescription drug elasticity – wider range, some higher elasticities
  - Part D response implies fairly high elasticity
- Chandra et al. first to look at elderly
  - Similar elasticities to RAND
  - But do find offset effects
    - Concentrated in chronically ill – 50% plus for this population

# Impacts of Insurance on Health

- Two overview issues
- Measurement of health is a challenge
  - Best possible measure: mortality
  - Self-reported is correlated
    - But need to worry about information effect
  - Lab testing is expensive
  - Process measures mix moral hazard & outcomes
- Need to distinguish here marginal impacts of more generous insurance from broader impacts of being insured

# Health Insurance Generosity and Health

- Starting point is RAND HIE
- No impacts on health (within standard errors)
- Suggestion of impacts for low income/chronically ill
  - Only one measure, not highly significant
- Very little work since due to data limitations
  - Chandra et al.: offset effect for chronically ill may suggest worse health

# Health Insurance Coverage and Health (I)

- Observational literature suffers from selection problems
- Quasi-experiments show consistently large effects
  - Lurie et al.: removal of public insurance in CA in 1980s – higher blood pressure
  - Hanratty: expansion of public insurance in Canada in 1960s – 4% decline in infant mortality
- Currie & Gruber: Medicaid expansions of the 1980s
  - Variation by state/year/age – complicated function of demographics
  - Create “simulated instrument” to parameterize
  - Strong reductions in newborn/child mortality
- Somers et al.: Massachusetts reform
  - Compare to other states, and focus on target groups
  - Sizable reductions in mortality – one death saved per 800 covered

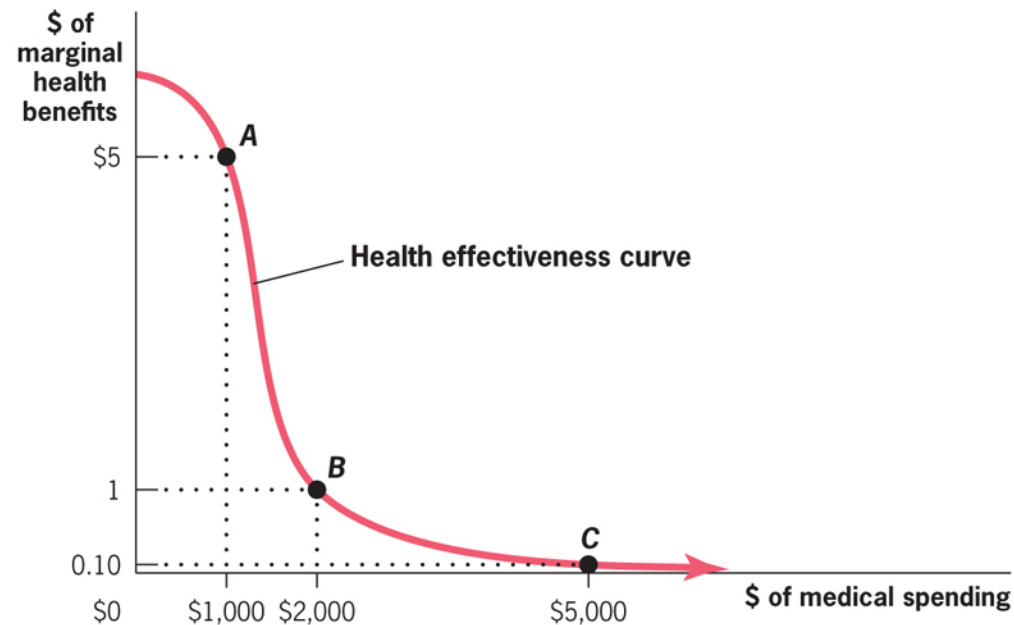


# Health Insurance Coverage and Health (II)

- Oregon experiment considers wider variety of outcomes – and has more mixed results
  - No significant impacts on physical health measures in near term
  - Enormous effects on mental health – 30% reduction in depression
  - Large effects on self-reported health – mostly mental
- Why contrast with quasi-experiments?
  - Power: confidence intervals include clinically relevant values
    - But then so do confidence intervals for RAND HIE
  - General equilibrium/treatment style effects

# Suggests “Flat of the Curve”

■ **FIGURE 15-4**

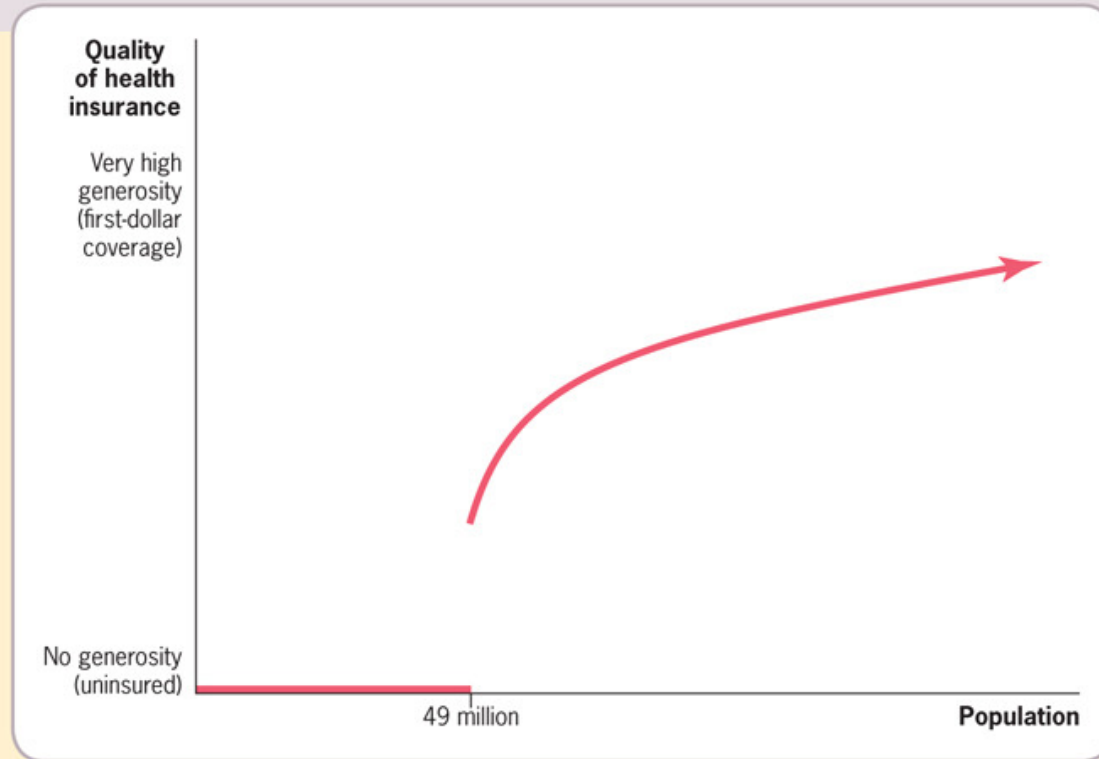


**The “Flat of the Curve”** • Spending on health care is assumed to initially be very productive in terms of improved health care outcomes, but that productivity dwindles as spending rises. The curve shows the value of improved health for each dollar in medical spending. At point A, when individuals are spending \$1,000 on health care, each dollar of medical spending buys \$5 worth of improved health; at point B, when individuals are spending \$2,000 on health care, each dollar of medical spending buys \$1 worth of improved health. Beyond point B, however, there is much less than \$1 in improved health for each \$1 in medical spending.

# Lessons for Optimal Health Insurance

- First dollar coverage is rarely optimal
  - DWL from moral hazard highest
  - Consumption smoothing benefits lowest – all comes from tails
    - Value of income-relating
    - Probably best done with OOP limits, not at level of cost-sharing.
- Exception may be for chronically ill – particularly low income
  - Suggestion from RAND HIE
  - Chandra et al. evidence
- Argument for “Value-Based Insurance Design”
  - Fendrick et al. (2001)
  - Case studies suggest value, but broader design issues await
- That’s not what HI in the U.S. looks like!

■ **FIGURE 15-5**



**The Generosity of Health Insurance in the United States** • The vertical axis in this diagram shows the generosity of health insurance, running from no insurance (uninsured) at the bottom to very generous insurance (first-dollar coverage) at the top. There are 49 million uninsured persons in the United States, who are at the bottom of this axis. The remaining persons in the United States almost all have insurance of high to very high generosity, leading to a jump upward in the curve. Why is there so little insurance of low to medium generosity in the United States, such as catastrophic coverage?

# Why “Overinsurance” in U.S.?

- Tax subsidy
  - Gruber & Lettau – elasticity of 0.7
  - But not large enough
- Access motive
  - Not all higher use is moral hazard – could be relaxing liquidity constraints
  - Hard to imagine this is important for first dollar coverage
- Behavioral motivations
  - Commitment device to have money and get care you need
  - Irrationality around tradeoffs between money & health

# Insurance for Long Term Care

- Institutional care in nursing homes: 70%, but falling
  - Medicaid is primary insurer – pays about half of costs
- Home care: 30%, but rising
  - Medicare is primary insurer through part A
- Major debate over financing
  - Individuals must “spend down” wealth before getting Medicaid
  - Happens rapidly with nursing home costs > \$60k/year
  - Crowds out savings for old age
- Small market for LTC insurance
  - Clear market failure problems & crowd out from Medicaid
    - Simulations (Brown & Finkelstein) suggest large crowd out

# Designing Health Insurance Markets

- Two issues to discuss
- First, what are the alternative structures of insurance arrangements?
- Second, how do we design systems to allow individuals choice across insurance products?

# Problem of Fee-for-Service Medicine

- Third form of moral hazard on compensation side
- Interacts with lack of patient cost sharing
- Led starting in 1980s to rapid growth of two alternatives



# Preferred Provider Organization (PPO)

- Dranove, Satterthwaite & Sindelar paper
  - Monopolistic competition in hospital market
  - PPO is middleman shopping on behalf of employer
  - Raises price elasticity of demand – lowers prices
- Rise of PPO did significantly reduce hospital prices
  - Is this lower costs or just lower rents
  - Lower costs could be converting from quantity/quality competition (“medical arms race”) to price competition
  - Evidence unclear

# Health Maintenance Organizations (HMO)

- Coordinate payment for and delivery of care
- HMO receives flat payment and bears risk
  - Prospective reimbursement model shifts the risk burden and mitigates moral hazard
- Two forms
  - Traditional HMO (Kaiser)
  - Independent Practice Organization (IPA)
- Large growth within Medicare – Medicare Advantage plan
  - Seniors given choice between traditional FFS Medicare and MA plan
  - If choose MA plan typically provides wrap around benefits

# Evidence on HMOs

- Clear evidence of selection
- Lower costs – not just selection
  - RAND HIE suggests 25% lower spending
  - Cutler, McClellan & Newhouse finds lower spending for observationally similar heart attack patients among non-elderly
    - Although effect is through pricing, not utilization intensity
  - Landon et al. look at traditional Medicare vs. MA
    - Lower utilization in MA
- No clear evidence for outcomes

# Choice in Medical Markets

- Traditionally little choice unless in a large employer
  - Small employers: single plan
  - Nongroup: discrimination could limit plan options & can't effectively shop
  - Government – monopoly
- Huge expansion in choice
  - Medicare advantage
  - Medicare Part D
  - Exchanges
  - Even choices across MMCOs for Medicaid enrollees
- And many policy arguments to go further
  - Move to “premium support” in Medicare

# Pros and Cons of Choice

- Pros come from standard econ 101
  - Competitive pressure on production efficiencies
  - Match consumer tastes
  - Duggan & Scott-Morton: Medicare Part D competitive markets lowered costs
- Cons come from imperfections in the market
  - Risk selection by insurers leads
    - Pricing inefficiency
    - Distribution across health groups
  - Confusion/choice inconsistencies

# Tradeoff: Cutler and Reber

- PPO vs. HMO at Harvard
  - Pre 1995: Harvard pays fixed share – subsidizes PPO
  - Post 1995: Defined contribution system – enrollee bears marginal cost of PPO
  - For some workers and no others
- Plan choice very elastic as price changes
- Created competitive pressure with lower premiums
- But also big selection
  - Created “death spiral” for most generous plan
- Lower premiums just a transfer to Harvard
- But market failure imposes welfare loss

# Quantifying Adverse Selection: Einav & Finkelstein

- Series of papers looking at health insurance plan variation
- Use structural model to quantify the welfare loss from adverse selection
- Key insight: Estimate slope of cost curve as plan prices change
  - Tells you whether you will get the Cutler-Reber type effect
- Find fairly small welfare losses
- Why?

# Intertia in plan choice

- Very low rates of health plan switching
  - Typically less than 10%
- Handel (2013)
  - Identify inertia by dominated choices when prices change
  - Use to identify structural model of plan choice
  - Find that adverse selection would double with no inertia
- Does this imply that inertia is good because it mitigates adverse selection?
  - Not necessarily – Polyakova job market paper – if there is negative autocorrelation in plan generosity selection can worsen with inertia



# Choice Inconsistencies – Abaluck & Gruber

- Individuals may not be choosing according to the standard model
- Medicare Part D
  - Standard benefits package (deductible, coinsurance, donut hole)
  - 90% of plans differ – more generous, priced in premium
  - Huge variety of choices – more than 50 PDPs, plus MA plans
- Reduced form fact: elders do not cost minimize/portfolio maximize
  - Add total costs: premium plus expected oop costs
    - Alternative models of expectations
  - 12% of elders choose lowest cost – can save 30% on average
  - Very few elders on efficient frontier

# Structural Model of Choice Inconsistencies

- Derive logit choice model to show rejection of standard assumptions
  - Dollar of premiums worth 4-5 times dollar of OOP costs
  - Elders value plan characteristics independent of individual effect
  - Large welfare loss from inconsistent choices
- Is there learning (recent working paper)
  - No – choices become worse over time
  - Most elders don't switch
  - Those that do switch don't do any better
  - Meanwhile choice set becomes more “dangerous”
- Structure critical here
  - Ketcham et al. argue that results consistent with some forms of preferences

# Addressing Problems with Risk Selection

- In principle, technical solutions to both of these problems
- Risk selection: use risk adjustment mechanisms – imperfect
  - $R^2$  on even best measures for total spending less than 0.33
- Cutting edge of risk adjustment in Medicare Advantage
  - Newhouse and others: has wiped out selection into MA
  - Duggan and others: plans have figured out how to game the system
  - Glazer & McGuire: need to risk adjust on individual \* illness
- Improvements, but not there yet

# Addressing Problems with Choice Inconsistencies

- First best is appropriate decision support
  - But need to overcome inertia in using the support
- Second best may be restrictions on choice set
- Massachusetts standardization experience
  - Ericson and Starc: standardization improved welfare
    - Individuals more responsive to plan characteristics
  - But small firm demand for more choice!

# Expanding Health Insurance Coverage

- Historically no appetite for single payer
  - Starr (2011): Have built a system that works for most
- Incremental approaches face problem of imperfect targeting
  - Tuna & dolphins: e.g. one-quarter of uninsured turn down ESI, but only 7% of those who turn it down are uninsured
- Leads to concern about “crowd out”
  - Not necessarily an issue for social efficiency
  - But major issue for government “bang for the buck”
    - Not just coverage per dollar – depends on who is covered
    - Dollars of coverage value per dollar of government spending

# Crowd Out Not Just for Public Insurance!

- Crowd-out is about efficiency of public spending on insurance
- Contrast with making all insurance tax deductible (e.g. treating non-group insurance like ESI)
  - Level playing field with ESI
  - But largely infra-marginal
    - Half of uninsured don't pay taxes!
  - And reduces incentive for employers to offer
    - If they drop, then more may become uninsured
  - Gain in insurance value per dollar of government expenditure small
  - But does increase horizontal equity

# Behavioral Responses – Private insurance

- What do we know about relevant behavioral responses?
- Employer offering decision price sensitivity varies (Gruber & Lettau)
  - 0.7 elasticity for small firms
  - Small or no elasticity for medium & large firms
- Takeup of ESI incomplete but not price sensitive
  - Gruber & Washington: tax deductibility for federal employees had no effect
  - Inefficient population to target with government subsidies

# Behavioral Responses – Public Insurance

- Takeup of Medicaid only partial
  - Partly because some already have insurance
  - But also large issue with non-takeup of free insurance
    - Stigma?
    - Information?
- Cutler & Gruber: 50% crowdout from Medicaid expansions
  - Smaller effects with longitudinal approach
  - Need to consider effect on families & firms & non-entry
- Takeup fairly sensitive to even small price changes



# Incremental Universalism

- Biggest innovation in Massachusetts in 2006 – “Three legged stool”
- Insurance market reforms – community rating, guaranteed issue
  - One of several states in 1990s
  - Destroyed non group market – highest in the country
- Individual mandate to purchase insurance
  - Bring healthy individuals into the pool
  - End strategic uninsurance
- Subsidies to make insurance affordable
  - Extensive subsidies to those below 300% poverty line

# Effects of MA reform

- Covered 2/3 of uninsured – uninsured rate down to 3%
- Improved non group market – rates down 50% relative to nation
- Crowd-in: Employer sponsored insurance increases
- No impact on employer premiums – rates rose at national average
- Broadly popular
- Becomes basis for ACA

# Affordable Care Act

- Insurance market reforms nationwide:
  - Just age (3:1), tobacco (1.5:1) & geography as rating factors
  - Guaranteed issue & no pre-existing conditions exclusions
- Individual mandate
  - Tax penalty rising to greater of \$695 or 2.5% income
  - exemption if very poor or cost >8% of income
- Subsidized insurance
  - Medicaid expansions for those <133% FPL
  - Tax credits for 133-400% FPL – sliding scale with income
- State/federal exchanges to improve shopping
- Wide variety of cost control steps – mostly on supply side
  - Exception is cadillac tax

# ACA – Projected Impacts

- Little impact on existing ESI & government insured
- 50-60% reduction in uninsured
- Remaining uninsured
  - Undocumented immigrants
  - Exempt from mandate
  - Pay mandate penalty
- Modest erosion of employer sponsored insurance
- 1% rise over 10 years in level of health care spending
  - Unclear growth effects
  - How much credit for current historic slowdown?

# Research Questions: Insurance Coverage

- How does insurance coverage change by ex-ante status?
- Can we distinguish subsidy vs. mandate margins?
- What about role of employers
  - Offering
  - Generosity of insurance

# Research Questions: Exchanges

- Optimal design of exchanges
  - Active vs. passive purchasing agent?
  - Role of standardization?
  - Role of decision support – how are choices made?
- Role of exchange in larger market
  - Monopoly exchange?
  - What is the role of brokers?
- Narrow network plans
  - Major source of cost savings
  - Gruber & McKnight: MA results show through more efficient utilization
  - Selection through network design?

# Research Question: Small Businesses

- Most likely to drop – assumed large in existing modeling
- But some factors which enhance
  - Tax credit
    - Tightly targeted – little takeup
  - Employee choice on the exchange
- Is there a real value proposition here?

# Research Questions: Labor Market

- Impact on job mobility
- Impact on entrepreneurship
- Impact on labor force entry/exit
  - Impact of Medicaid expansion on labor force participation
  - Mixed evidence to date
  - Effect of implicit taxes through phaseout of subsidies
- Impact on employers
  - Employment
  - Wages
  - Can we separate demand & supply side effects?



# Research Questions: Benefits of Insurance Expansion

- Effects on health
  - Differentiate private vs. public insurance
  - Differentiate impacts of more vs. less generous coverage
    - Largely endogenous but some income-related cost sharing subsidies
- Effects on financial security/consumption smoothing
- Effects on overall well-being
  - OHIE: huge rise in reported well-being
  - May be the most important benefit
- Awkward question: what is “affordable”
  - Key term in public debate about which economics has been largely silent

# Research Question: Cadillac Tax

- First attempt to address open ended ESI tax subsidy
- Incidence of cadillac tax?
- Impact on ESI Offering
- Impact on ESI Generosity
  - Cost Sharing
  - Network breadth
  - Other responses?

# Research Question: What to do about LTC?

- Existing system: essentially tax estate to pay for LTC – bias towards nursing homes
- ACA attempted to set up voluntary LTC insurance through employers
  - Huge selection issues – couldn't break even
  - CLASS Act repealed
- Could have mandatory public insurance
  - Moral hazard? Existing evidence is that it is small for nursing homes
    - Depends on how widely dollars could be used
  - Shift the burden from children to the senior
  - Savings crowd-out – better or worse?

# AEA CONTINUING EDUCATION PROGRAM



**HEALTH ECONOMICS**  
ADRIANA LLERAS-MUNNEY, UCLA

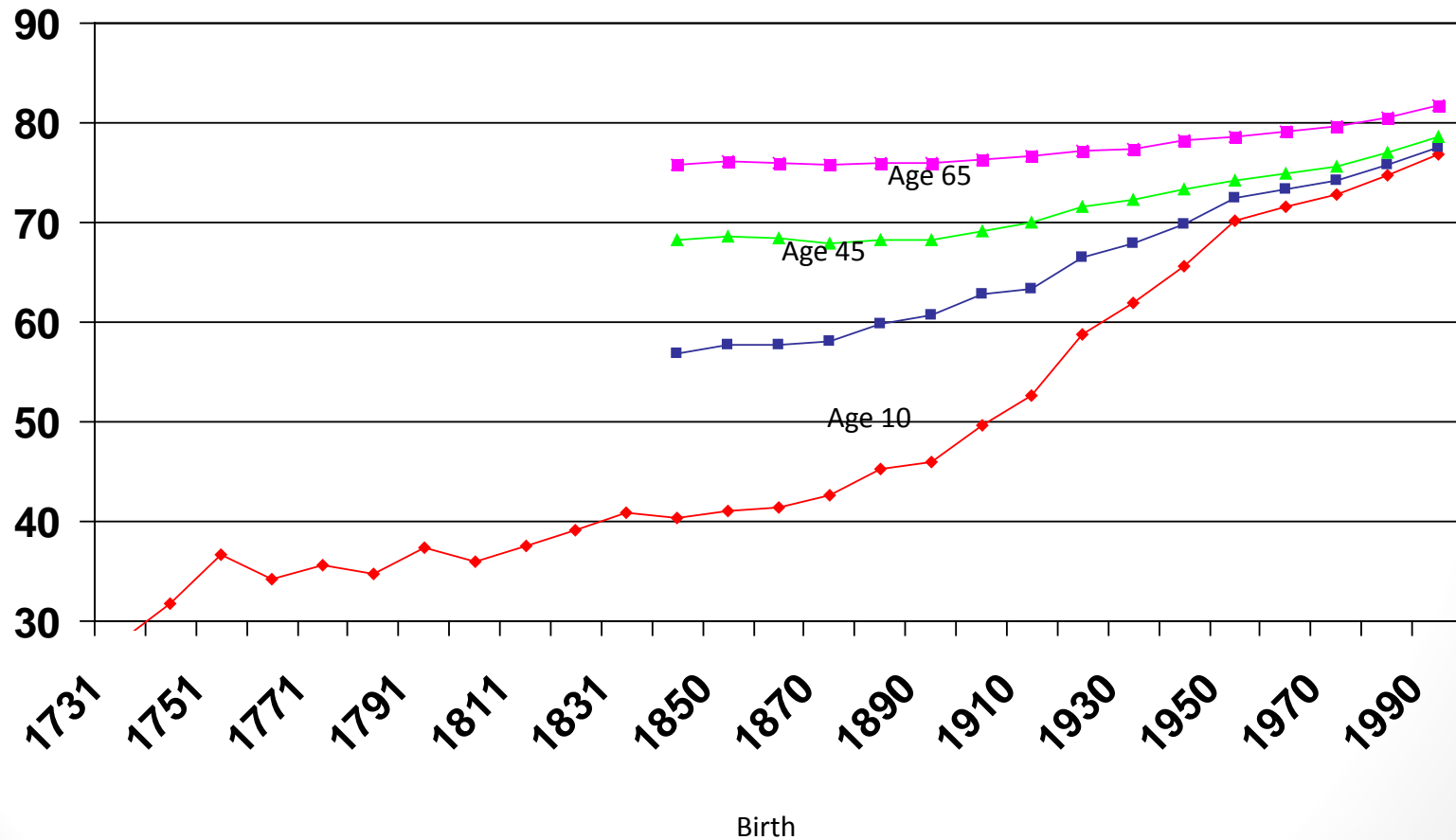
**JANUARY 5-7, 2015**

# **AEA LECTURES 2015 HEALTH AND HEALTH CARE ECONOMICS**

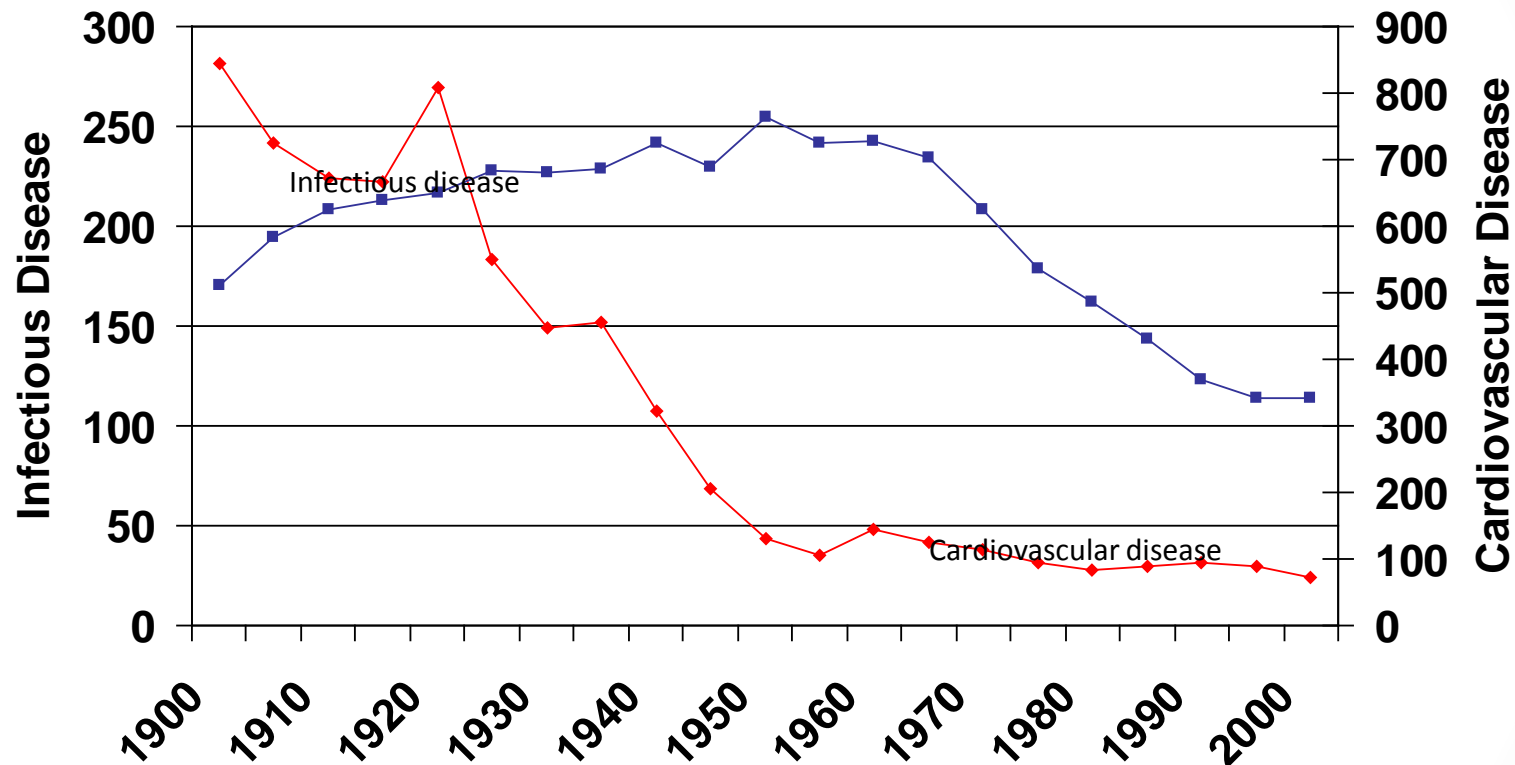
**Part I: Demographic and Socio-Economic Determinants of Health**

Adriana Lleras-Muney (UCLA)

# Huge increases in Life Expectancy



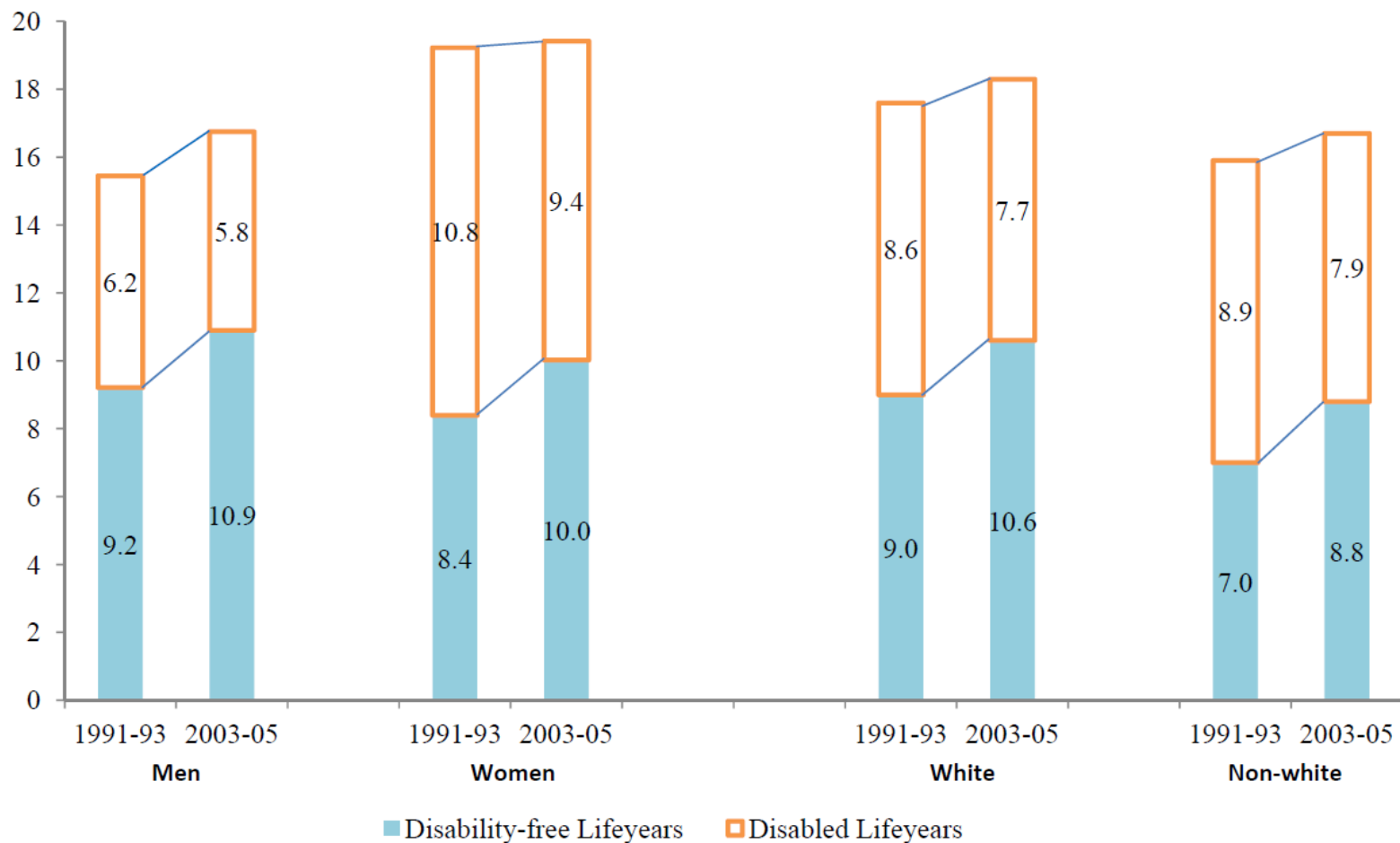
# Causes of death shifting



Today Cancer, Alzheimer.

# Quality of life also rising

Figure 15: Trend in Disabled and Disability-Free Life Expectancy at 65, by Gender and Race



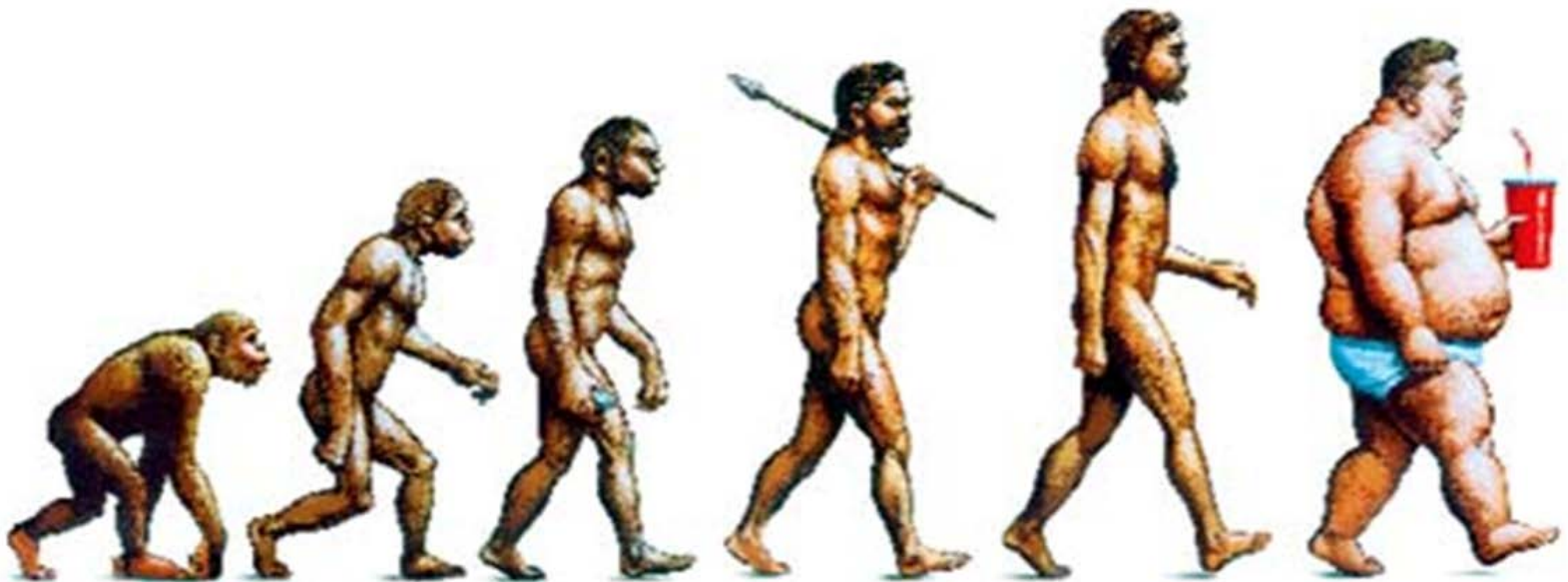


# Unequal gains

- Richer and educated countries, richer and more educated people live longer
- Women
- Large differences by race & ethnicity

Though some interesting exceptions

- Costa Rica, US
- India
- Hispanic paradox

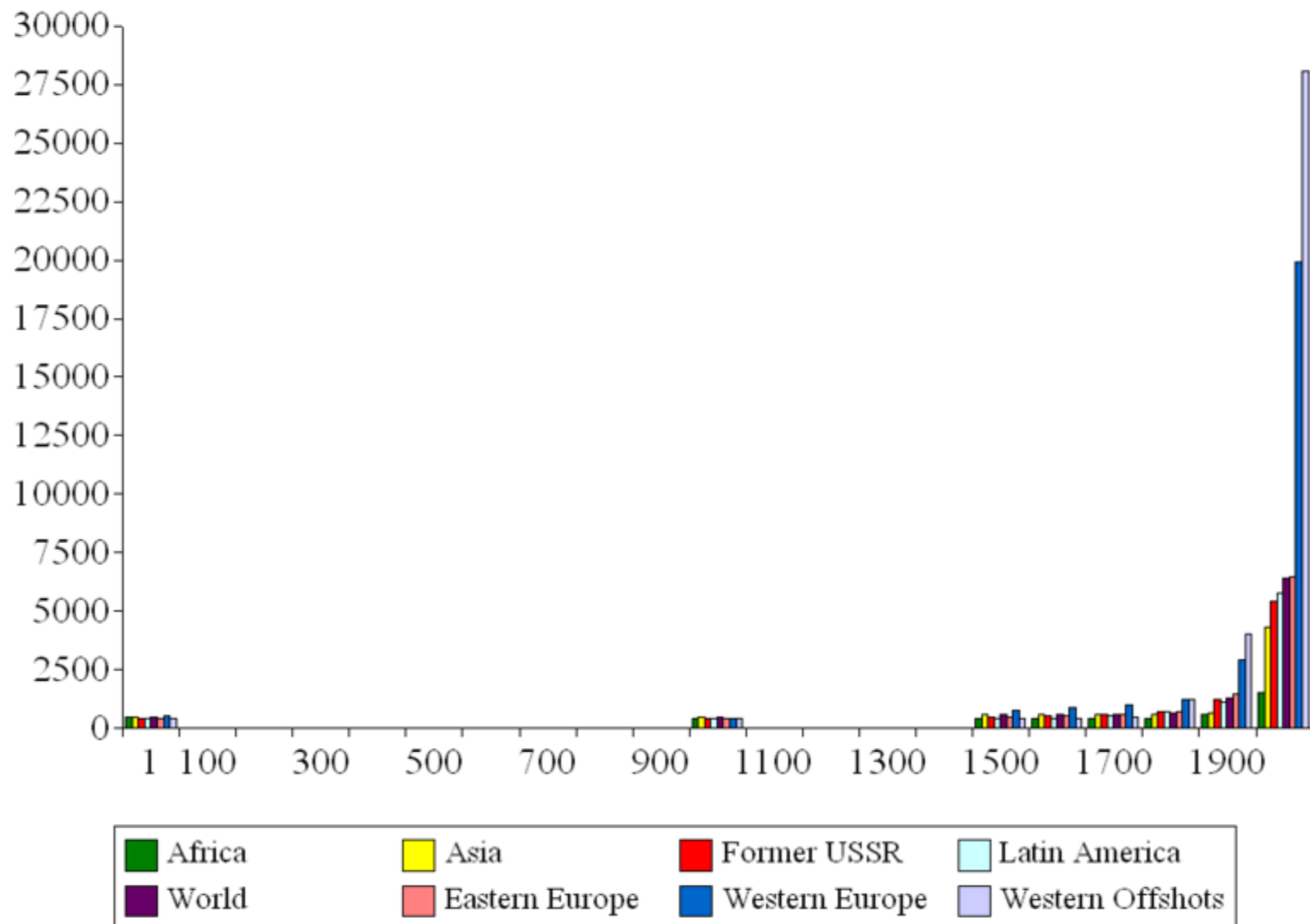


THE LONG VIEW: WHY HAS HEALTH  
INCREASED?

# Evolution of Life expectancy

• Period	Timeline	Life Expectancy
• Stone Age	5M – 10000 BC	~20
• Agricultural Age	10,000 BC – 1750 AD	~24
• Industrial Age	1750 – 1900 AD	~30-45
• Information Age	Today	~75-80

# World GDP/capita 1-2003 A.D.



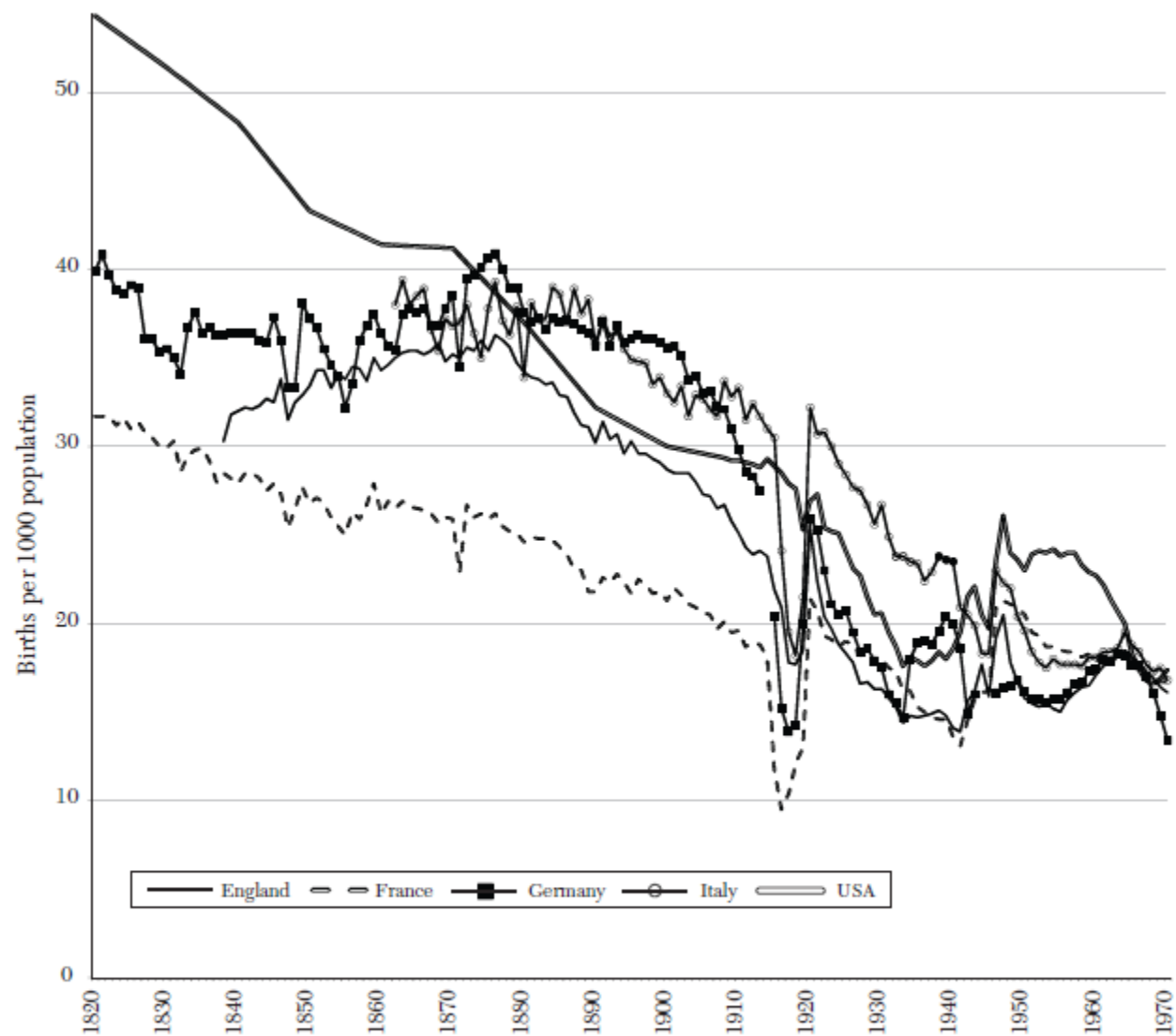
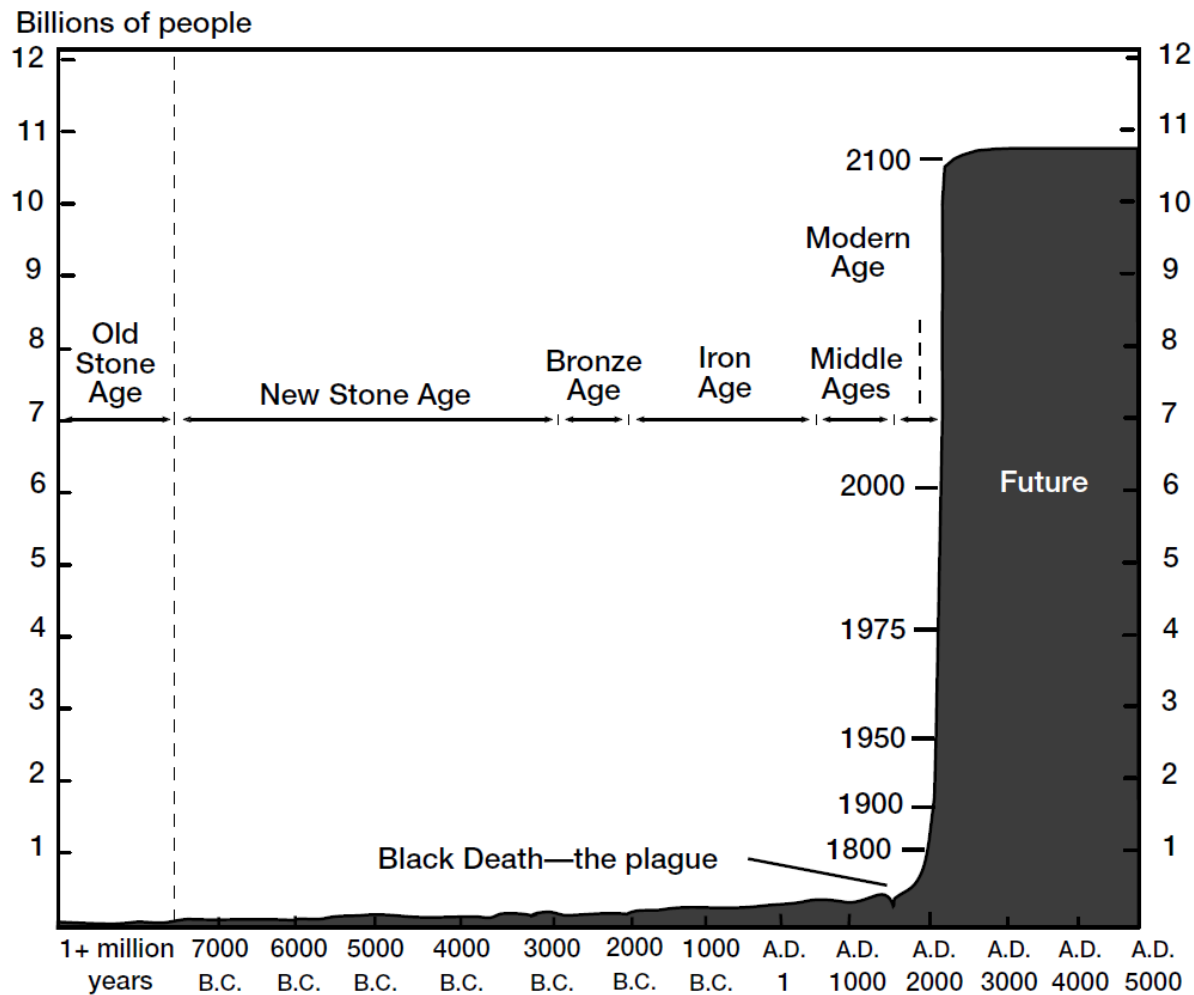


Figure 1. Crude Birth Rates, Selected Countries, 1820–1970

Note: For the United States, values before 1909 are linear interpolations between decennial census years.

Source: Crude birth rates as reported in Mitchell (1980).

## World Population Growth Through History



Sources: Population Reference Bureau; and United Nations, *World Population Projections to 2100* (1998).

# Other remarkable trends

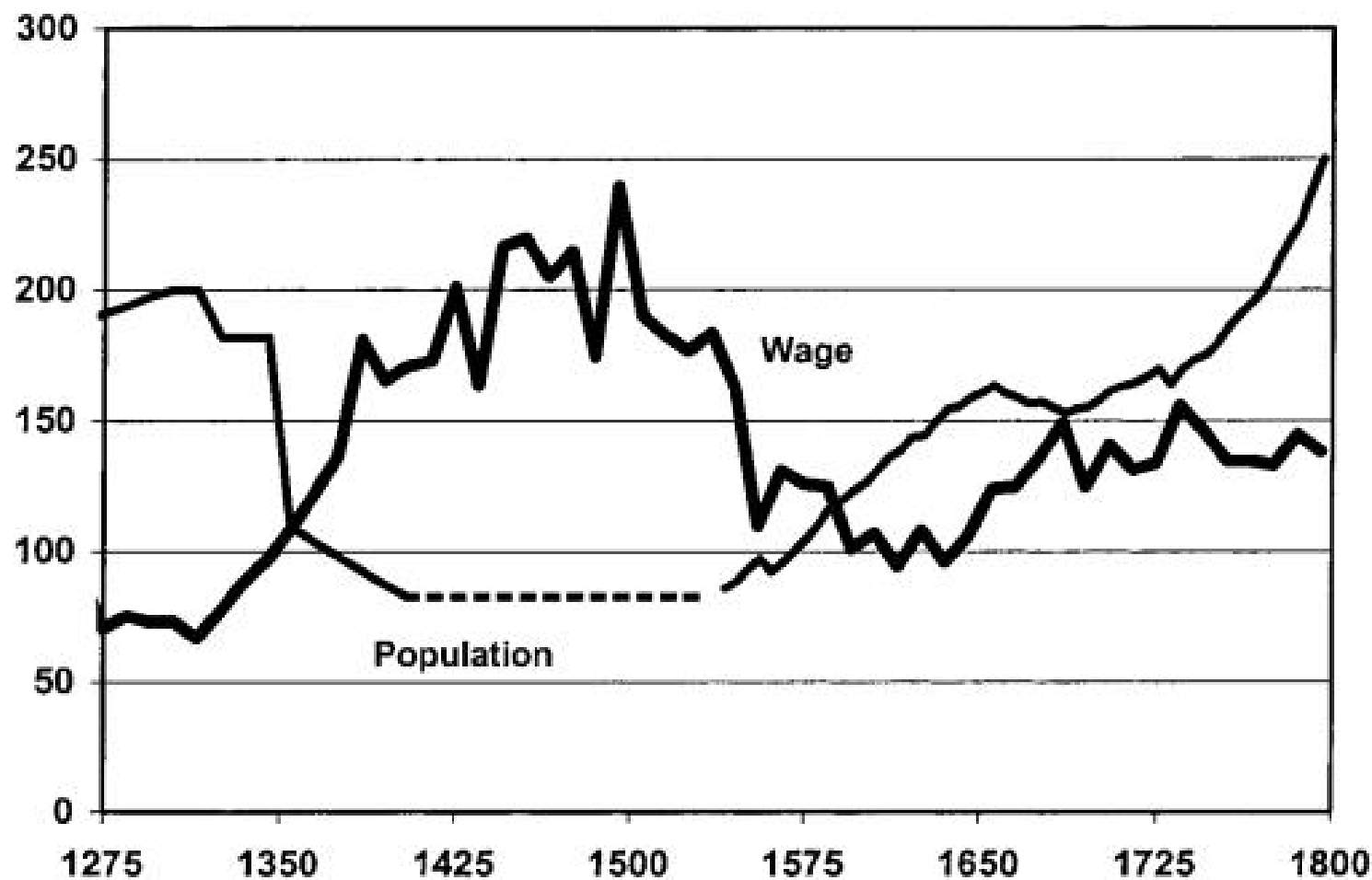
- HK measures also rising rapidly though unevenly
  - Higher educational attainment
  - Flynn effect
  - Heights rising
- Women's LFP

# Malthusian Theory

- Agricultural economy with a fixed factor (land):
  - This implies decreasing marginal product for other factors. When population grows, marginal product of labor falls and thus wages fall.
- Fertility and health increase with income.
- LR population (density) function of technology, wages/living standard fixed



# Labor and Wages in England



# BUT we escaped!

- Integrated growth theory (Galor 2010):
  - Why did we “escape” the Malthusian equilibrium?
  - Is there a connection between the demographic transition and industrialization?
- Technological change towards non-fixed factor technologies
  - Makes increasing wages and population possible
- That rewards cognition/learning/early investments
  - Increases in education
  - Height premium
  - Female LFP
  - Tilts quantity/quality trade-off towards fewer children
- Empirical evidence for these theories is lacking.
  - Timing of events unclear
  - Role of fertility and/or mortality unclear (cause, consequences, neither?).

# Why did LE start increasing?

## Fogel: Nutrition and heights

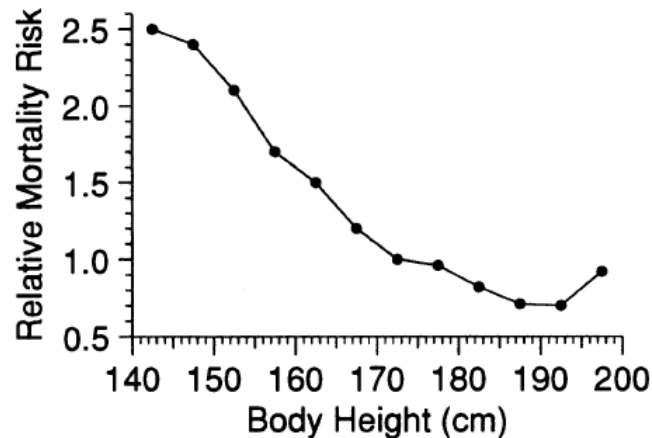
TABLE 1—ESTIMATED AVERAGE FINAL HEIGHTS OF MEN WHO REACHED MATURITY BETWEEN 1750 AND 1875 IN SIX EUROPEAN POPULATIONS, BY QUARTER CENTURIES

Row	Date of maturity by century and quarter	Height (cm)					
		Great Britain	Norway	Sweden	France	Denmark	Hungary
1	18-III	165.9	163.9	168.1	—	—	168.7
2	18-IV	167.9	—	166.7	163.0	165.7	165.8
3	19-I	168.0	—	166.7	164.3	165.4	163.9
4	19-II	171.6	—	168.0	165.2	166.8	164.2
5	19-III	169.3	168.6	169.5	165.6	165.3	—
6	20-III	175.0	178.3	177.6	172.0	176.0	170.9

*Sources:* Fogel (1987 table 7) for all countries except France. For France, rows 3–5 were computed from M. A. von Meerton (1989) as amended by Weir (1993), with 0.9 cm added to allow for additional growth between age 20 and maturity (Benjamin A. Gould, 1869 pp. 104–5) (cf. Gerald C. Friedman, 1982 p. 510 [footnote 14]). The entry to row 2 is derived from a linear extrapolation of Meerton's data for 1815–1836 back to 1788, with 0.9 cm added for additional growth between age 20 and maturity. The entry in row 6 is from Fogel (1987 table 7).

# Fogel: Nutrition and health

A. *Relative Mortality Risk among Norwegian Men Aged 40–59, Between 1963 and 1979*



B. *Relative Rejection Rates for Chronic Conditions in a Sample of 4,245 Men Aged 23–49, Examined for the Union Army*

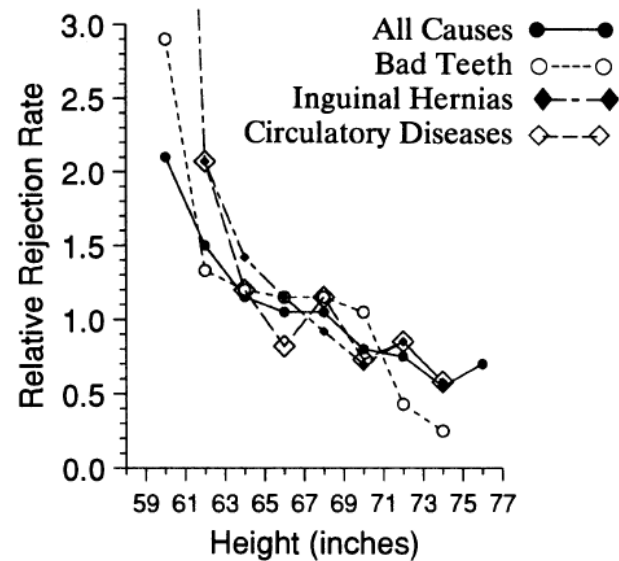
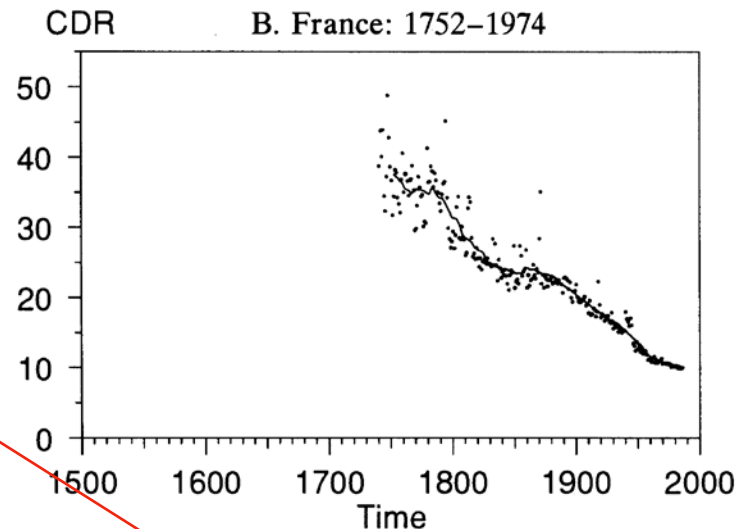
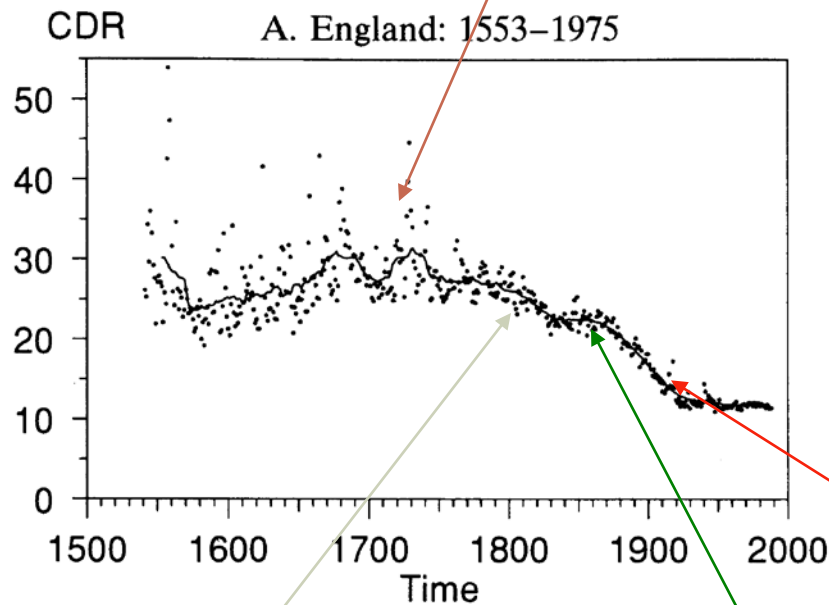


FIGURE 2. COMPARISON OF THE RELATIONSHIP BETWEEN BODY HEIGHT AND RELATIVE RISK IN TWO POPULATIONS

# But when did mortality start falling?

## Trends in mortality rates in England and France

Mortality relative constant from 16<sup>th</sup> C through mid-18<sup>th</sup> C.



Rapid decline from 1750 through 1820

Mortality constant from 1820-70

Continued declines after 1870

# Timing and causes of take-off: trends for famous individuals

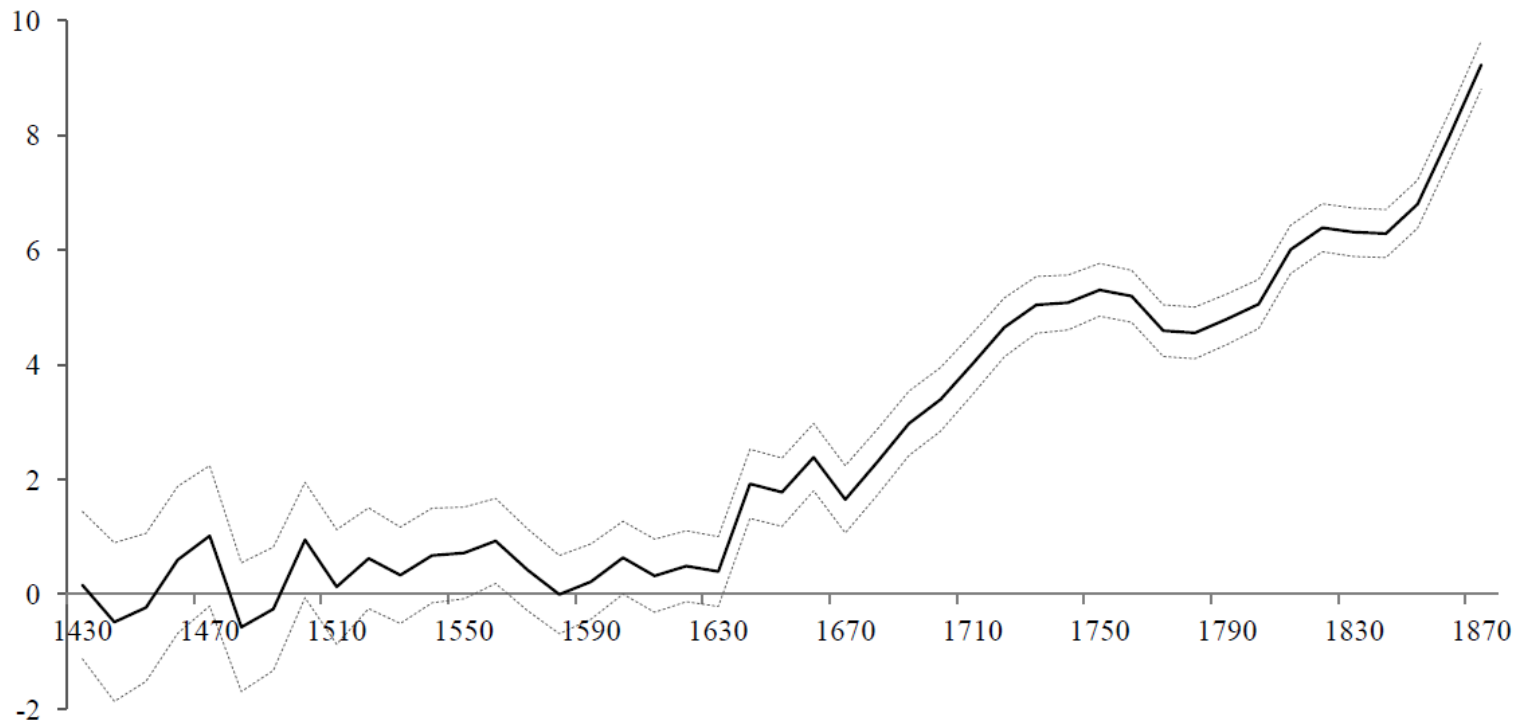


Figure 6: Conditional Mean Lifetime: Cohort dummies and 95% confidence interval

# Height and health: always positively related?

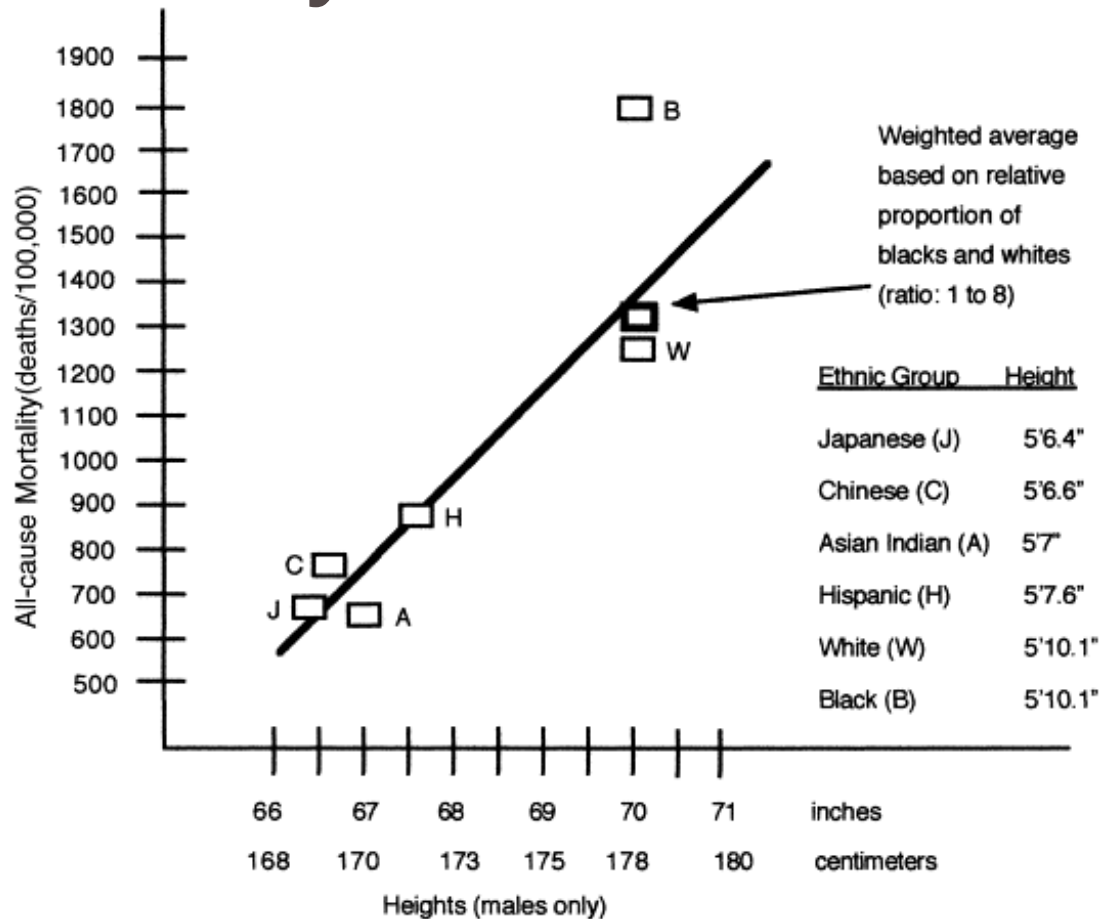
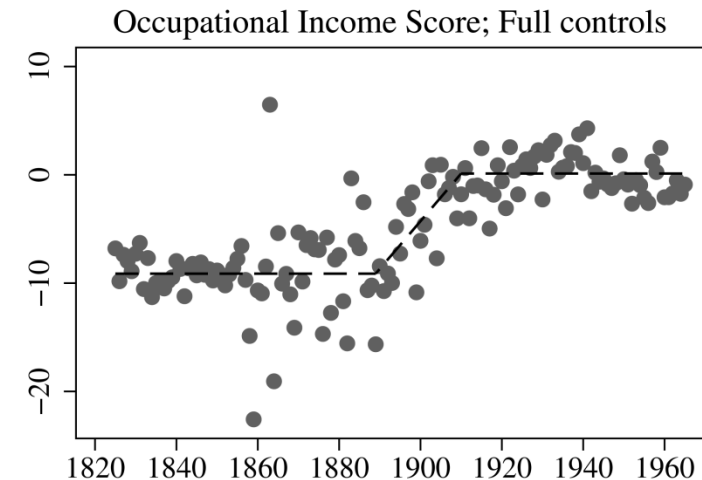
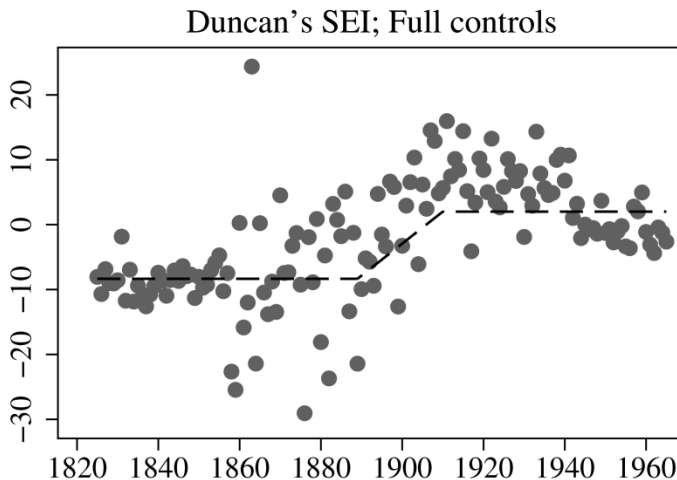
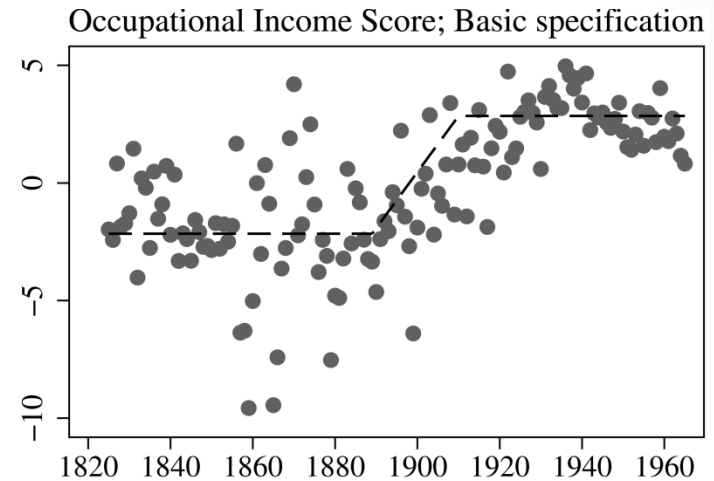
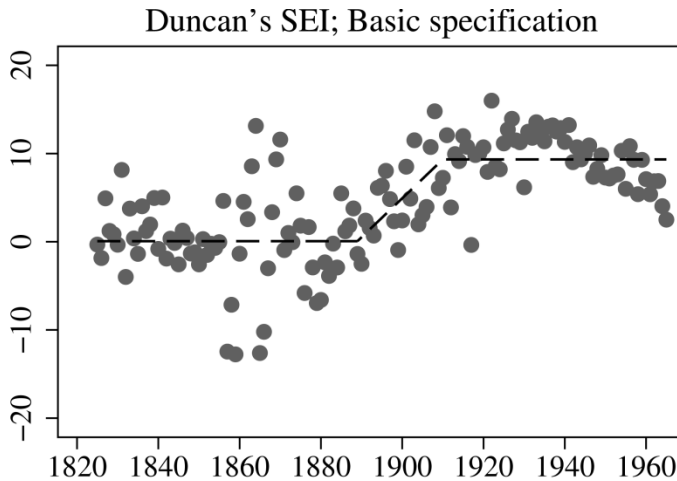


Fig. 1 Age-adjusted mortality rates vs height for six ethnic groups in California, age range: 25–84 years.

# Nutrition or disease? Hookworm and outcomes (Bleakley 2007)



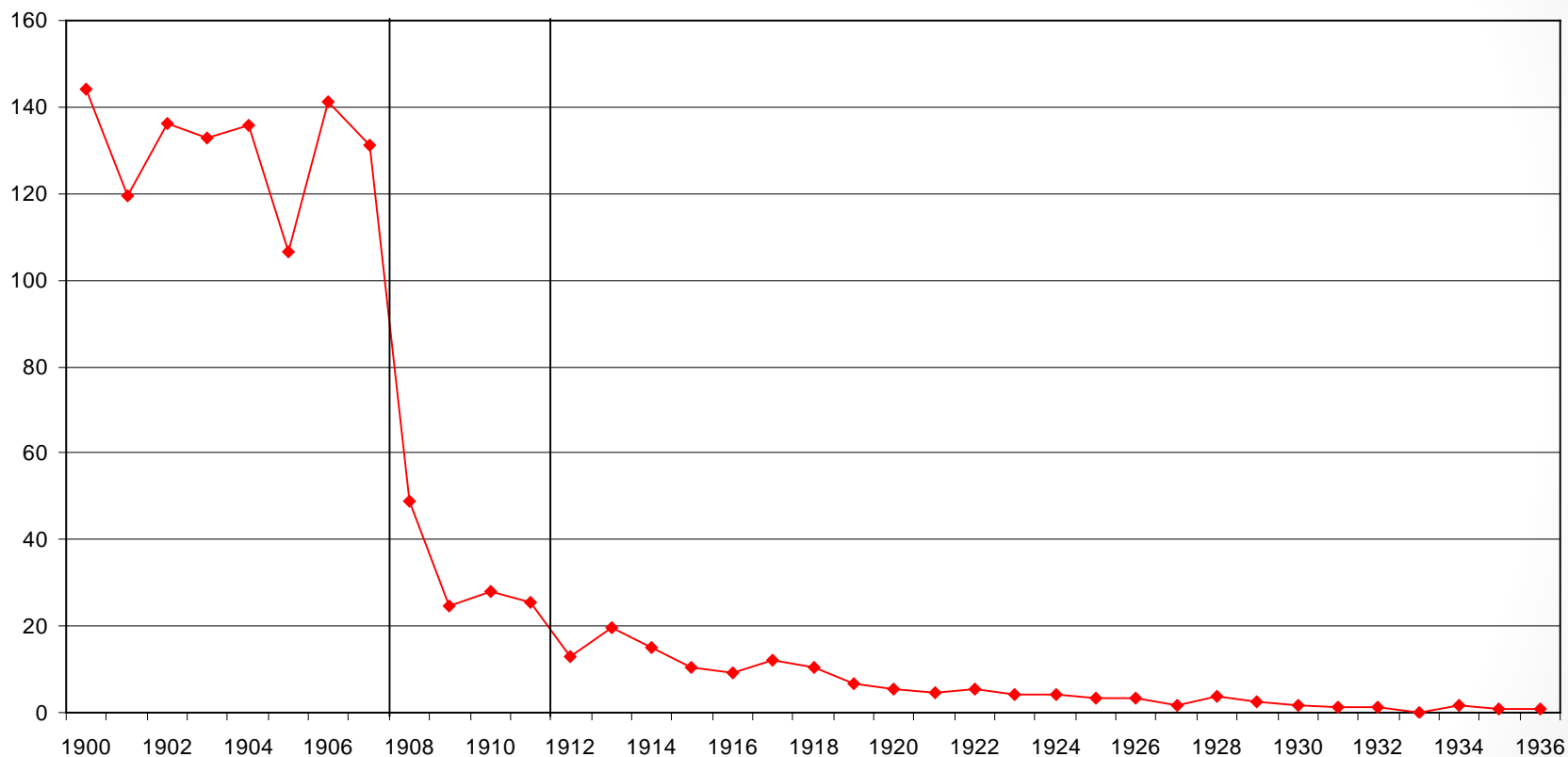


# Explanation 2: Public Health

- Macro public health: clean water, sanitation
- Micro public health: boiling water, washing hands
- Cutler/Miller: Clean water explains  $\frac{1}{2}$  of the reduction in mortality in the first third of the 20<sup>th</sup> century.
- Preston and Haines (Fatal Years) IMR fell first among doctors

# Pittsburgh Typhoid Fever Mortality Rates (Deaths / 100,000)

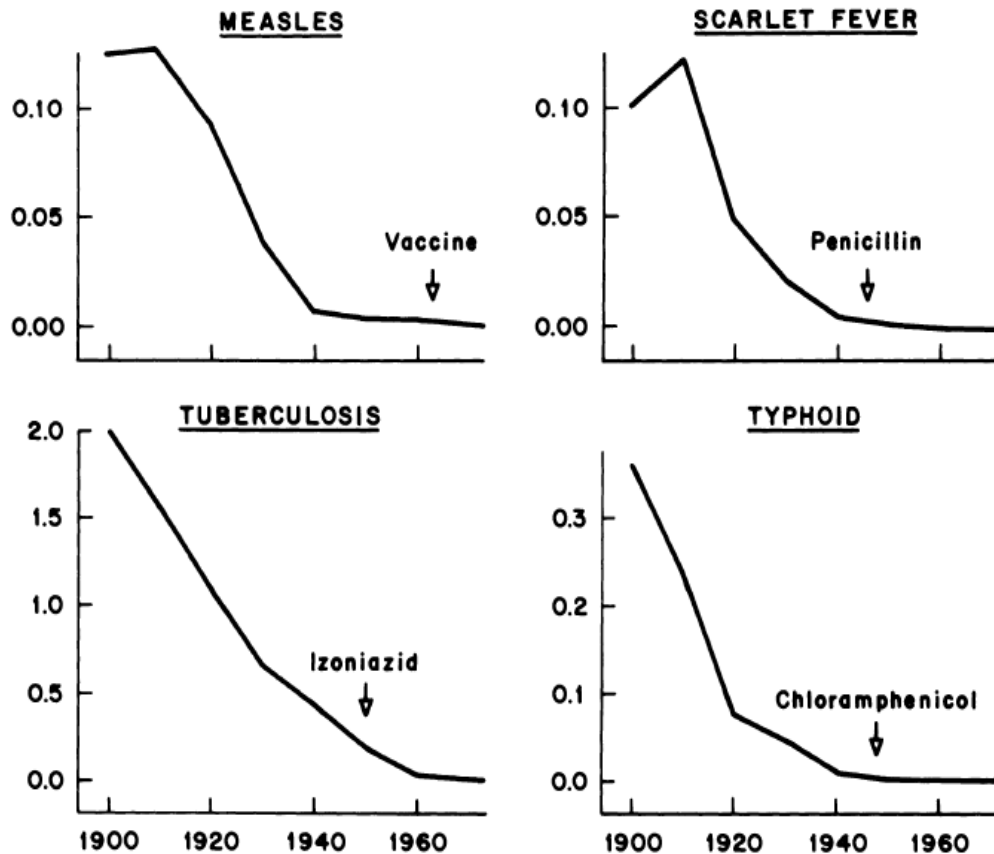
Filtration    Chlorination



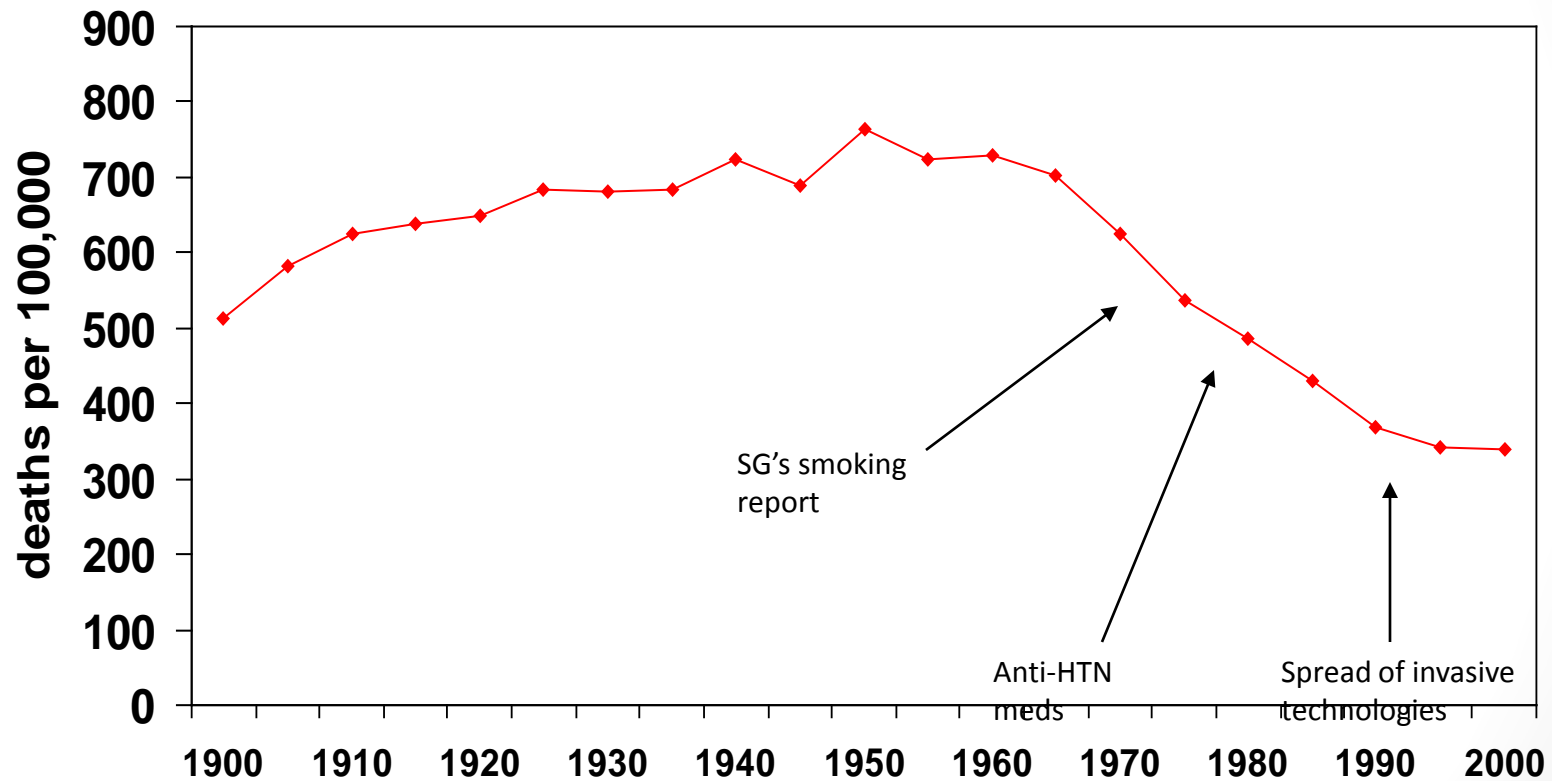
# Urbanization

- Most likely explanation for stalling mortality reduction between 1820 and 1870, while incomes were rising.
  - Though there is a good deal of controversy about living standards during this period.
  - Urban mortality penalty until 1940 in the US
- Role of infectious diseases, density
- Pollution and industrialization
- Other poorly understudied factors: segregation, crime, inequality

# Vaccines & treatment came late: Effect of vaccinations in US



# Except for Cardiovascular Disease

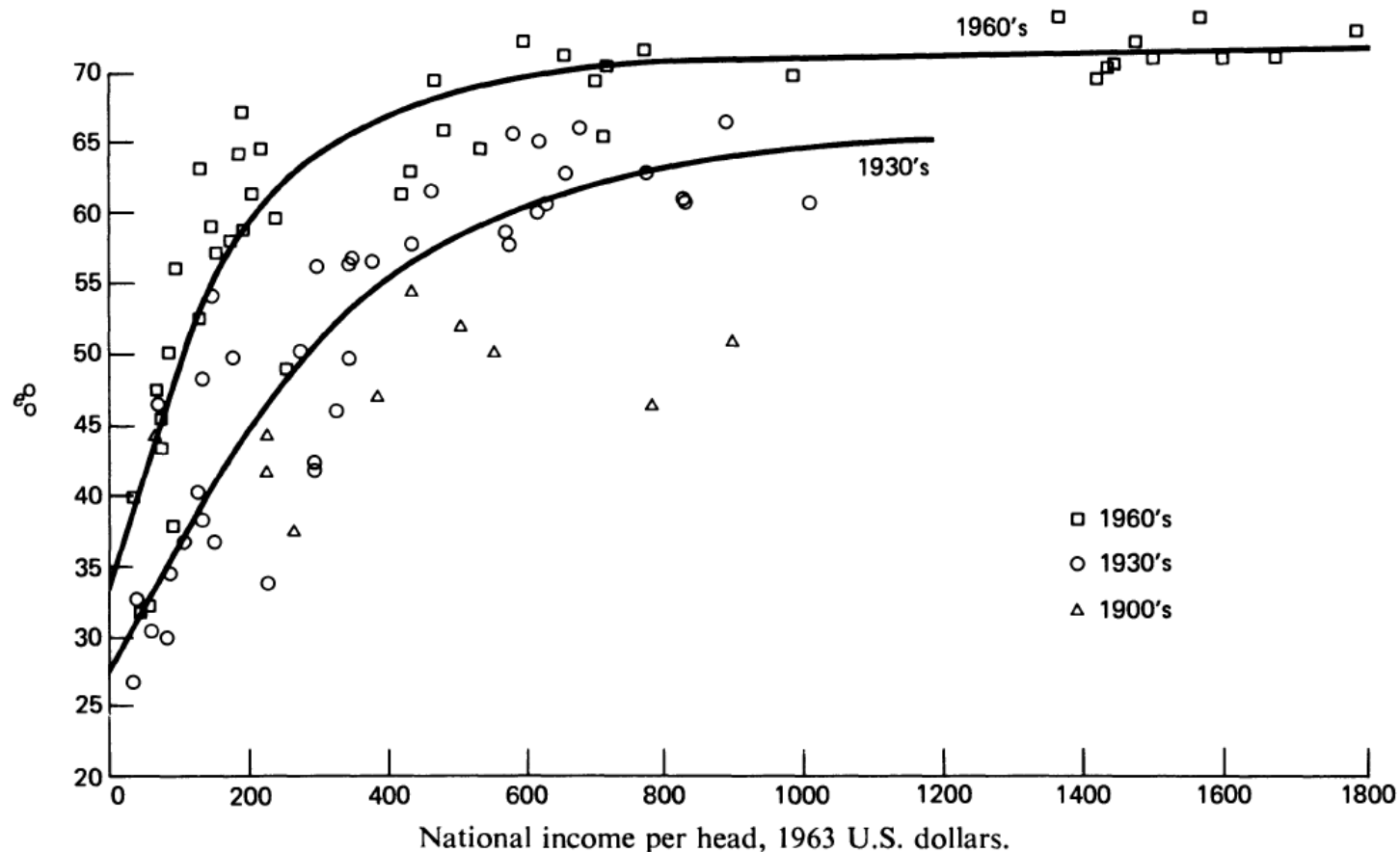


David Cutler: About 1/3 of this is due to medical care.

# Economic growth alone?

## Original Preston curves

Scatter-diagram of relations between life expectancy at birth ( $e_0^o$ ) and national income per head for nations in the 1900s, 1930s, and 1960s.



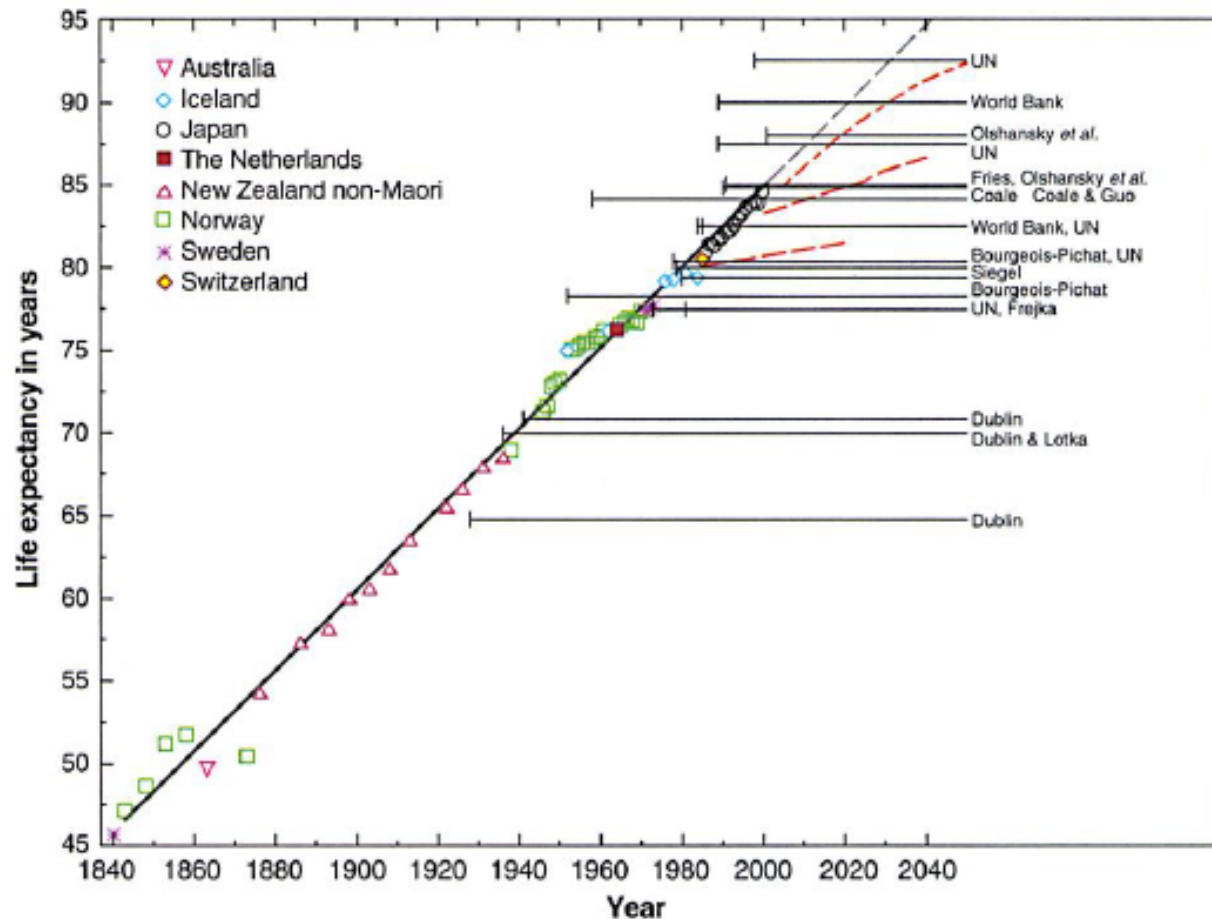
<http://www.youtube.com/watch?v=jbkSRLYSojo>

# Summary

- Nutrition / Public health
- Social technology (public health)
- Personal technology (medical care)
- It's the technology, stupid.
  - Health insurance/access?

Income matters, not necessary not sufficient condition.

# Will we live forever? what is F?



**Fig. 1.** Record female life expectancy from 1840 to the present [suppl. table 2 (1)]. The linear-regression trend is depicted by a bold black line (slope = 0.243) and the extrapolated trend by a dashed gray line. The horizontal black lines show asserted ceilings on life expectancy, with a short vertical line indicating the year of publication (suppl. table 1). The dashed red lines denote projections of female life expectancy in Japan published by the United Nations in 1986, 1999, and 2001 (1): It is encouraging that the U.N. altered its projection so radically between 1999 and 2001.



# Increases in longevity, well-being and inequality. Becker et al (2005)

TABLE 1—EVOLUTION OF CROSS-COUNTRY INEQUALITY IN INCOME AND LIFE EXPECTANCY, 1960–2000

	Income per capita			Life expectancy		
	1960	1990	2000	1960	1990	2000
Relative mean dev.	0.4751	0.4733	0.4215	0.1179	0.0507	0.0509
Coeff. of variation	1.2344	1.2529	1.1662	0.2629	0.1245	0.1361
Std. dev. of logs	1.0178	1.0300	0.9620	0.2552	0.1326	0.1513
Gini coeff.	0.5104	0.5187	0.4873	0.1293	0.0690	0.0730
Regression to the mean		−0.0069	−0.0741		−0.6133	0.0364
over previous date		( <i>p</i> -value = 0.86)	( <i>p</i> -value = 0.00)		( <i>p</i> -value = 0.00)	( <i>p</i> -value = 0.31)

*Notes:* Income per capita is GDP per capita in 1996 international prices, adjusted for terms of trade (Penn World Tables 6.1). Life expectancy is life expectancy at birth (World Development Indicators, World Bank). Inequality measures weighted by country population (abstracting from within country inequality). Sample includes 96 countries, comprising more than 82 percent of the world population. Regression to the mean is the coefficient of a regression of the change in the variable over the period on its initial level (natural logs used in the income regressions; weighted regressions).

Inequality in income has not declined, but inequality in LE fell a lot (though not after 1990). What has happened to inequality once value of LE is taken into account?

# How to value increases in LE?

- The Economist's approach: Revealed preference.
  - How much are individuals willing to pay to increase life (survival profiles) by a certain amount?
- VSL literature looks at *marginal* changes in survival profiles, Becker et al look at *infra-marginal* (large) changes
- Only alternatives:
  - Legal. Sum direct and indirect losses from disease/death
  - Contingent valuation

# Simple Model: Rosen (1988)

- One period model. Maximize:

$$EU = p[U(c) - M]$$

$$\text{s.t. } W + (1 - p)W / p$$

- Where  $p$ : survival rate,  $M$ : utility if die,  $W$ : wealth.
- Note  $M$  was subtracted in EU from both states
- Assume actuarially fair annuity:  $W=pc$

$$EU = pU(c) \quad (1)$$

$$\text{s.t. } W = pc \quad (2)$$

- Take total differentials of (1) and (2)

$$dEU = [U(c) - cU'(c)]dp + U'(c)dW = 0$$

- **Value of life (v)** : willingness to pay for a small increase in the survival rate = Marginal rate of substitution

$$v = -dW / dp$$

$$v = [(1 - \varepsilon) / \varepsilon] * (w / p) \text{ with } \varepsilon = [U'(c) * c] / U(c)$$

- **VSL literature estimates  $-dW/dp$** 
  - Eg 0.0001 increase in risk of death associated with job needs \$240 additional annual salary. Value of life is  $240/0.0001 = \$2.4$  million

# Becker et al

- Similar except consider infra-marginal changes (rather than marginal changes) in survival rates
- Idea: find  $W$  such that

$$U(Y+W, DR_1)=U(Y, DR_2)$$

- Where  $Y$  is lifetime income,  $DR$  is a set of age-specific death/survival rates.
- $W$  makes individual indifferent between two death rate profiles.

- Individual problem:

$$V(Y, S) = \max \int_0^{\infty} U(c(t))S(t)e^{-\rho t} dt \quad \text{s.t.}$$

$$Y = \int_0^{\infty} c(t)S(t)e^{-rt} dt = \int_0^{\infty} y(t)S(t)e^{-rt} dt$$

Under assumptions here  $c^*(t)=c=y$ , so that

$$V(y, S) = U(y) \int_0^{\infty} S(t)e^{-rt} dt = U(y)A(S)$$

- $A(s)$  value of annuity based on survival profile  $S$  (if annuity pays \$1 a year, EPDV of that stream of income)

- Choose

$$u = \frac{c^{1-1/\gamma}}{1-1/\gamma} + \alpha$$

- $\gamma$ : 1.25
- $\alpha$ : U from death based on annual level of consumption that makes individual indifferent between life and death (normalization)=-16.2 ?
- $r=0.03$
- Do not value decline in mortality risk of others
- No accounting for changes in quality of life.
- Value of inter-temporal elasticity of substitution matters hugely (See computations in Weil)

# Growth of full income

TABLE 3—EVOLUTION OF CROSS-COUNTRY INEQUALITY IN FULL INCOME, 1960–2000

	Income per capita			Full income	
	1960	1990	2000	1990	2000
Relative mean dev.	0.4751	0.4733	0.4215	0.4397	0.3760
Coeff. of variation	1.2344	1.2529	1.1662	1.1664	1.0463
Std. dev. of logs	1.0178	1.0300	0.9620	0.9758	0.9476
Gini coeff.	0.5104	0.5187	0.4873	0.4935	0.4561
Regression to the mean over 1960		–0.0069 ( <i>p</i> -value = 0.86)	–0.1338 ( <i>p</i> -value = 0.01)	–0.1006 ( <i>p</i> -value = 0.02)	–0.2638 ( <i>p</i> -value = 0.00)

One we put a value on the reductions in mortality and compute “full income” measures, we find that inequality is much lower and it has decreased much more than income-based measures alone suggest.



# Murphy and Topel (2006)

Willingness to pay for health (both mortality and morbidity)

- increases with wealth
- depends on leisure

The social value of improvements in health is greater

- The greater the population
- the greater the existing level of health,
- the closer the ages in the population to the age of onset of disease.

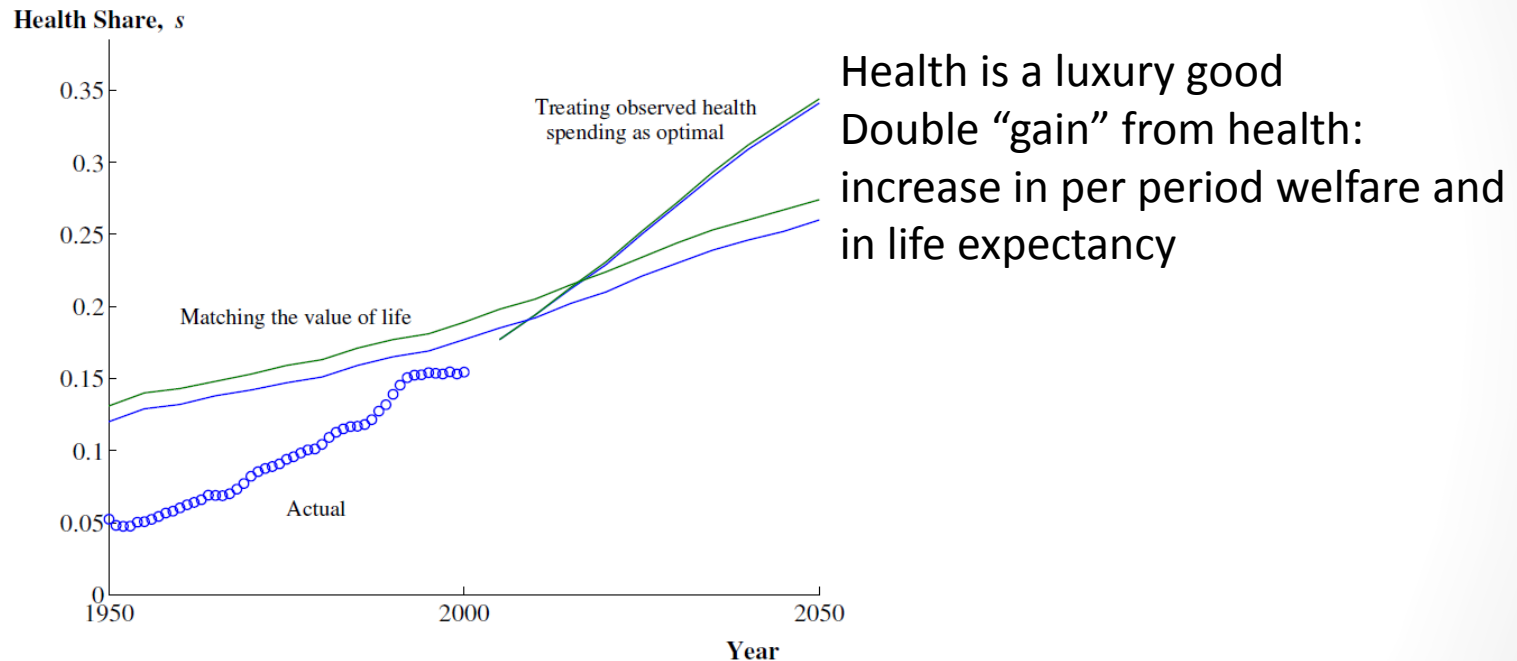
Improvements in health tend to be complementary:

- once we eradicate CVD value of reductions in cancer mortality rises.

Calibrated values: value of health HUGE.

# Hall and Jones (2007): Implications for health care spending

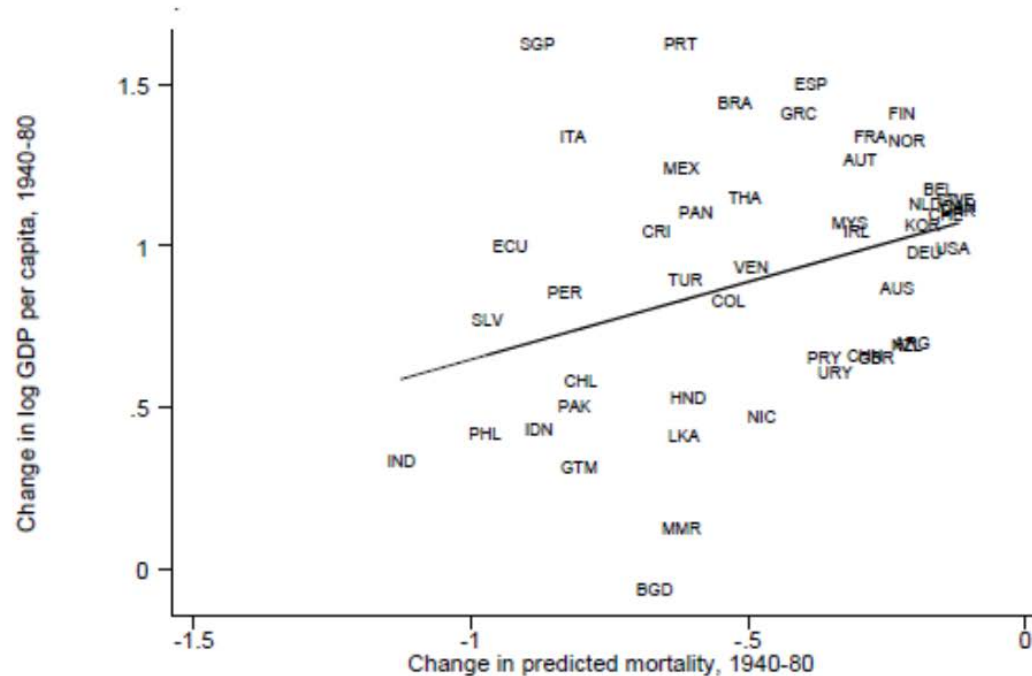
FIGURE 7. Simulation Results: The Health Share of Spending



Circles “o” show actual data for the health share. The upward-sloping lines for the period 2005-2050 show the projected health share based on the full model where the VSL is inferred from the health technology, as in Table 1. The gently sloping lines for the period 1950-2050 show the hypothetical historical and projected share for preferences inferred from the VSL literature. Within these two approaches, the upper line corresponds to the case that includes a quality-of-life term ( $\alpha > 0$ ), while the lower line does not ( $\alpha = 0$ ).

# Effect on economic growth unclear: Acemoglu and Johnson (2007)

Figure 11: Change in log GDP per capita and change in predicted mortality, 1940-80, base sample





# WHO INVESTS IN HEALTH?

*"MOST (IF NOT ALL) DEATHS ARE TO SOME EXTENT SUICIDES"*

*BECKER (1974)*

**Table 3.1 US Deaths Related to Modifiable Risk Factors, 1990 and 2000**

Cause of Death	1990	2000
Tobacco	400,000 (19%)	435,000 (18%)
Poor diet/physical inactivity	300,000 (14%)	365,000 (15%)
Alcohol consumption	100,000 (5%)	85,000 (4%)
Microbial agents	90,000 (4%)	75,000 (3%)
Toxic agents	60,000 (3%)	55,000 (2%)
Motor vehicles	25,000 (1%)	43,000 (2%)
Fire arms	35,000 (2%)	29,000 (1%)
Sexual behavior	30,000 (1%)	20,000 (1%)
Illicit drug use	20,000 (1%)	17,000 (1%)
All modifiable risks	1,060,000 (50%)	1,159,000 (48%)

Taken from "Economics of Risky Behaviors," Cawley and Ruhm, Chapter 3, Volume 2, Handbook of Health Economics.

# How Would One Reduce Mortality in the world today?

		Millions of deaths		
Measure		World	Low income	High income
Respiratory Infections	Antibiotics	3.96	2.90	0.34
HIV/AIDS	Prevention and HAART	2.78	2.14	0.02
Perinatal deaths	Pre- and post-natal care	2.46	1.83	0.03
Diarrhea	Oral rehydration therapy	1.80	1.54	---
Tuberculosis	Preventable with public health; treatable	1.57	1.09	0.01
Malaria	Partially preventable; treatable	1.27	1.24	---
DPT/Polio/ Measles	Vaccinations	1.12	1.07	---

About 2/3 of under-5 deaths could be averted with simple, relatively cheap preventative technologies (e.g., anti-malarial bednets, bleach for water purification, ORS kits for diarrhea) (Jones et al., Lancet, 2003)

# Grossman 1972's model of Health: a rational individual model

- Prices, wages, non-labor income are the exogenous factors
- Given a set of preferences (shape of  $U$ ) and level of knowledge/technology that produces health
  - Individuals will demand health (health care) in the same way they demand other goods.
  - if  $H$  is an investment, treat like any other  $I$
- In lifetime model where  $H$  is both  $C$  and  $I$ , most predictions are ambiguous (Wages: inc and subs)

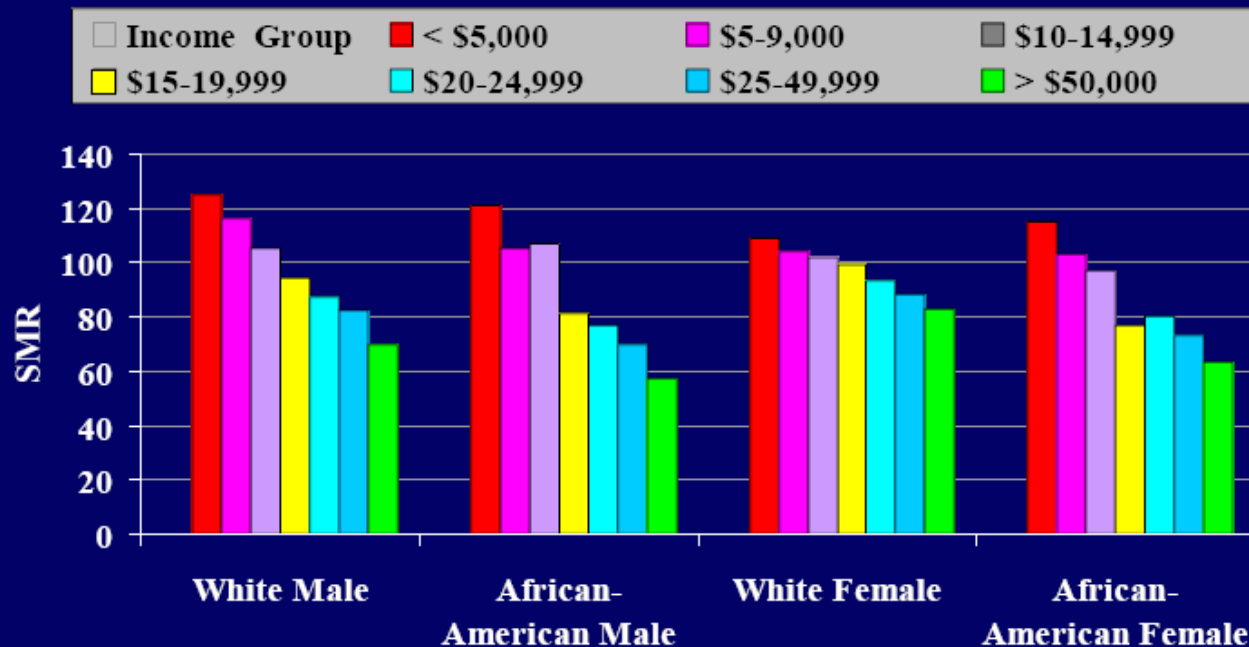
Basis for all models of health, including adoption and health behaviors

# ROLE OF PRICES AND INCOMES



# Within countries: Higher incomes associated with lower mortality (USA example)

## All-cause Mortality by Income NLMS, 25+ Years



# Does access matter?

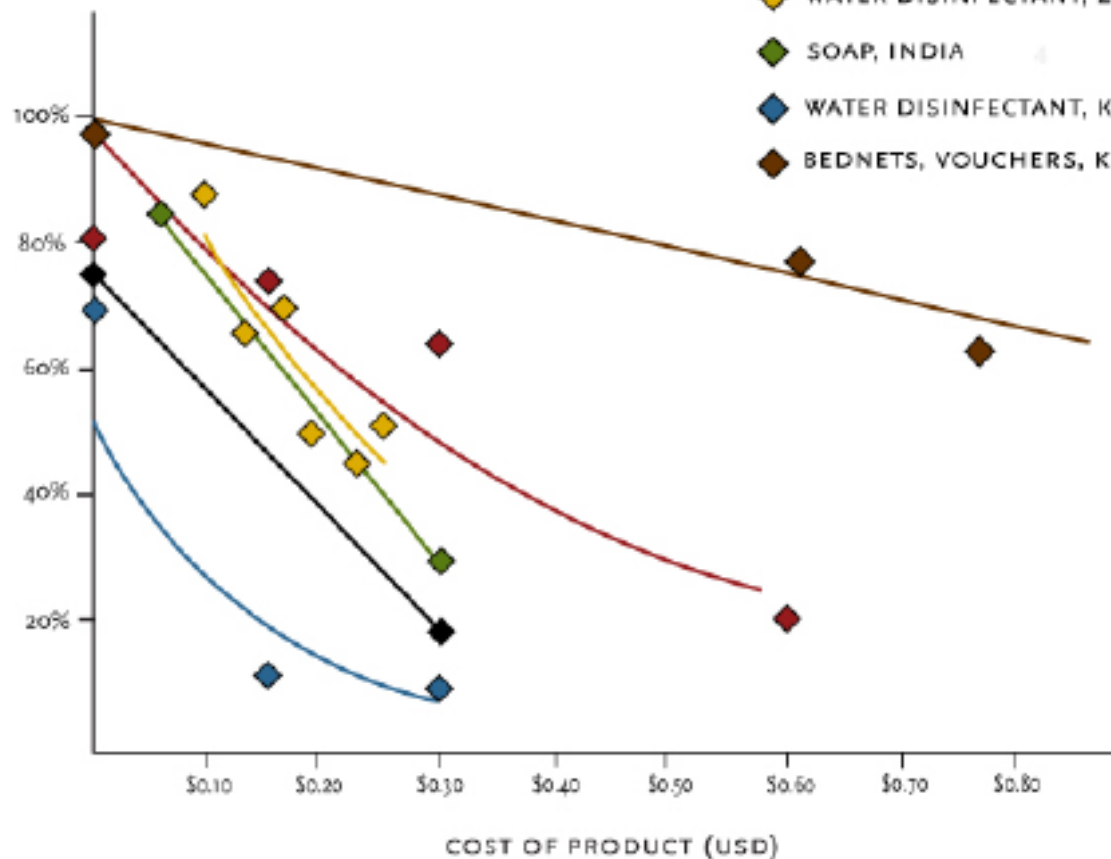
Figure 1:

DEMAND FOR PREVENTIVE HEALTHCARE  
PRODUCTS BASED ON PRICE

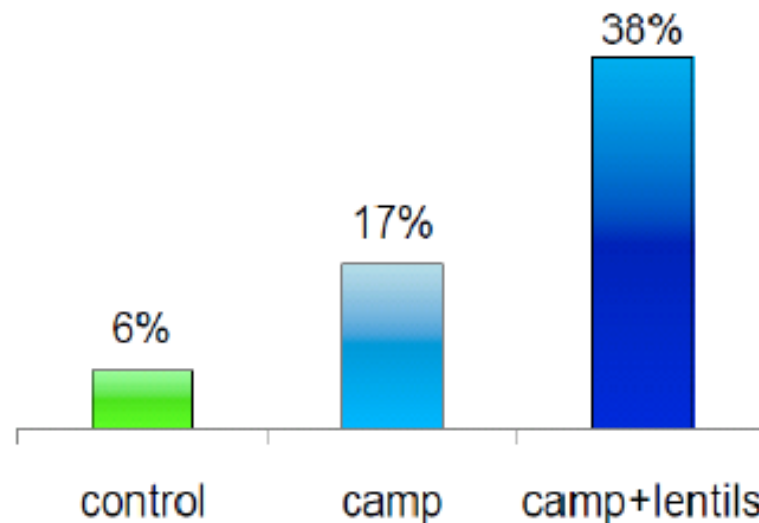
[www.povertyactionlab.org](http://www.povertyactionlab.org)

**Demand is very price elastic**

- ◆ DEWORMING, KENYA
- ◆ BEDNETS, PRENATAL CLINICS, KENYA
- ◆ WATER DISINFECTANT, ZAMBIA
- ◆ SOAP, INDIA
- ◆ WATER DISINFECTANT, KENYA
- ◆ BEDNETS, VOUCHERS, KENYA



# But even with subsidies immunization rates in India remain low



Source: Banerjee, Abhijit, Esther Duflo, Rachel Glennerster, and Dhruva Kothari (2010). "Improving Immunization Coverage in Rural India: A Clustered Randomized Controlled Evaluation of Immunization Campaigns with and without Incentives." *British Medical Journal* 340:c2220.

**Free distribution or subsidies do not guarantee 100% take-up (or use).**

# Are poor credit constrained?

## YES.

- Dupas and Robinson (2013): Increasing “health-specific” savings devices had dramatic take-up and substantial effects on savings and health expenditures.
- Impact of free HI in the US on health: effects but only for poorest-sickest of the population, at least in SR

BUT

- In panel SR effect of income do not have large positive health benefits
- Arrival of checks increases mortality

# Money and prices are not all

- Many healthy behaviors do not involve **monetary** costs yet low SES (poor/uneducated) are less likely to adopt them
  - Seat belt: why do more educated wear it more?
  - Smoking: not smoking cheaper. Why poor/uneducated do it more?
  - Eating is costly: why are obesity rates larger among the poor? Many forms of exercise are free (jogging): why do high SES do it more?
- Growth and rises in incomes can lead to poorer health

# Alcohol, cigarettes normal goods

**Table 3.11** Estimates of Income Elasticity of Demand for Cigarettes

Category	Variable	Median Income Elasticity	Number of Estimates
Elasticity estimate	Short run	0.28	295
	Long run	0.39	80
Aggregation	Country	0.33	341
	State/province	0.30	24
	Individual	0.06	10
Gender	Men	0.27	11
	Women	1.23	8
Age	Adult	0.06	6
	Young adult	0.05	1
	Teen	—	0

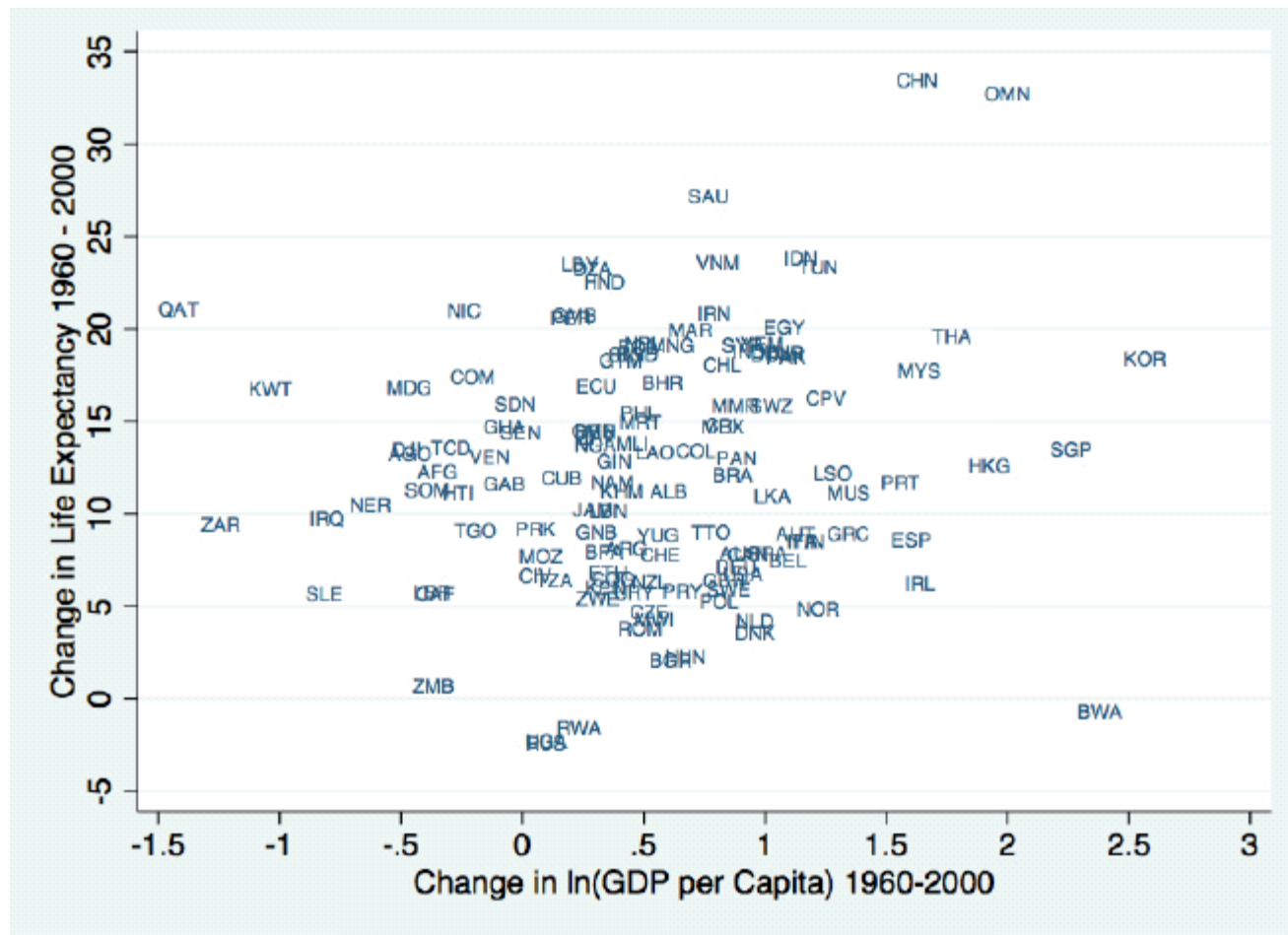
Source: Gallet and List (2003), Table 2, column 2.

**Table 3.12** Estimates of Income Elasticity of Demand for Alcohol

Category	Variable	Median Income Elasticity	Number of Estimates
Elasticity estimate	Short run	0.676	901
	Long run	0.860	113
Aggregation	Country	0.768	581
	State/province	0.572	359
	Individual	0.213	74
Gender	Men	0.193	2
	Women	0.120	11
Age	Adult	0.267	30
	Young adult	0.328	4
	Teen	−0.001	2

Source: Gallet (2007), Table 2, column 2.

# Aggregate: changes uncorrelated



# BUT Family Income Matters for kids

(Case et al 2002)

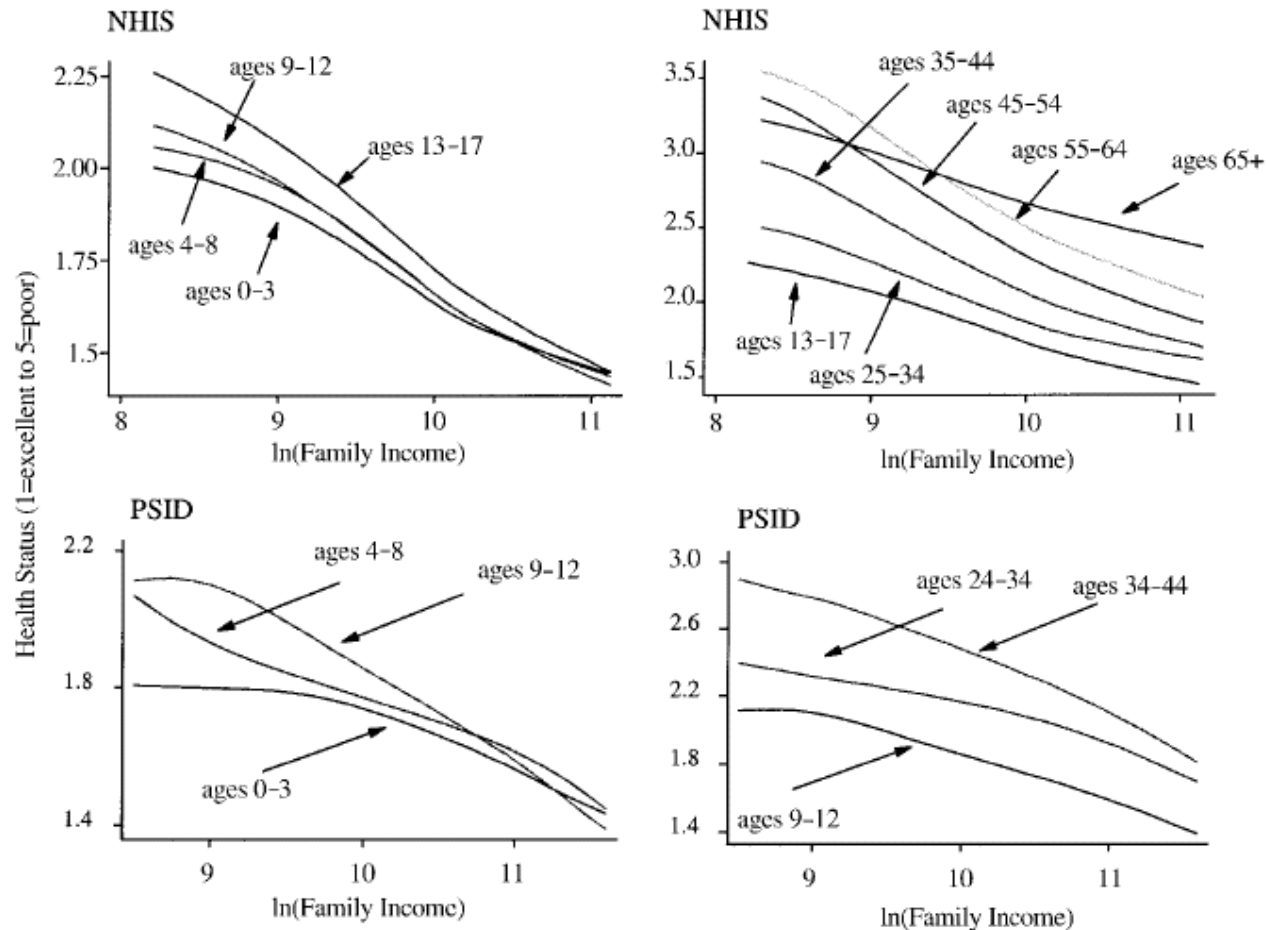
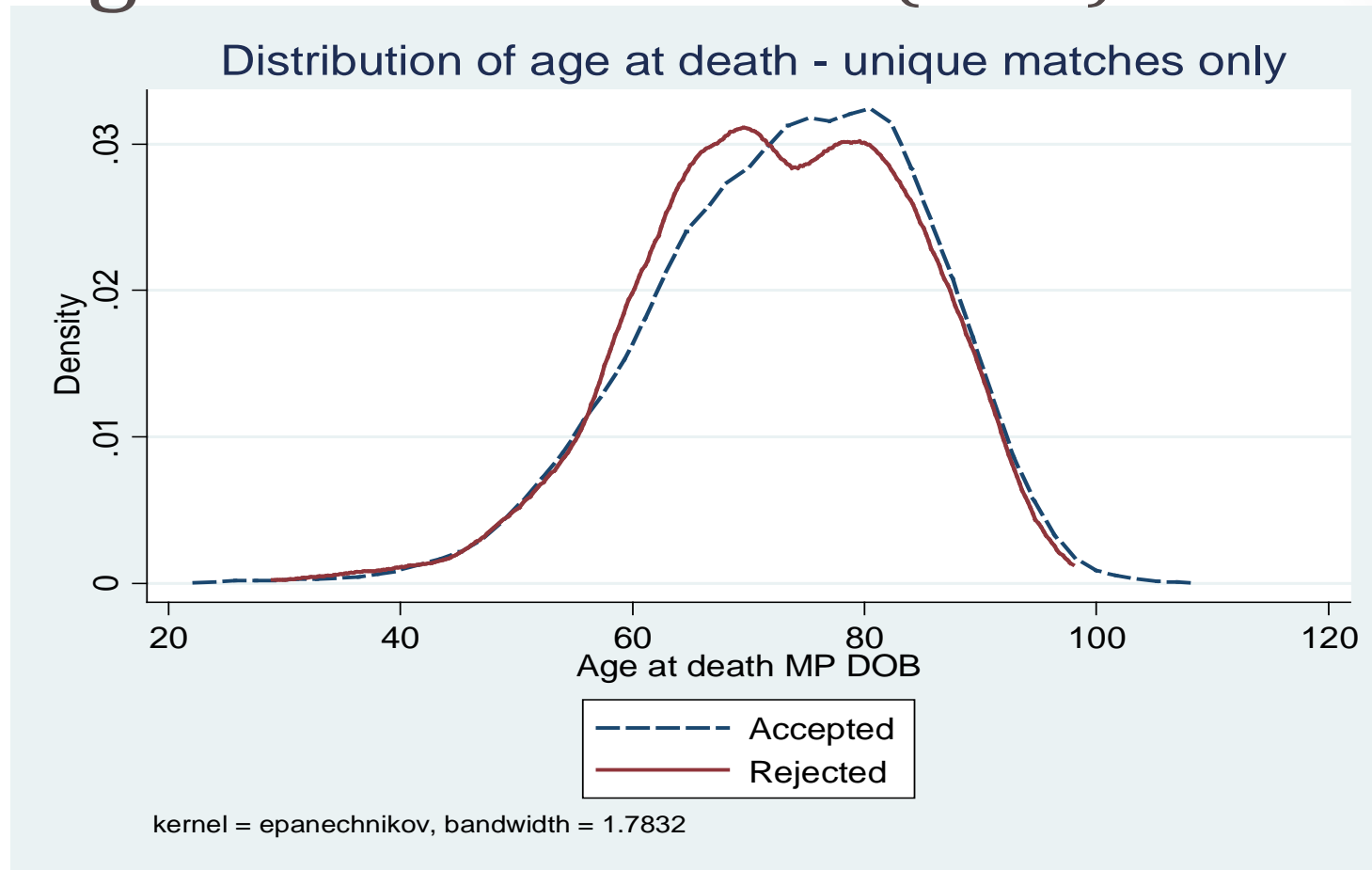


FIGURE 1. HEALTH AND INCOME FOR CHILDREN AND ADULTS: NHIS (1986-1995) AND PSID

Long term measures of income are much more predictive than short-term.  
“disadvantage cumulates”. low SES/poor are subject to more shocks



# Evidence from earliest welfare program in US Aizer et al (2014)



~30% increase in income for poor mothers without husbands  
increase LE of sons by 1-1.5 years. higher education, wages and nutrition.

# Short term and long term effects of recessions on health OPPOSITE

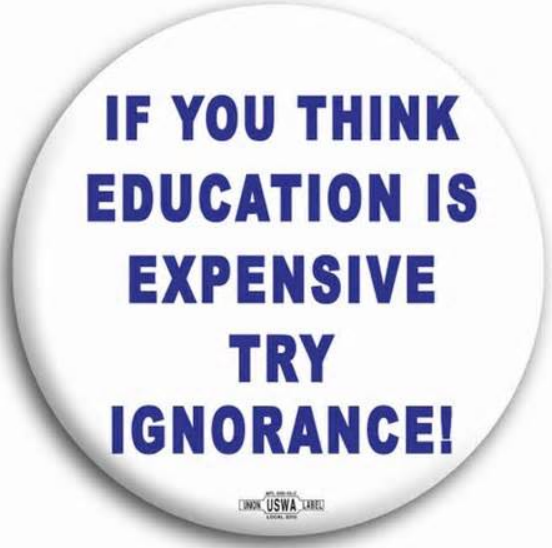
**Table 0: Impact of Contemp. And Earlier life GDP fluc. On Mortality rates aged over 30**

VARIABLES	(1)	(2)	(3)
	Dependent var. is Mortality rates in percentage		
	All population	Men	Women
<i>Contemporaneous GDP fluc.</i>			
GDP Fluc.	0.0212 (0.160)	-0.442** (0.181)	0.438** (0.189)
GDP Fluc. Square	10.53*** (2.922)	13.06** (4.997)	8.316*** (1.440)
<i>GDP Fluc.at ealier life</i>			
Age 0	-0.179*** (0.0628)	-0.161*** (0.0564)	-0.192*** (0.0598)
Age 1 - 5	-0.353** (0.138)	-0.343** (0.142)	-0.362*** (0.126)
Age 6 - 10	-0.497** (0.207)	-0.503** (0.196)	-0.507** (0.203)
Age 11 - 15	-0.577** (0.266)	-0.645** (0.262)	-0.543** (0.257)
Age 16 - 20	-0.575** (0.274)	-0.688** (0.256)	-0.470* (0.267)
Age 21 - 25	-0.423** (0.189)	-0.566*** (0.164)	-0.347* (0.197)
Age 26 - 30	-0.174 (0.172)	-0.398** (0.175)	-0.0631 (0.174)

Taken from Cutler et al (2015)

# A summary of Income and Health: Timing is everything

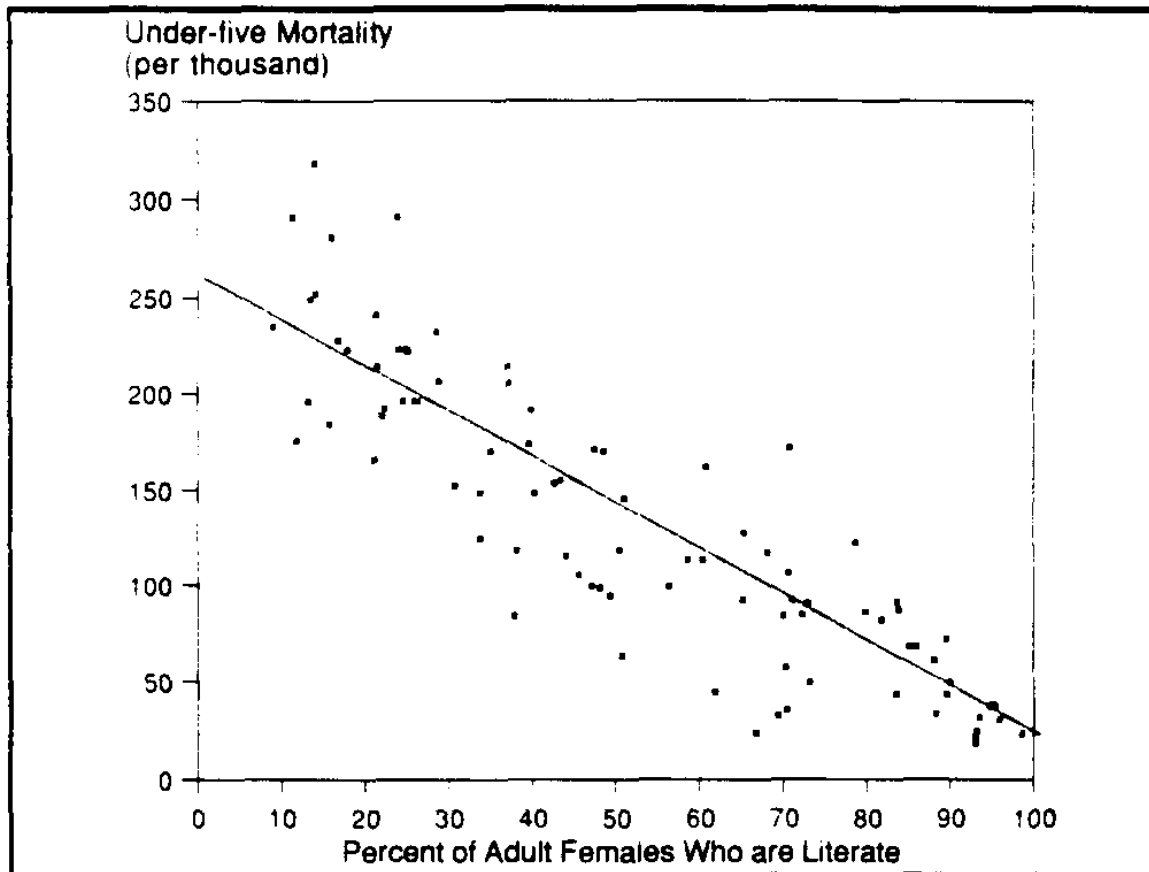
- Permanent family income matters. But
  - improvements in nutrition and early investments pay off over lifetime. Full effects take one (or more) generations
  - Income and normal goods
- Wealth matters but
  - slow diffusion of knowledge and access
  - Peers/norms & political process (public health) UNDERSTUDIED
- Negative short run effect of income on health
  - growth and pollution, Income growth and inequality/stress/work hours
- Better modelling of individual and macro determinants of health
- Effects of permanent income and SR income deviations differs



**IF YOU THINK  
EDUCATION IS  
EXPENSIVE  
TRY  
IGNORANCE!**

EDUCATION AND INFORMATION

**Figure 6.7 Under-Five Mortality by Degree of Adult Female Literacy**

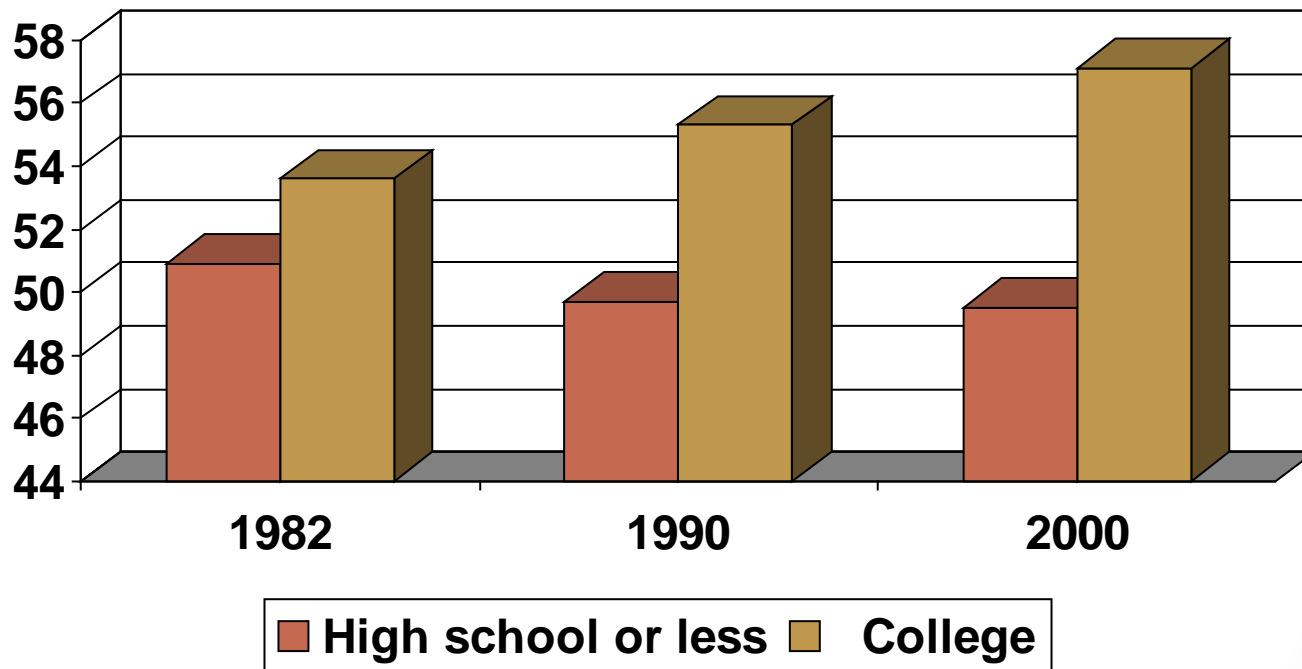


**Source:** Chapter 16, "Population and Human Development," Tables 16.3 and 16.6.

**Note:** Based on data reported by 89 developing countries. Each dot represents data from one country.

# Large and growing education gaps in life expectancy in developed countries: US case

**Life Expectancy at Age 25, by Education**



# Information and education

---

Year of survey:	1949	1954	1957	1969
-----------------	------	------	------	------

---

## **Panel A: gap in knowledge increases and then falls**

Dependent variable:	"Do you think cigarette smoking is harmful or not?"	What is your opinion--do you think cigarette smoking is one of the causes of lung cancer, or not?		
---------------------	--	---	--	--

---

<HS	.057*	-.054*	-.065**	-0.041
Some college	0.012	0.032	.116**	0.045
College+	0.021	0.067	.172**	.111**

## **Panel B: gap in smoking rate gets bigger**

Dependent variable:	Current Smoker?			
---------------------	-----------------	--	--	--

---

<HS	-.056*	-0.016	0.024	.054*
Some college	0.019	-0.026	-0.008	0.011
College+	-0.045	-0.061	-0.003	-.076*

---

# Bad health in childhood predicts low education

## Direct effects:

- In utero shocks (eg influenza: Almond 2006) lower education
- Low birth weight predicts education (Black et al 2007)
- Malaria (Bleakley 2010), hookworm eradication increased education (Miguel and Kremer 2004 Bleakley 2007)

## Expectation effects: Longer lives result in greater investments in ed.

- Jayachandran and Lleras-Muney (2009): Sri Lanka's MMR declines increased investments in girls
- Oster et al (2013: Test results for Huntington's disease affects investments in education
- Elasticity of years of education wrt to LE  $\sim 1$ .



# Is there a “causal” effect of education? Education and mortality

Lleras-Muney (2005)

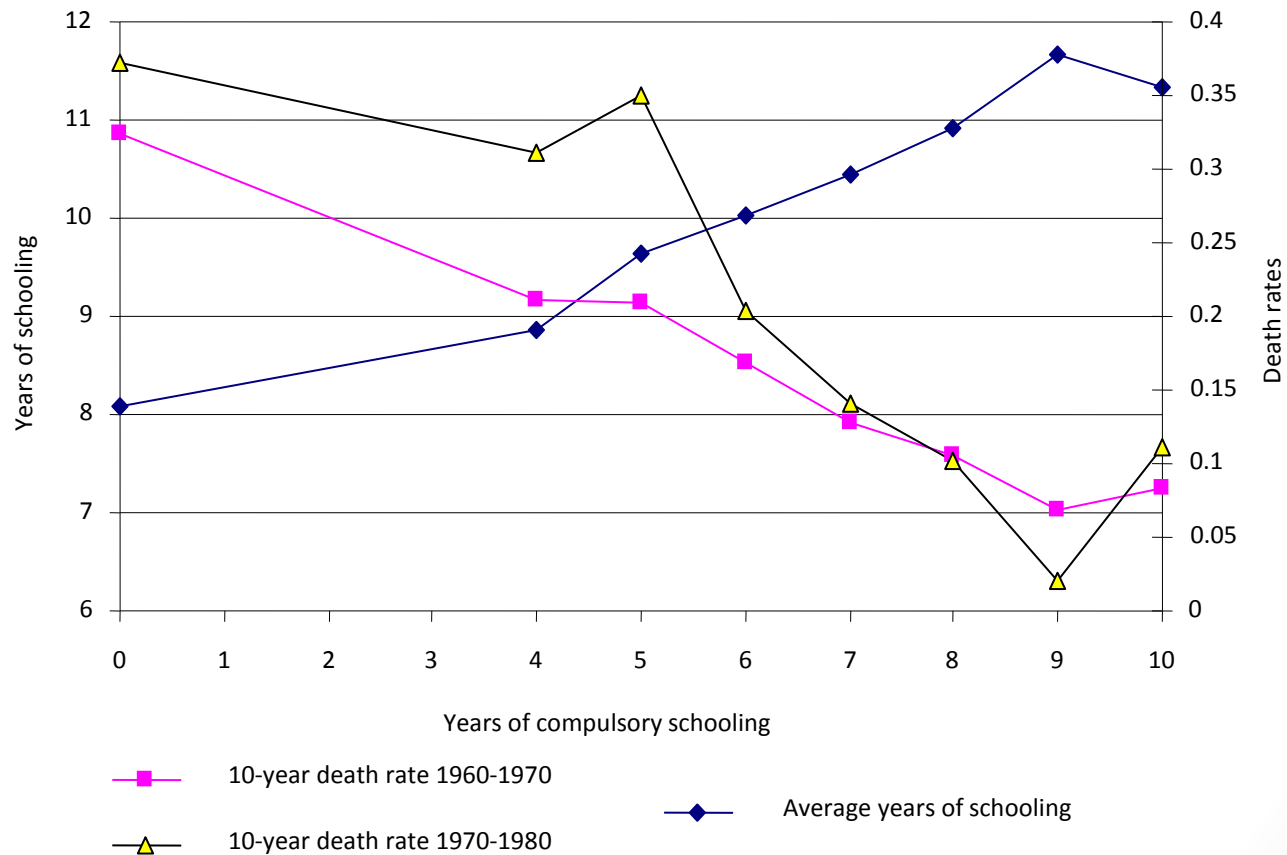
- Use compulsory schooling legislation in US as instruments for education. Compare cohorts before and after law is changed within states.
- Laws affected a small subset of population. Those credit constrained?

Royer and Clark (2013)

- Look at changes in UK increasing leaving ages from 14 to 15, or 15 to 16.
- Affected a large fraction of individuals. Almost all were already leaving exactly at the minimum leaving age.

# Effect of compulsory schooling on mortality: more education leads to longer life

White cohorts born 1901-1925 US (Lleras-Muney 2005)



# Royer and Clark AER (2013)

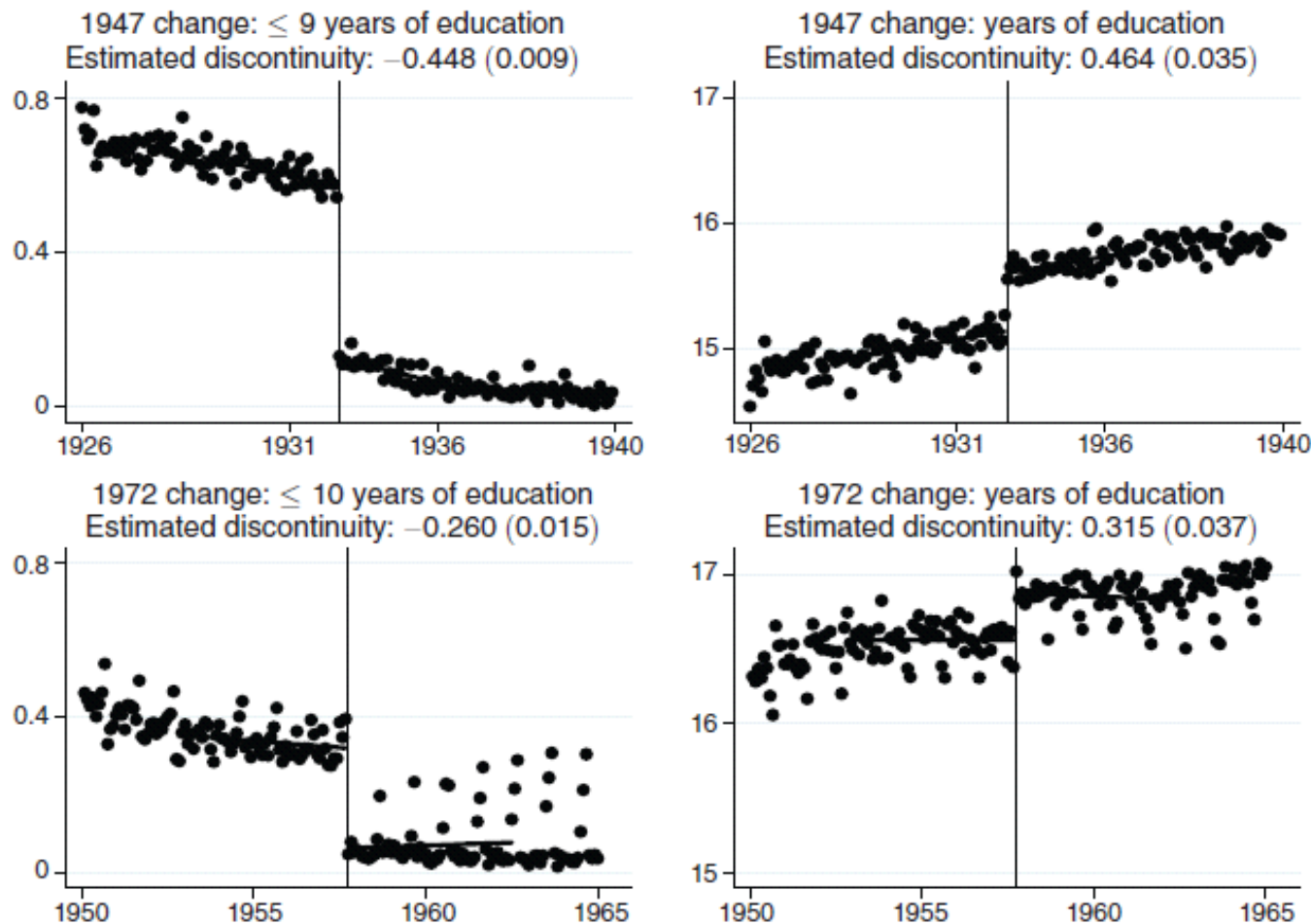


FIGURE 2. THE IMPACT OF THE COMPULSORY SCHOOLING CHANGES ON EDUCATIONAL ATTAINMENT

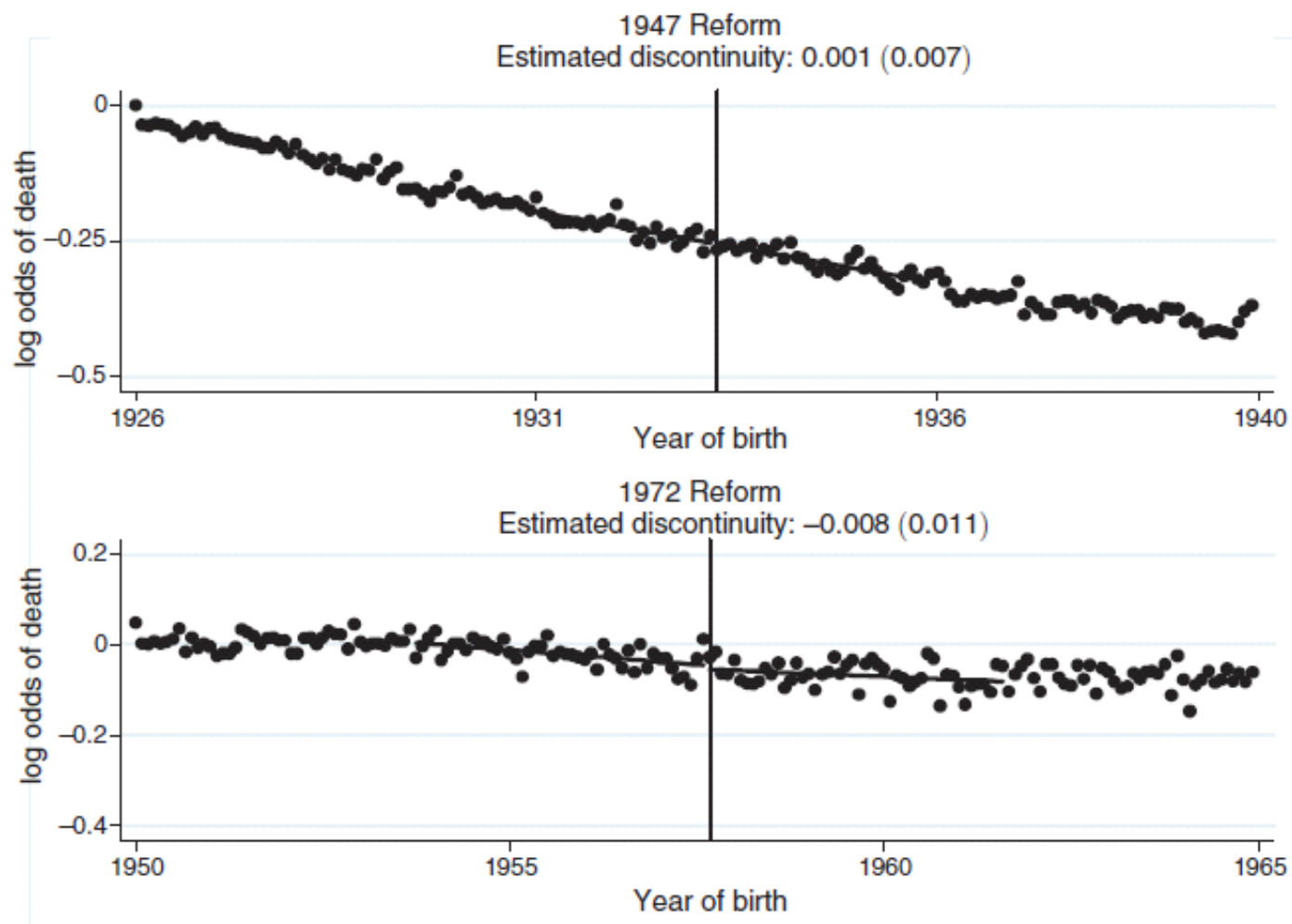


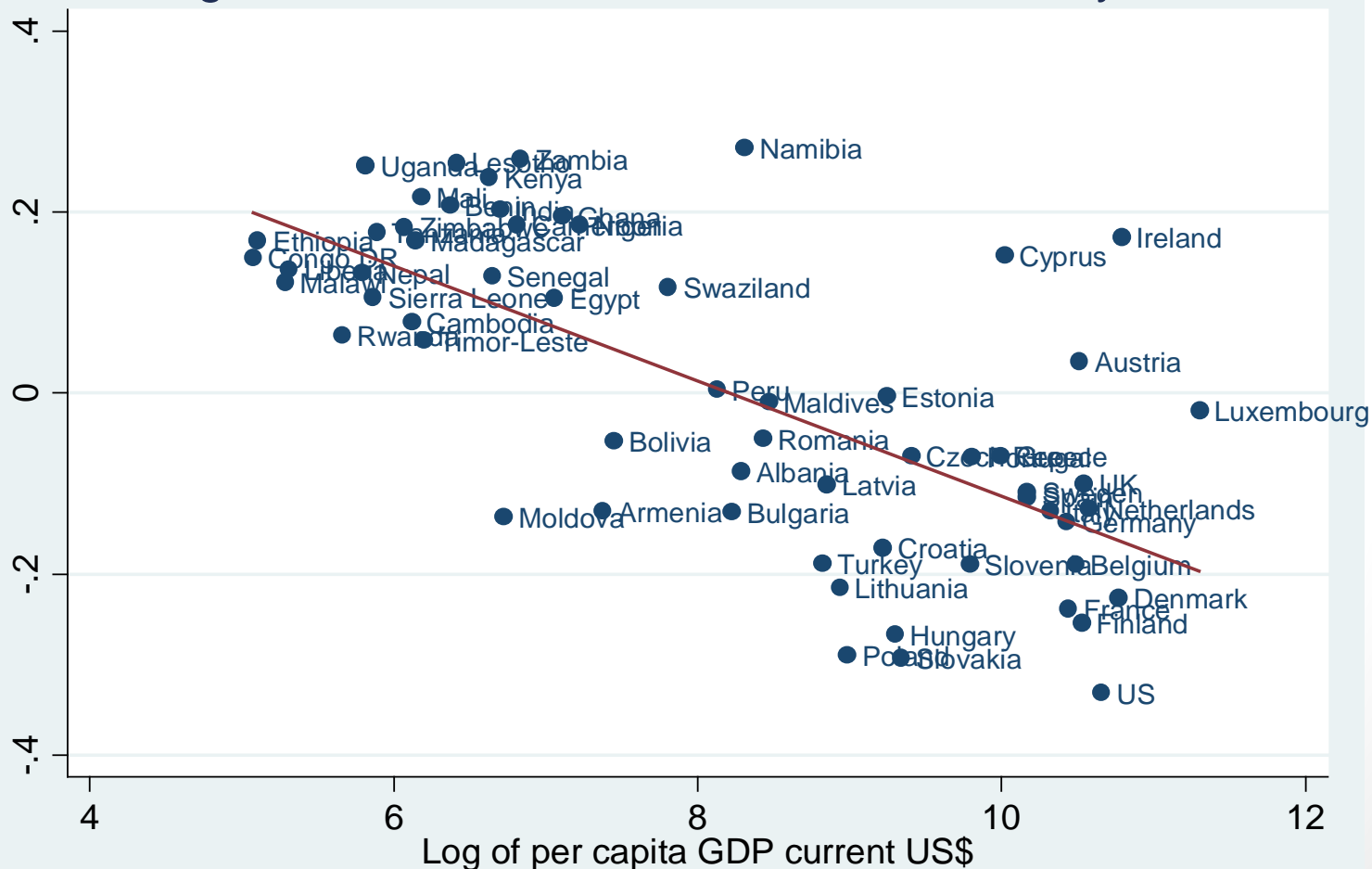
FIGURE 3. THE IMPACT OF THE COMPULSORY SCHOOLING CHANGES ON MORTALITY

# Why such stark differences?

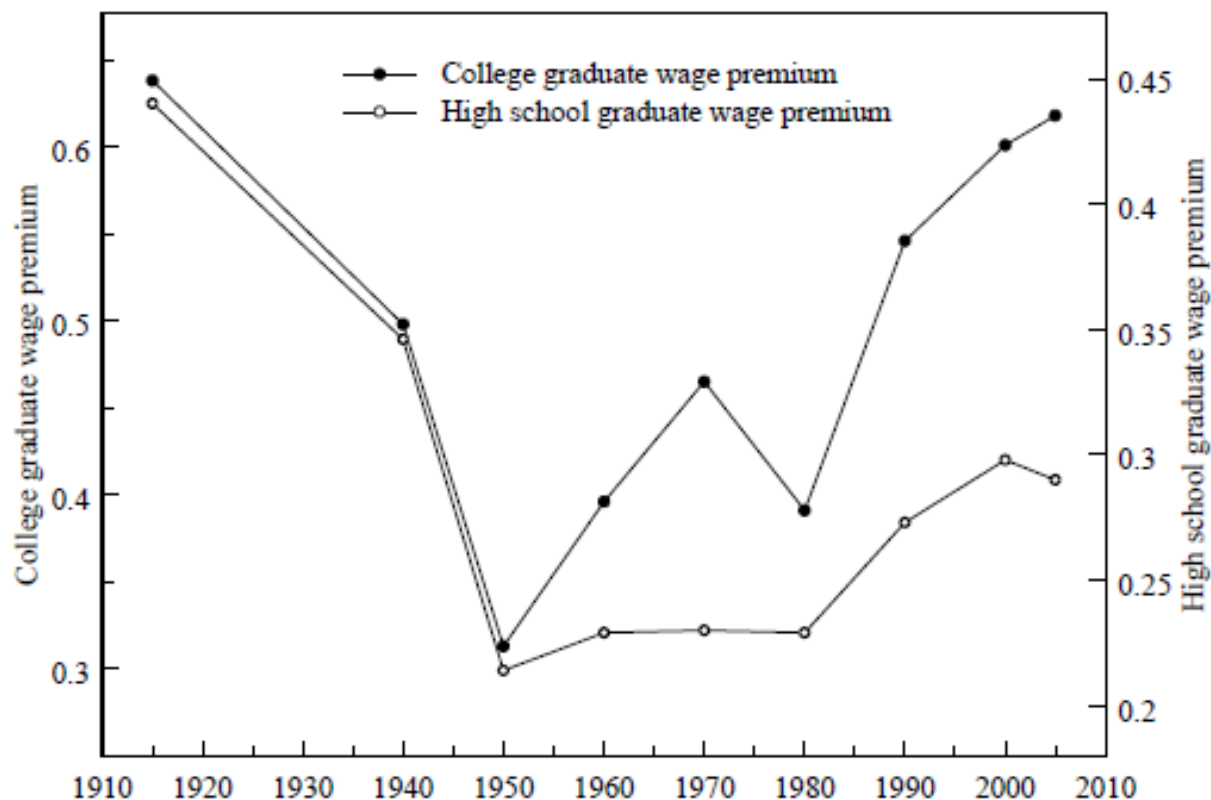
- Heterogeneous effects
  - Ability and education are substitutes. CSL has negative effects on high ability and positive effects on low ability
  - Low returns in England: many at the constraint.
  - Entrance and exit laws: timing matters
- Effects of education on health depend on time and place
  - What is good for health is shifting
  - Returns to education in labor market vary
- Zero sum games
  - Aggregate effects: if supply of educated workers respond with a lag the “overeducated” worker is a possibility (Freeman 1976)
  - If education stands in (partially) for social rank, then level shifts might not matter.
  - Networks of affected students stayed the same in UK, not in US

# Education “effects” depend on stage of epidemiological transition

Figure 1: Coefficient of Education on BMI by GDP



# Returns to education in labor market also vary a lot Goldin and Katz (2010)



Bleakley and Hong (2013): returns to education fell post civil war

# Education “matters” more for those graduating in bad times: Europe

**Table 2: Education, Unemployment Rate and Outcomes in Eurobarometer**

Dependent variables	(1) Income Quartile (1:highest - 4:lowest)	(2) General Poor Health (Yes = 1)	(3) Life dissatisfaction (Yes = 1)	(4) Obesity (Yes =1)	(5) Smoker (Yes = 1)	(6) Daily drinker (Yes = 1)
<i>Panel A. Mean Unemployment Rate around year of graduation (3 years)</i>						
UR when graduating (3 years average)	1.313** (0.372) [0.727]	0.052 (0.134) [0.184]	0.122* (0.072) [0.078]	0.089 (0.128) [0.156]	0.411** (0.120) [0.156]	0.203* (0.123) [0.103]
(Education - 9) * UR	-0.102* (0.053) [0.120]	-0.033** (0.016) [0.018]	-0.047** (0.010) [0.015]	-0.047** (0.019) [0.013]	-0.041** (0.017) [0.030]	-0.028 (0.018) [0.014]
Observations	50,590	28,440	87,450	17,734	48,367	19,656
R-squared	0.259	0.062	0.169	0.036	0.073	0.065

Taken from Cutler et al (2014)



# But early HK interventions have large returns: RT in US

TABLE 1—PROGRAM TREATMENT EFFECTS

Variable	Treatment effect			Control group		Treatment group	
	Effect	Effect size	<i>p</i> -value	Mean	Standard error	Mean	Standard error
<i>Panel A. Males</i>							
CAT total at age 14, end of grade 8	0.566*	0.652	(0.060)	0.000	(0.164)	0.566	(0.204)
Number of misdemeanor arrests, age 27	−1.21**	−0.363	(0.036)	3.03	(0.533)	1.82	(0.445)
Number of felony arrests, age 27	−1.12	−0.324	(0.101)	2.33	(0.554)	1.21	(0.342)
Number of adult arrests (misd.+fel.), age 27	−2.33**	−0.402	(0.024)	5.36	(0.927)	3.03	(0.734)
Monthly income, age 27	0.876**	0.607	(0.018)	1.43	(0.231)	2.31	(0.352)
Use tobacco, age 27	−0.119*	−0.236	(0.093)	0.538	(0.081)	0.419	(0.090)
Number of misdemeanor arrests, age 40	−3.13**	−0.372	(0.039)	8.46	(1.348)	5.33	(1.042)
Number of felony arrests, age 40	−1.14*	−0.266	(0.092)	3.26	(0.684)	2.12	(0.598)
Number of adult arrests (misd.+fel.), age 40	−4.26**	−0.373	(0.041)	11.7	(1.831)	7.46	(1.515)
Number of lifetime arrests, age 40	−4.20*	−0.346	(0.053)	12.4	(1.945)	8.21	(1.778)
Employed, age 40	0.200**	0.394	(0.024)	0.500	(0.085)	0.700	(0.085)
Sample size	72			39		33	

Taken from Heckman et al 2013

# Heckman and Cunha 2007:

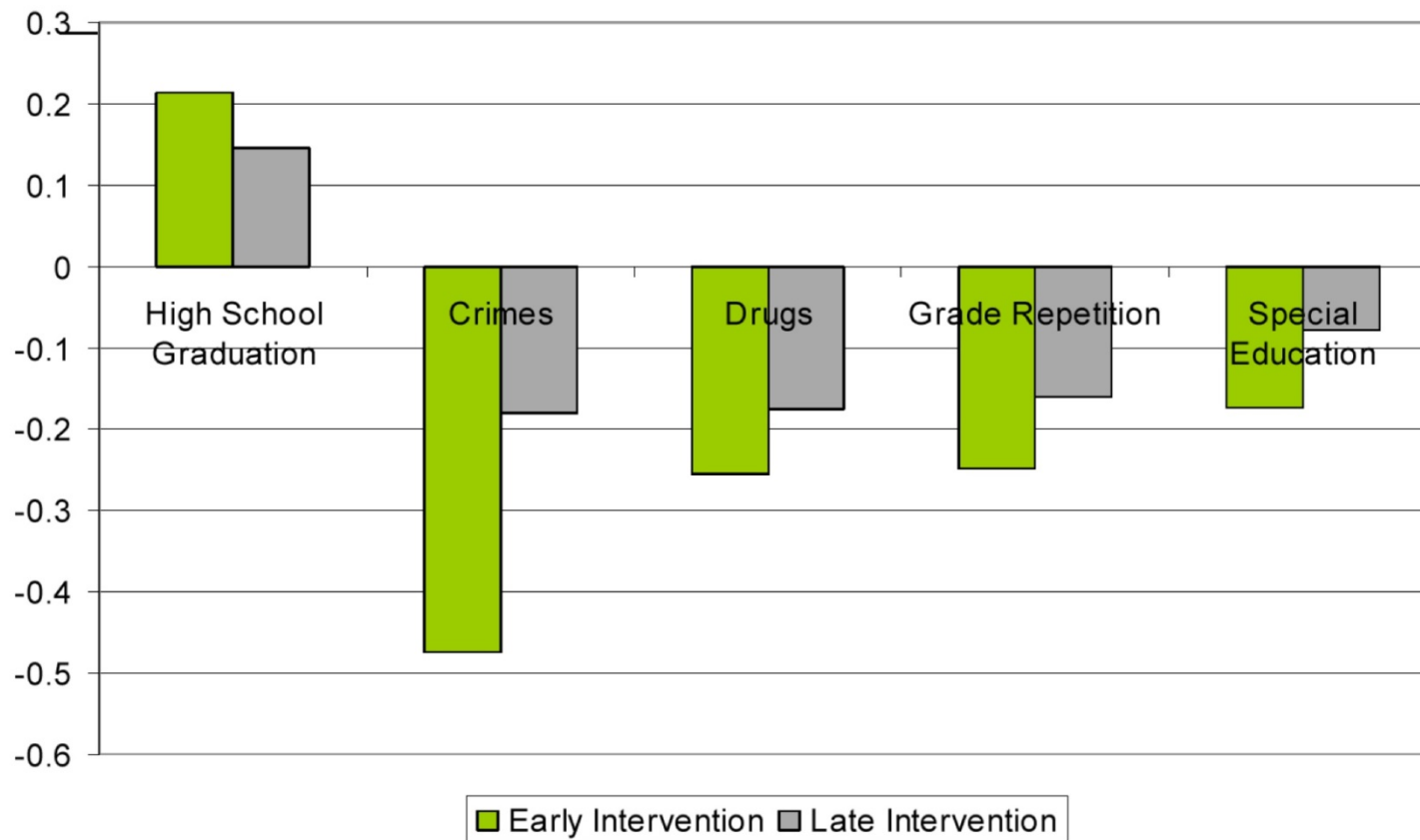
## A model of investments in children

- Gaps in outcomes emerge early
- Returns to non-cognitive skills is large
  - Early HK/education interventions RT in US find wage & health effects.
  - But often no effects on education or IQ measures
- Critical periods
  - Height, language, music, reading, math & social skills
  - differs by skill
  - Credit constraint matter differently depending on age
- Dynamic Complementarity: over time in investments
  - Optimal interventions vary by age & type of skill
  - Return to investment later early in life is greater if followed up by investments late in life

From Cunha and Heckman, 2007



Figure  
Percentage Change as Response to Early or Late Interventions  
Targeted to Children Born in Families Below Poverty Line



# Cunha, Heckman and Schennach 2010

- Estimate model using NLSY

## Findings

1. Cognitive skills are less malleable at older ages
2. Social/soft skills are equally malleable over ages  
Adolescent interventions should focus on these skills
3. No equity-efficiency trade-off for investments at early ages
4. Optimal investment strategy: target the most disadvantaged
5. Ignoring formation of soft skills yields very low estimates of the returns to early interventions.

# Education and Health: a summary

- Education is a well-measured characteristic of countries and people that strongly predicts health
- Education (and its quality, which is correlated) is an excellent summary statistic of ALL investments in children
  - Parental & public
  - Whether education is productive or not, societies and individuals invest in it with the belief it has (private) returns (signaling or not)
- NOT all forms of education matter
  - Returns to other investments might be larger: Sports v math, friends v SAT
  - Timing of investment matters: “critical windows”. quality matters!
- Returns to education on lifetime health depend on
  - How strongly education affects income, cognition, social skills, networks
  - The extent to which these have health returns
  - Several “shocks” (information, Labor market conditions, etc) likely to interact with education: DYNAMICS MATTER
- Unknown factors: Fertility education and cancer

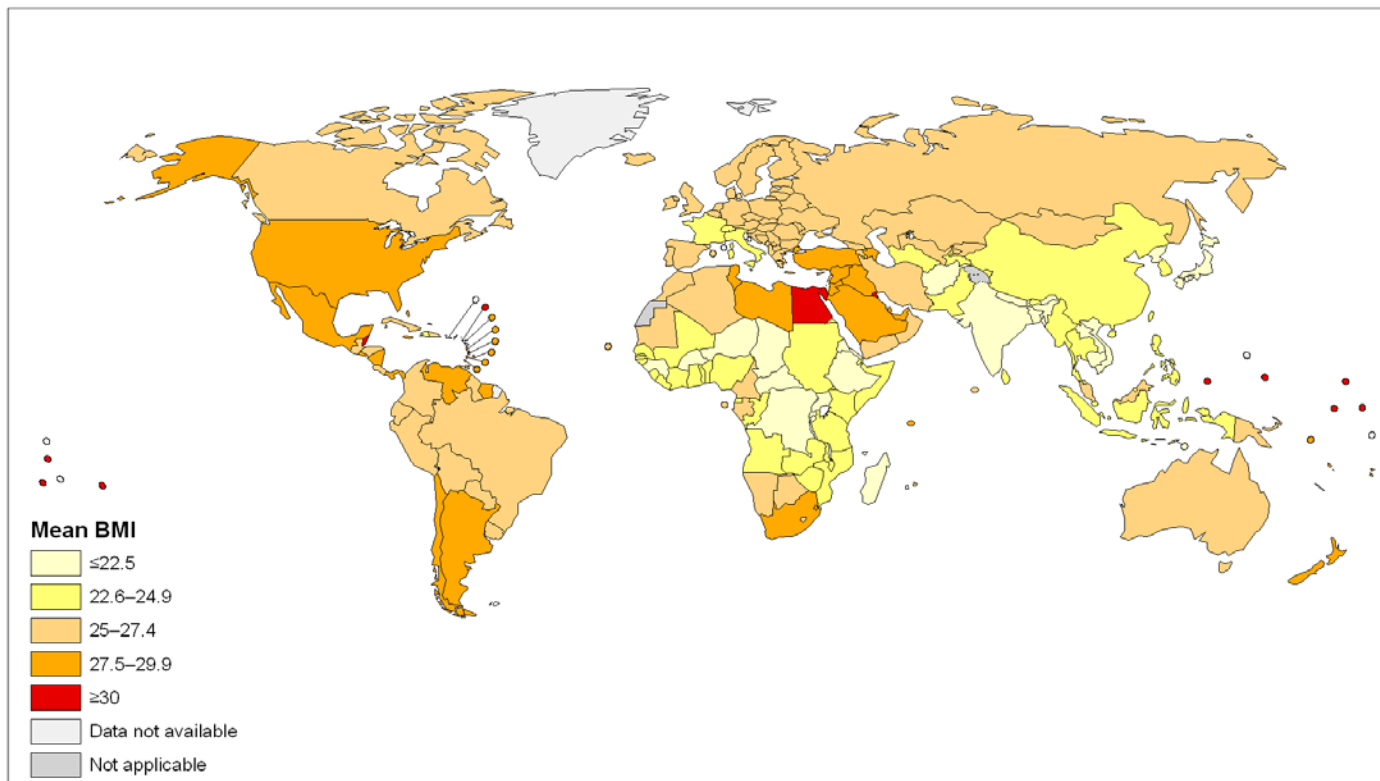


A CLOSER LOOK INTO OBESITY



# Rising in the US and EVERYWHERE else

Mean Body Mass Index (BMI), ages 20+, age standardized  
Females, 2008



The boundaries and names shown and the designations used on this map do not imply the expression of any opinion whatsoever on the part of the World Health Organization concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. Dotted lines on maps represent approximate border lines for which there may not yet be full agreement.

Data Source: World Health Organization  
Map Production: Public Health Information  
and Geographic Information Systems (GIS)  
World Health Organization



World Health  
Organization

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# The facts

- 34.9% (~79M) US adults are obese. 26% children.
- More among poor, uneducated and women.
- Obesity increases risks of diabetes, CVD, some cancers
  - medical costs are ~\$1,400 (or 40%) larger for obese individuals
  - About ½ of total costs are paid by Medicaid and Medicare (Finkelstein et al 2009)

Caloric intake has increased (more than exercise). Why?

- Cutler et al: French Fries! Time cost of calories has decreased dramatically due to technological innovation.
  - How many more calories consumed? About 100-150 a day yield 10-12 lbs increase in median population weight
  - Most comes in the form of snacks. Not from larger meals at home or at restaurants, calories at dinner have fallen.



# How good is the individual rational model?

- prices, information/education, income matter.
  - Time cost of healthy inputs underappreciated
- **BUT** these factors explain only a portion of differences in health
- Do we need better models of (health) behaviors?
  - Some goods are addictive (next)
  - Peers, social circumstance
- Non-individual factors
  - Role of geography and climate
  - Supply of health care varies by area
  - Many health goods are public goods—political considerations matter.
  - Role of institutions more generally: corruption, infrastructure, environment (pollution).
  - Shocks/luck
- INTERACTIONS and DYNAMICS must play an important role

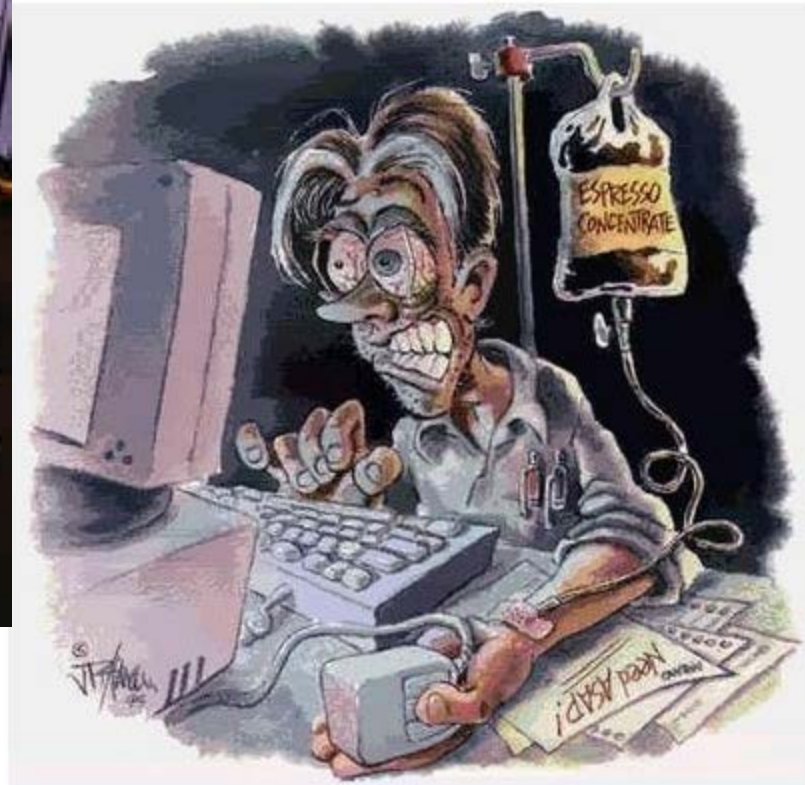
# A different view about health inequality: relative deprivation

- Theory of fundamental causes of disease (Link and Phelan)
- Education/income determines (relative) position in society
  - Higher relative ranking, lower stress (see Sapolsky, rat results)
  - Greater ability to control environment/life therefore better able to change, adhere to complex behaviors, etc.
- Diseases change but gradient remains: targeting particular behaviors ineffective in long run: your position in society determines how long you live relative to others—zero sum game?



20<sup>th</sup> century drugs

21<sup>st</sup> century drugs



# ADDICTIVE GOODS

# How do we think of addictive goods?

- Clinical addiction: alcohol, cocaine, caffeine, marijuana, nicotine, pain killers (opioids and other)
  - Other possibly “addictive” substances/activities: fats and sugars, sex, gambling, TV/internet.
- Large markets despite illegality of some
  - 18% adults smoke today.
  - 7% alcohol abuse (binge drinking, or heavy use)
  - 7% use marijuana currently
  - Prescription drug abuse rising
- Externalities of addiction are often large
  - Car accidents, crime, disease, violence.
  - Medical costs (pooling)
  - Manning, Willard, et. al. (1989) “The Taxes of Sin”: Optimal tax for cigarettes 0.15/per pack, alcohol \$1.19/ounce of alcohol

# What about addiction?

- No consideration in previous approach to fact alcohol and cigarettes are addictive. Policy prescription considers individual as rational and only worries about size of externality.
- Is there an additional role of government in these markets?
  - Rational addiction model (Becker and Murphy): No
  - Hyperbolic discounting & newest models of behavior: Yes
- Implications for optimal taxation are huge:
  - Optimal tax on cigarettes under \$1/per pack or about \$10-30/pack depending on your model/view

# “A theory of rational addiction”, Becker & Murphy, JPE '88

- 

$$U_t = U(Y_t, C_t, S_t)$$

- $Y_t$  = Good
- $C_t$  = Addictive Good
- $S_t$  = Stock of past consumption of C. Utility from consuming C depends on past consumption of C and evolves as:

$$\dot{S} = C_t - \delta S_t - h(D_t)$$

Can spend D to increase/decrease the stock (e.g. Program to quit smoking, program to appreciate wine)

- Good is harmful if we assume

$$\frac{\partial U}{\partial S} < 0$$

# Defining Addiction

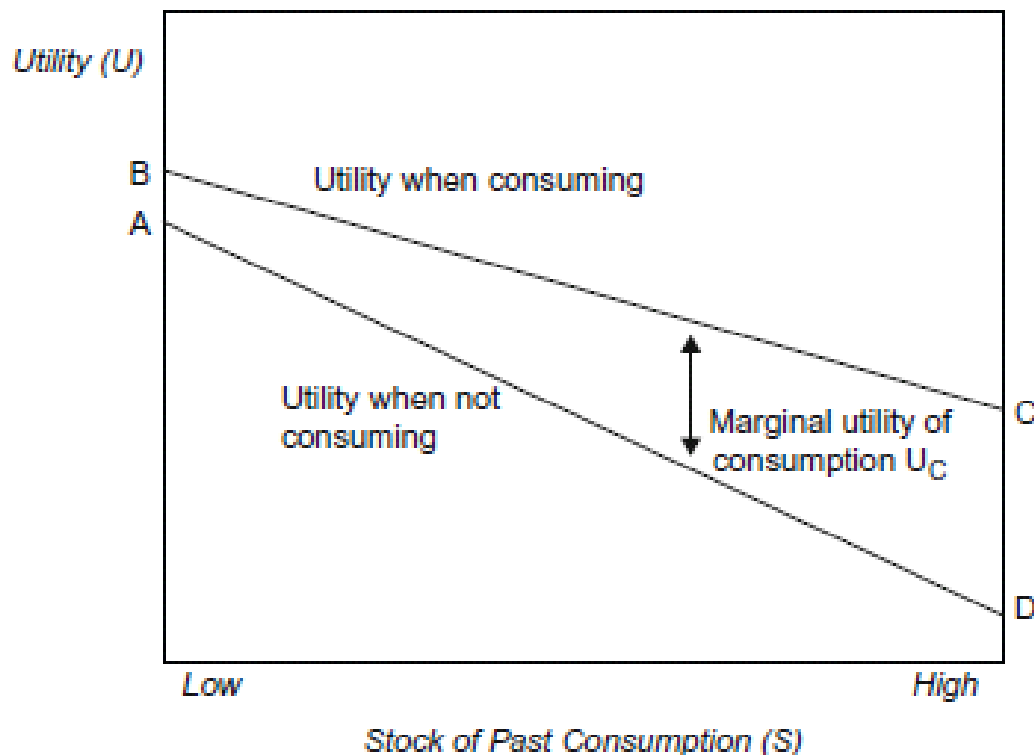
- **ADJACENT COMPLEMENTARITY:** current consumption increases the utility from consuming in the future by more than it increases cost (e.g. negative health effects).

$$\frac{\partial U}{\partial C} > 0, \quad \frac{\partial U}{\partial S} < 0, \quad \frac{\partial^2 U}{\partial C \partial S} > 0$$

- If  $U(c_t, c_{t-1}, x)$  then 
$$\frac{\partial^2 U}{\partial C_t \partial C_{t-1}} > 0$$

- i.e. current consumption and past consumption are complements.

# The shape of addiction



$U$  falls with stock: good is harmful

Withdrawal:  $MUC > 0$ , in current period consumption is better than non-consumption

Marginal utility of  $C$  increases with  $S$ : the more you've done it, the more you want it & the harder it is to quit



Consumer maximizes lifetime utility subject to lifetime budget constraint

$$\int_0^T e^{-\sigma t} U(y_t, C_t, S_t) dt \quad s.t.$$

$$\int_0^T e^{-rt} (y_t + p_t^c C_t + p_t^d D_t) dt \leq A_0 + \int_0^T e^{-rt} w(S_t) dt$$

- T = Life Expectancy
- $\sigma$  = rate of time preference
- A=initial wealth
- S is allowed to affect wages/productivity.
- Full “price” of cost of consuming the “bad” good is known.

# Predictions & Implications

- Addictive goods lead to bimodal dist. in consumption. (Cigarettes & cocaine).
- Addictions are best stopped “cold turkey”
- Stressful/temporary events (e.g. divorce, job loss) can trigger addiction (affect marginal utility of consumption).
- Increases in Prices/Taxes
  - lowers current consumption
  - bigger effect in long term than in short term
- So long as there are no externalities AND individuals are well informed, there is no role for government intervention
  - Taxes LOWER welfare even if they result in lower consumption.

# Some Issues with RA model: what is really different about addiction?

- **Unsuccessful attempts to quit.**
  - “Eight in ten smokers in America express a desire to quit the habit, but many fewer than that actually do quit.
  - Over 80% of smokers try to quit in a typical year, and the average smoker tries to quit every eight and a half months.
  - 54% of serious quit attempts fail within one week.” (Gruber)
- **Self described mistakes**
  - Individuals describe use as mistake, leading to bad outcomes they want to avoid repeating, but can't.
- **Self-control through pre-commitment**
  - Voluntary confinement

→ Inconsistent with perfect control of consumption in RA

→ LR mistakes (repeating patterns known to lower  $u$ ) are not possible in RA

→ Inconsistent with “cold-turkey”: recidivism when largest “cost” of quitting has been paid.

# Gruber and Koszegi (2001): Internalities and time inconsistencies

- Standard preferences

$$\sum_{i=0}^{T-t} \delta^i U_{t+i}$$

- Laibson [1997] Hyperbolic discounting preferences

$$U_t + \beta \sum_{i=1}^{T-t} \delta^i U_{t+i}$$

First period is discounted more than all others

Optimal consumption path today is not optimal tomorrow.

Current self would like to tax future self: internalities

Cost to self should be included in optimal tax.

The tax is greater for naïve consumers.

- A model of hyperbolic discounting consumers can explain
  1. Inability to quit
  2. Use of commitment devices
  3. Also generates “rational” price responses and anticipatory behavior.
    - Evidence on price responses alone cannot be taken as supporting the RA model only.
- Has starkly different implications regarding welfare implications of taxes.
  - Taxes = commitment device, raise welfare.
  - Gruber and Mullanaithan (2005): taxes make smokers happy.

# The problem with taxes

- Demand for cigarettes is inelastic both in the short and long run: taxes are NOT very effective at lowering consumption

EXCEPT for TEENS

- Poor are more likely to smoke: these taxes are very regressive, and make people poorer.
- More generally if addict cannot quit, price increases lead to more externalities (stealing etc).

# Demand for cigarettes is inelastic

**Table 3.7** Estimates of Price Elasticity of Demand for Cigarettes

Category	Variable	Median Price Elasticity	Number of Estimates
Elasticity estimate	Short run	-0.40	368
	Long run	-0.44	155
Aggregation	Country	-0.40	335
	State/province	-0.60	101
	Individual	-0.39	87
Gender	Men	-0.50	24
	Women	-0.34	15
Age	Adult	-0.32	17
	Young adult	-0.76	22
	Teen	-1.43	8

Source: Gallet and List (2003), Table 2, column 1.

EXCEPT for TEENS

# So is the demand for alcohol and illegal drugs

**Table 3.9A** Estimates of Price Elasticity of Demand for Alcohol

Consumption	Mean Price Elasticity of Demand	Number of Estimates
All alcohol consumption	-0.51	91
Beer	-0.46	105
Wine	-0.69	93
Distilled spirits	-0.80	103
Heavy alcohol use	-0.28	10

**Table 3.10** Estimates of Price Elasticity of Demand for Various Illicit Drugs

Addictive Good	Estimate of Price Elasticity of Participation	Estimate of Price Elasticity of Demand Conditional on Use	Source
Marijuana	-0.3		Pacula et al. (2001)
Cocaine	-1.0	-0.3 to -0.4	Chaloupka et al. (1999)
Heroin	-0.89		Saffer and Chaloupka (1999)



# Evidence on self control based policies: smoking commitment

- “Put Your Money Where Your Butt Is: A Commitment Contract for Smoking Cessation” Gine et al
  - *“The product (CARES) offered smokers a savings account in which they deposit funds for six months, after which they take a urine test for nicotine and cotinine. If they pass, their money is returned; otherwise, their money is forfeited to charity. **Eleven percent of smokers offered CARES took-up**, and smokers randomly offered CARES were 3 percentage points more likely to pass the 6-month test than the control group. This effect persisted in surprise tests at 12 months, indicating that CARES produced lasting smoking cessation.”*
  - *“Despite its large treatment effects **a surprisingly large proportion of smokers who voluntarily commit with CARES, 66%, ended up failing to quit**”*
- Demand for commitment in this case low
- Even with voluntary commitment success rate low
- POPULATION Effects small, despite large and significant TT effects.

# Optimal Obesity policy?

- Pigouvian logic: tax BMI outside “normal”
  - Japan’s policy
- Let premiums vary by weight:
  - ACA allows discount if employee enrolled in wellness program
  - regressive
- Taxing soda, sugar: likely to fail.
  - Large costs on consumers that are not obese.
  - Large possibilities for substitution: effectiveness questionable
  - Tax evasion lowers effectiveness
  - Why not tax TV viewing? Fat content? Salt content?
  - Regressive
  - Eliminate corn soybean subsidies?
- Subsidize weight loss?
  - Burger and Lynham (2010): among 51 placed bets on own weight loss
  - Payoffs of more than \$2000, but 80% lost bet.

# Types or circumstances?

- Addiction in previous models considered a characteristic of the person
  - Some goods are addictive to some people
  - Some people are “rational” others are not. Then naïve v sophisticated
- Individual behavior is often inconsistent over time
  - RA model allows for “shocks” to utility
  - Hyperbolic discounter is always discounting too-much.
- Individual behavior is different across domains
  - Hyperbolic discounters make “mistakes” in all domains.
  - This is inconsistent with small correlation within individuals in health behaviors (Cutler and Glaeser )

# “Addiction and Cue-Triggered Decision Processes”

## Bernheim and Rangel (2004)

Additional observations on the nature of addiction:

- Cue triggered recidivism
    - reminders/associations with times/places when consumption took place trigger recidivism. Moving helps.
- Like stressful events in RA, but different definition of stressor
- Self-control through behavioral and cognitive therapy
    - Cue avoidance: Adopting new lifestyle
    - Cue management: refocus attention when triggered (prayer)
    - Successful programs often do not provide any new Information
- Changing preferences/decision making, rather than prices or information.

# Key intuitions from neuroscience

1. Hedonic forecast mechanism HMF
  - Learns to anticipate reward from cues (smell will trigger forecast). Larger rewards increase level of anticipated response. Trigger precedes consumption.
2. HMF does not necessarily increase pleasure, and pleasure does not necessarily activate HMF.
  - Separate hedonic system (wanting versus liking)
3. HFM influences choices.
  - Pursue triggers. Follow smell.
4. Frontal cortex FC: slower but also influences choice and overrides HFM for longer term harder decisions (eg change in environment).
5. “addictive” substances: HMF over-predicts and is more likely to override FC

Neuroscience emphasizes “decision-process” effects rather than hedonic effects emphasized in RA (tolerance and withdrawal)

- Other examples: Fudenberg and Levine (2006) “A dual model of impulse control” AER.
  - “Our theory proposes that many sorts of decision problems should be viewed as a game between a sequences of short run impulse selves and a long-run patient self”
- Although these decision systems appear in conflict, they are in fact complementary: fast and efficient v slow and deliberate.

# Model implications

- Consumption can be a mistake (but isn't always)
- Experience sensitizes individual to environmental cues than later trigger “mistakes”
- Individuals recognize “mistakes”
  - Demand commitment device (bring preferences in line with choice)
  - learn to avoid cues
- Adjacent complementarity is not necessary to generate addiction. Shoplifting not a stock.
- Although individuals make mistakes, they also make rational decisions (cold state) and can have sophisticated strategies

# Policy Implications

- Criminalization and taxation
  - Price sensitivity is small because not all use is deliberate. Taxes are ineffective particularly with peer pressure etc.
  - Increase cost of addiction and possible externalities (crime)
  - They hurt deliberate consumers
- Education/information
  - Prevention yes
  - Treatment: unlikely
- Harm reduction policy
  - Needle distribution
  - Subsidizing rehabilitation centers
  - But increases experimentation & use

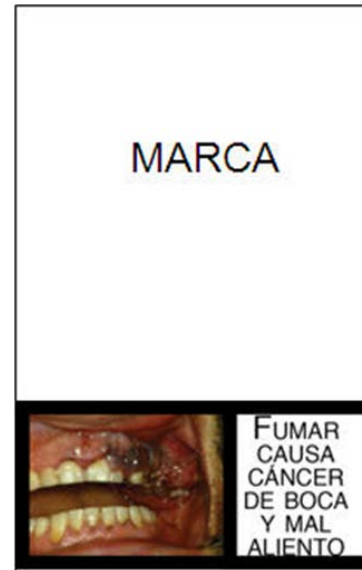


- Regulation of use

- Restricting use in locations lowers triggers.
- Lowers exposure.

- Regulating cues

- Restrict advertising
- Create counter cues



- Increase likelihood of self-regulation while minimizing compulsory “choices”. Increase “cognitive” regulation policies

# Some comments

- What is the empirical content of this model?
- Welfare evaluations:
  - If preferences and behavior diverge, then the standard “revealed preference” approach is no longer valid.
- Children and adolescents: In almost all countries, smoking, drinking, sex, obesity start in adolescence
  - Should we treat adolescents/children differently?
  - What is the optimal exposure path to eg alcohol?
- peer effects are not part of this framework
  - Peer effects in initiation, cessation and consumption are thought to be large.

# Deviations from rationality in non-addictive areas

- Circumstances matter more generally: Decision making worsens under poverty/hunger “Poverty impedes cognitive function”
- Low probability events: difficult to evaluate (prospect theory, Kahneman and Tversky 1979)
- Substantial inertia, particularly in complex decisions involving uncertainty



ON SOCIAL INTERACTIONS

# Peer effects in risky health behaviors

Case and Katz (1991) “like begets like”. Why?

- Shared resources: money, information
- Norms/peer pressure
  - individuals are punished when they deviate from the group norm. Similar to peer pressure.
  - Anti norms (rebels, “economics of acting white”, snob)
- Learning models
  - observe neighbor and learn from his experience (agriculture)
- Endogenous preference formation
  - married people & TV consumption
- Coordination games
  - War of the sexes, elevators

# Why do we care about endogenous social effects?

- They generate “social multipliers”, spillovers.
- Policy interventions should take this into account.
  - the amount of advertising needed to convince youngsters not to smoke could be quite small if peer effects are large and we can convince a few that smoking is bad.
  - Also important in understanding optimal group design.
- Help us understand behavior of markets, diffusion of technology.
- Multiple equilibria

# Manski's Reflection problem

- Mean regression of y on x and z:

$$E(y | x, z) = a + bE(y|x) + c E(z|x) + d x + e z$$

- y=outcomes
- x=characteristics used to define a group
- z=observed attributes that affect y
- u=unobserved attributes that affect y
- $b \neq 0$ : b is an endogenous social effect
  - the mean outcome for the group determines the outcome for individual i.
- $c \neq 0$ : exogenous/contextual effect:
  - outcome for individual i varies with the mean of Z in the group
- $d \neq 0$ : correlated effects:
  - persons in group behave similarly because they have similar unobserved characteristics (selection) or face similar environments (common shocks)

# Using random roommate assignment: Sacerdote 1996

- What is the equation of interest?

$$GPA_i = b + b_1 * ACA_i + b_2 * ACA_j + b_3 * GPA_j + e_i \quad (1)$$

$$GPA_j = b + b_1 * ACA_j + b_2 * ACA_i + b_3 * GPA_i + e_j \quad (2)$$

- Where  $b_2$  is the contextual effect and  $b_3$  is the endogenous effect.
- Does random assignment of roommate solve the identification problem?



# How could you separate endogenous and contextual effects?

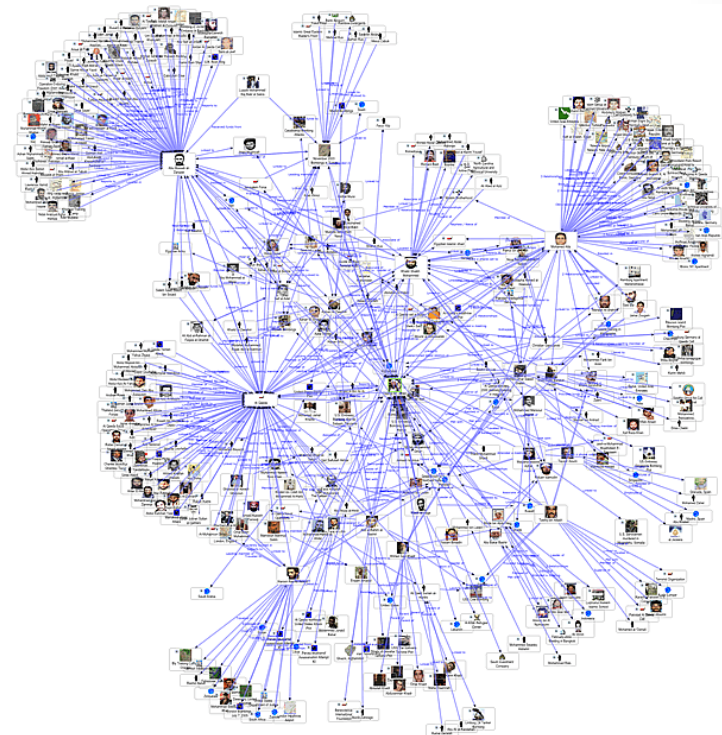
- You would need an additional intervention that directly affects your roommate's GPA *without moving anything else*, like for example tutoring. (essentially require an “**exclusion restriction**” )
- “Is poor fitness contagious?” Carrell et al. (2011)
  - randomized assignment of students at the U.S. Air Force Academy to squadrons (groups of 30 with whom cadets spend most of their time) (N=13,000)
  - A s.d. increase in the high school fitness scores of peers raises college fitness score by 0.165 s.d.
    - ~ 40% of effect of own high school fitness.

# Networks: Looking more into dynamics and motives of social interactions

- Explicitly model how individuals affect each other, in particular network formation
- There is a close connection between the theory of network formation and the characteristics of the network.
- The decision to consume is affected by the network and affects network in turn

# Network formation

- Random has certain “baseline properties” we can test & reject
  - Non-random: needs modelling.
- If decision to “connect” is strategic then games
  - Standard game theory
  - actions are either strategic complements or substitutes
- Multiple equilibria issue



# Carrell, Sacerdote, and West (2013).

- Estimate peer effects across cadets within squadrons using random assignment from the U.S. Air Force Academy.
- These peer effects were non-linear:
  - Low (baseline) ability students appeared to benefit significantly from being in the same squadron as high-ability students, with limited negative effect on high-ability students.
- constructed “optimally designed” squadrons based on results
  - exposure of low-ability cadets to high-ability ones was maximized by creating “bimodal” squadrons.
- Result: LOSSES among low-ability cadets.
- WHY? Intervention affected sorting
  - Low-ability and high-ability cadets may have stopped working and being friends in the bimodal squadrons. As a result, the peer effects from high-ability to low-ability cadets weakened or disappeared, leading to negative results.

# Joint estimation of formation and treatment effects

- Smoking cessation diffusion in the Framingham study: monotonic effects

<http://www.nejm.org/doi/full/10.1056/NEJMsa0706154>

- Obesity diffusion in the Framingham study: network clusters. Monotonic effects

<http://www.nejm.org/doi/full/10.1056/NEJMsa0706154>

- Theory provides some guidance:
  - Infectious diseases versus other models



WHAT ABOUT GENES?

# Genes, social science and policy (Manski)

- Heritability studies

$$Y = g + e \text{ (Outcome= genes + environment)}$$

$$\text{Var}(Y) = \text{var}(g) + \text{var}(e) + 2 \text{cov}(g,e)$$

If  $\text{cov}=0$ , then  $\text{var}(g)/\text{var}(y)$  : fraction explained by genetic factors

- $\text{Cov}=0$  unlikely assumption
- Linear model without interactions: unlikely
- Twin and family studies find many psychological and economic measures are moderately heritable ( $\approx 30\text{-}50\%$ ).

# Heritability is not a useful policy concept

- Eyesight might “heritable” but eyeglasses can be developed.

“if it were shown that a large proportion of the variance in eyesight were due to genetic causes, then the Royal Commission on the Distribution of Eyeglasses might as well pack up. And if it were shown that most of the variation in rainfall is due to natural causes, then the Royal Commission on the Distribution of Umbrellas could pack up too.”

- Targeting is: does having a gene/trait modify/predict the effect of a given intervention?
  - Does not require “causal” interpretation of genetic “role”

“[I]t would seem evident that our interest lies in purposive manipulation of the x's in order to effect an improved performance in terms of y. We can, and should, ask for the expected change in y induced by spending some specific amount of money (or political capital, man hours, etc.) on working a change in X2, say, as compared with the alternative of spending the same sum on X3. Budgetary cost is not necessarily the only basis of comparability. But unless some such basis is defined and its relevance to policy explained, the question of "strength" has no meaning”

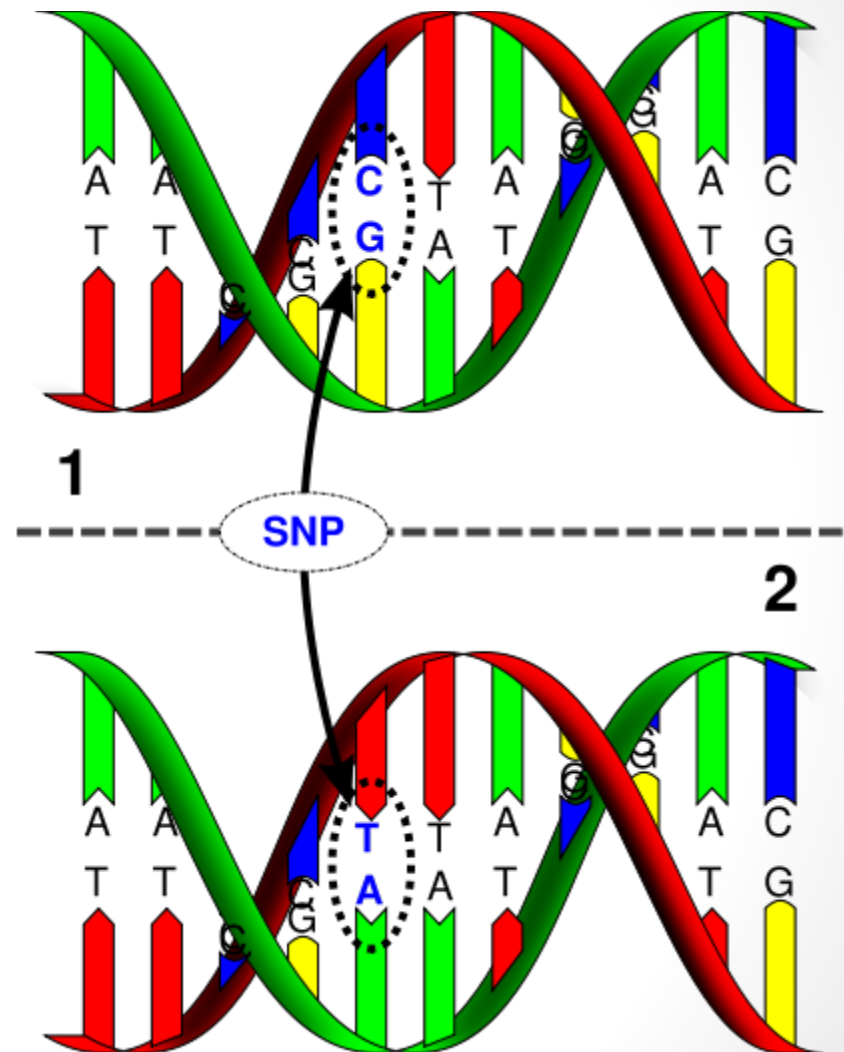


# How about finding specific genes?

## Genetics Primer

- Human DNA is a sequence of ~3 billion nucleotide molecules (in 23 chromosomes).
- This human genome has 20,000-25,000 subsequences called **genes**.
- Genes provide instructions for building proteins that in turn affect body function.
- At the vast majority of locations, there is no variation in nucleotides across individuals.

- **Single-nucleotide polymorphisms (SNPs):**  
Nucleotides where individuals differ (a small % of all nucleotides).
- At vast majority of SNP locations, there are only 2 possible nucleotides:
  - **major allele** (more common)
  - **minor allele** (less common).
- From each parent, may inherit either allele; SNP unaffected by which received from whom.
- **Genotype** for each SNP:  
#minor alleles (0,1,2).



# Genetic Effects

- Let  $i$  index individuals;  $j$  index SNPs.
- Let  $y_i$  denote some outcome of interest.
- Best linear approximation to true model:

$$y_i = \mu + \sum_{j=1}^J \beta_j x_{ij} + \epsilon_i.$$

$\mu$  : population mean of the outcome.

$x_{ij}$  : genotype  $\in \{0,1,2\}$  of person  $i$  for SNP  $j$ .

$\beta_j$  : effect of SNP  $j$ . *Typically  $j=0.5-2.5$  million.*

$\epsilon_i$  : effect of residual factors.

# Interpreting Genetic Effects

- $\beta_j$  is the average treatment effect from changing an individual's SNP at conception.
  - Experiment is done in animals;
  - hypothetical in humans (so far..."Is the Gene-Editing Revolution Finally Here?")
- Average over distribution of genotypes and environments.
  - If include  $G \times G$  and  $G \times E$  interactions, combinatorial challenges.
  - To limit hypotheses tested, find "main effects" first.
  - How to control for "race/population"?

**Not necessarily a structural parameter; e.g., could be environmentally mediated.**

- E.g. sweat

# Discovering Genetic Effects

- A naïve approach would be to run the regression

$$y_i = \mu + \sum_{j=1}^J \beta_j x_{ij} + \epsilon_i.$$

- Even if one could measure all  $J$  SNPs in the genome, would fail the rank condition.
- It is standard to instead run  $K \ll J$  separate regressions,

$$y_i = \mu + \beta_j x_{ij} + \epsilon_i$$

for each of  $K$  SNPs.

- If SNPs uncorrelated, get unbiased estimates.
- In fact, issue of identifying causal SNP.

# Identification Issues

- “the number of observable genetic and environmental variables available for use as covariates will no doubt exceed the size of humanity before too long”
- More “potential” explanatory variables than observations.
  - AKA “curse of dimensionality”
  - Science = parsimony = approximation that is “useful”
- If we include gene interactions and environment\*gene interactions the model can never be estimated—need for parsimony

# Candidate-Gene Study ( $K$ small)

- Specify *ex ante* hypotheses about small set of SNPs based on believed biological function.
  - Set significance threshold  $\alpha = .05 / K$ .
- Virtually all existing work in social-science genetics.  
(Reviews: Ebstein, Israel, Chew, Zhong, and Knafo, 2010; Beauchamp et al., 2011; Benjamin et al., 2012)
  - Has worked (e.g., *APOE* and Alzheimer's)
- But social-science results often fail to replicate.
  - Weak hypotheses (except for highly proximal behaviors).
  - Low power (in the small samples typically used).
  - Population stratification.
  - Uncorrected multiple hypothesis testing / publication bias.

# Most Reported Genetic Associations With General Intelligence Are Probably False Positives

Christopher F. Chabris<sup>1</sup>, Benjamin M. Hebert<sup>2</sup>, Daniel J. Benjamin<sup>3</sup>,  
Jonathan Beauchamp<sup>2</sup>, David Cesarini<sup>4</sup>, Matthijs van der Loos<sup>5</sup>,  
Magnus Johannesson<sup>6</sup>, Patrik K. E. Magnusson<sup>7</sup>, Paul Lichtenstein<sup>7</sup>,  
Craig S. Atwood<sup>8</sup>, Jeremy Freese<sup>9</sup>, Taissa S. Hauser<sup>10</sup>,  
Robert M. Hauser<sup>10</sup>, Nicholas Christakis<sup>11,12</sup>, and  
David Laibson<sup>2</sup>

BIG DATA issue

FMRI, claims/admin data, Text/web:  
Facebook



# The DEAD FISH: what is the correct p-val?

- One mature Atlantic Salmon participated in the fMRI study. The salmon was approximately 18 inches long, weighed 3.8 lbs, and was not alive at the time of scanning.
- The salmon was shown a series of photographs depicting human individuals in social situations with a specified emotional valence. The salmon was asked to determine what emotion the individual in the photo must have been experiencing.
- Stimuli were presented in a block design with each photo presented for 10 seconds followed by 12 seconds of rest. A total of 15 photos were displayed. Total scan time was 5.5 minutes.

1-Multiple testing

2-N observations versus number of tests?

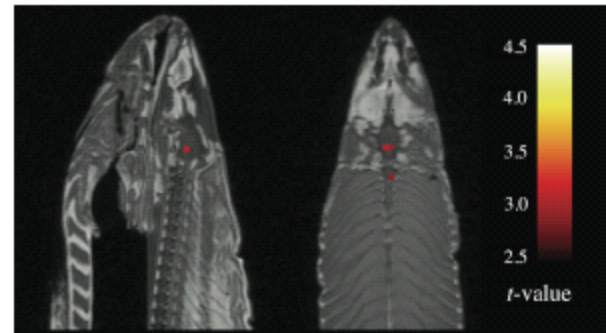
3-CLUSTERING matters, in particular

CLUSTERING ACROSS dimensions:

What is the “real” unit of observation?

4-what is the signal to noise?

## GLM RESULTS



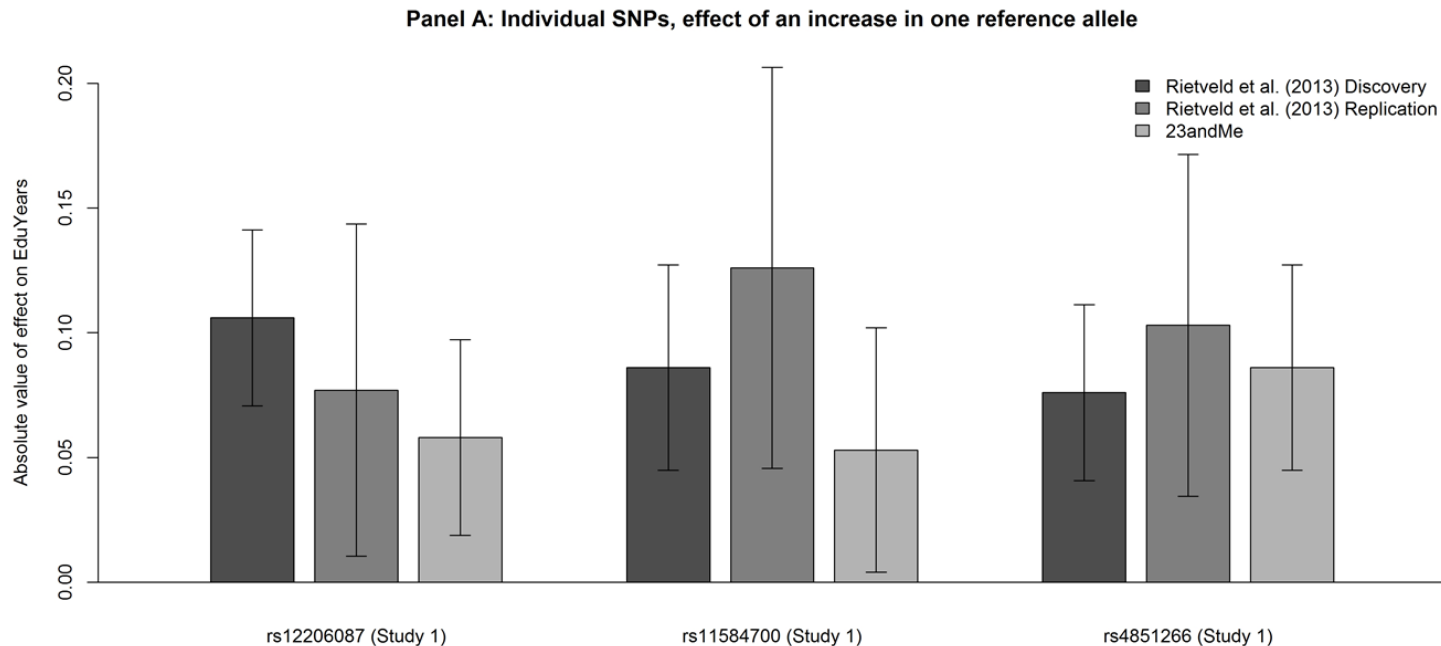
A  $t$ -contrast was used to test for regions with significant BOLD signal change during the photo condition compared to rest. The parameters for this comparison were  $t(131) > 3.15$ ,  $p(\text{uncorrected}) < 0.001$ , 3 voxel extent threshold.

- “Can we conclude from this data that the salmon is engaging in the perspective-taking task? Certainly not. What we can determine is that random noise in the EPI time series may yield spurious results if multiple comparisons are not controlled for. (...) We argue that relying on standard statistical thresholds ( $p < 0.001$ ) and low minimum cluster sizes ( $k > 8$ ) is an ineffective control for multiple comparisons.”

# Genome-Wide Association Study (GWAS) ( $K$ large)

- **A-theoretical** testing of all SNPs measured on the chip (typically 0.5-2.5 million).
- “consortia” meta-analyze results from GWASs in many samples
  - novel gene discover now requires very large samples ( $> 30,000$ ) for top journals
  - Set significance threshold  $\alpha = 5 \times 10^{-8}$  (since  $\approx 1$  million independent SNPs in genome).
- Some advantages of GWAS:
  - Hypothesis-free design makes the need to correct for multiple hypothesis testing transparent.
  - It is possible and standard practice to control for principal components of the GWAS data—helps with major potential confound of population stratification.

# Three SNPs Genome-Wide Significant and Replicate for education Rietveld et al (2013)



- Years: difference between those with 0 and 2 minor alleles is  $\approx$  2 months of educational attainment.
- College: difference in probability of college completion  $\approx$  3.6%.
- Effect size  $R^2 \approx 0.02\%$  an *order of magnitude* smaller than for complex physical / medical traits  $\rightarrow$  greater power challenges!

# Sobering

- Individual effects small
  - Power issues large: Important for design and conduct of studies
  - positive effects from small sample studies should be viewed with caution.
- How to adjust for SE?
  - Family, gene, sets of genes?
- We know almost nothing
  - Use of genes as instruments likely premature (and likely invalid)
- Role of interactions not known but thought to be large
  - Interactions across SNPs and with environment
  - Functional form?

# Exciting areas of research: Data-Mining and computer learning

## LARGE DATA CHALLENGES

- DIMENSION reduction, model selection, Instrument selection: SPARSE MODEL
  - Belloni, Chen, Chernozhukov, and Hansen (Econometrica, 2012)
- MODEL FIT: LASSO & Machine learning
- Who should know about your genes?
  - Cost of genotyping ~100 per person and falling.
  - Google Genomics and others
  - Implications for behavior and insurance markets

# AEA CONTINUING EDUCATION PROGRAM



**HEALTH ECONOMICS**  
JONATHAN SKINNER, DARTMOUTH

**JANUARY 5-7, 2015**

# Health Economics III: Competition, Provider Behavior, and Supply-side Productivity

Jonathan Skinner

[jon.skinner@Dartmouth.edu](mailto:jon.skinner@Dartmouth.edu)

AEA Continuing Education, January 5-7<sup>th</sup>, 2015

# Thanks to.....

- Leemore Dafny
- Cory Capps
- Gautam Gowrisankaran
- Heidi Williams

For their excellent teaching slides....



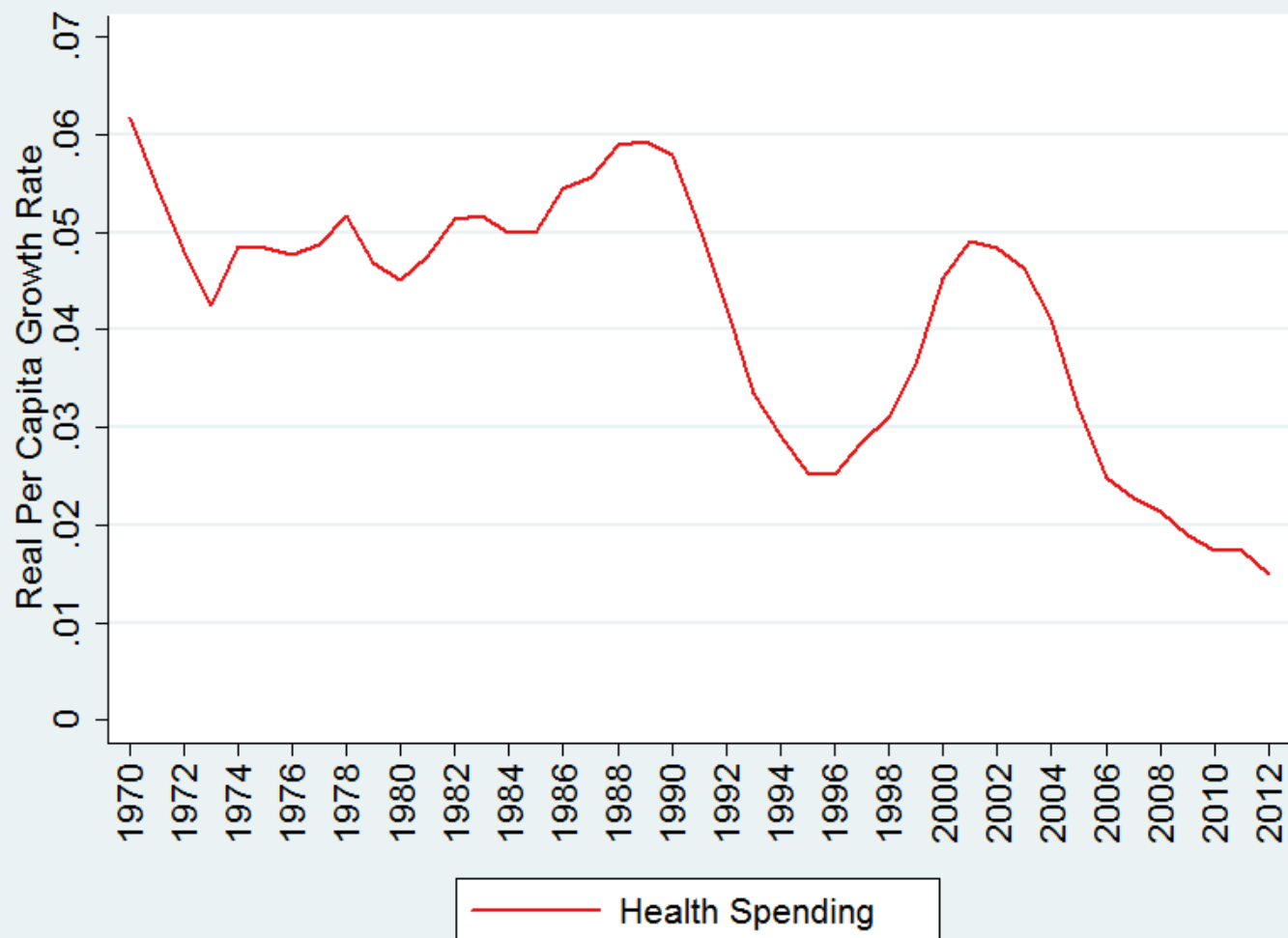
# Course Objectives

- A. To understand *recent* papers in three areas:
  - 1. Hospital competition, insurer competition, and bargaining
  - 2. Health care provider: Economic incentives and behavior
  - 3. The efficiency and productivity of health care systems
  
- B. To discuss potential research topics that remain shrouded in mystery

# Course Objectives

- A. To understand *recent* papers in three areas:
  - 1. Hospital competition, insurer competition, and bargaining
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  - 3. The efficiency and productivity of health care systems
- B. To discuss potential research topics that remain shrouded in mystery
- C. *To answer Jon Gruber's question about where health care costs are going....*

# Per capita growth of health care expenditures



Source: Chandra, et al, BPEA 2013

# Optimism from health experts...

...a good metaphor for the US health care system today is the opening sweeping panorama [in *The Sound of Music*] followed by the crescendo of Julie Andrews' voice singing "The Hills are Alive" with the sound of care process redesigns and incentive changes designed to make better outcomes sustainable at lower total cost.

*Len Nichols, congressional testimony, 2013*



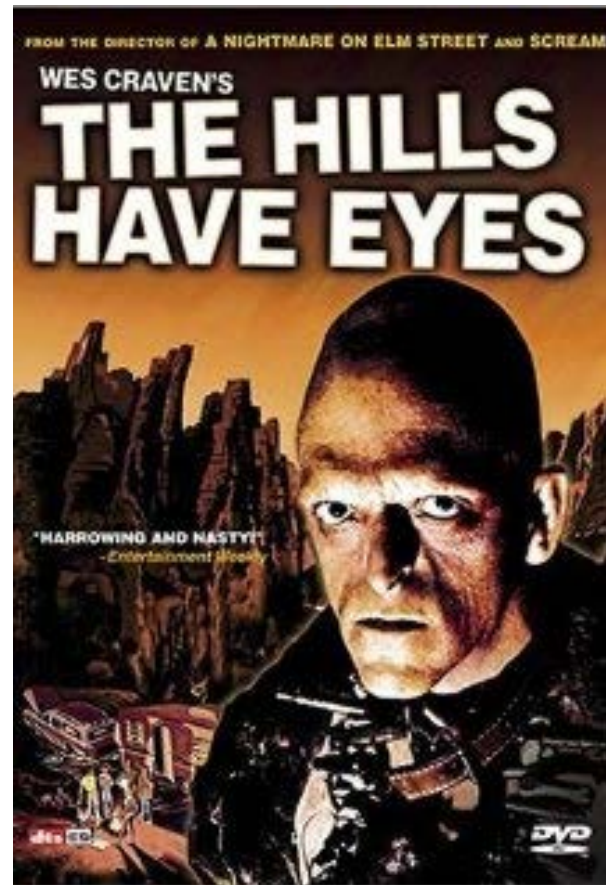
# I'm not so optimistic....

## The Hills are Alive

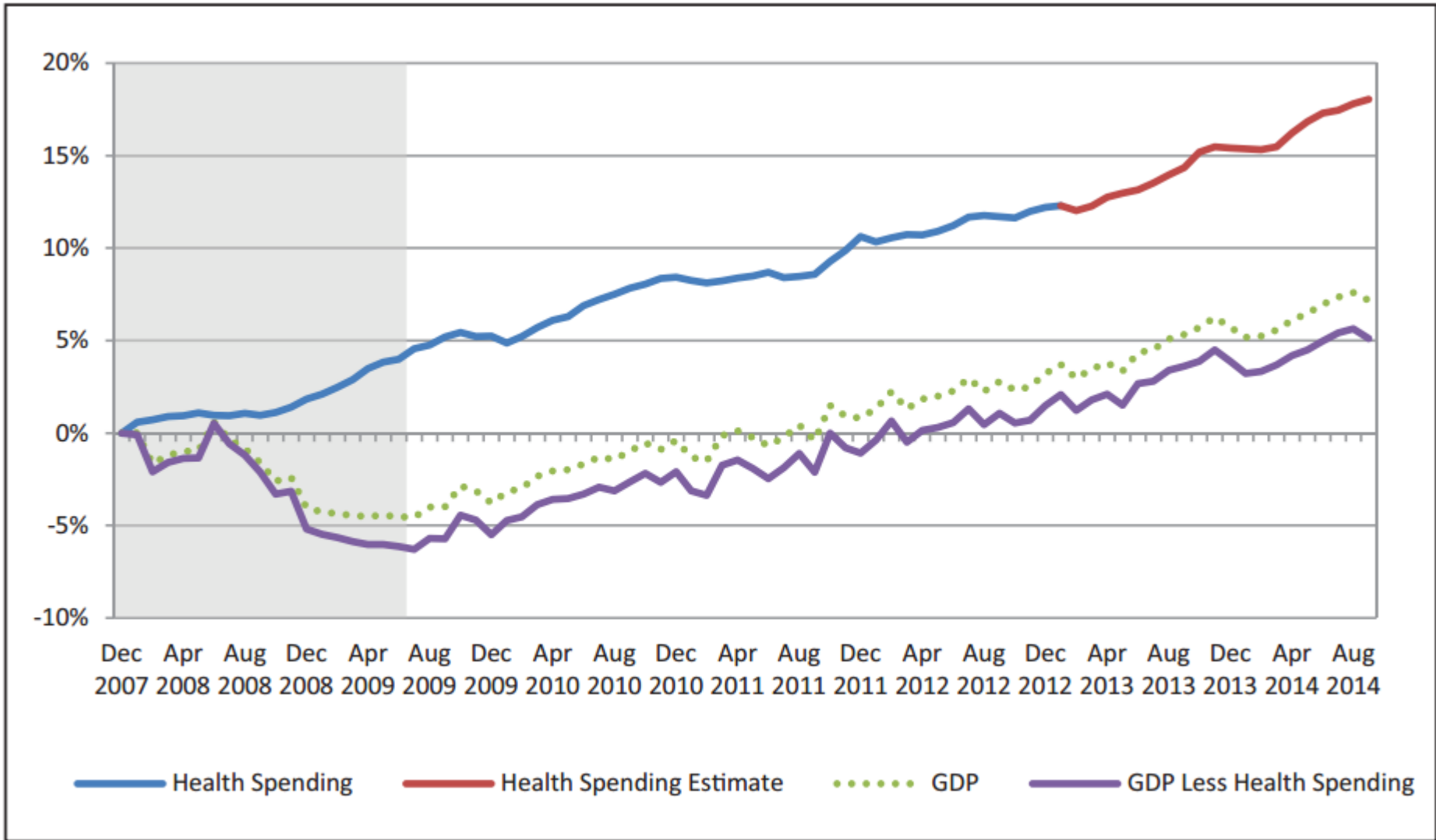


I'm not so optimistic....

The Hills are Alive, or....

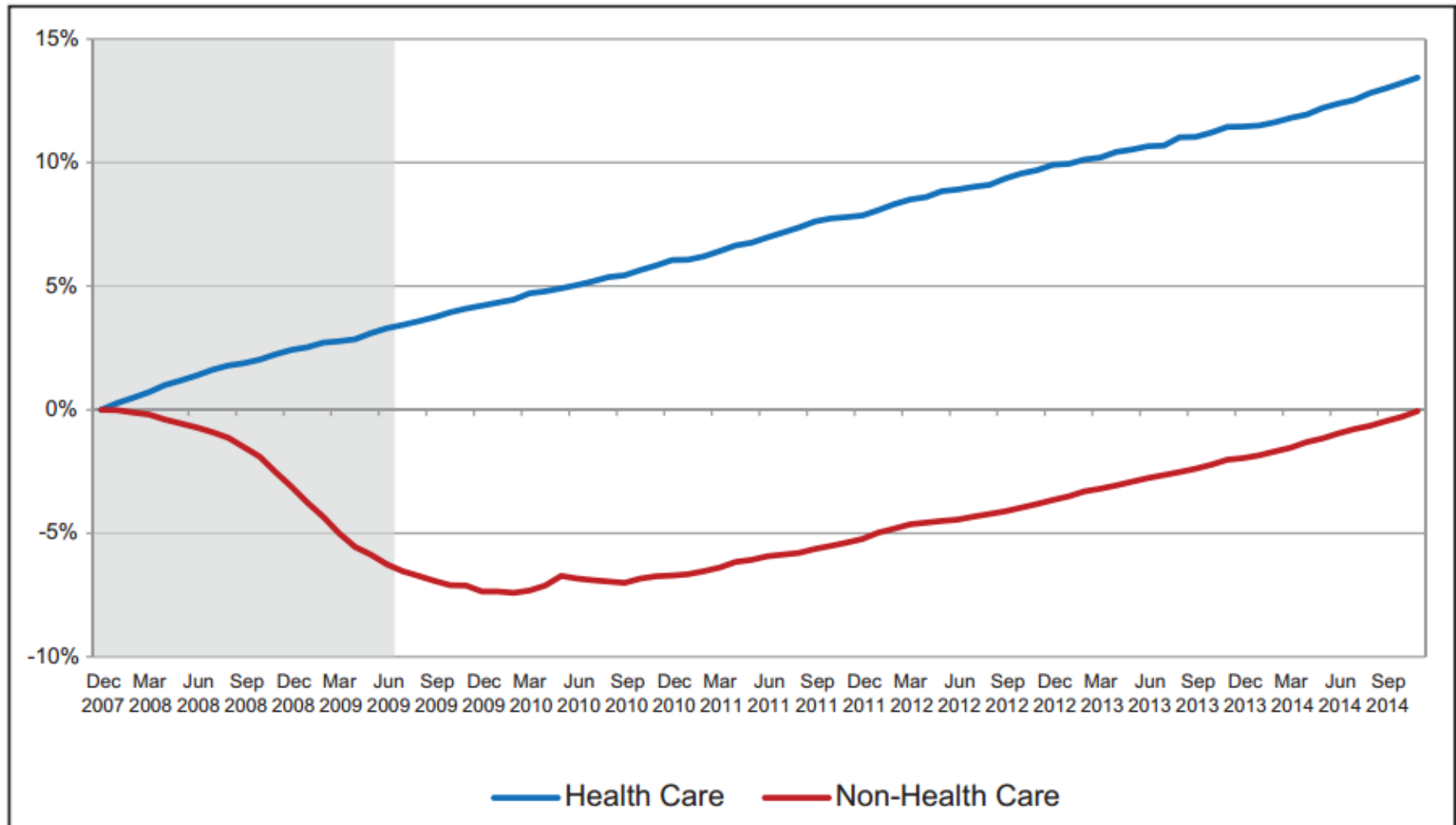


# Altarum Institute: Health Spending v. GDP





# Health Care and Non-HC Employment (2007=100)



Source: Altarum Analysis of BLS Data

Note: Shading indicates recession period



# 1. Hospital Competition, Insurer Competition, and Bargaining in Health Care

J. Skinner AEA 1/6/14

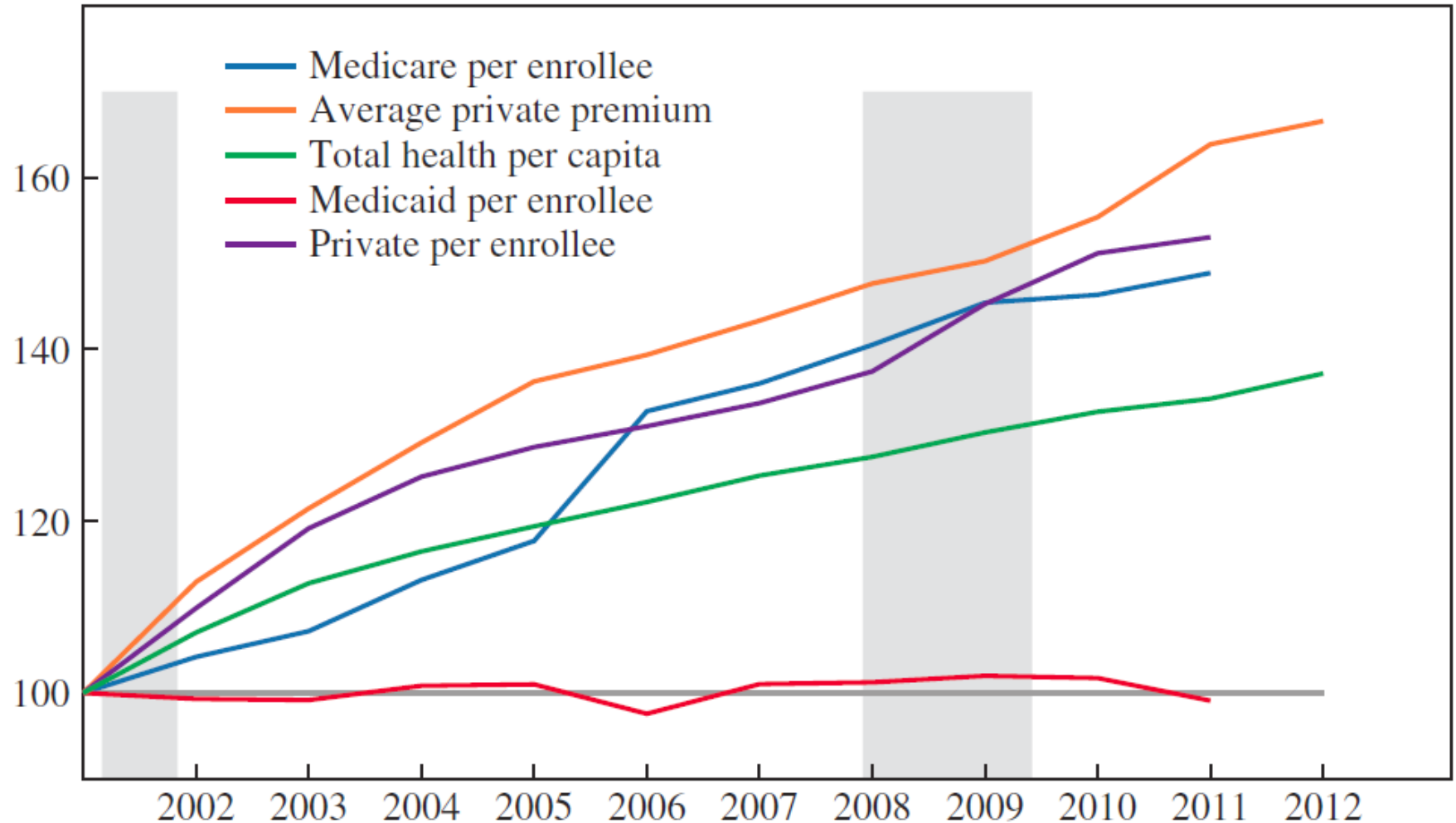
# Consolidation in US Hospitals, 2011

	Percentage <sup>a</sup>
Hospital data (N = 4973) <sup>b</sup>	
Hospitals in a health system	60
No. of hospitals in typical system	3.2
Offering nonhospital services	
Home health care	60
Skilled nursing facilities	37
Hospice services	62
Assisted living care	15
Mergers and acquisitions <sup>b,c</sup>	
No. of deals	432
No. of hospitals	832
Ownership of physician practice <sup>d</sup>	
By hospitals	49
By physicians	41
Other <sup>e</sup>	10

Source: Cutler and Scott-Morton, 2013

# Health Insurance Premiums: Most Rapid Component of Health Cost Increase, 2001-12

(2001 = 100)

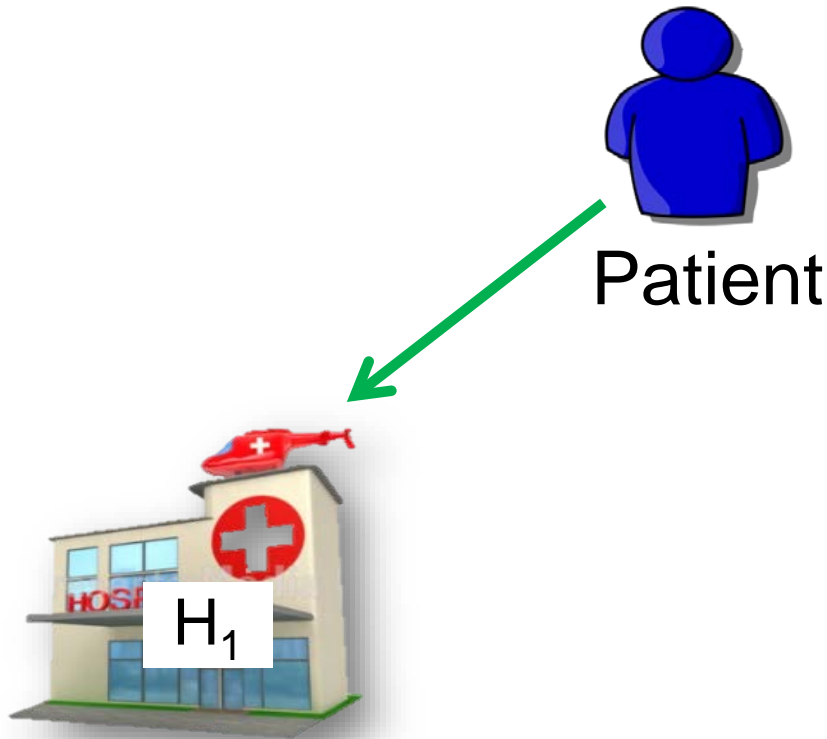


Source: Chandra, Holmes, and Skinner, BPEA 2013

# Questions addressed in this section...

- Hospital have consolidated and “accountable care organizations” (ACOs) are on the rise
  - What is the likely impact of consolidation on quality of care?
  - What is the likely impact of consolidation on prices charged by hospitals and physician groups?
- There has been considerable consolidation in the health insurance industry.
  - What is the likely impact on insurance premiums and margins?

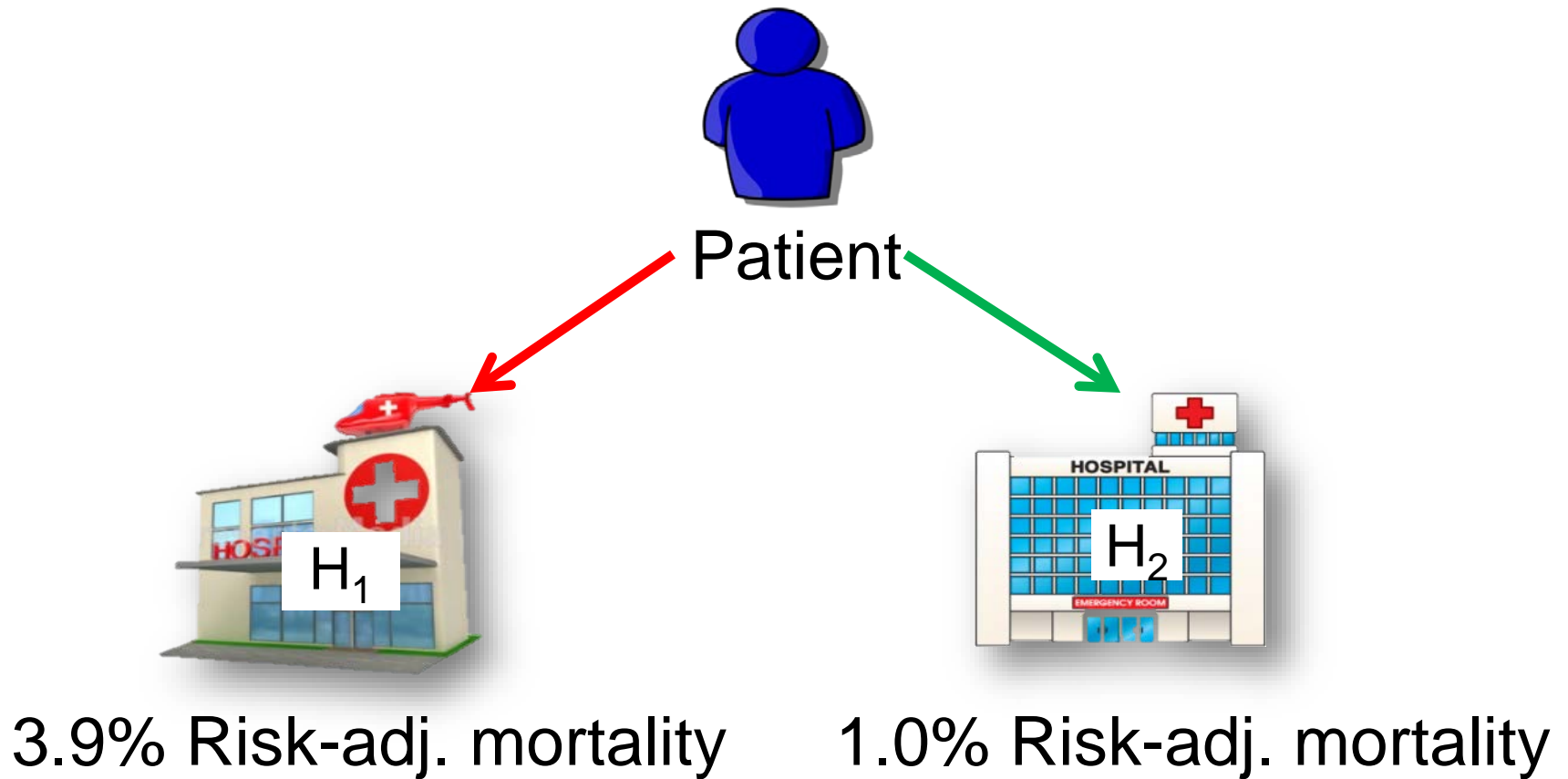
# What is the Impact of Competition on Quality?



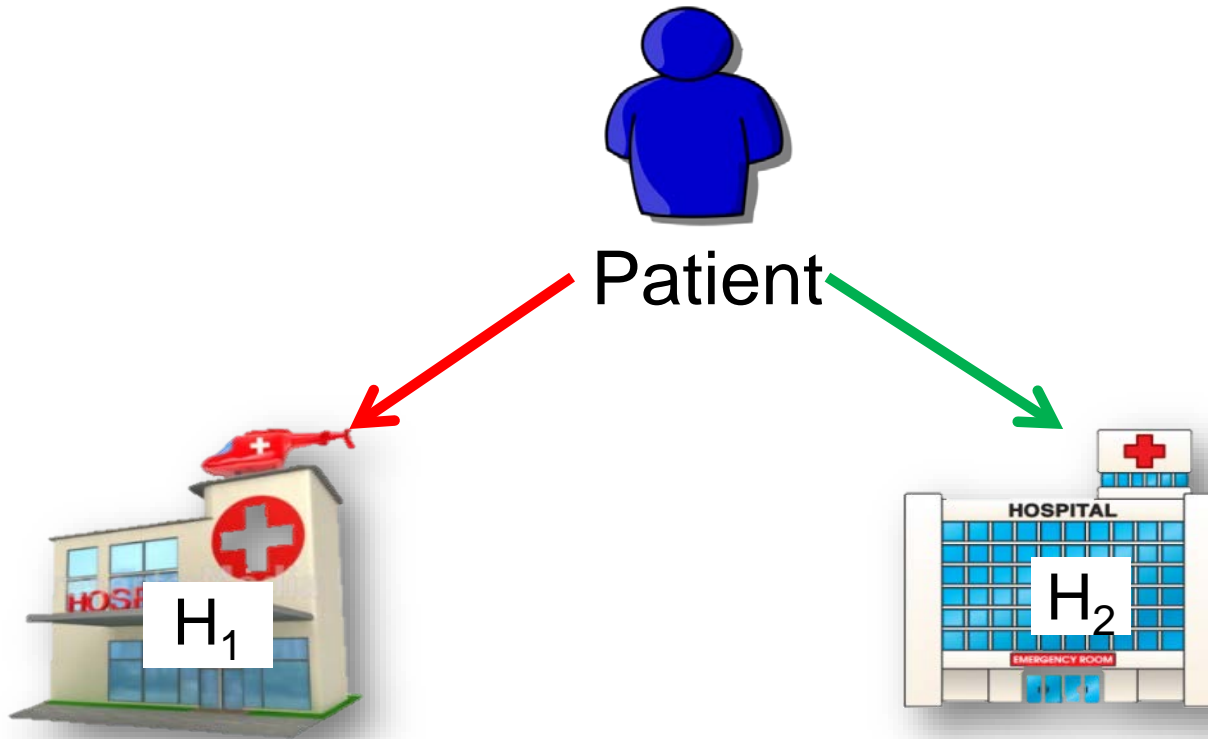
3.9% Risk-adj. mortality

*Note: We are holding prices constant (e.g., Medicare)*

# First-Order Impact: More Choice



# Second-Order Impact: Slackers Gets Better



2.5% Risk-adj. mortality?

1.0% Risk-adj. mortality

# First-order Condition for Hospital Quality

$$Q_j = \{P - MCx_j\}(\eta_s + \eta_D) [X_j / MCq_j]$$

- $Q_j$  is quality for hospital  $j$
- $P - MCx$  is price minus marginal cost of increasing the number of patients ( $X$ )
- $\eta_s, \eta_D$  are elasticity of market share ( $s$ ) and overall market demand ( $D$ ) with respect to quality
- $MCq$  is the marginal cost of improving quality by one unit

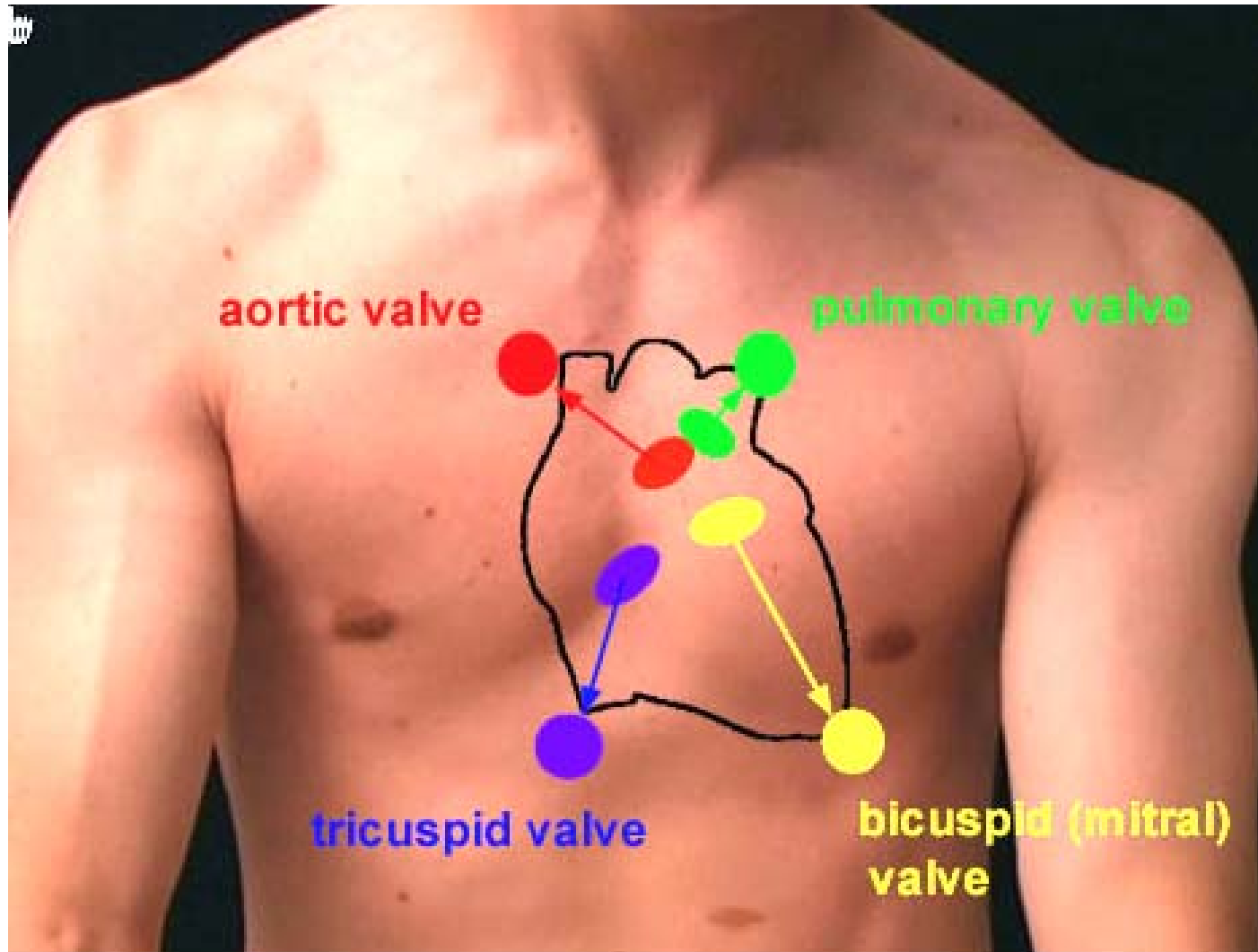
Source: Gaynor and Town, Handbook of Health Economics II, 2012



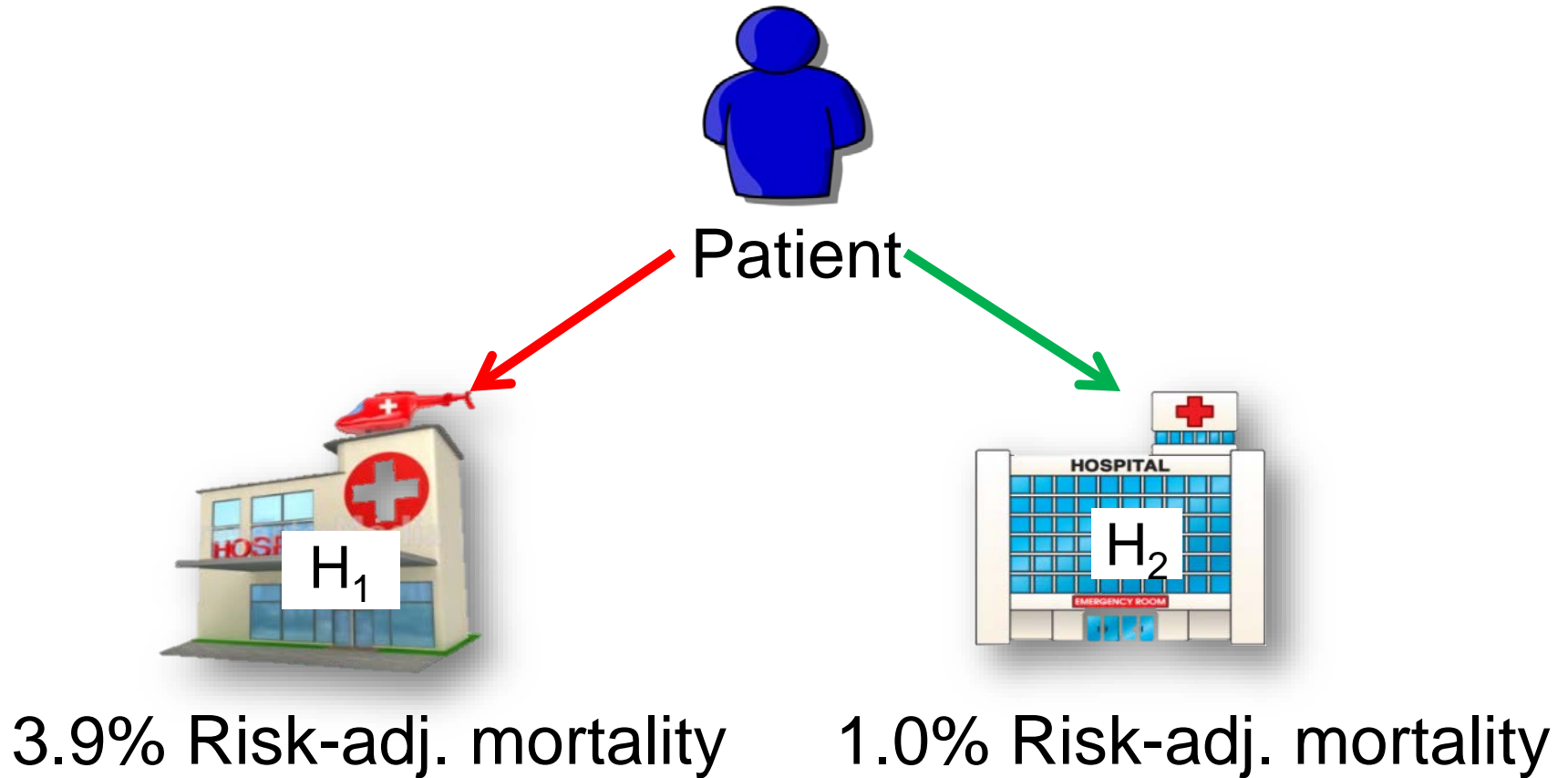
# Results All Over the Map

- Competition improves quality
  - Propper et al. (2004); Cooper et al. (2011); Gaynor et al., (2013), Bloom et al., (2011), Kessler and McClellan (2000)
- Competition does not improve quality
  - Feng et al., JHSRP, 2014; Propper et al. (2008), Colla et al., 2015, Gravelle et al. (2012) – mixed evidence, Capps (2005), Ho and Hamilton (2000)
- *Theoretically perhaps not so surprising....*
  - Brekke et al., Scandinavian J, 2011; M. Katz, IJIO, 2013

# Many Studies Focus on Heart Attacks (AMI)



# Common assumption: Heart attack mortality proxies for other dimensions of hospital quality



# Yet Correlation Among Quality Measures Low

<i>Variable</i>	AMI Mortality	Hip – Comp.	Knee – Comp.	Dementia - Tube
30-Day AMI Mortality	1			
Hip – Any Complication	0.007	1		
Knee – Any Complication	0.019	0.162	1	
Dementia – feeding tube	0.061	0.056	0.063	1

Source: Colla, Bynum, Austin, and Skinner, 2015; also see Gravelle et al., 2012

# Limitations of the standard model...

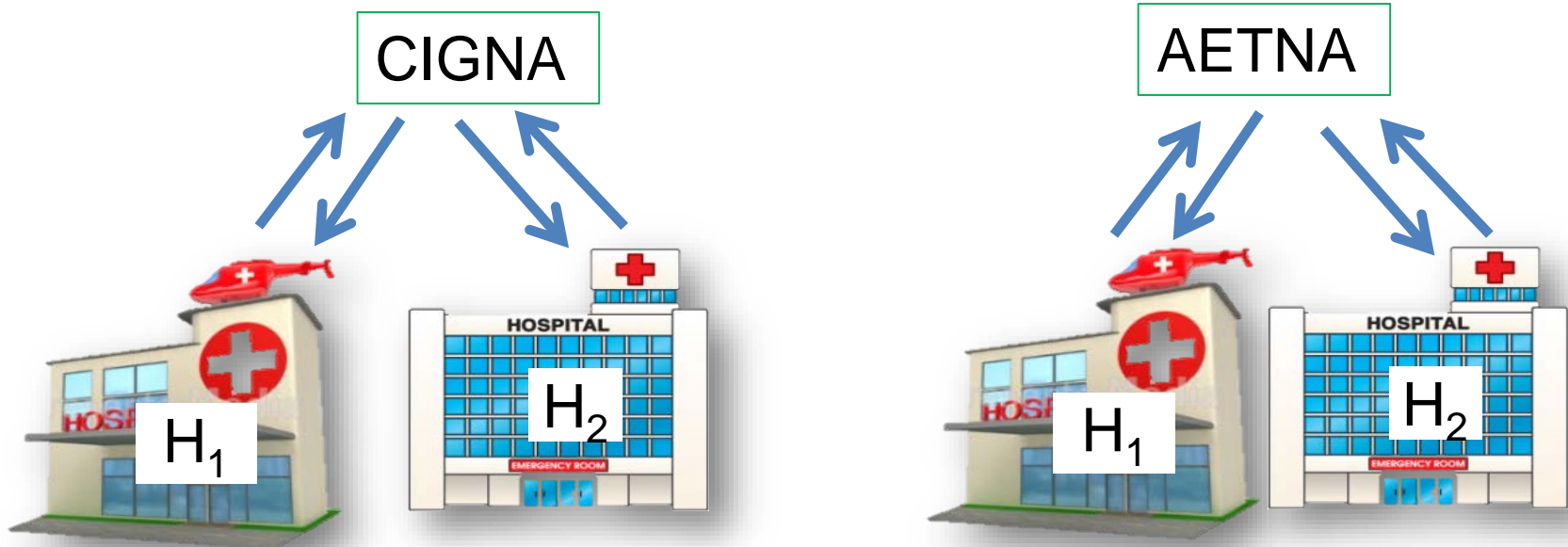
Hospitals may compete on more than clinical quality:

- Amenities (valet parking)
- Networks to capture high-margin procedures
- Billing more (upcoding, additional services)

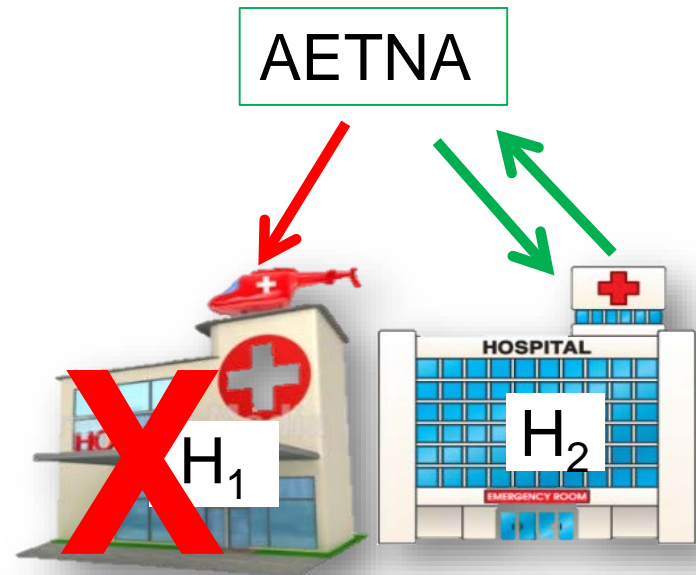
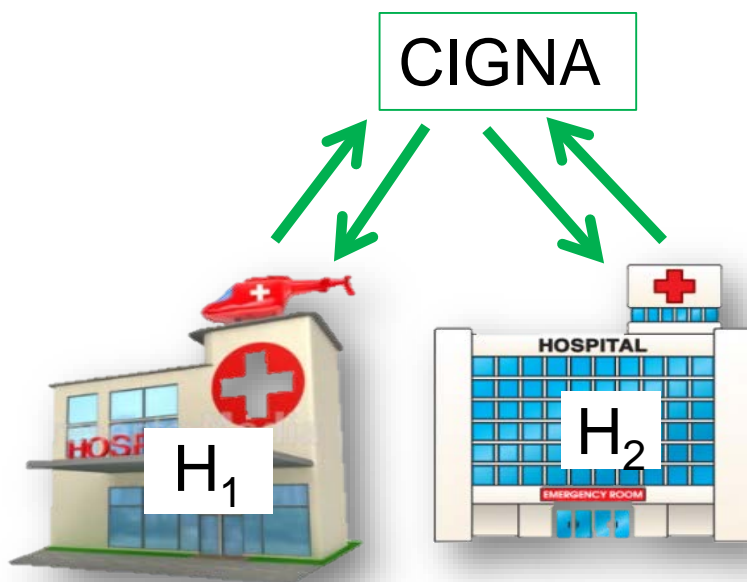
# Question: Do Hospital Mergers Raise Price?

- A seemingly straightforward question
- Early studies (e.g., Conner, Feldman, and Dowd, 1989) found modest (if any) effects of mergers
- Dafny (JLE, 2009): Cleaner test: “Colocation” as an instrument for a merger
- Ho (AER, 2009; JAE, 2006) develop structural model of competition between insurance plans and hospitals

## Model: Insurance Plan First Negotiates with Hospitals on Price and Network Inclusion



# Aetna Excludes $H_1$ From Network





# What happens when you go “out of network”



Menu

Shop

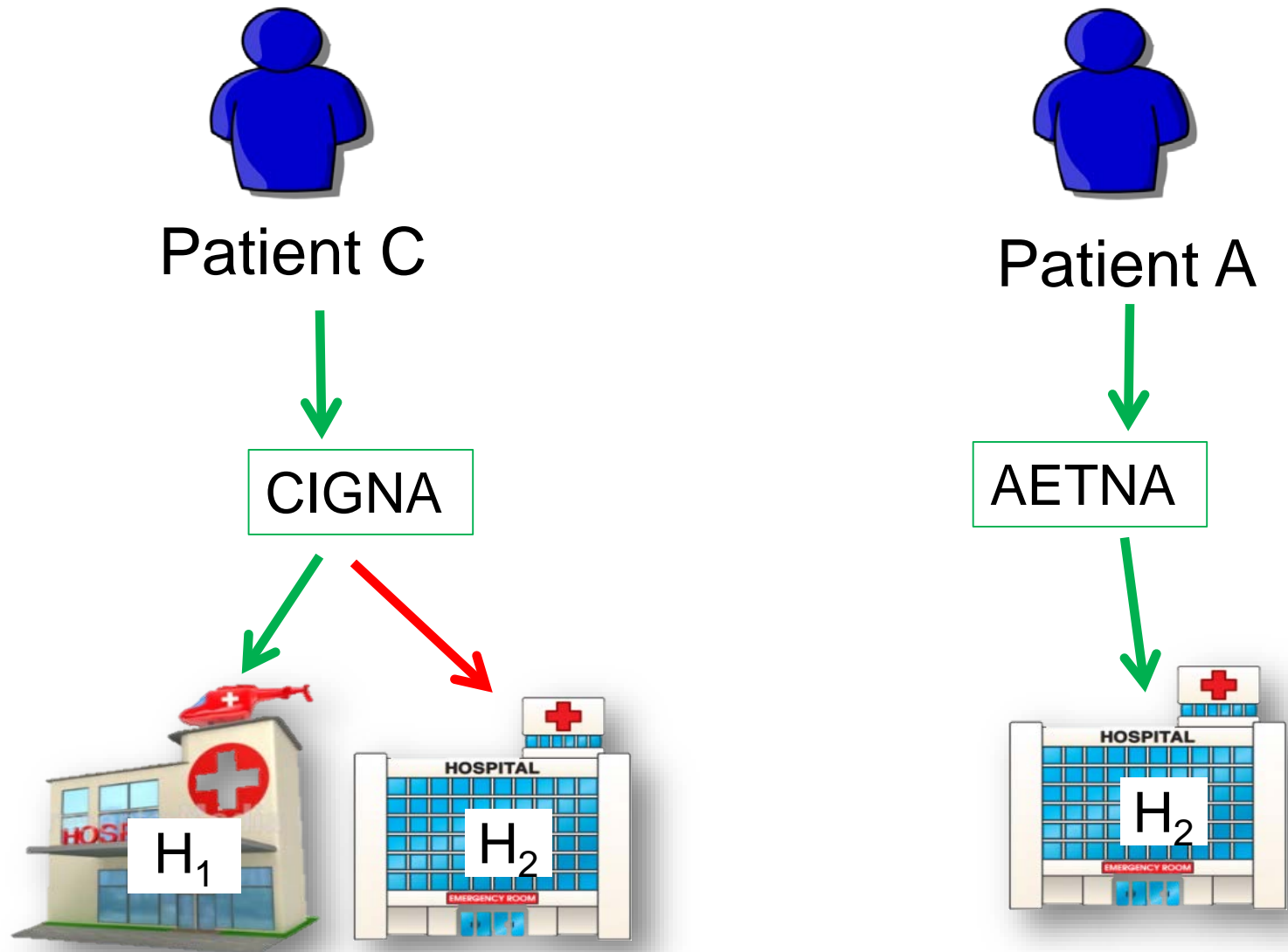
Log In/Register

C

## How Aetna Pays Out-of-Network Benefits

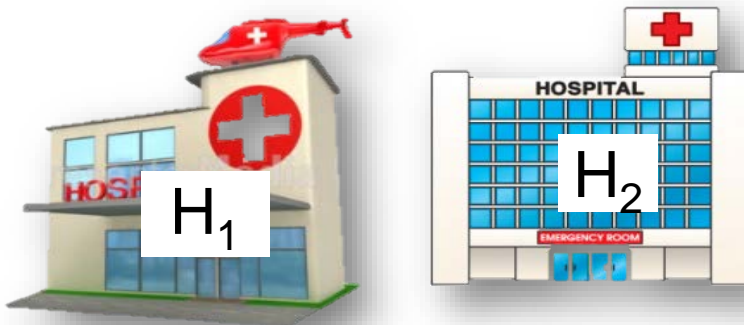
In this example, you had an office visit with an out-of-network doctor. The doctor charged \$250 for your visit. The Aetna Out-of-Network Rate for the service you received is \$100, so that is the “allowed” amount. Your plan will then pay 60% of \$100, which is \$60. The doctor may bill you for the difference between her charge and what Aetna pays.

# Patient Chooses Hospital, Given Network & Disease

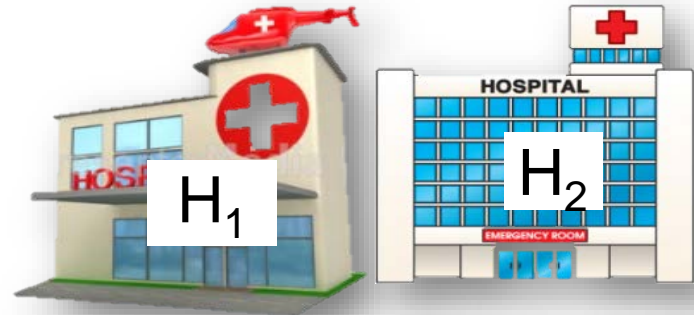


# How Does Aetna Decide to Contract (or Not) with Hospital H1?

CIGNA



AETNA



# Willingness to Pay: A Definition

- The difference between the value of a network that includes a given hospital (or system) and one that does not:

$$WTP \text{ for Hospital } X = \text{Value of Network With } X - \text{Value of Network Without } X$$

- Example:
  - Network that includes all hospitals is worth \$10 million to consumers (gross value)
  - Network that includes all hospitals except Hospital X is worth \$8 million
  - ➔ An insurer would be *willing to pay* up to \$2 million to include Hospital X

Source: Capps, Dranove, and Satterwaite, 2003

# WTP Applied to Merger Analysis

- Two hospitals can have low stand-alone WTPs
- *But if* they are close substitutes, then together, they can have much higher WTP
  - A network that excludes *both* may be of substantially less value than a network that excludes just one
  - Example:
    - WTP for Hospital 1: 4,000
    - WTP for Hospital 2: 1,000
    - WTP for Hospital 1 *and* Hospital 2: 6,000 (an extra 1,000)
    - The Increase in WTP = WTP for (Hospitals 1 & 2) – (WTP for Hospital 1 + WTP for Hospital 2)

Source: Capps, Dranove, and Satterwaite, 2003

# Quiz: Choose the Most Likely 2-Hospital Merger

- A. MSK Cancer Center
- B. Special Surgery Hospital (Ortho)
- C. Large Academic Hospital “C”
- D. Large Academic Hospital “D”



Hint: What is the “diversion ratio” for each of the 6 possible mergers?

# GNT: Structure of Bargaining

- Network hospitals and prices decided via bargaining game
- There are  $M \times S$  contracts
  - Contract is for unique MCO ( $m$ ) and hospital system ( $s$ ) pair
  - Contract specifies all negotiated base prices for its pair
  - Each hospital within a system has a separate base price
- Following Horn and Wolinsky (1988):
  - Each contract solves price vector as Nash bargaining solution
  - Disagreement points are second-stage values to each party from having no agreement

Note: MCO is *Managed Care Organization*

# GNT: Allows for Different Copays and Networks

- We assume that out-of-pocket price is:

$$c_{id} \times w_d \times p_{m(i)j}$$

where:

- $c_{id}$  is individual  $i$ 's coinsurance rate
- $w_d$  is the DRG weight
- $p_{m(i)j}$  is the negotiated price between  $i$ 's MCO  $m(i)$  and hospital  $j$
- Utility consists of an unobservable  $e_{ij}$  plus

$$\delta_{ij} = \beta x_{ijd} - \alpha c_{id} w_d p_{m(i)j}$$

- $\alpha$  and  $\beta$  are parameters to be estimated
- Consumer surplus (necessary for MCO objective function):

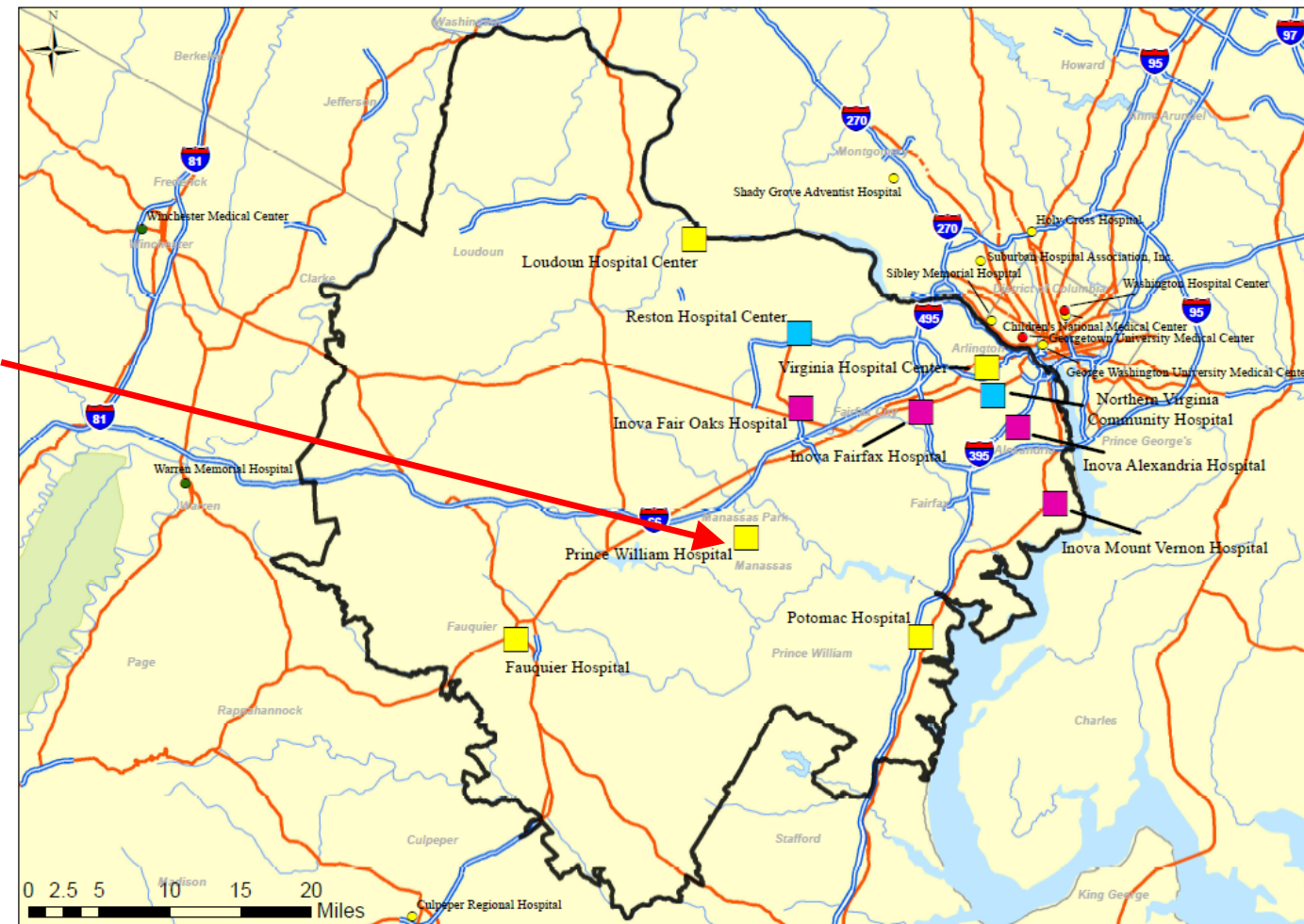
$$W_i(\mathcal{N}_{m(i)}, \mathbf{p}_{m(i)}) = \sum_{d=1}^D f_{id} \ln \left( \sum_{j \in 0, \mathcal{N}_{m(i)}} \exp(\delta_{ijd}) \right)$$



# Should Inova Be Allowed to Acquire Prince William?

Prince William Hospital (170 beds)

5 Inova Hospitals (1876 Beds)



# Findings

- The effective price-elasticity of demand is complicated and depends on copayments and bargaining power of hospitals and MCOs
- Copayments are effective mechanisms to increase the effective elasticity of demand and hence lower prices
- Preventing Prince William Hospital from merging kept prices from rising by 3.1 percent market-wide

# Limitations of Models

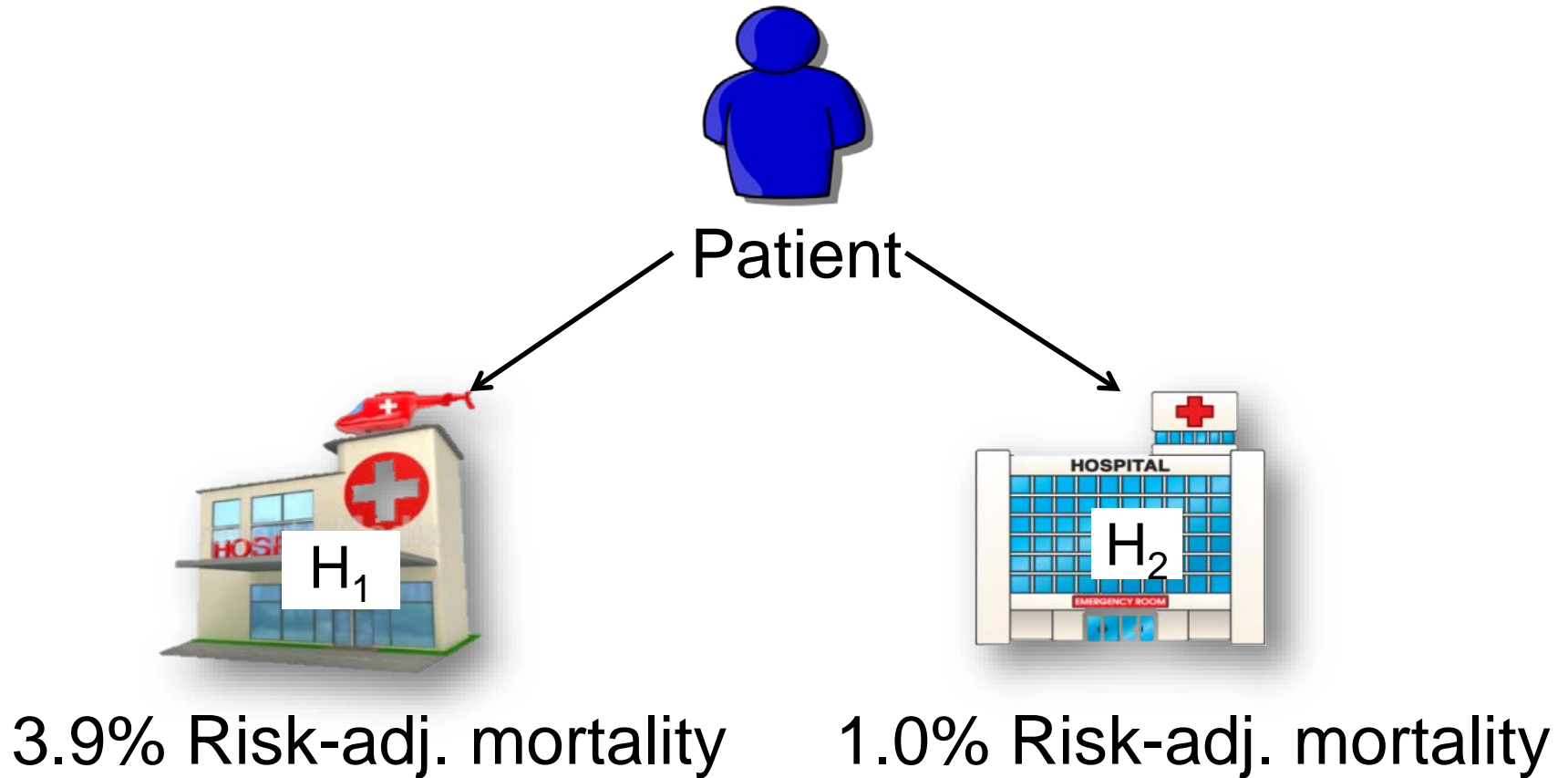
- Assumption of optimizing agents choosing Nash solutions with specific functional forms
- What is optimal strategy for quality/costs with multiple and overlapping health insurance plans (e.g., Private, Medicare, Medicaid, uninsured)

# Limitations of Models

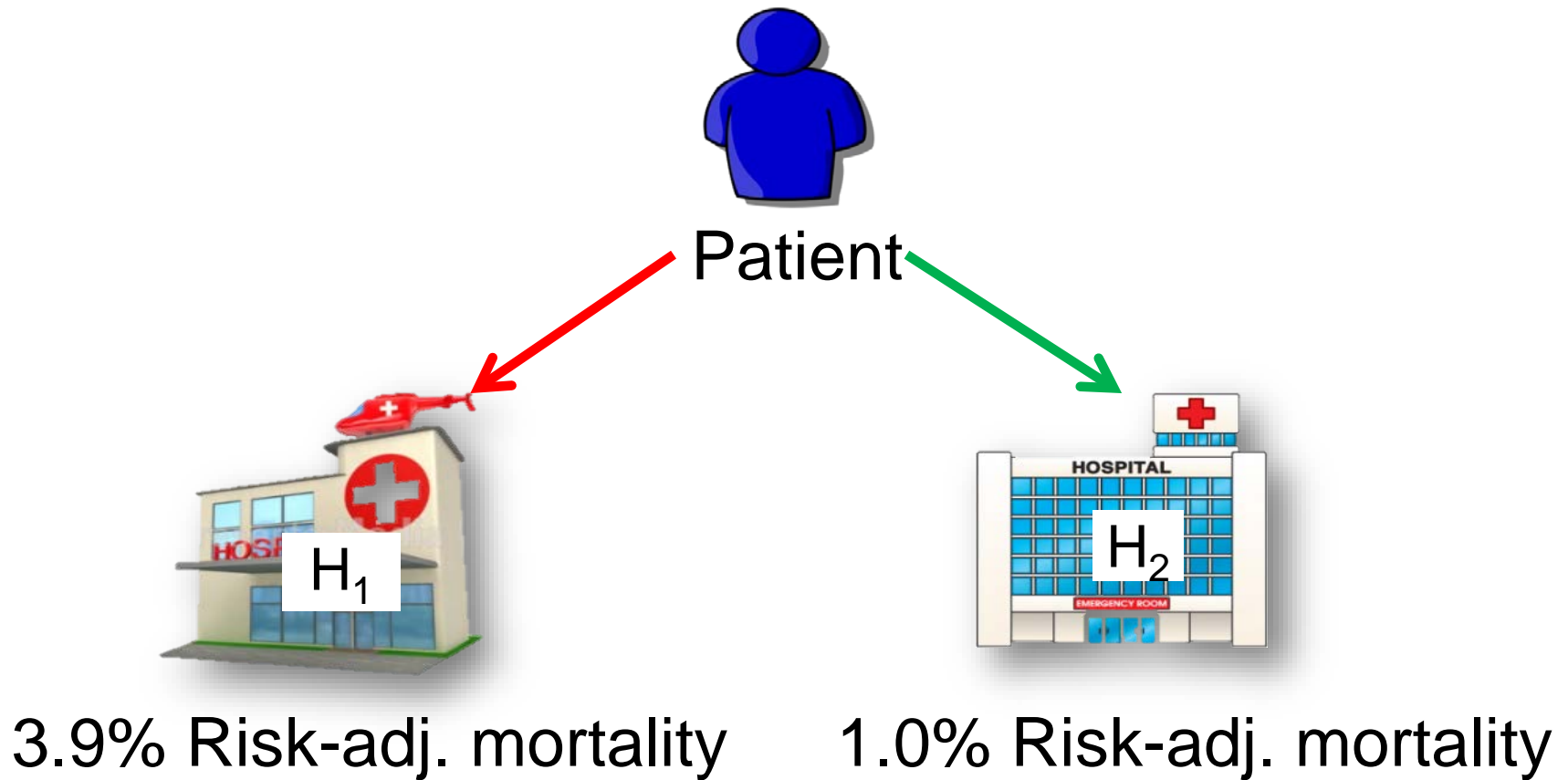


- Assumption of optimizing agents choosing Nash solutions with specific functional forms
- What is optimal strategy for quality/costs with multiple and overlapping health insurance plans (e.g., Private, Medicare, Medicaid, uninsured)
- Estimated quality of hospital depends on where patients go; More difficult to determine impact of competition on quality of care

# The standard theory of health care competition (Bypass surgery)



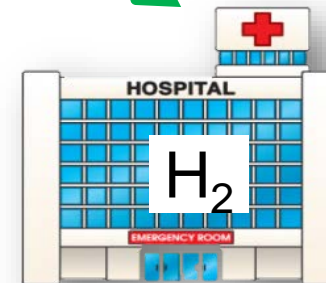
# The standard theory of health care competition (Bypass surgery)



# Health care competition in theory

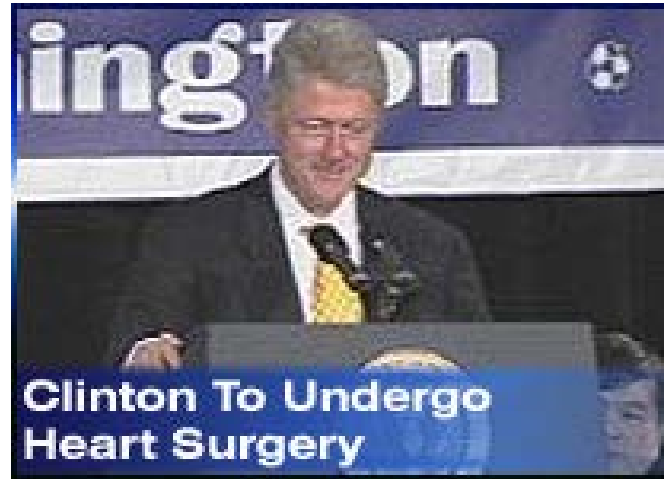


3.9% Risk-adj. mortality

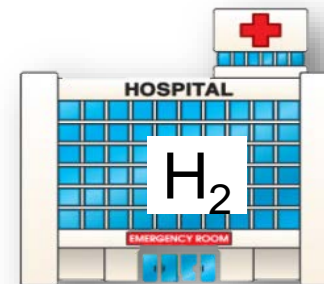


1.0% Risk-adj. mortality

# Health care competition in practice



3.9% Risk-adj. mortality



1.0% Risk-adj. mortality

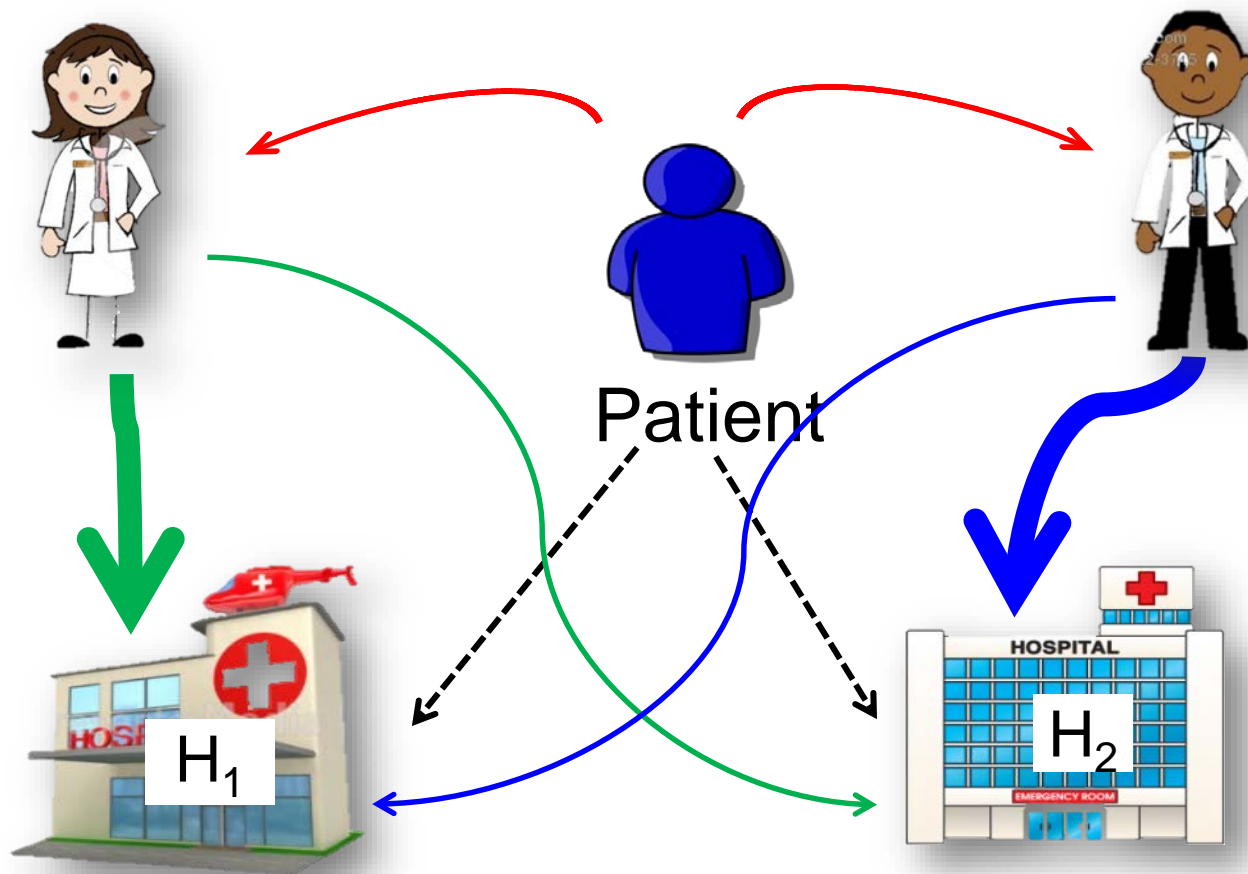


# Why Mr. Clinton went to Columbia-Presbyterian

Indeed, like many people who suddenly learn they have heart disease and need bypass surgery, Mr. Clinton had little chance to study statistics or consult experts on where to go. He simply found himself on a medical-referral track that led from a small hospital near his home in Chappaqua, N.Y., to the Westchester Medical Center, where tests revealed the extent of his problem and cardiologists suggested Columbia-Presbyterian.

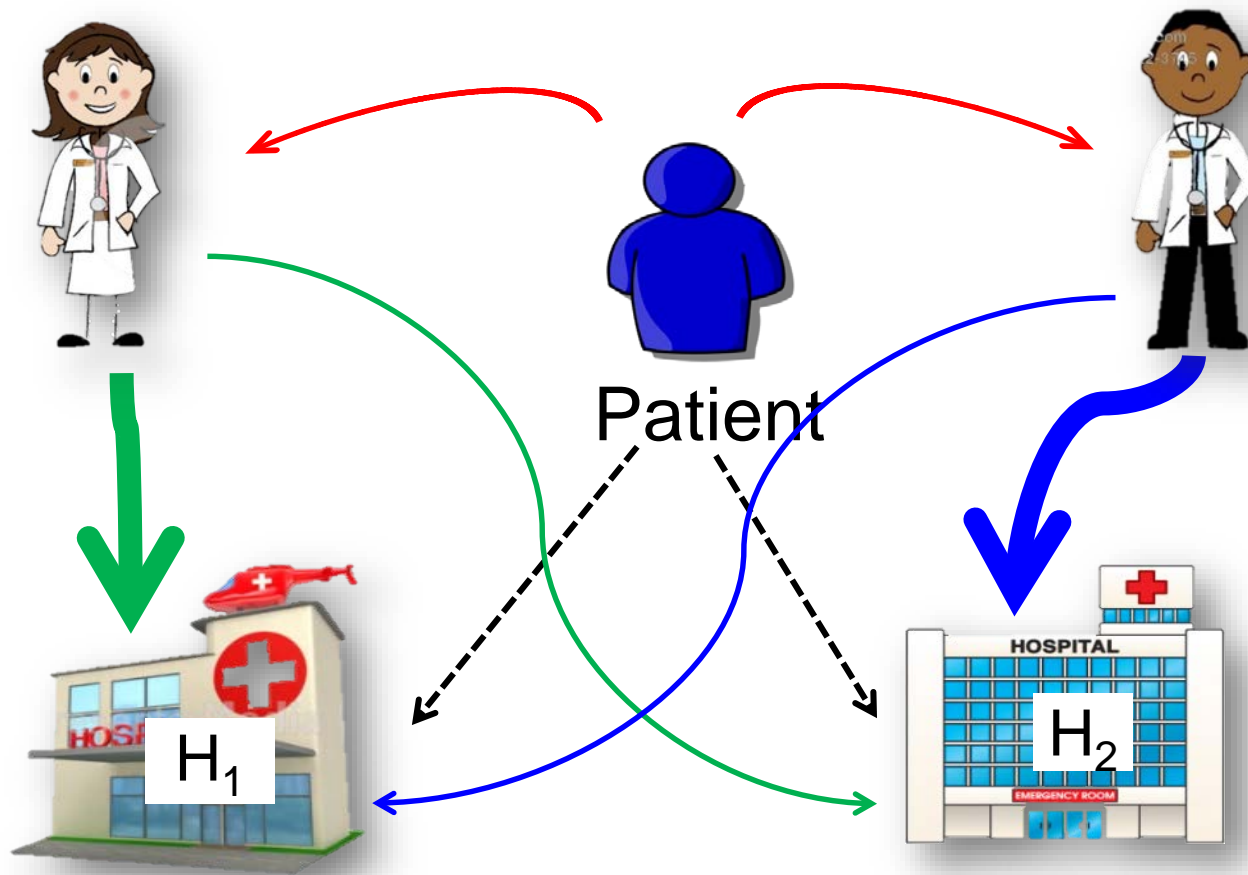
*Lawrence Altman, NYT (Nov 4, 2004)*

# Networks Complicate Hospital Choices



Source: Julie Bynum et al. ongoing work on "Physician-Hospital Networks"

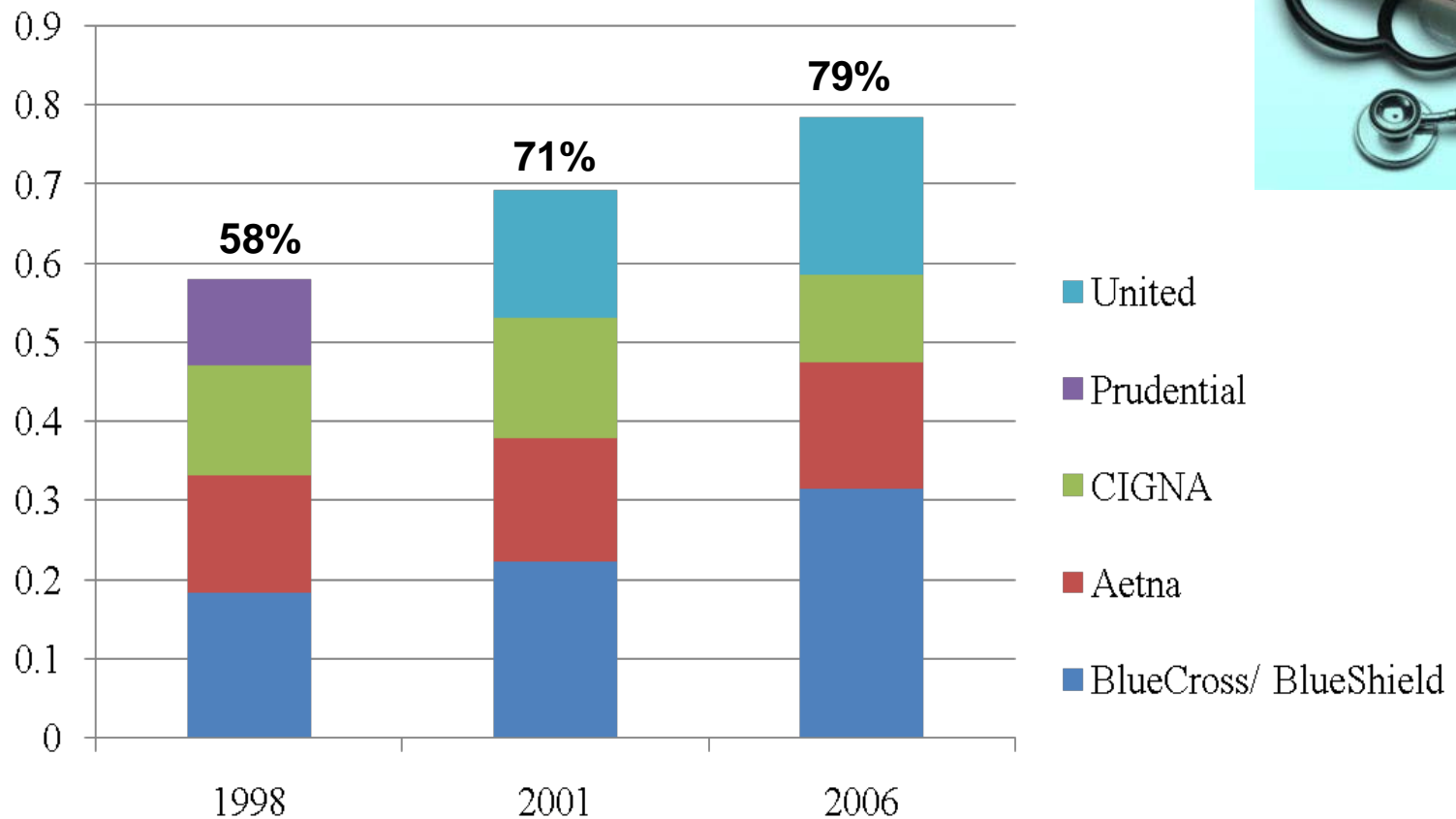
# Competition Could Lead to Fragmented Care



Source: Julie Bynum et al. ongoing work on “Physician-Hospital Networks”

# L. Dafny, "Premium on Your Premium," AER 2012

## Health Insurance Four-Firm Concentration Ratio



Source: Dafny, 2010

# An Amazing Database on Insurance Contracts

1406

THE AMERICAN ECONOMIC REVIEW

SEPTEMBER 2010

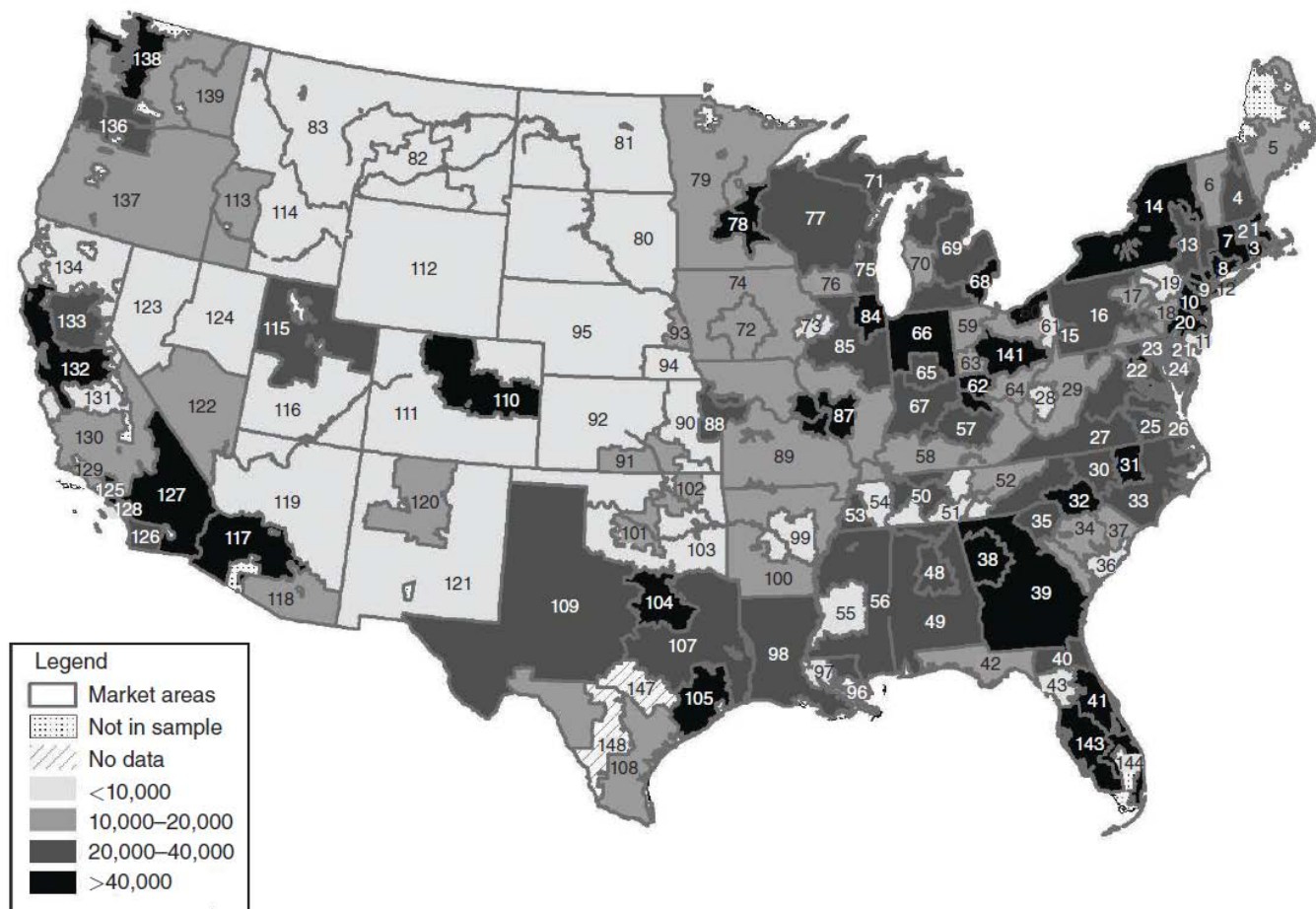
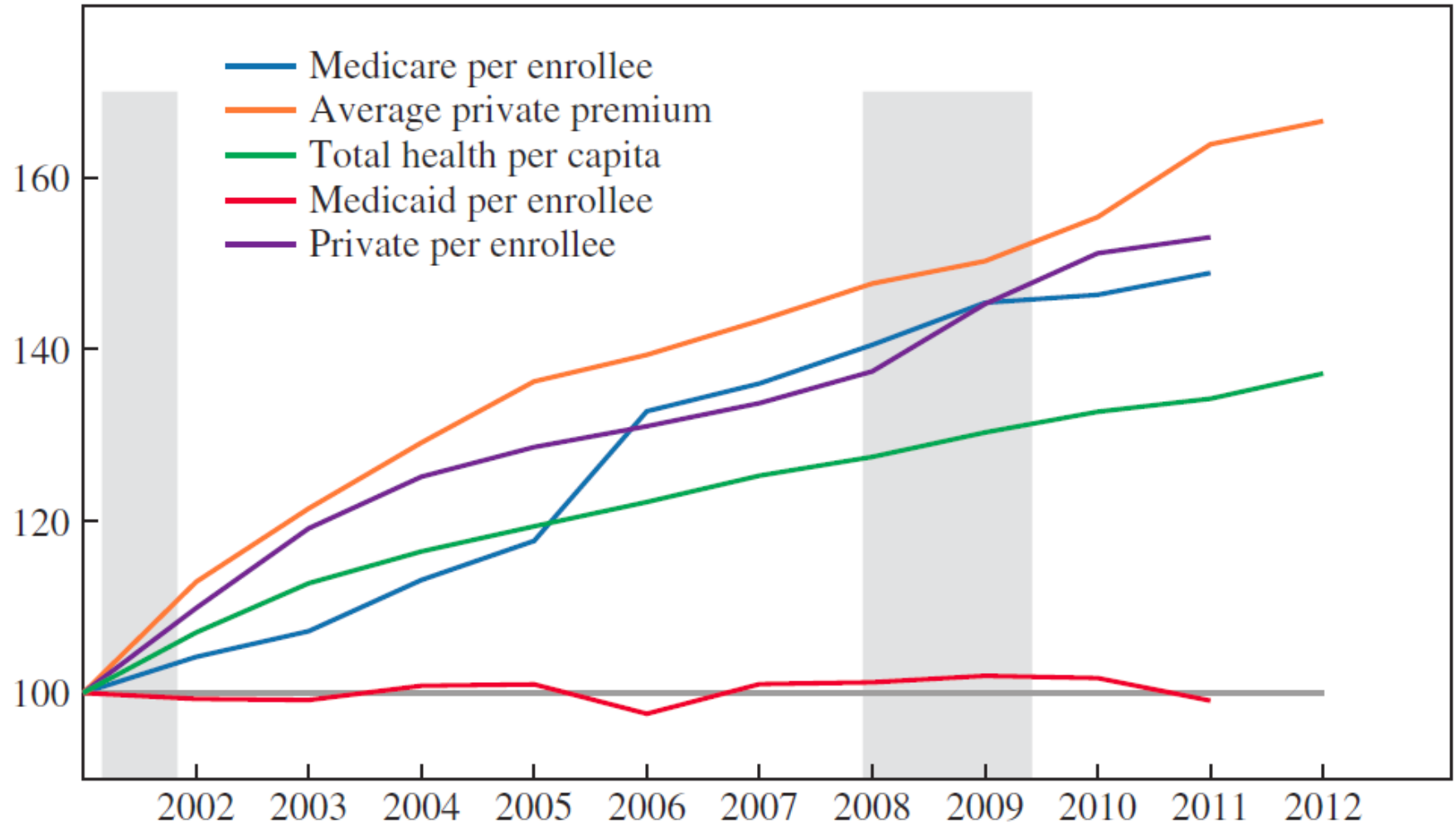


FIGURE 4. GEOGRAPHIC DISTRIBUTION OF EMPLOYEES IN LEHID SAMPLE

# Per Capita Expenditures, by Payer, 2001-12

(2001 = 100)



Source: Chandra, Holmes, and Skinner, BPEA 2013

# Coincidence?

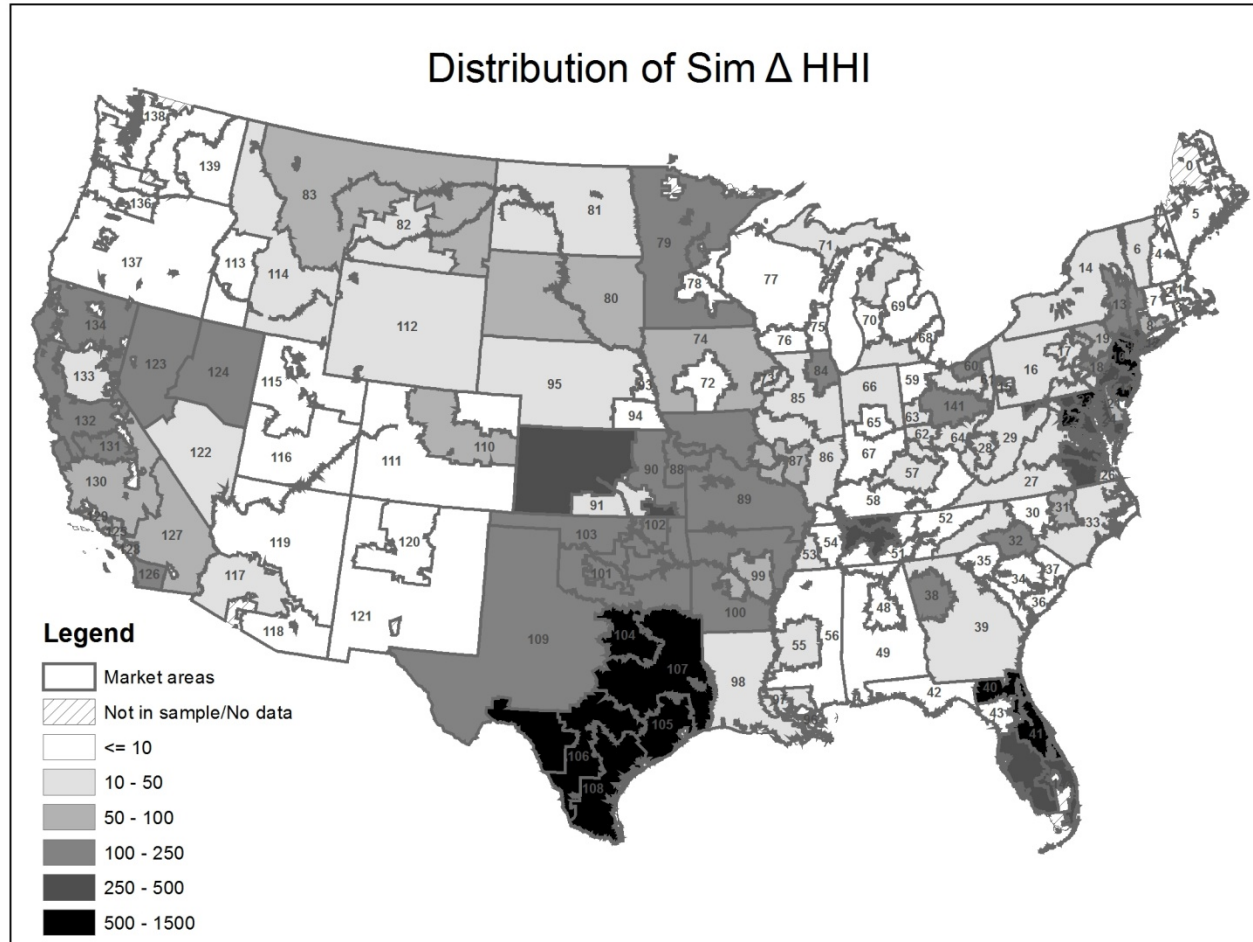
- Simply looking at the relationship between changes in premiums and changes in market concentration will not answer the question.
- Strategy: Use the Aetna-Prudential merger (1999) as a natural experiment
- Construct a simulated HHI change in local markets, and test for changes in premium prices
$$\Delta \text{HHI}_m = [\text{Aetna sh}_{99,m} + \text{Pru sh}_{99,m}]^2 - [(\text{Aetna sh}_{99,m})^2 + (\text{Pru sh}_{99,m})^2]$$
- Control state: Texas (DOJ required divestment there)

# Intuition

“For example, in our sample the pre-merger market shares of Aetna and Prudential in Jacksonville, Florida were 19 and 24 percent, respectively, versus just 11 and 1 percent, respectively, in Las Vegas, Nevada. Holding all else equal, this implies an increase in post-merger HHI of 892 points in Jacksonville, but only 21 points in Las Vegas.”

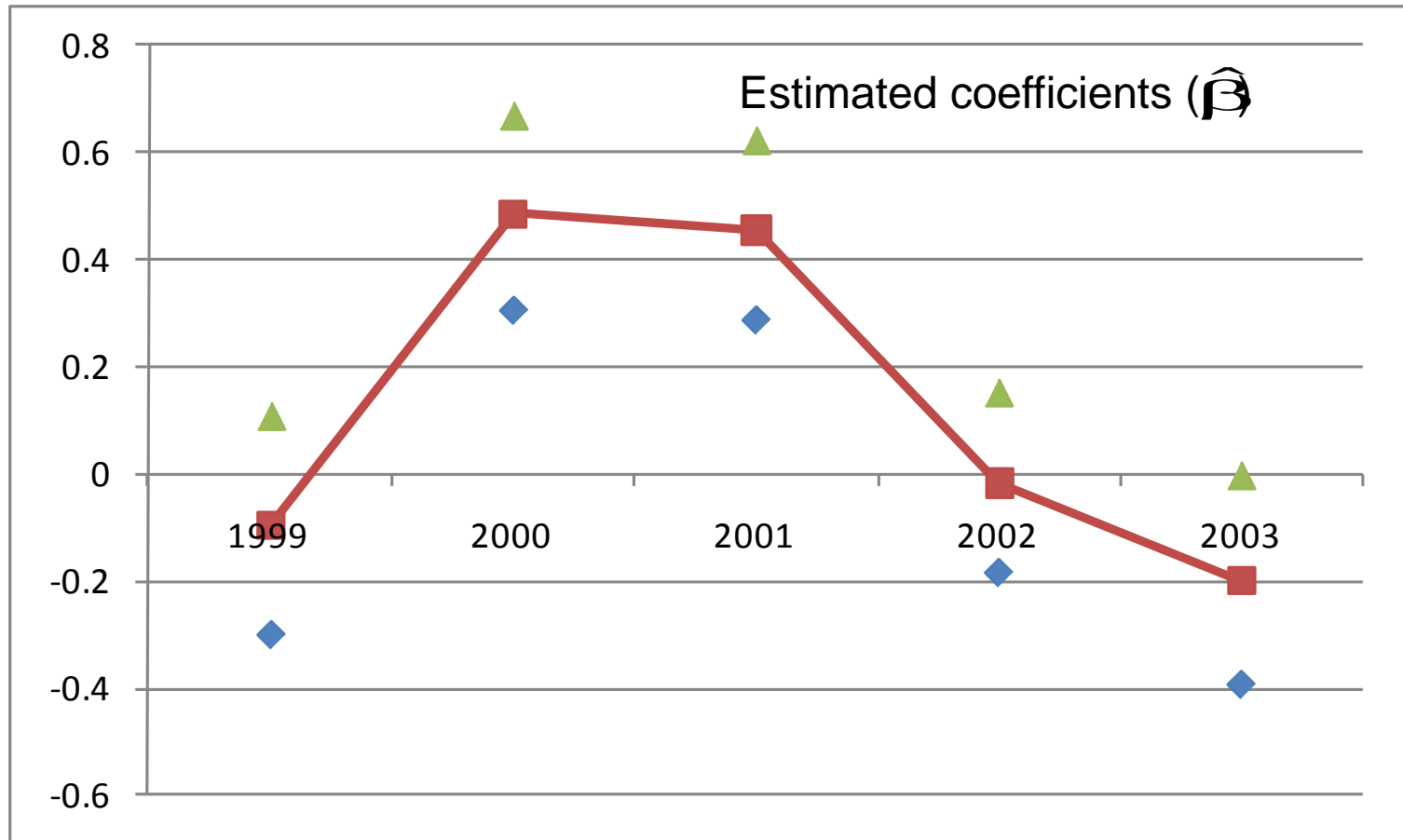


# The Aetna-Prudential Merger



# The Aetna-Prudential Merger

$$HHI_{mt} = \alpha + \lambda_m + \tau_t + \beta sim \Delta HHI_m \bullet \tau_t + \varepsilon_{mt}$$



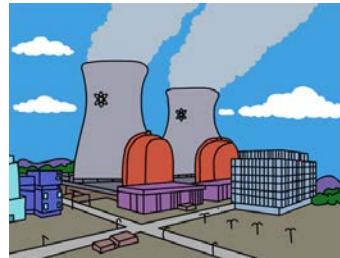
# Findings

- Consolidation between 1998 and 2006 resulted in an estimated increase of 7 percent in premiums, or \$34 billion in 2007
  - Estimate based on *changes* (i.e. consolidation) but markets already heavily concentrated in 1998
- Consolidation associated with decreases in employment of workers in health care industry, decreases in physician earnings, and substitution toward nurses

# Are Health Insurance Markets Competitive?

L. Dafny, AER, 2010

# Now the *Employer* Shops for Insurance

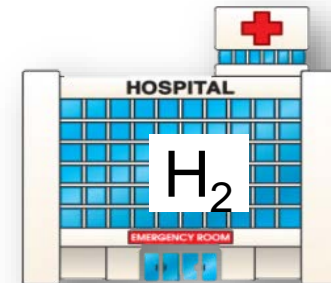
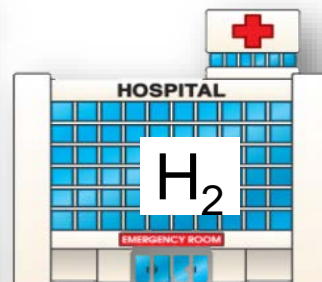


Springfield Power Company



CIGNA

AETNA



# Approach

- In perfectly competitive markets: Prices determined by marginal cost of services – not by ability to pay of buyer
- Hypothesis: Do firms with higher profits face higher premiums?
  - Exploit panel feature of data to see whether *changes* in profits are **followed by** *changes* in premiums
- Alternative hypothesis: Profit margin correlated with willingness-to-pay (WTP)
  - Key test: Premiums of profitable firms rise *only* in concentrated markets

# Data consistent with hypothesis....

<b>Lagged profit margin*</b>				
<b>&lt;=4 carriers</b>	<b>.151***</b> (.058)	<b>.148**</b> (.072)	<b>.145**</b> (.072)	<b>.168**</b> (.075)
<b>5-6 carriers</b>	<b>.047*</b> (.027)	<b>.092**</b> (.042)	<b>.092**</b> (.042)	<b>.060</b> (.043)
<b>7-8 carriers</b>	<b>.034***</b> (.012)	<b>.056***</b> (.018)	<b>.055***</b> (.018)	<b>.042**</b> (.018)
<b>9-10 carriers</b>	<b>.013**</b> (.014)	<b>.043**</b> (.019)	<b>.042**</b> (.019)	<b>.034*</b> (.019)
<b>&gt;10 carriers</b>	<b>.011</b> (.015)	<b>.035</b> (.024)	<b>.034</b> (.024)	<b>.027</b> (.024)
<b>Emp-Mkt-Plantype-Carr FE</b>		<b>X</b>	<b>X</b>	<b>X</b>
<b>Mkt-Year Covariates</b>			<b>X</b>	<b>N/A</b>
<b>Mkt-Year FE</b>				<b>X</b>

# Why are more profitable firms willing to pay more?

- Field interviews suggested profitable firms less willing to switch carriers
  - Switching plans is costly to employees:
  - Not switching is a form of “rent sharing”
- Thus profitable employers are less elastic and insurers can demand higher prices



# Summing Up

- Competition in health care: It's complicated
- New and exciting developments in health care IO
- Many interesting questions:
  - Mergers reduce competition, raise prices (as noted earlier)
  - Do mergers lower costs? (e.g., Dranove and Lindrooth, 2003)
  - Do mergers increase quality (by increasing e.g. volume or by reducing fragmentation?)
  - Are some kinds of mergers better than others?
  - Time to break up health insurance companies? Large health care systems?

## 2. Provider Incentives and Behavior

J. Skinner AEA 1/7/14

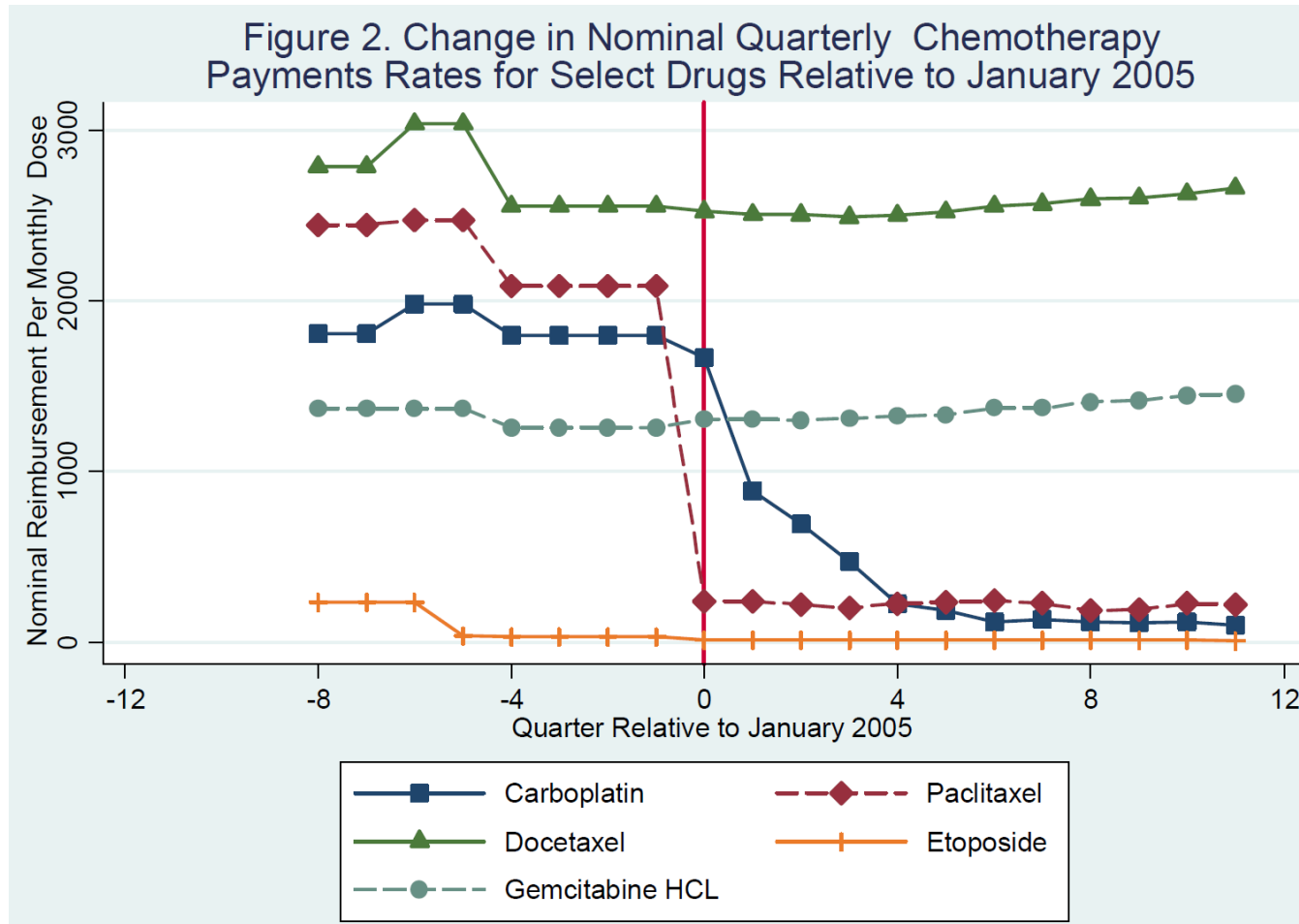
# Topics Addressed

- New evidence on the role of physician income and substitution effects
- Pay-for-performance
- Revisiting malpractice

# What's the Effect of a Price Change on Behavior?

- Pauly and McGuire (1991), Gruber et al. (1999), Yip (1998), etc. – income and substitution effects
  - Nearly any empirical finding is consistent with theory....
- A recent natural experiment: A drop in chemotherapy drug reimbursements (M. Jacobson, T. Chang, J. Newhouse, C. Earle, NBER WP 2013)

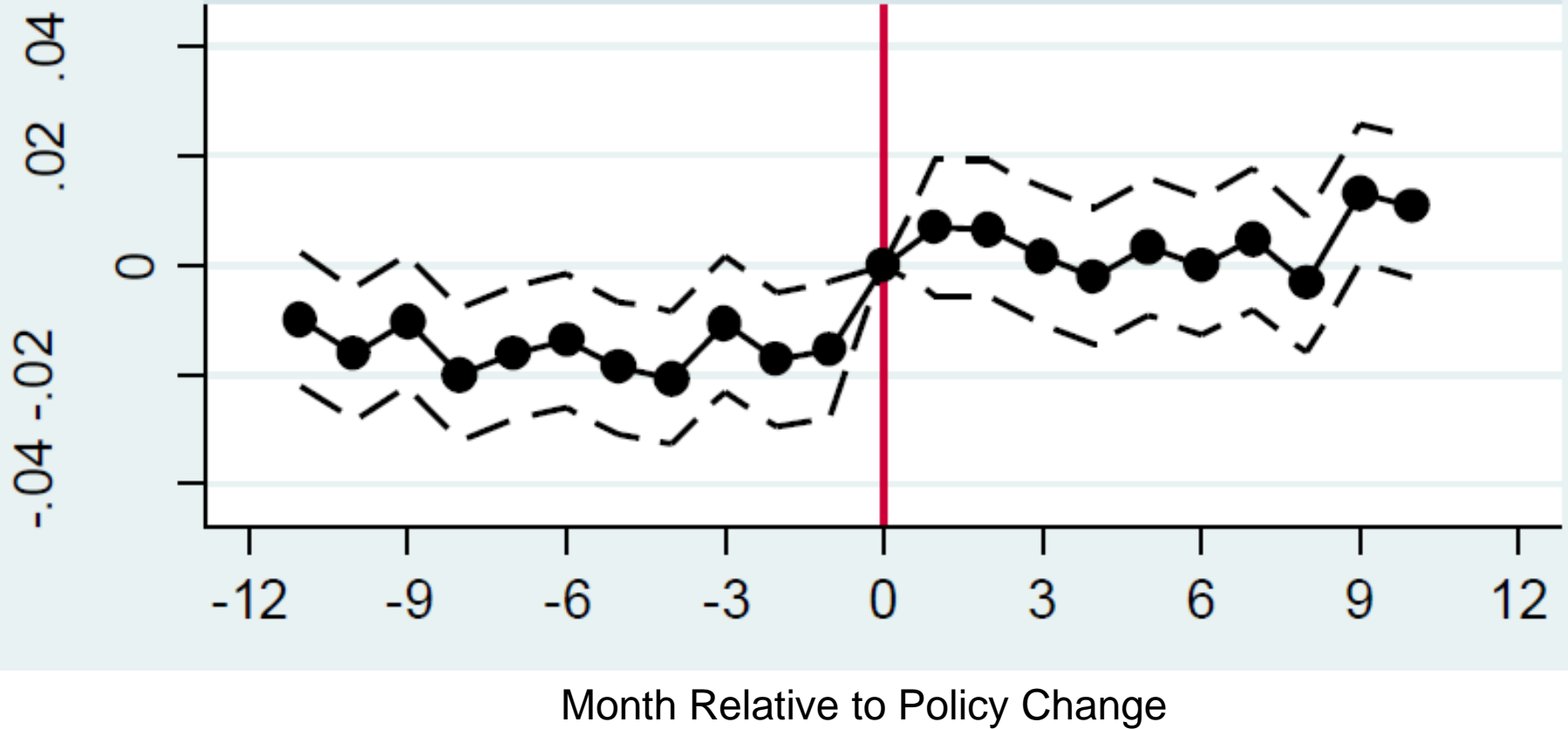
# Major Price Decline of Some Chemotherapy Drugs



*Percent receiving Paclitaxel dropped 4%, Carboplatin dropped 3%*

# An Increase in Fraction Receiving Chemotherapy

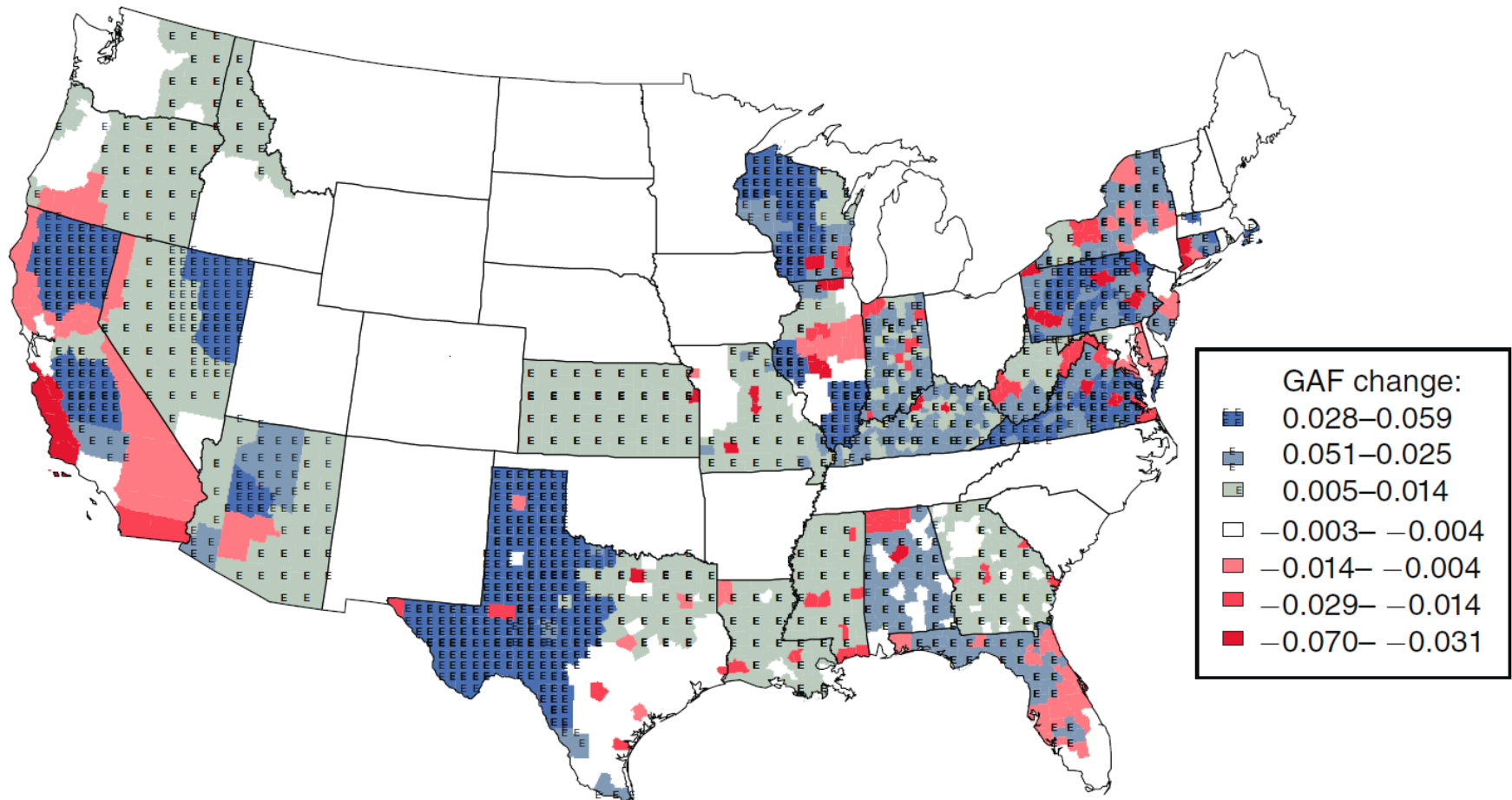
Fig 3c. Physician's Office



# A Uniform Change in Part B Reimbursement Rates

Do Physicians' Financial Incentives Affect Medical Treatment and Patient Health?<sup>†</sup>

By JEFFREY CLEMENS AND JOSHUA D. GOTTLIEB\*



# In This Case: Substitution Effects Dominate, Bigtime

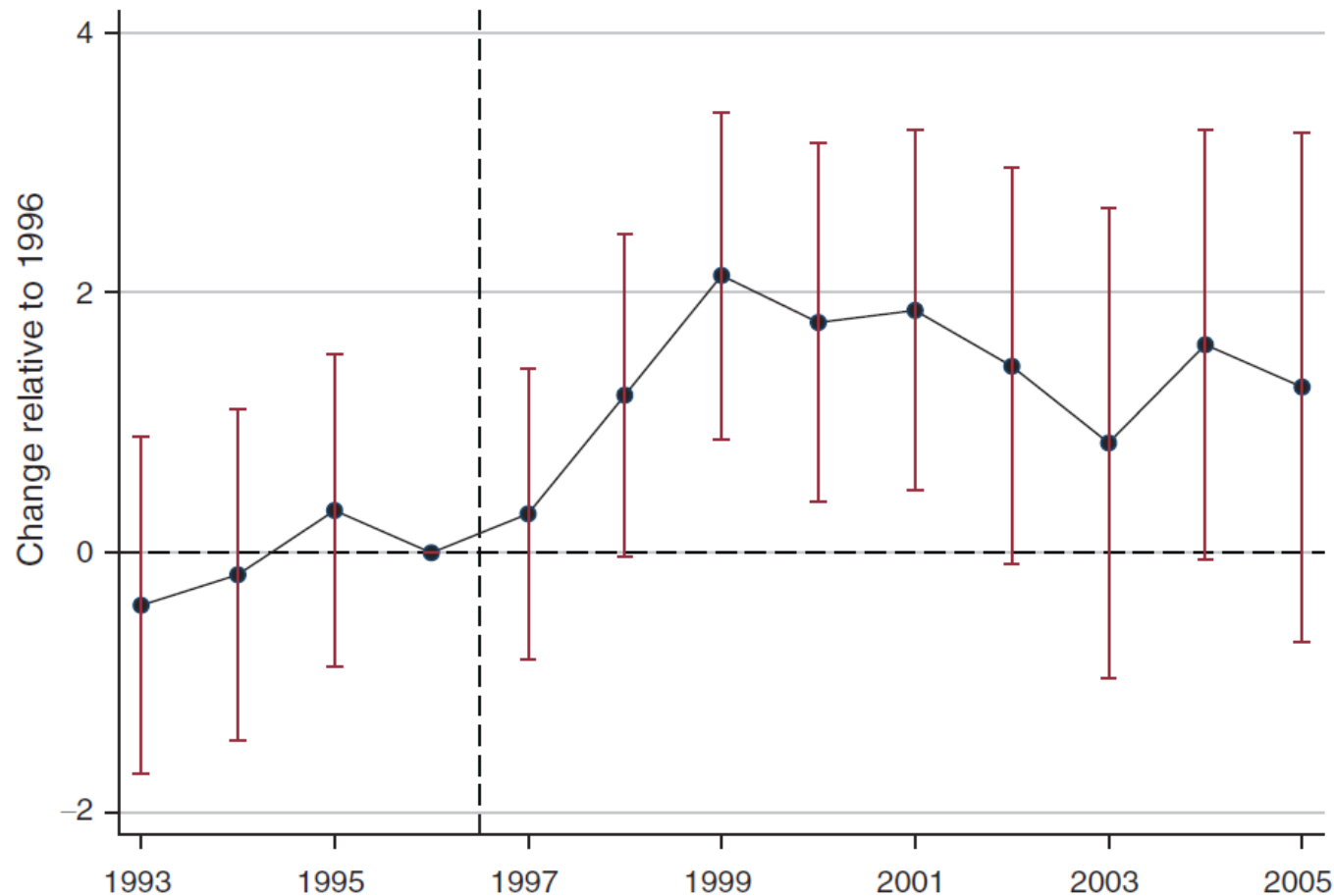


FIGURE 3. IMPACT OF PRICE CHANGE ON AGGREGATE QUANTITY SUPPLIED



# How Can These Results be Reconciled?

- Income versus substitution effects? Part B reimbursements a large fraction of physician salaries – income effects should matter more
- C&G: Most of the increase in utilization came from new investments in (e.g.) scanning equipment – a Finkelstein (2007) style model of diffusion encouraged by generous insurance payments
- Outcome effects: For JWNE, lower price saved lives(!), for CG, no impact

# Theory: Physicians Respond to Incentives

## *Earlier results.....*

- M.B. Rosenthal, R.G. Frank, Z. Li, and A.M. Epstein, “Early Experience with Pay-for-Performance: From Concept to Practice,” *JAMA*, 2005.
- Z. Song, D.G. Safran, B.E. Landon, M.B. Landrum, et al., “The 'Alternative Quality Contract,' Based On a Global Budget, Lowered Medical Spending and Improved Quality,” *Health Affairs*, 2012, 31(8):1885-1894

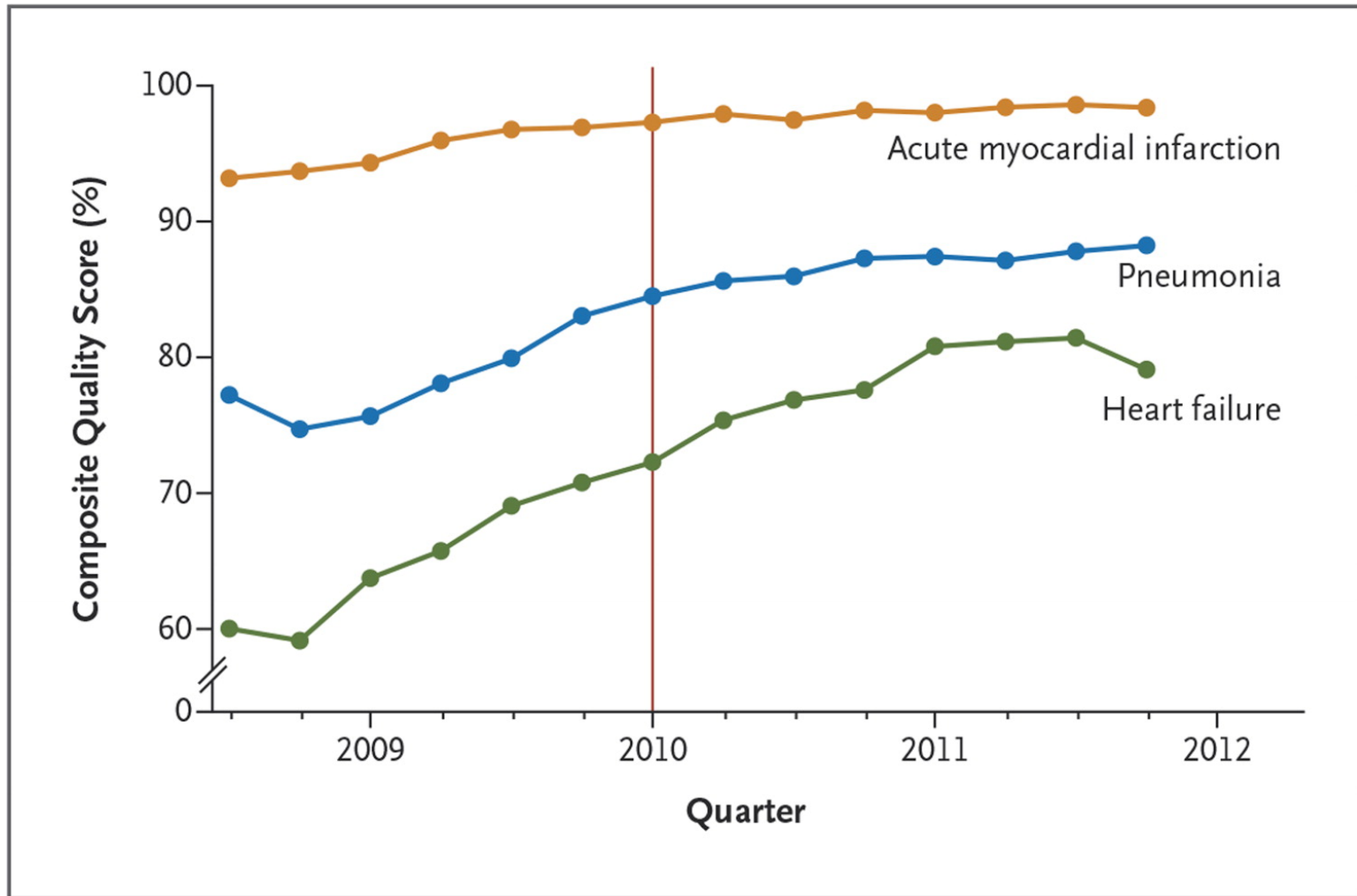
## Long-Term Effect of Hospital Pay for Performance on Mortality in England

Søren Rud Kristensen, Ph.D., Rachel Meacock, M.Sc.,  
Alex J. Turner, M.Sc., Ruth Boaden, Ph.D., Ruth McDonald, Ph.D.,  
Martin Roland, D.M., and Matthew Sutton, Ph.D.

Our previous evaluation of the Advancing Quality program, ... showed that its adoption in one region of England in 2008 led to a clinically significant reduction in 30-day in-hospital mortality during the first 18 months.

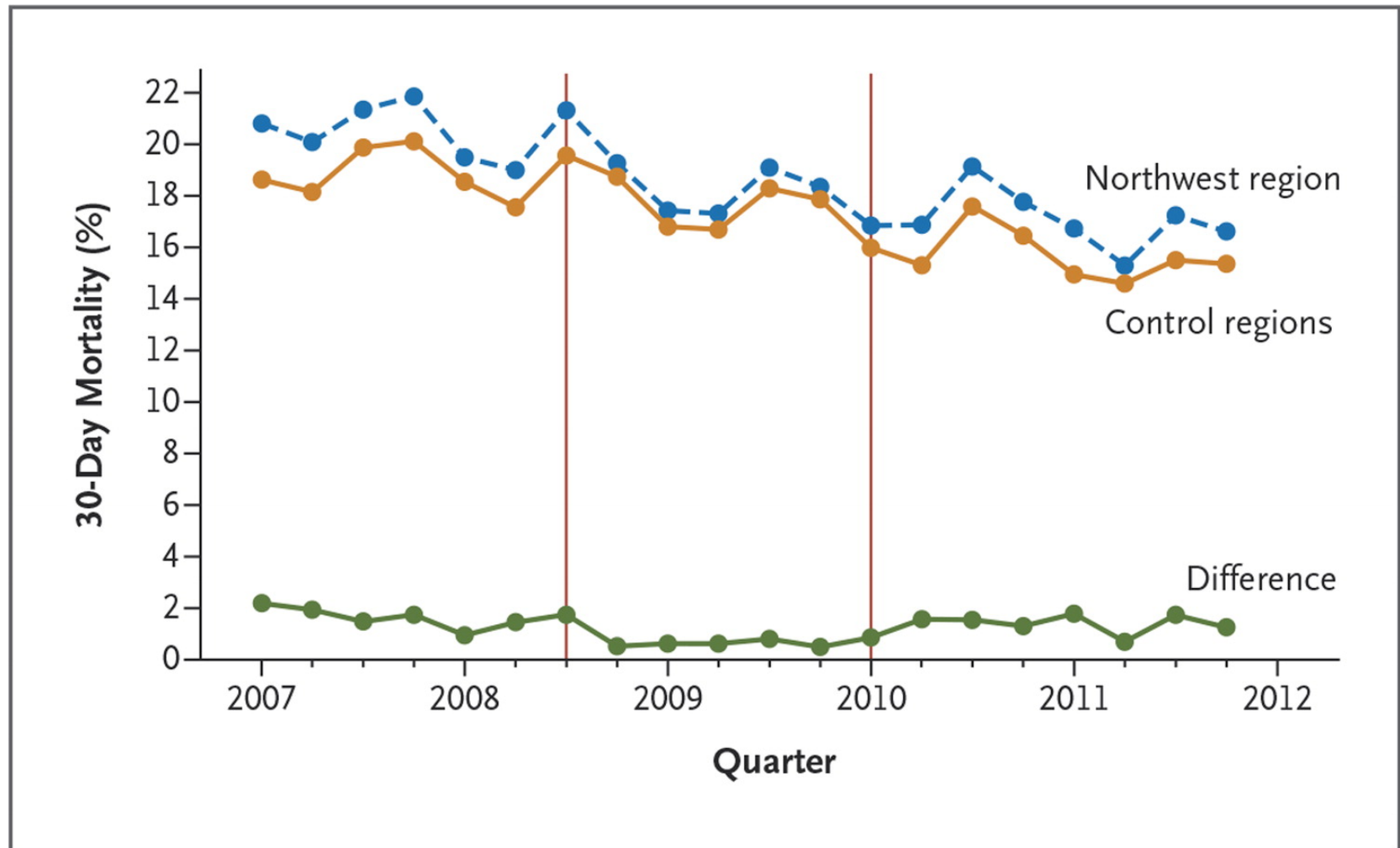
The fact that the program had a more positive effect in England than in the United States has been attributed to the universal participation of hospitals within the region in England, the larger bonus payments, and the collaborative nature of the initiative, which led hospitals to make more general investments in quality improvement.

# Average Hospital Performance: Quality Measures



Kristensen SR et al. N Engl J Med 2014;371:540-548.

# 30-Day In-Hospital Mortality: Treatment & Control



Kristensen SR et al. N Engl J Med 2014;371:540-548.

# Accountable Care Organizations (ACOs)

- Financial risk-bearing entity (hospital system, physician group, federally qualified health centers (FQHCs), or even pharmacies)
- Patients assigned annually based on plurality of charges
- Requires that they meet quality standards
- Institution shares savings with Medicare if they are able to maintain spending growth below targets

# A Pilot Study of Accountable Care Organizations

ORIGINAL CONTRIBUTION

## Spending Differences Associated With the Medicare Physician Group Practice Demonstration

Carrie H. Colla, PhD

David E. Wennberg, MD, MPH

Ellen Meara, PhD

Jonathan S. Skinner, PhD

Daniel Gottlieb, MS

Valerie A. Lewis, PhD

Christopher M. Snyder, PhD

Elliott S. Fisher, MD, MPH

**T**O IMPROVE CARE AND SLOW cost growth, payers are increasingly turning to new payment

**Context** The Centers for Medicare & Medicaid Services (CMS) recently launched accountable care organization (ACO) programs designed to improve quality and slow cost growth. The ACOs resemble an earlier pilot, the Medicare Physician Group Practice Demonstration (PGPD), in which participating physician groups received bonus payments if they achieved lower cost growth than local controls and met quality targets. Although evidence indicates the PGPD improved quality, uncertainty remains about its effect on costs.

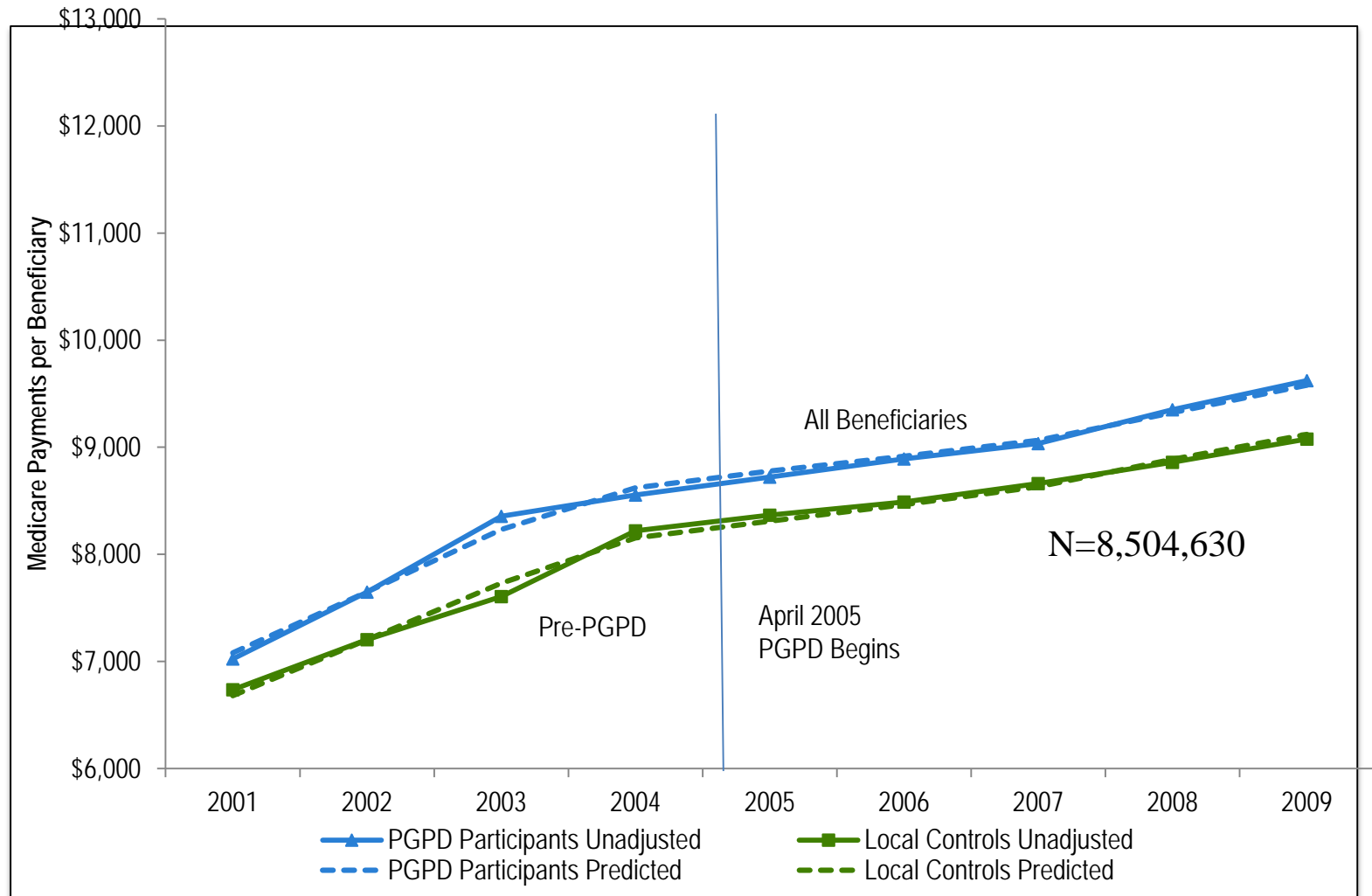
**Objective** To estimate cost savings associated with the PGPD overall and for beneficiaries dually eligible for Medicare and Medicaid.

**Design** Quasi-experimental analyses comparing preintervention (2001-2004) and post-intervention (2005-2009) trends in spending of PGPD participants to local control groups. We compared estimates using several alternative approaches to adjust for case mix.

**Setting** Ten physician groups from across the United States.

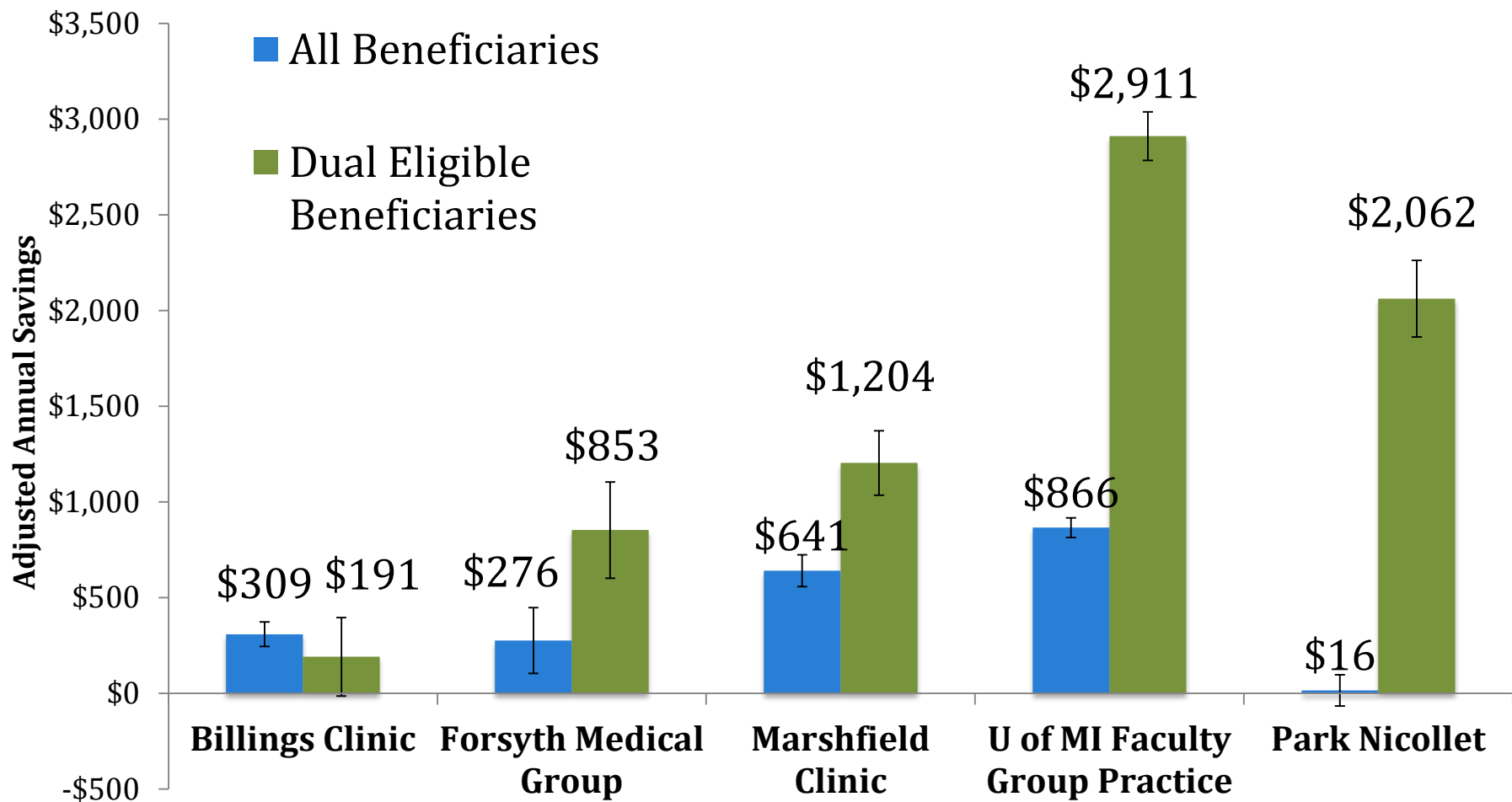
- Ten institutions chosen to get bonuses if they (a) attain high quality metrics, and (b) reduce risk-adjusted spending relative to “control” Medicare enrollees in region
- Quality metrics all went up

# Aggregate Differences in Growth Modest (\$114/Enrollee)





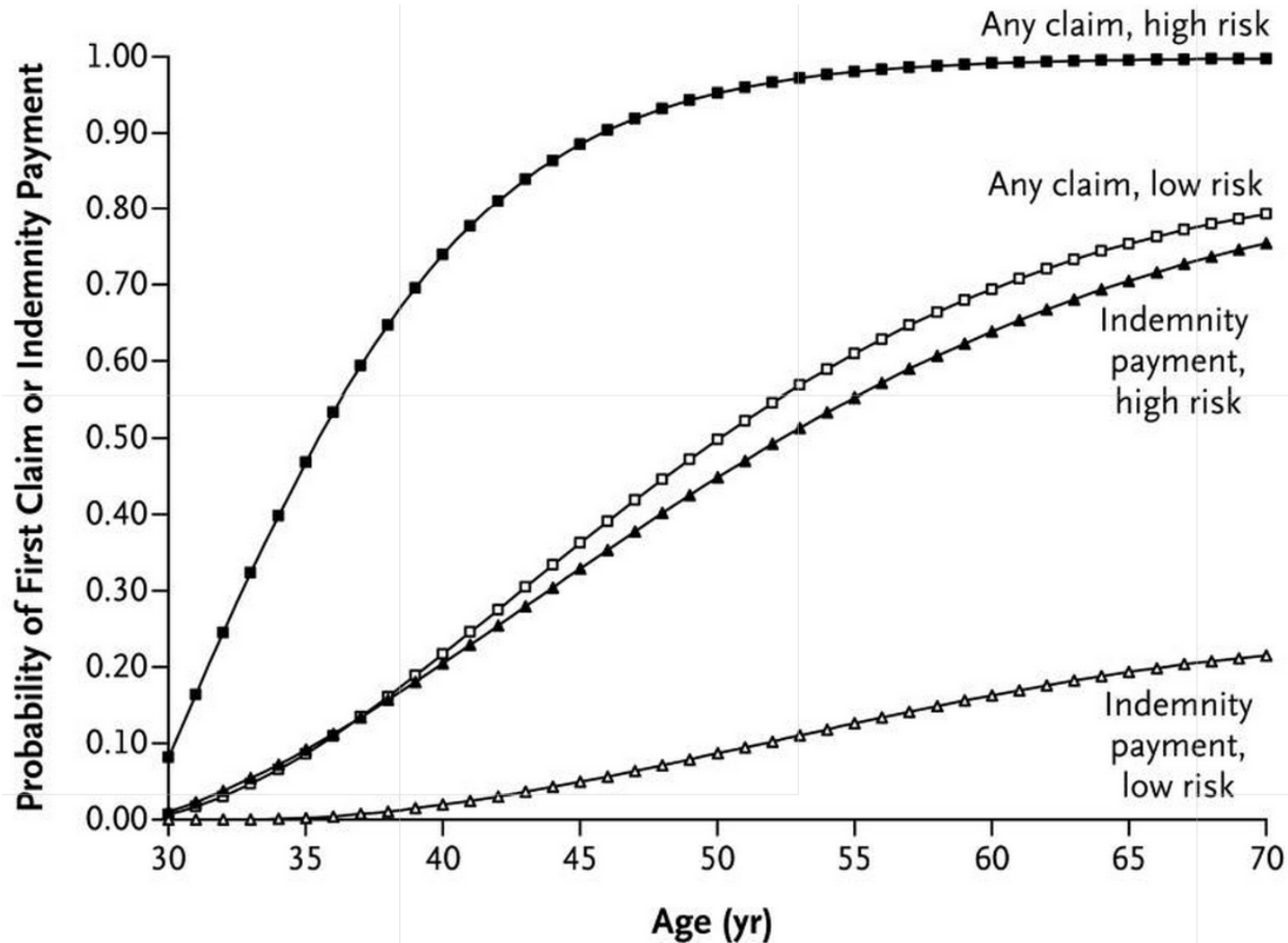
# 5 Sites Achieved Real Savings



# How the Other 5 Institutions Responded



# Cumulative MD Probability of Facing Malpractice



AB Jena, et al., NEJM August 18, 2011

# How do Physicians Respond to Malpractice Risk?

- Conventional view: The US is so expensive because of malpractice risk
- But... they might do less if doing so exposes them to less risk of litigation (Currie and MacLeod, 2008)
- Or, they stick close to legal norms of practice, whether local or national (Frakes, 2013)

# Concluding Thoughts

- Economists tend to focus on physician incentives with regard to prices and malpractice policies
  - For good reason, as it turns out
- But... there are other factors that play a role in physician behavior
  - Peer effects, reliance on referrals, patient demand(s), and physician beliefs about efficacy of certain treatments (Cutler, Skinner, Stern, Wennberg, 2013)
- There are also many others making health care decisions that affect quality and costs
  - Nurse practitioners, nurses, pharmacists, etc.

### 3. Technology Growth, Innovation, and Health System Efficiency in Health Care

J. Skinner AEA 1/6/14

# A Seemingly Simple Question

Do regions or hospitals that spend more get better health outcomes as a result?

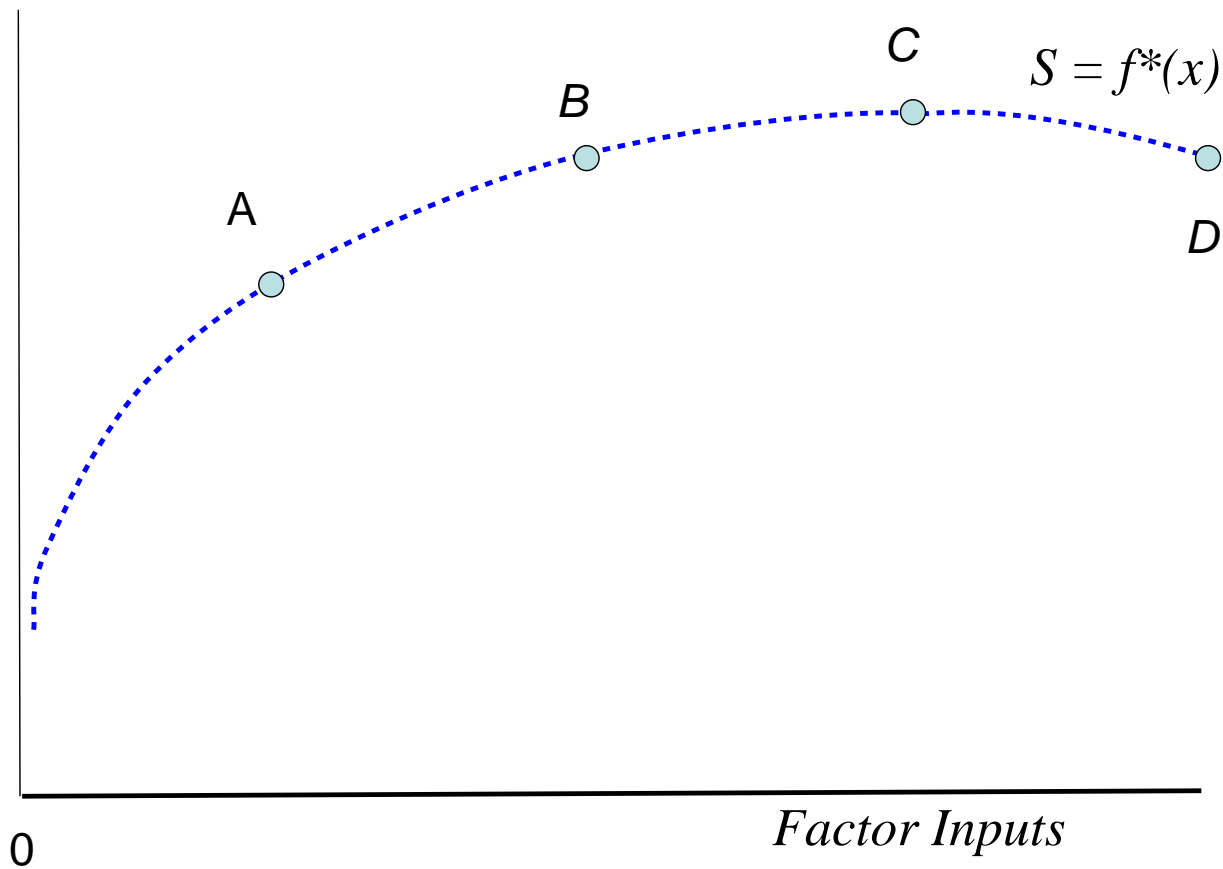
# Estimates All Over the Map

- More is not better: Fisher et al., 2003a,b; Fisher et al, 2004; Yasaitis et al., 2009; Skinner et al., 2005; Glance et al., 2010; etc. Bekelis, et al., 2014, etc.
- More is better: Silber et al., 2010; Doyle, 2011; Doyle et al., 2012; Romley et al., 2011; Barnato et al., 2010, Doyle et al., forthcoming, etc.
- It depends: Skinner and Staiger, forthcoming.

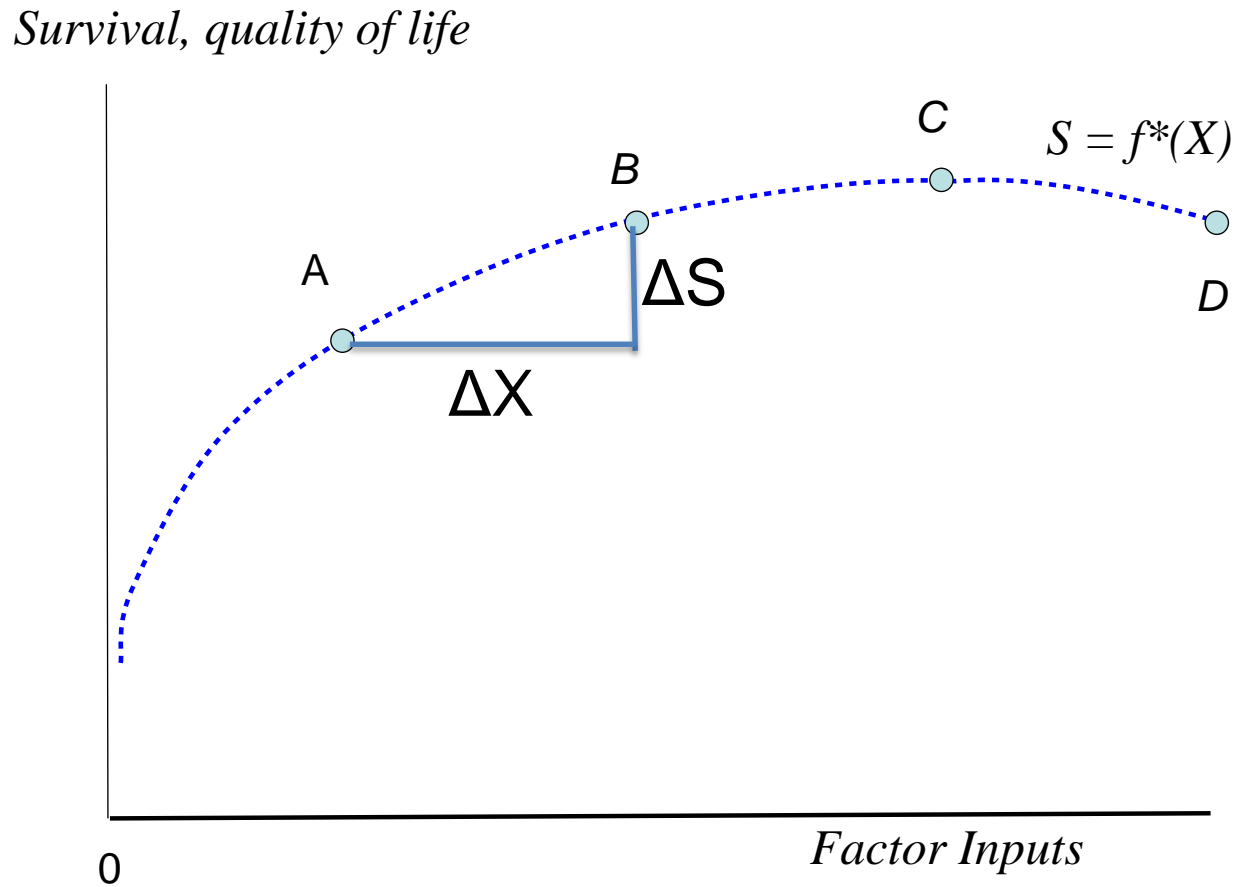


# A Health Production Function

*Survival, quality of life*



# What the Researcher Seeks to Estimate



# Standard approach

- $S_{it} = \theta Z_{it} + \beta X_{it} + u_{it}$

Where  $S$  is the health outcome,  $Z$  is a matrix of “risk adjusters”,  $X$  is health care expenditures or inputs, and  $\beta$  is the marginal return to health care spending (or  $\Delta S / \Delta X$  in the graph)

- Hypothesis: Is  $\beta > 0$ ?

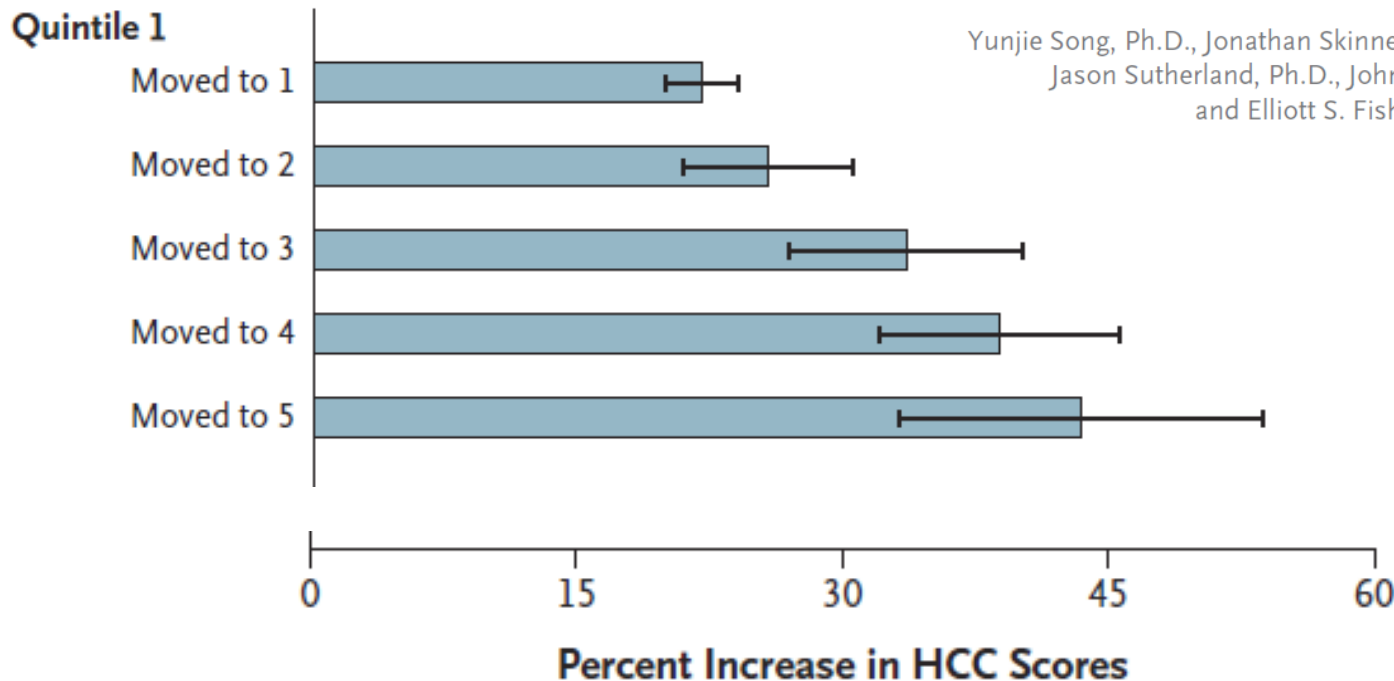
# The Risks of Risk Adjustment: See More Doctors, Find More Disease

The NEW ENGLAND JOURNAL of MEDICINE

SPECIAL ARTICLE

## Regional Variations in Diagnostic Practices

Yunjie Song, Ph.D., Jonathan Skinner, Ph.D., Julie Bynum, M.D., M.P.H.,  
Jason Sutherland, Ph.D., John E. Wennberg, M.D., M.P.H.,  
and Elliott S. Fisher, M.D., M.P.H.



# One Solution: Natural Randomization to Hospitals

## Measuring Returns to Hospital Care: Evidence from Ambulance Referral Patterns

Joseph Doyle

John Graves

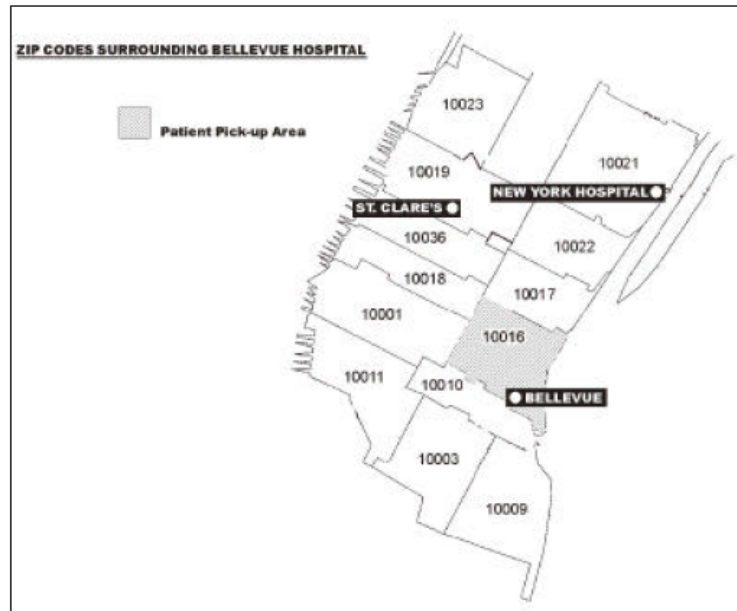
Jonathan Gruber

Samuel Kleiner \*

April 22, 2014



# Ambulance Affiliation and Hospital Assignment



Destination of Patients Picked Up In The Bellevue Hospital Zip Code Area

Destination	All Voluntary Hospital Ambulances	Fire Department Ambulances
Bellevue Hospital (HHC)	25%*	61%**
Any Voluntary Hospital	75%	39%

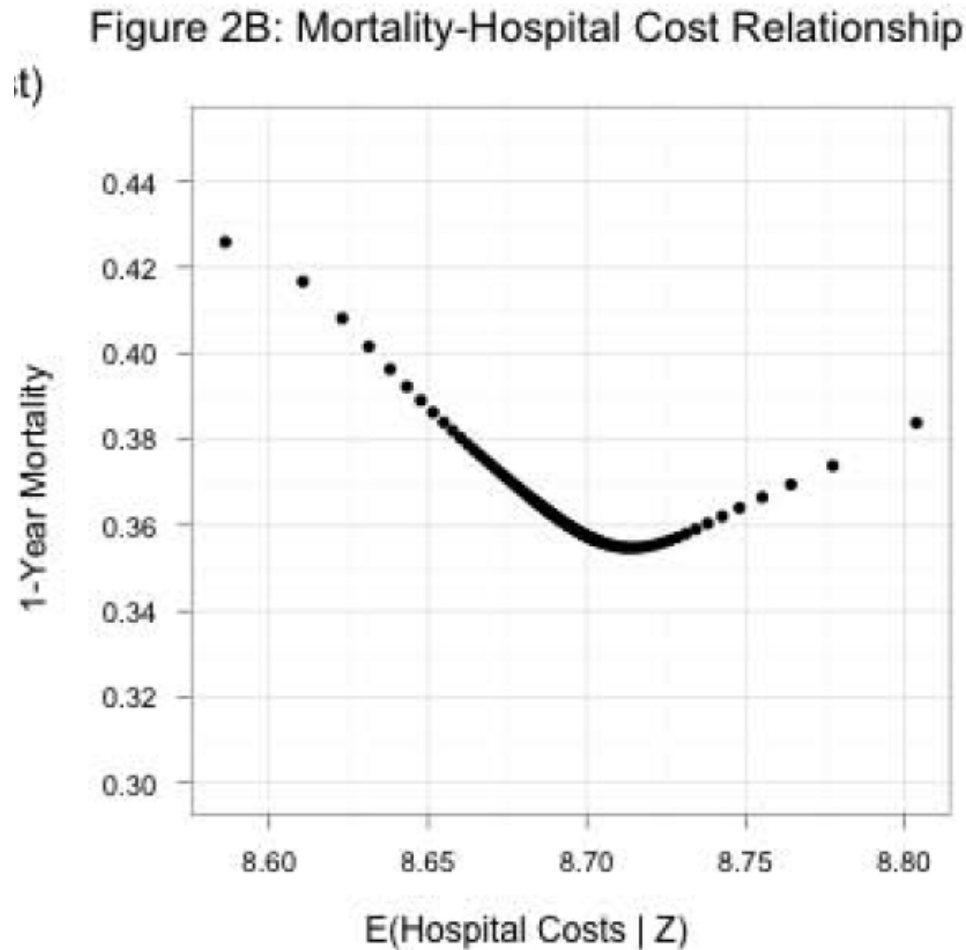
\*157 taken to Bellevue/632 total. \*\*815 taken to Bellevue/1,346 total

Doyle et al., from Skura 2001

TABLE 3—AMBULANCE STRATEGY: ONE YEAR MORTALITY &amp; HOSPITAL SPENDING

Dependent Variable: 1-Year Mortality	(1)	(2)	(3)	(4)
Panel A: OLS				
Avg. log(Hospital Spending)	-0.069 (0.007)**	-0.034 (0.007)**	-0.018 (0.007)*	-0.020 (0.007)**
Observations	351,701	351,701	351,701	351,701
Outcome Mean	.364	.364	.364	.364
Panel B: 2SLS				
Avg. log(Hospital Spending)	-0.235 (0.063)**	-0.210 (0.059)**	-0.188 (0.059)**	-0.187 (0.056)**
Observations	351,701	351,701	351,701	351,701
Outcome Mean	.364	.364	.364	.364
Diagnosis Controls	Yes	Yes	Yes	Yes
Demographic Controls	No	Yes	Yes	Yes
Ambulance Controls	No	No	Yes	Yes
Comorbidity Controls	No	No	No	Yes
ZIP Code Fixed Effects	Yes	Yes	Yes	Yes

# Generally Lower Mortality with More Spending

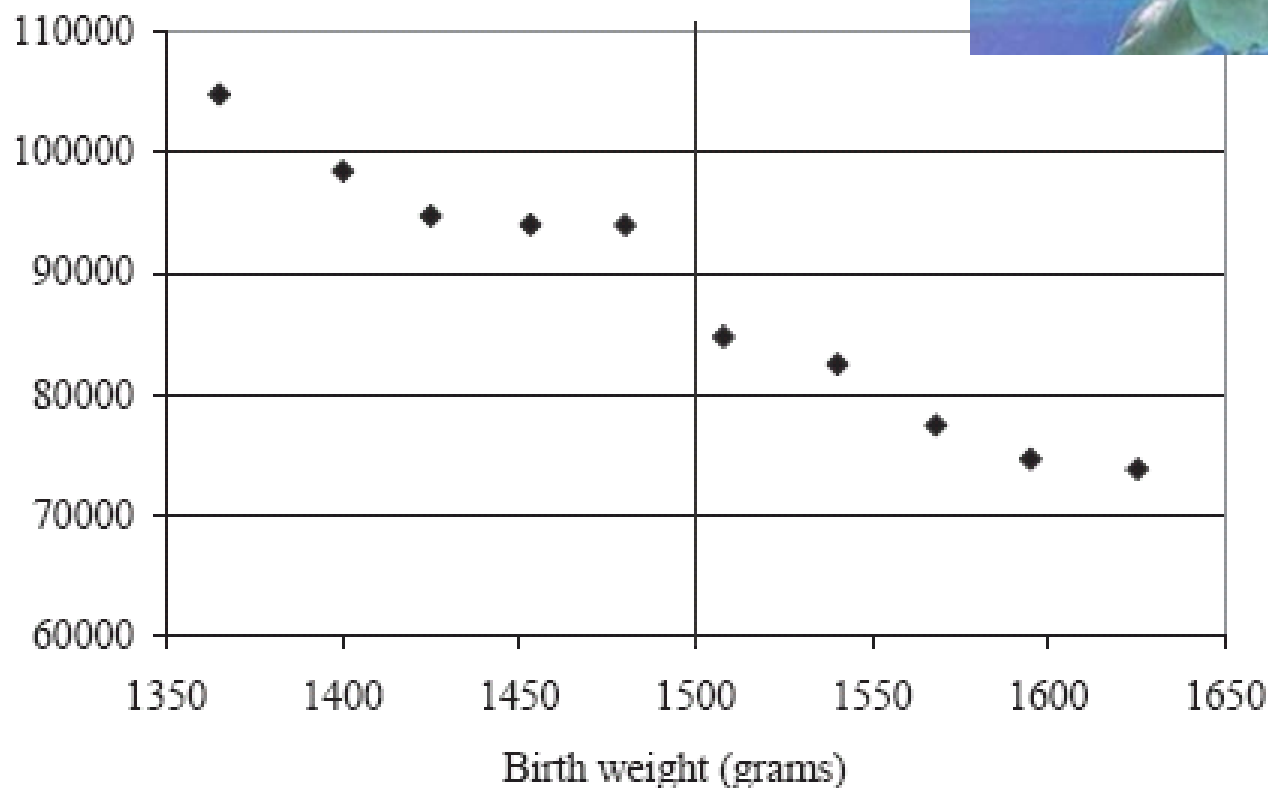


Source: Doyle et al., forthcoming



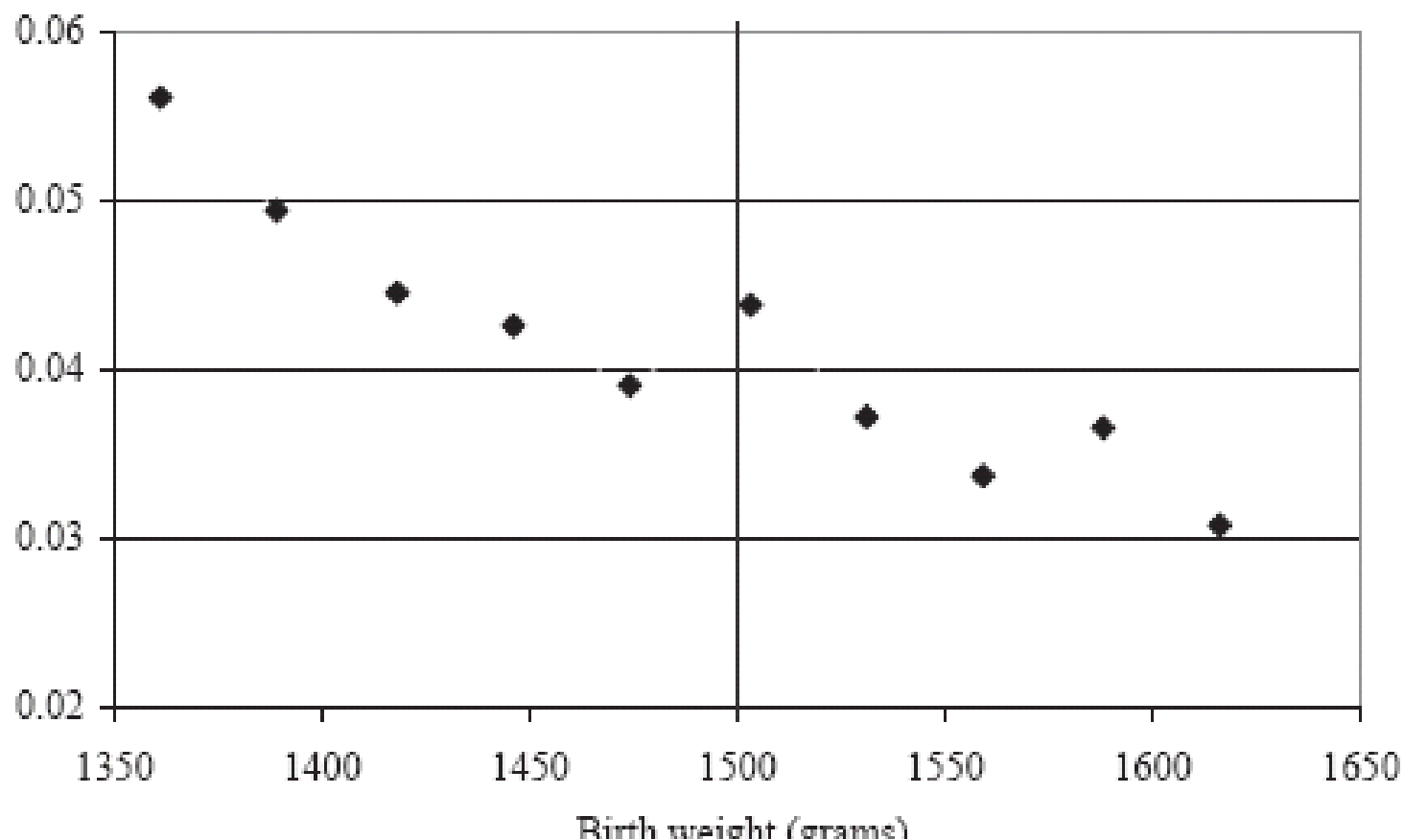
# Another: ADKW (2010), Saving Babies by Spending More

A. Hospital charges



# Regression Discontinuity @ 1500 g

B: 28-Day mortality



## SAVING BABIES? REVISITING THE EFFECT OF VERY LOW BIRTH WEIGHT CLASSIFICATION\*

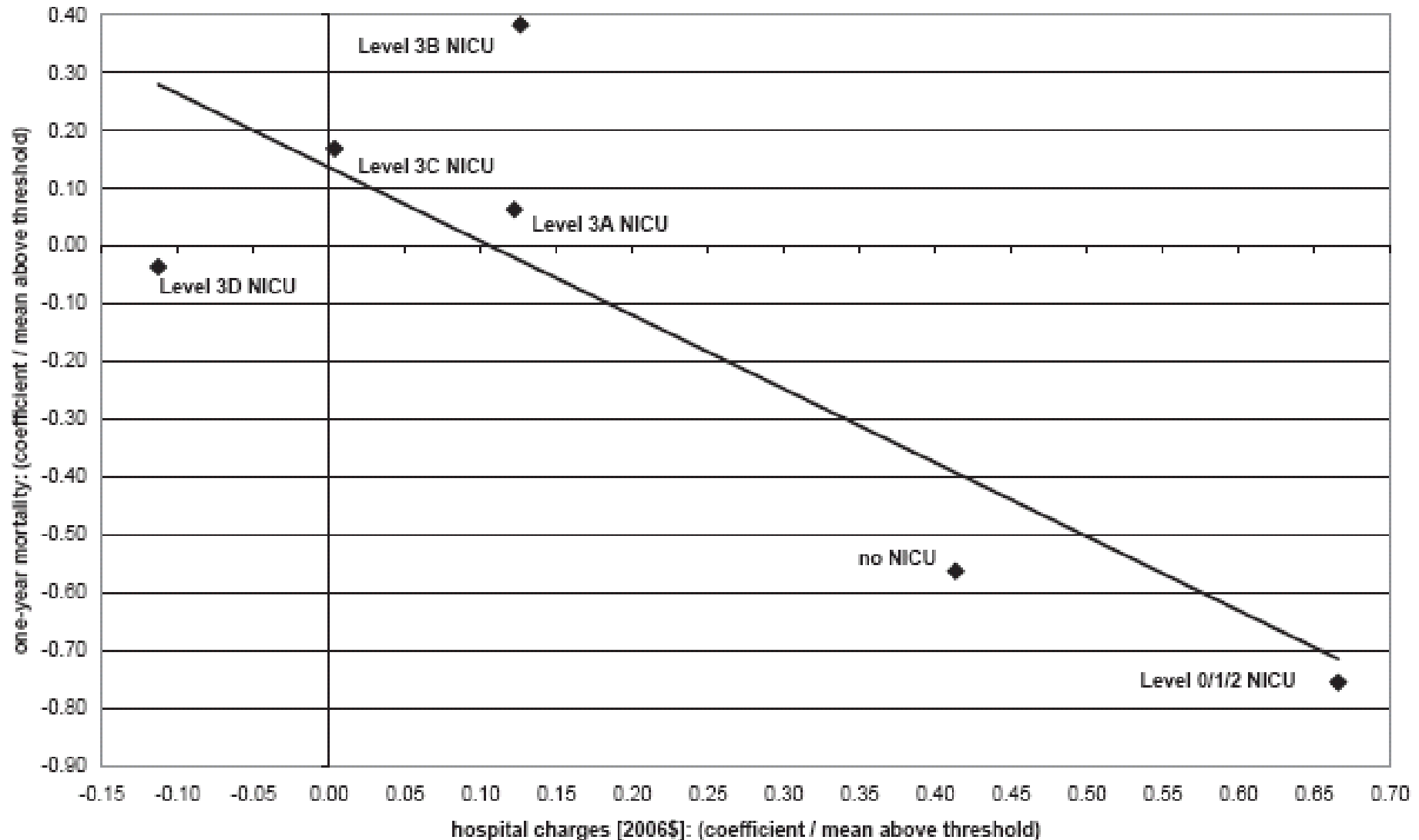
ALAN I. BARRECA  
MELANIE GULDI  
JASON M. LINDO  
GLEN R. WADDELL

We reconsider the effect of very low birth weight classification on infant mortality. We demonstrate that the estimates are highly sensitive to the exclusion of observations in the immediate vicinity of the 1,500-g threshold, weakening the confidence in the results originally reported in [Almond, Doyle, Kowalski, and Williams \(2010\)](#). *JEL* Codes: I12.

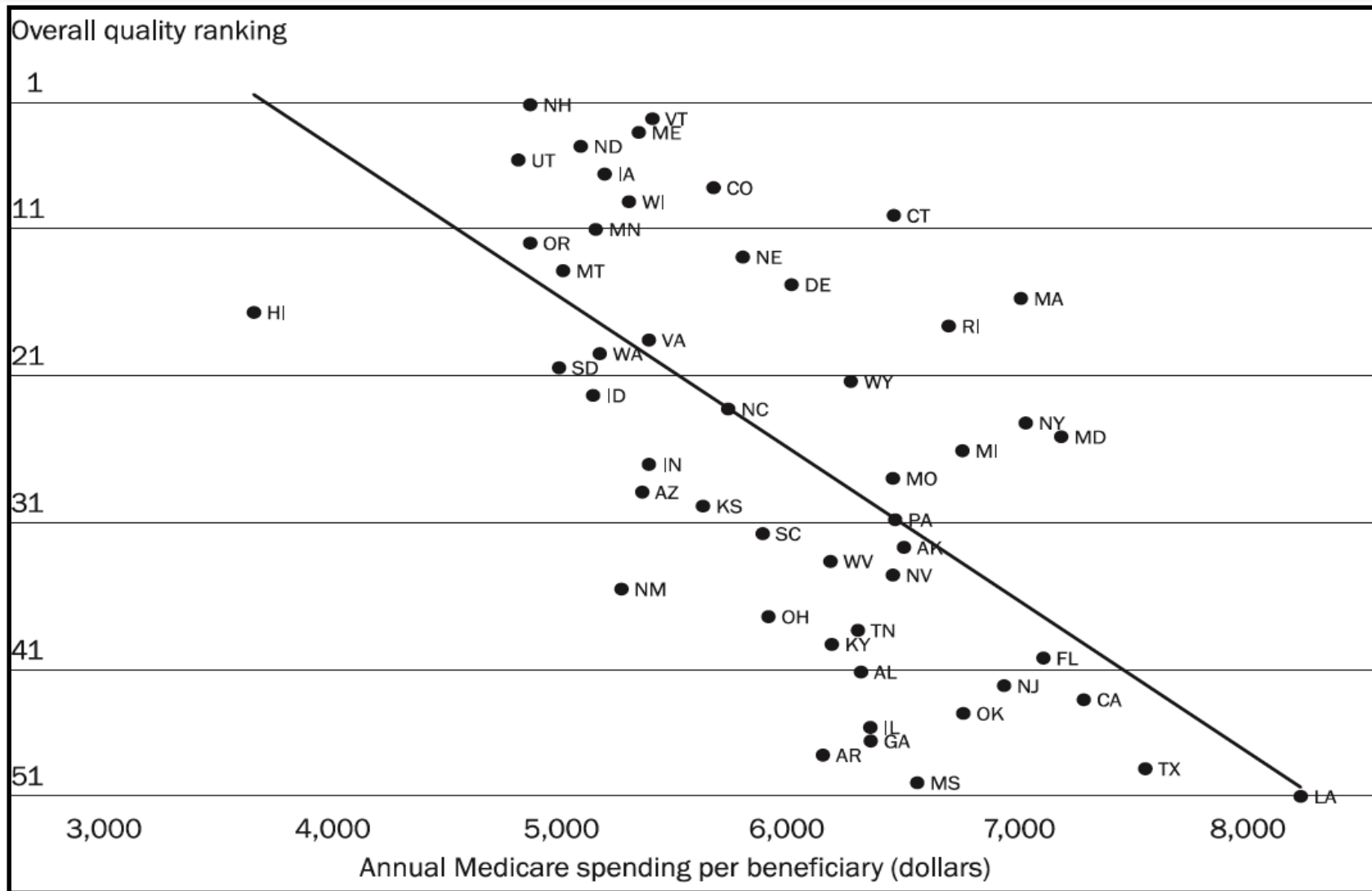
## THE ROLE OF HOSPITAL HETEROGENEITY IN MEASURING MARGINAL RETURNS TO MEDICAL CARE: A REPLY TO BARRECA, GULDI, LINDO, AND WADDELL\*

DOUGLAS ALMOND  
JOSEPH J. DOYLE, JR.  
AMANDA E. KOWALSKI  
HEIDI WILLIAMS

# Key Finding: Effect Depends on *Hospital Quality*

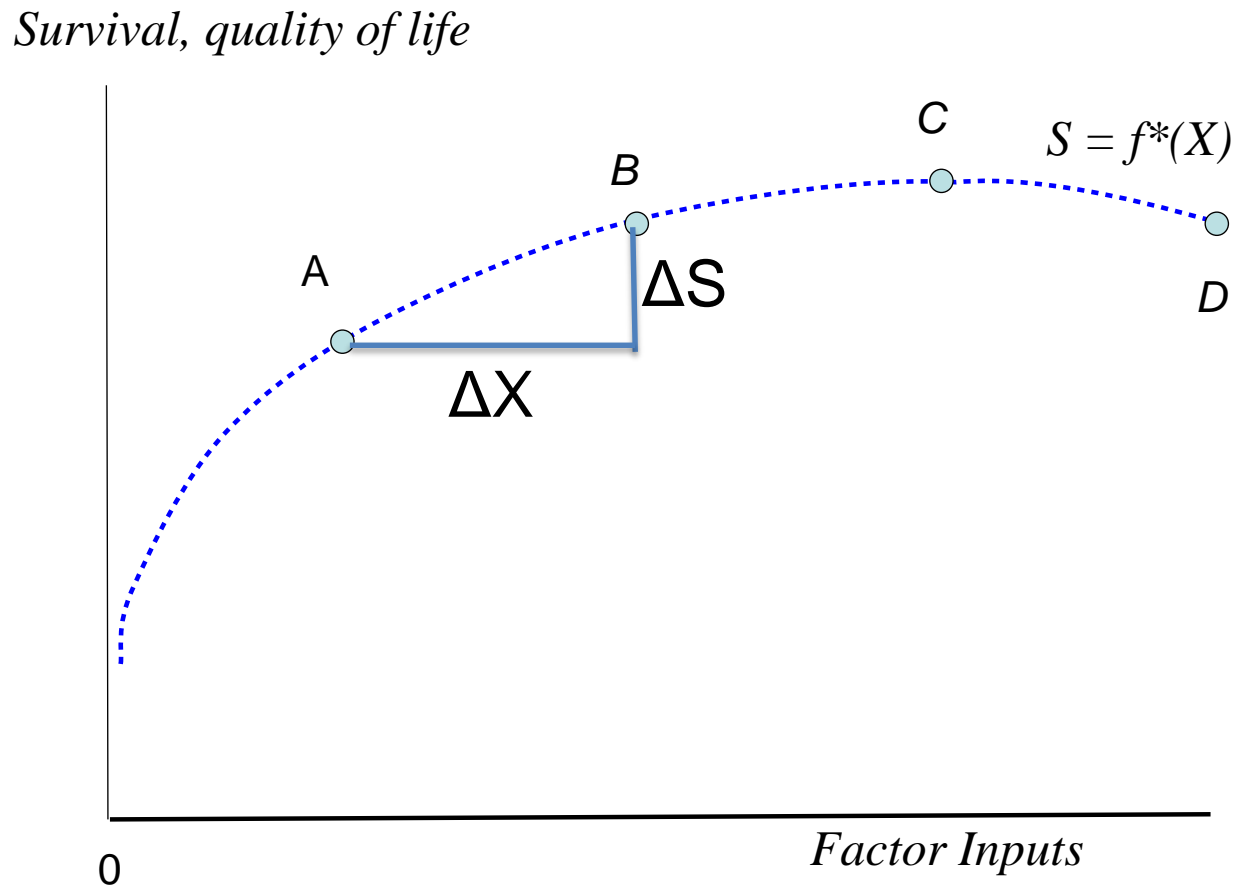


### 3. On the Other Hand: Spending and Quality



Source: Baicker and Chandra, *Health Affairs*, 2004

# What the Researcher Seeks to Estimate



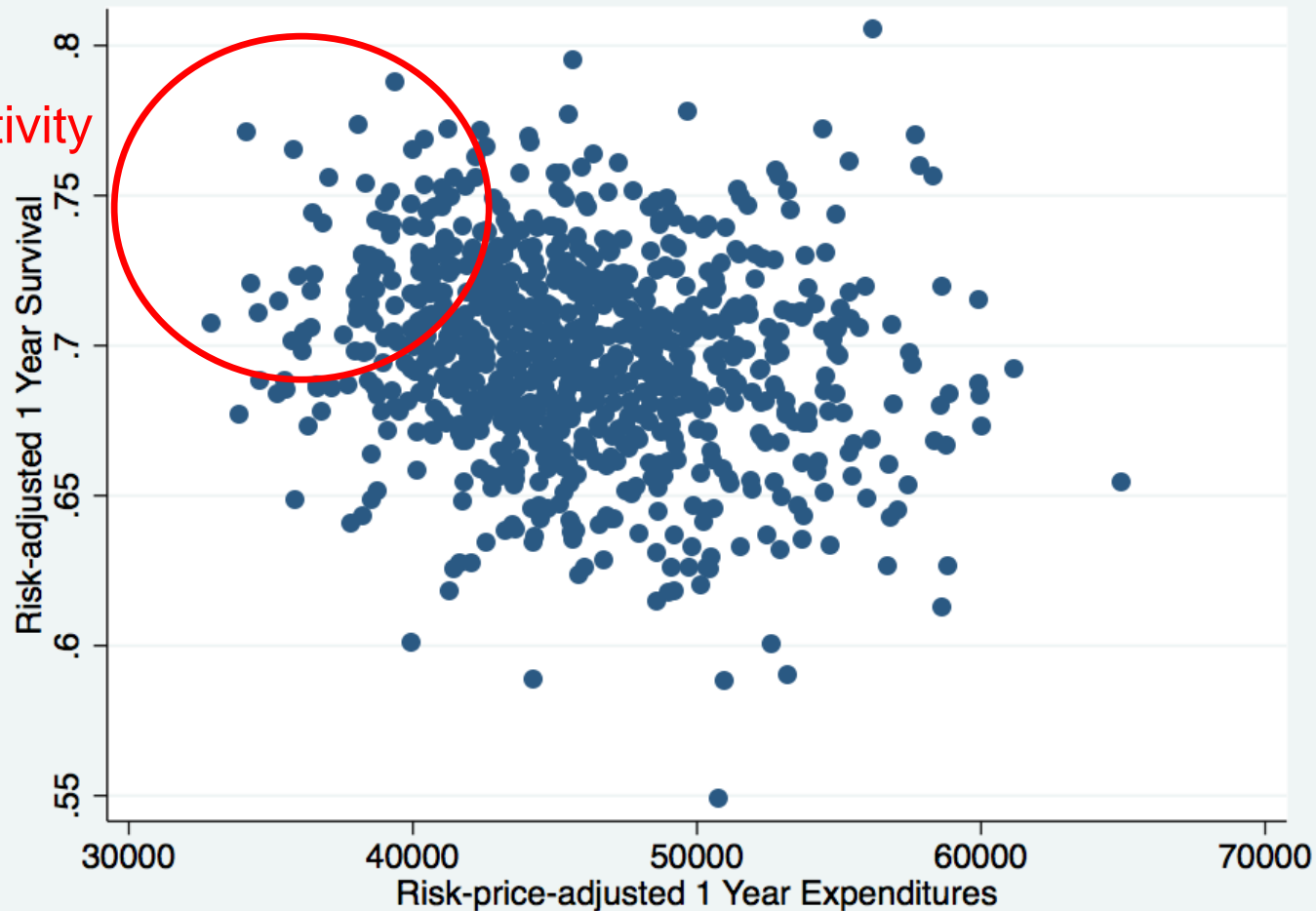
# What the Researcher Sees: AMI Survival and Risk-Adjusted Expenditures, by Hospital, 2007-11



Note: Sample limited to hospitals with at least 400 AMI patients age 65+; 2007-11.  
Source: Chandra, Colla, and Skinner, 2015

# Implies Large Differences in Hospital Productivity

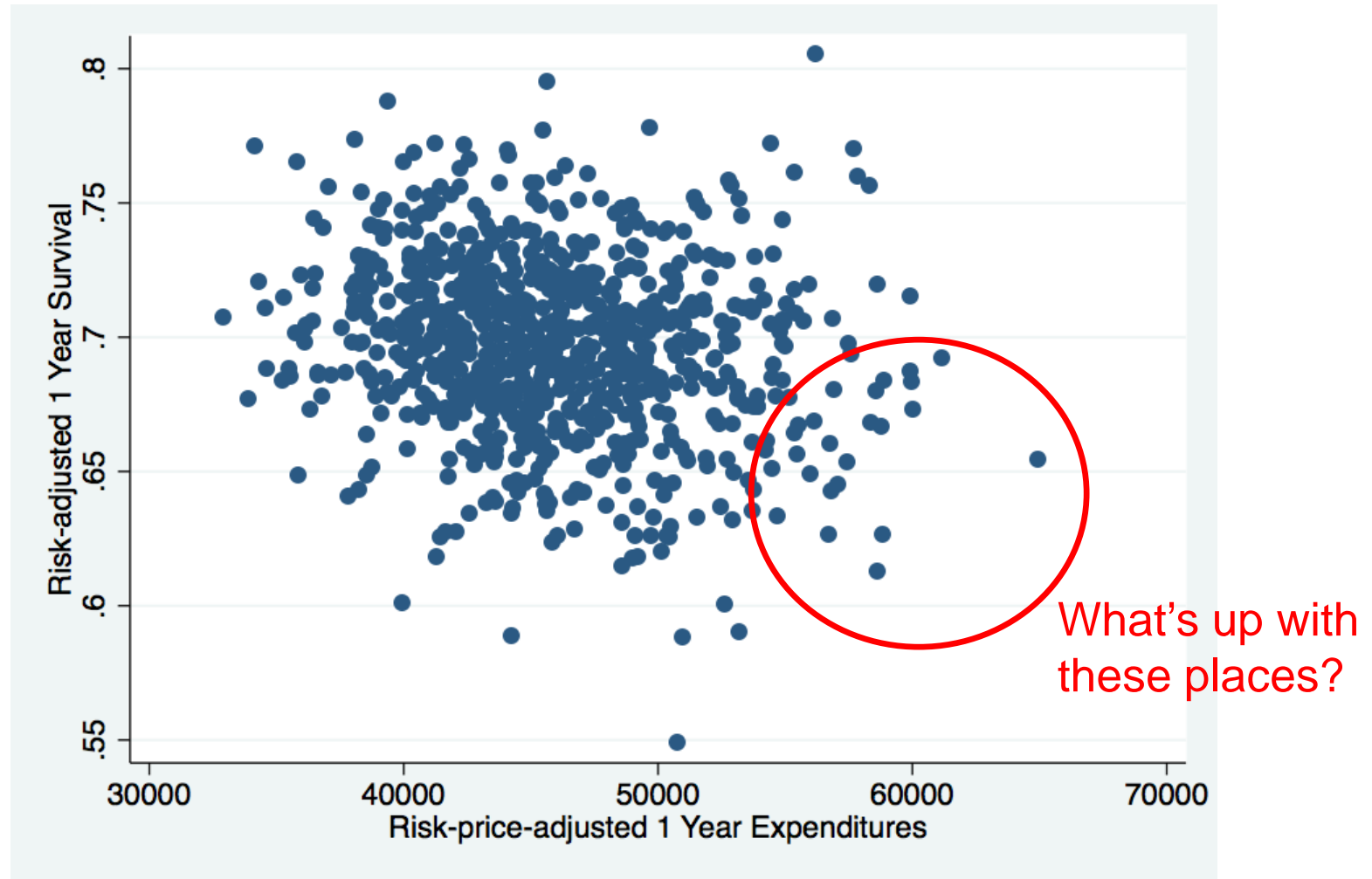
High  
productivity



Note: Sample limited to hospitals with at least 400 AMI patients age 65+; 2007-11.  
Source: Chandra, Colla, and Skinner, 2015



# Implies Large Differences in Hospital Productivity



Note: Sample limited to hospitals with at least 400 AMI patients age 65+; 2007-11.  
Source: Chandra, Colla, and Skinner, 2015

# A Framework to Think About Health Care Productivity

Chandra, A., A. Finkelstein, A. Sacarny, and C. Syverson, "Healthcare Exceptionalism? Productivity and Allocation in the U.S. Healthcare Sector," NBER WP, 2013

Skinner, J., and D. Staiger, "Technology Diffusion and Productivity Growth in Health Care , *Review of Economics and Statistics*, forthcoming

**Productivity Spillovers in Health Care: Evidence from the Treatment of Heart Attacks**

---

Amitabh Chandra

*Harvard University and National Bureau of Economic Research*

Douglas O. Staiger

*Dartmouth College and National Bureau of Economic Research*

## Technology Growth and Expenditure Growth in Health Care



AMITABH CHANDRA AND JONATHAN SKINNER\*

# What Can Explain These Productivity Differences?

## 1. Management quality

---

### ORIGINAL INVESTIGATION

---

#### HEALTH CARE REFORM

## Management Practices and the Quality of Care in Cardiac Units

*K. John McConnell, PhD; Richard C. Lindrooth, PhD; Douglas R. Wholey, PhD;  
Thomas M. Maddox, MD; Nick Bloom, PhD*

JAMA Internal Medicine 2013

# What Can Explain These Productivity Differences?

1. Management quality
2. Expertise of specific physicians in a given treatment or diagnosis

**Productivity Spillovers in Health Care: Evidence from the Treatment of Heart Attacks**

---

Amitabh Chandra

*Harvard University and National Bureau of Economic Research*

Douglas O. Staiger

*Dartmouth College and National Bureau of Economic Research*

Also see Currie and MacLeod, NBER WP, 2013

# What Can Explain These Productivity Differences?

1. Management quality
2. Expertise of specific physicians in a given treatment or diagnosis
3. Adoption and diffusion of new innovations

## Technology Growth and Expenditure Growth in Health Care

AMITABH CHANDRA AND JONATHAN SKINNER\*

## Barriers to Technology Adoption and Development

---

Stephen L. Parente

*Northeastern University*

Edward C. Prescott

*Federal Reserve Bank of Minneapolis and University of Minnesota*

# Three Categories of Health Care Innovations

- I. Innovations that are cost-effective for nearly every patient
- II. Heterogeneous treatments: Cost-effective for some patients, cost-ineffective or useless for others
- III. Treatments with uncertain or low benefits

# Category I Treatments for Heart Attacks

1. Beta Blockers
2. Aspirin
3. Reperfusion  
within 12 hours

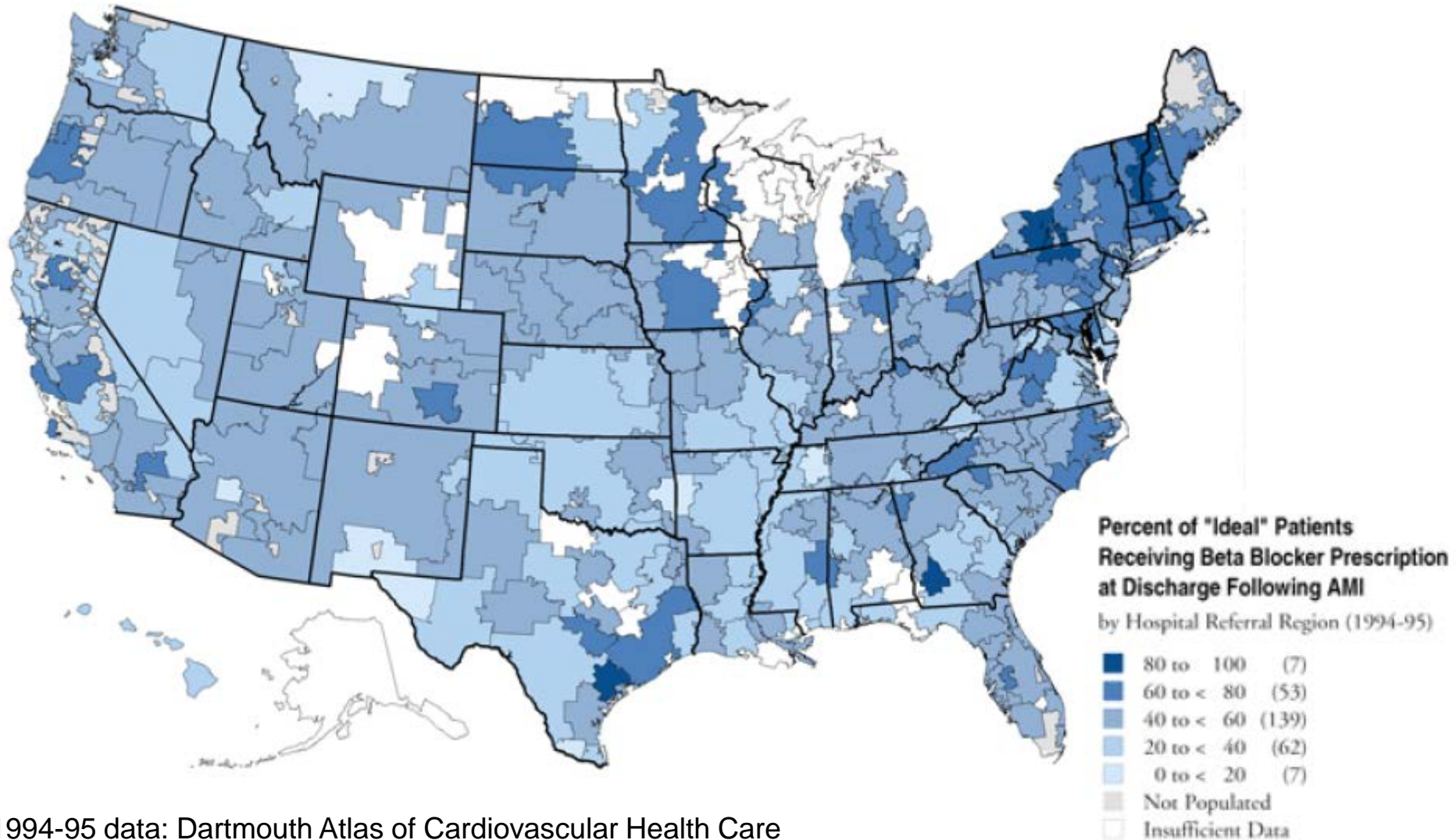


# What was known about beta blockers in 1985

“Long-term beta blockade for perhaps a year or so following discharge after an MI is now of proven value, and for many such patients mortality reductions of about 25% can be achieved.” (Yusef et al., p. 335)



# Beta Blocker Use Among Ideal AMI Patients, 1994/95

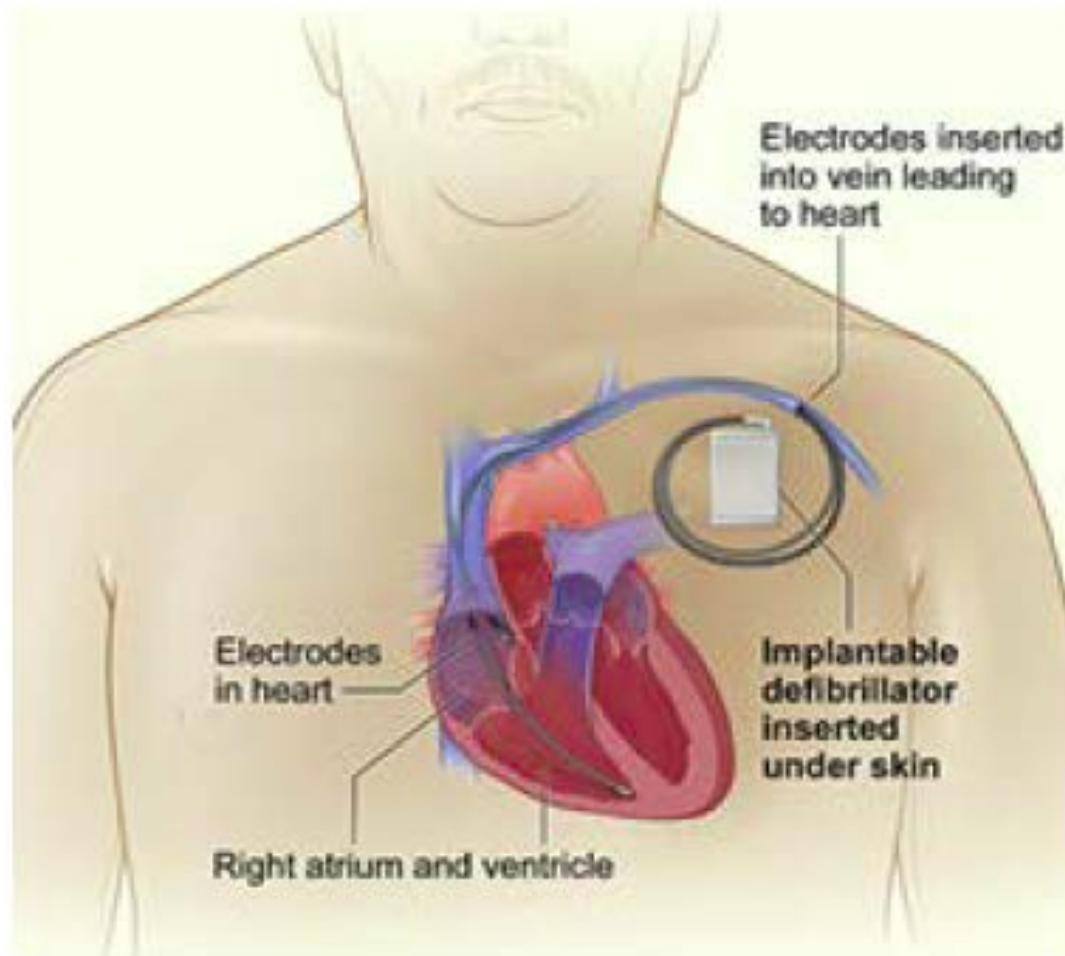


1994-95 data: Dartmouth Atlas of Cardiovascular Health Care

# Three Categories of Health Care Innovations

1. Innovations that are cost-effective for nearly every patient
2. Treatment is cost-effective for some patients, cost-ineffective for others
3. Innovations with uncertain or low benefits

# Category II: Implantable Defibrillators



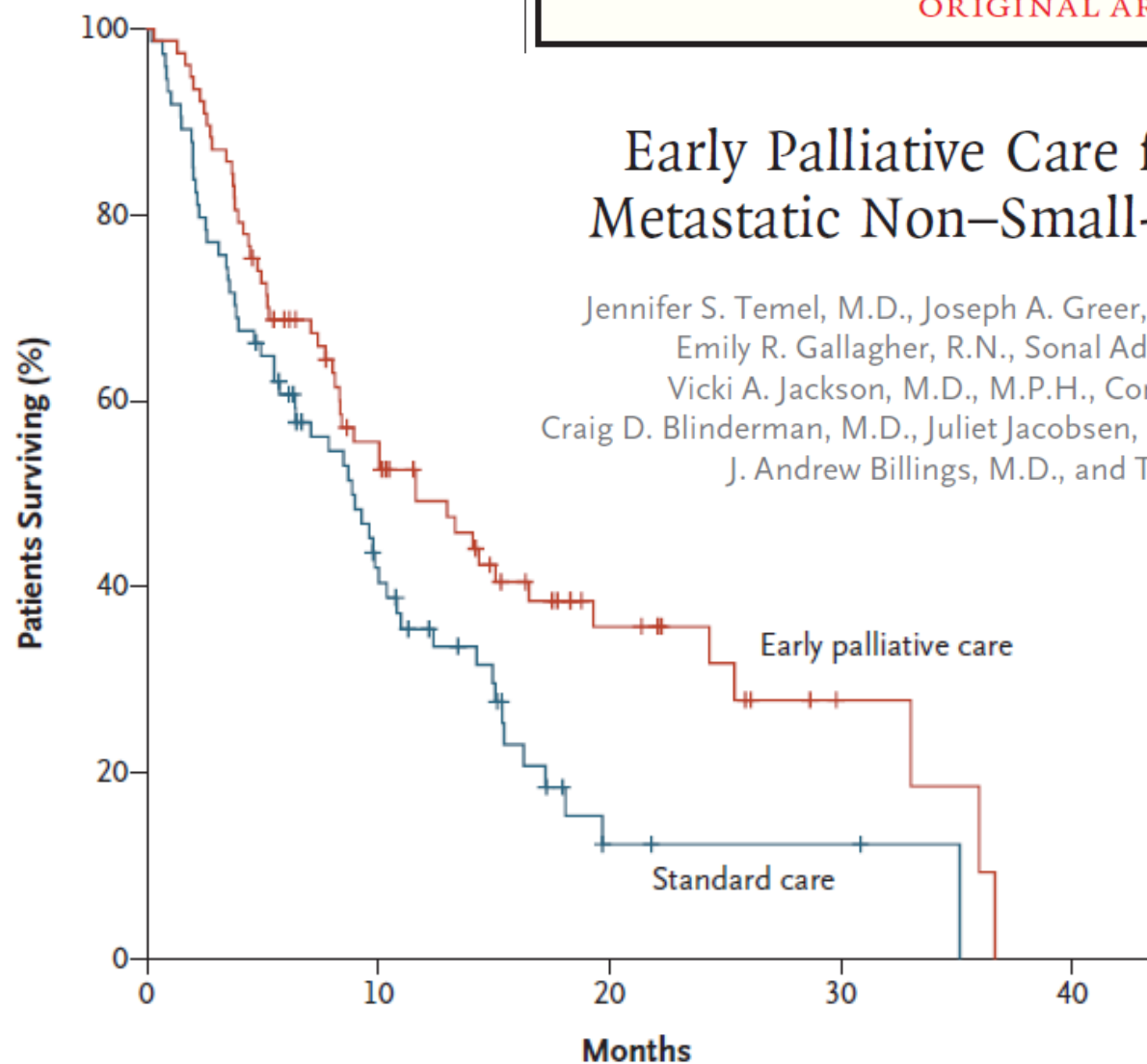
# Three Categories of Health Care Innovations

1. Innovations that are cost-effective for nearly every patient
2. Treatment is cost-effective for some patients, cost-ineffective for others
3. Innovations with uncertain or low benefits

## ORIGINAL ARTICLE

## Early Palliative Care for Patients with Metastatic Non–Small-Cell Lung Cancer

Jennifer S. Temel, M.D., Joseph A. Greer, Ph.D., Alona Muzikansky, M.A., Emily R. Gallagher, R.N., Sonal Admane, M.B., B.S., M.P.H., Vicki A. Jackson, M.D., M.P.H., Constance M. Dahlin, A.P.N., Craig D. Blinderman, M.D., Juliet Jacobsen, M.D., William F. Pirl, M.D., M.P.H., J. Andrew Billings, M.D., and Thomas J. Lynch, M.D.



**Figure 3.** Kaplan–Meier Estimates of Survival According to Study Group.

# Medicare Claims Show Overuse for CT Scanning



Christopher Capozziello for The New York Times

Richard Miller of Waterford, Conn., undergoing a CT scan of his chest, pelvis and abdomen, administered by Cheryl Monde.

By WALT BOGDANICH and JO CRAVEN MCGINTY

Published: June 17, 2011

Long after questions were first raised about the overuse of powerful CT scans, hundreds of hospitals across the country needlessly exposed patients to radiation by scanning their chests twice on the same day, according to federal records and interviews with researchers.

**The New York Times**



# Tube Feeding in Patients With Advanced Dementia

## A Review of the Evidence

Thomas E. Finucane, MD

Colleen Christmas, MD

Kathy Travis, MD

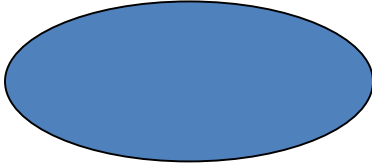
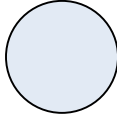
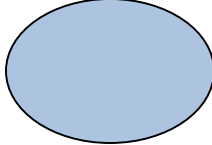
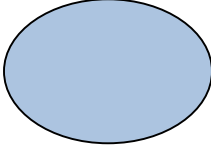
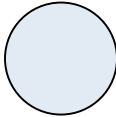
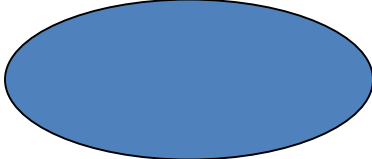
**P**ATIENTS WITH ADVANCED DEMENTIA commonly develop difficulty eating, often when they become bedridden and dependent in all activities of daily living. They may resist or be indifferent to food, fail to manage the food bolus properly once it is in the mouth (oral phase dysphagia), or aspirate when swallowing (pharyngeal phase dysphagia). Enteral tube

Patients with advanced dementia frequently develop eating difficulties and weight loss. Enteral feeding tubes are often used in this situation, yet benefits and risks of this therapy are unclear. We searched MEDLINE, 1966 through March 1999, to identify data about whether tube feeding in patients with advanced dementia can prevent aspiration pneumonia, prolong survival, reduce the risk of pressure sores or infections, improve function, or provide palliation. We found no published randomized trials that compare tube feeding with oral feeding. We found no data to suggest that tube feeding improves any of these clinically important outcomes and some data to suggest that it does not. Further, risks are substantial. The widespread practice of tube feeding should be carefully reconsidered, and we believe that for severely demented patients the practice should be discouraged on clinical grounds.

JAMA. 1999;282:1365-1370

[www.jama.com](http://www.jama.com)

# Some Inputs Save Lives, Others Cost Money

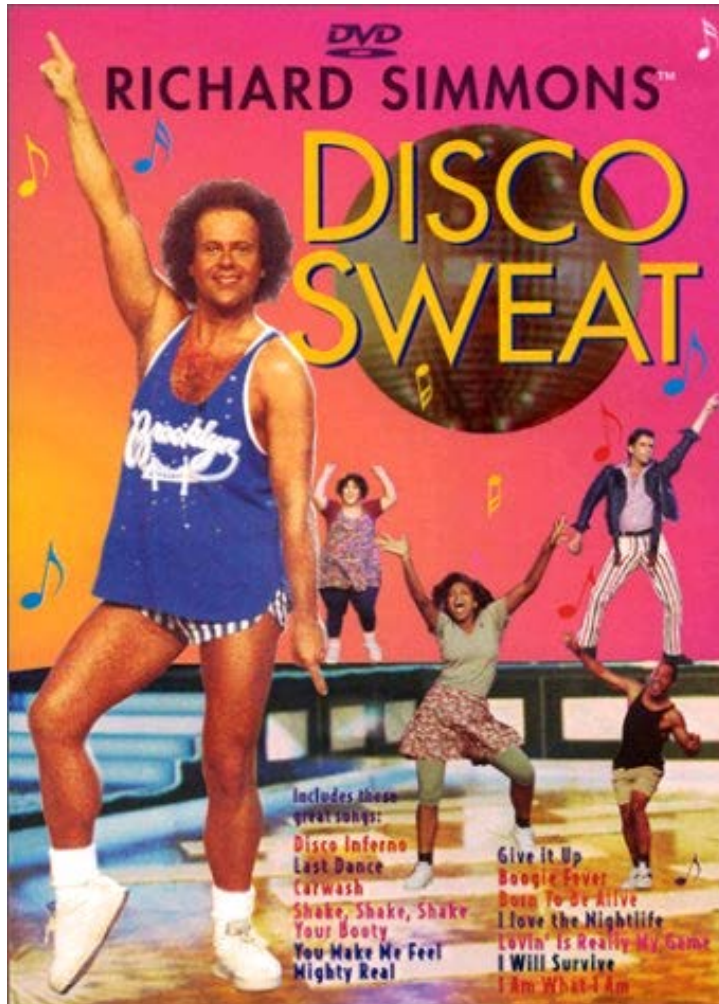
	Improved Health	Increased Costs
Category I (Cost-Effective)		
Category II (Heterogeneous)		
Category III (Unknown or small)		



# Cardiovascular Mortality Decline 1980-2000

% Mortality Decline	Type of Medical/Surgical Treatment or Risk Factor Change
61%	Decline: smoking, hypertension, cholesterol, physical inactivity
-17%	Rise: body-mass index (BMI) and diabetes
<b>44%</b>	<b><i>Subtotal: Deaths prevented: health risk factors</i></b>
22%	Category I: Aspirin, heparin, warfarin, anti-hypertensives, $\beta$ -blockers, diuretics
13%	Category I+: Statins, ACE Inhibitors, IIb/IIIa antagonists, thrombolytics
12%	Category II: Angioplasty/stents, bypass surgery (CABG), cardio-pulmonary resuscitation, cardiac rehabilitation
<b>47%</b>	<b><i>Subtotal: Deaths prevented: health care</i></b>
10%	Unexplained
<b>100%</b>	<b><i>Total deaths prevented (341,745 total)</i></b>
Source: Ford, et al., NEJM 2007.	

# Who saved more lives?

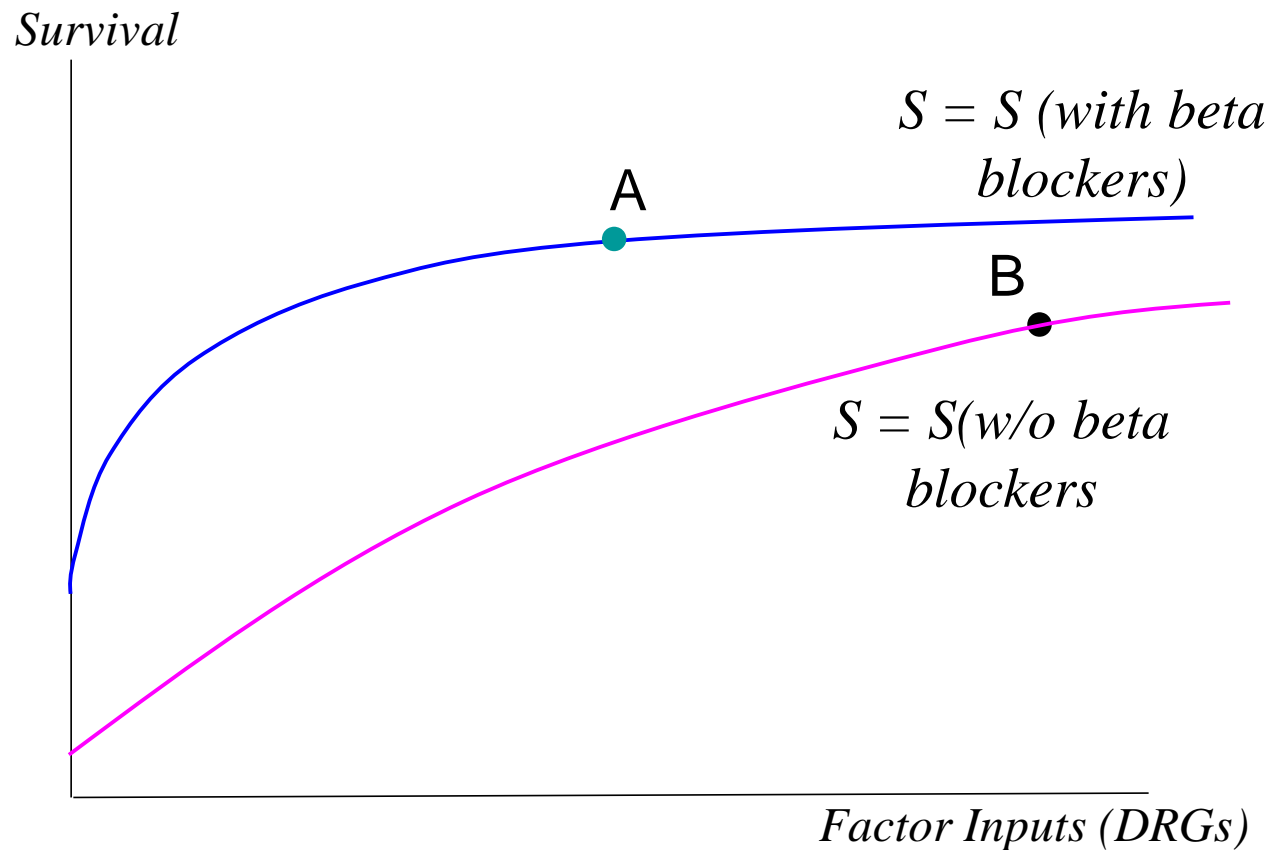


# How Can This Framework Make Sense of the Data?

- When a hospital invests in treatment  $j$ , it affects both survival ( $S$ ) and expenditures ( $X$ ). If there were just one treatment  $j$ ,  $\beta = dS/dX = dS/dj / dX/dj$ .
- But there isn't just one treatment  $j$
- Suppose high-quality doctors eschew Category II or III treatments (e.g., Doyle, JHE 2010)
- Then the estimate of  $\beta$  has uncertain interpretation

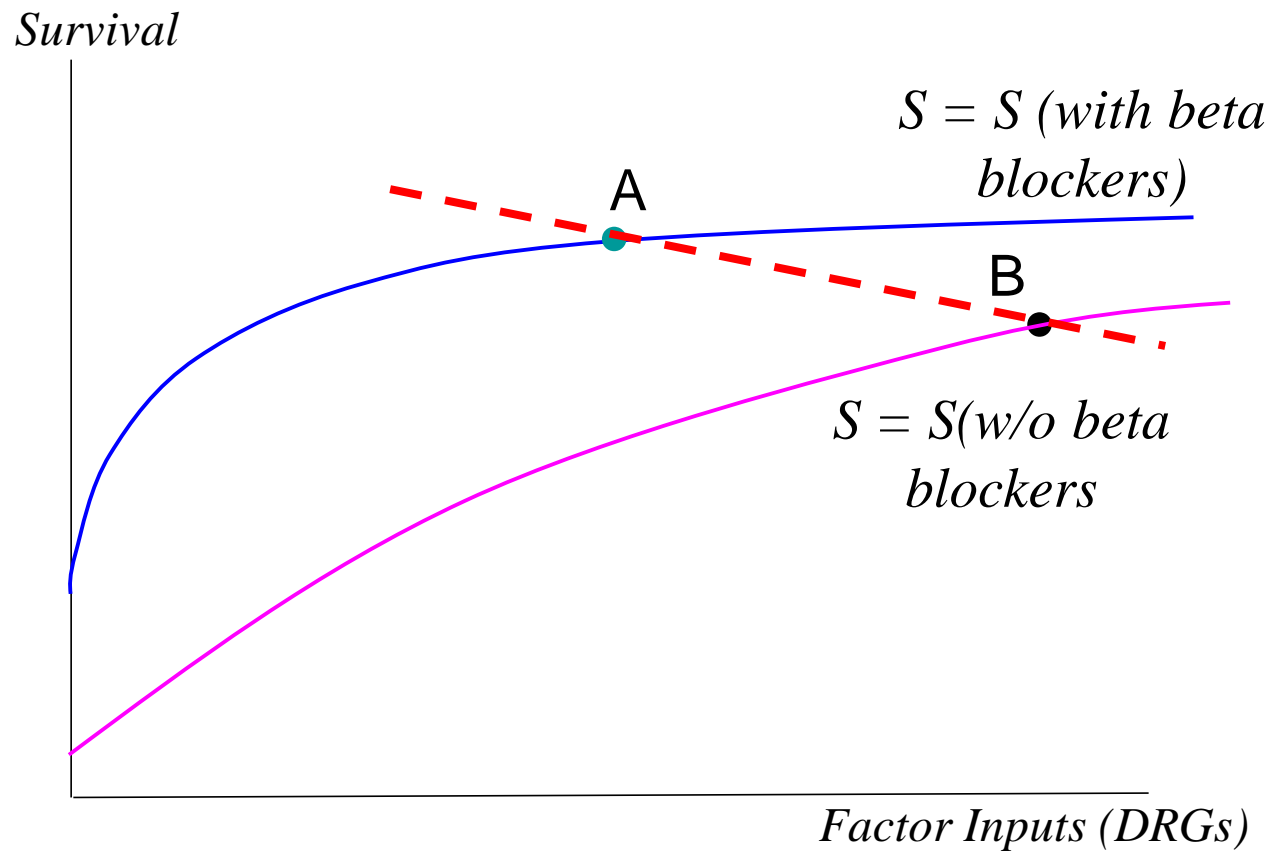
Chandra, Colla, and Skinner, 2015

# At a Point in Time, Some Hospitals Adopted $\beta$ Blockers, Others Didn't

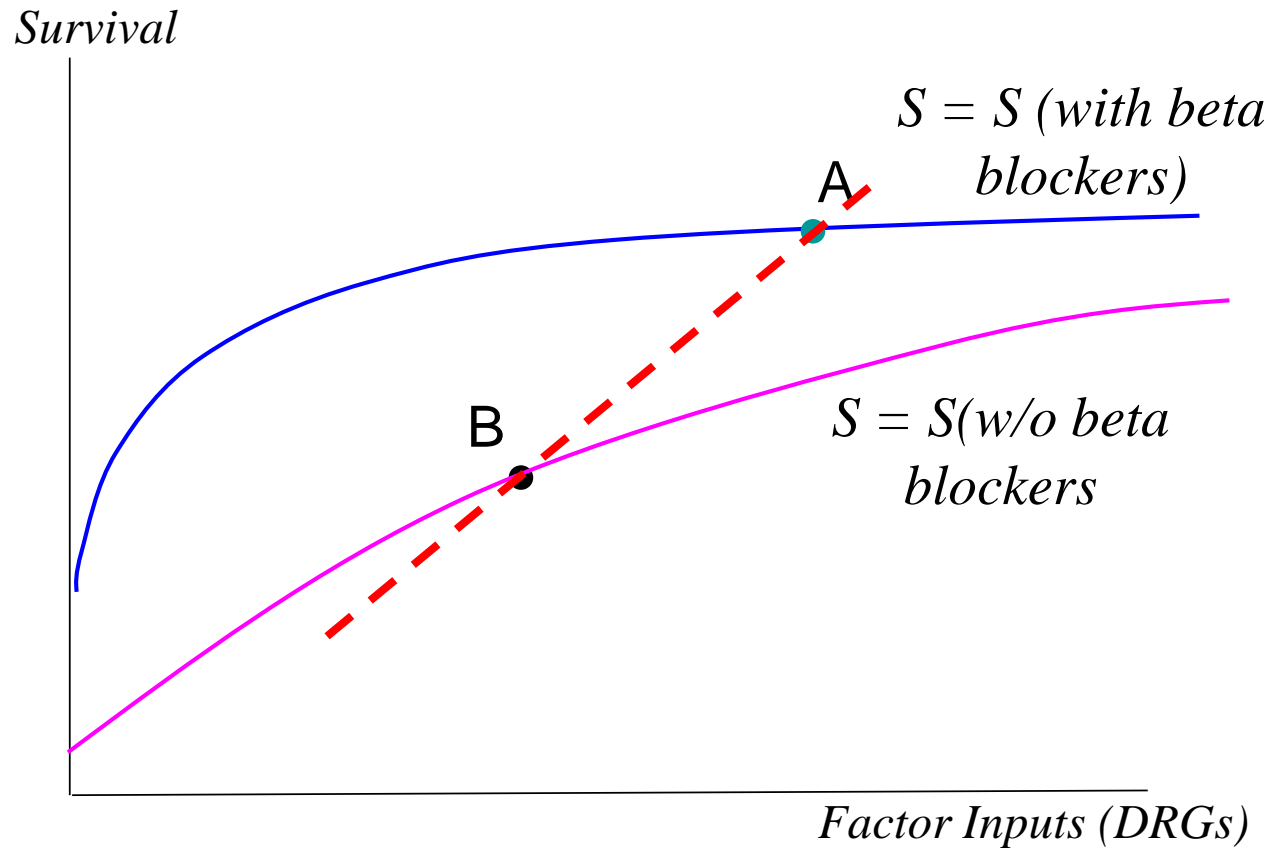


Source: Skinner and Staiger, forthcoming

# Could Imply “More is Worse”



# Or Could Imply More is Much Better



# Pausing for Breath



- Estimates of “the” impact of health care spending on health are highly variable -- it matters *how* the money is spent
- Variation in technology diffusion can explain puzzling patterns of spending and outcomes
- But what factors determine the magnitude and types of new health care innovations?

# Insurance Coverage Affects Technology Diffusion

## IMPACT OF MEDICARE ON HOSPITAL BEHAVIOR

	Utilization		Inputs		Expenditures	
	Log admissions	Log patient days	Log employment	Log beds	Log payroll expenditures	Log total expenditures
1. First 2 years: (1967–1965 vs. 1965–1963)	0.272** (0.040)	0.402*** (0.0004)	0.253*** (0.001)	0.094 (0.363)	0.342*** (0.003)	0.279*** (0.006)
2. First 5 years: (1970–1965 vs. 1965–1960)	0.504*** (0.004)	0.567*** (0.0001)	0.340*** (0.009)	0.346*** (0.006)	0.560*** (0.0001)	0.332** (0.011)

## QUARTERLY JOURNAL OF ECONOMICS

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THE AGGREGATE EFFECTS OF HEALTH INSURANCE:  
EVIDENCE FROM THE INTRODUCTION OF MEDICARE\*

AMY FINKELSTEIN

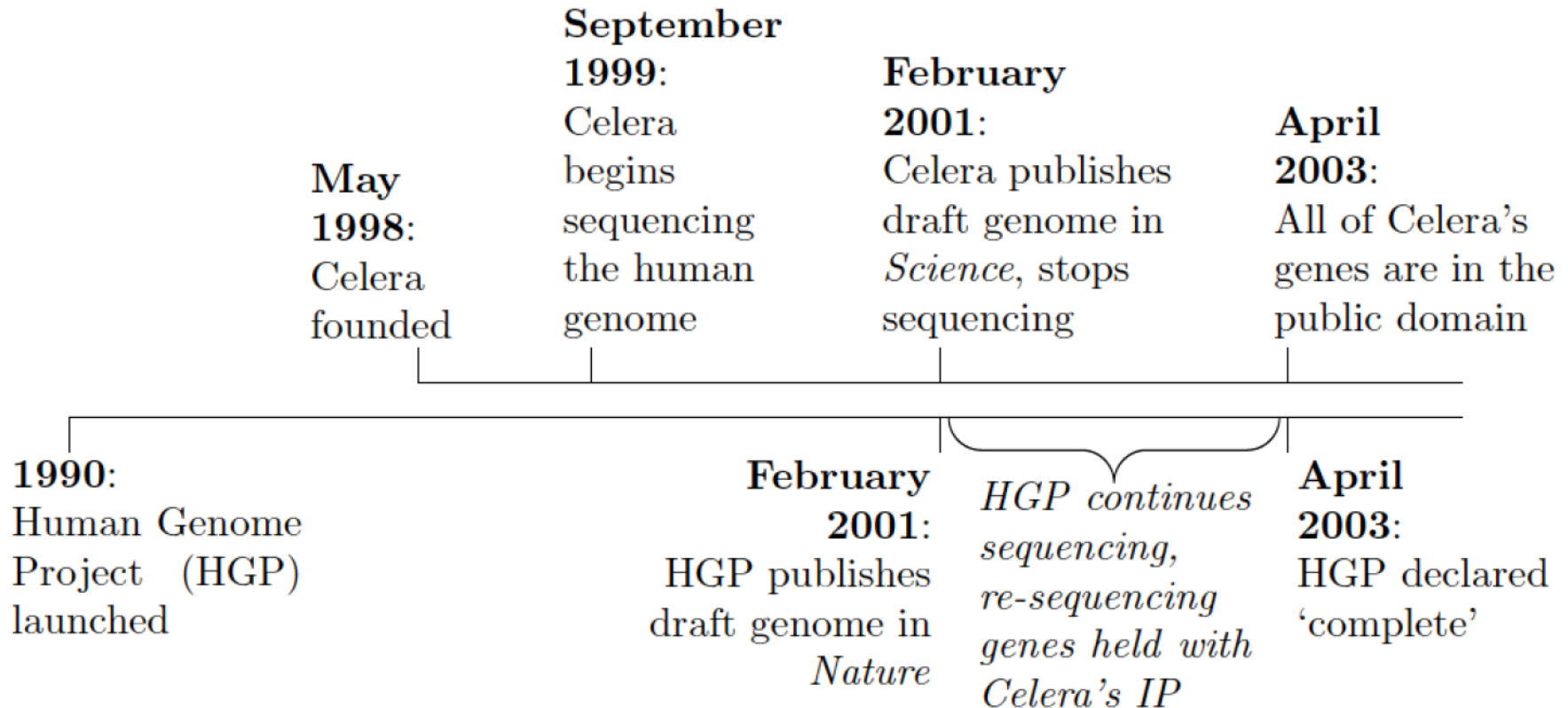


# (Gene) Patenting Affects Technology Development

Heidi Williams: Intellectual Property Rights and Innovation, *JPE* 2013

- Innovation is a key driver of economic growth
- Competitive markets may under-incentivize innovation due to the non-rival nature of ideas (Nelson 1959; Arrow 1962)
- Intellectual property (IP) policies aim to promote R&D
  - ▶ Traditional focus: Role of IP in incentivizing R&D on new technologies
  - ▶ However, in many markets innovation is *cumulative* - product development results from several steps of invention and research

# Williams: Intellectual Property Rights and Innovation



# Intuition

- Suppose the firm Celera holds IP on a human gene
- Suppose Pfizer discovers a diagnostic test based on Celera's gene
- Will Celera's IP discourage Pfizer from developing this test?
  - ▶ In a perfect contracting environment, Celera and Pfizer would negotiate a license such that cumulative research is not hindered
  - ▶ However, transaction costs - e.g. private information about R&D costs - may cause licensing negotiations to break down
  - ▶ Rich theoretical literature, but empirical evidence is scarce

# William's Basic Result

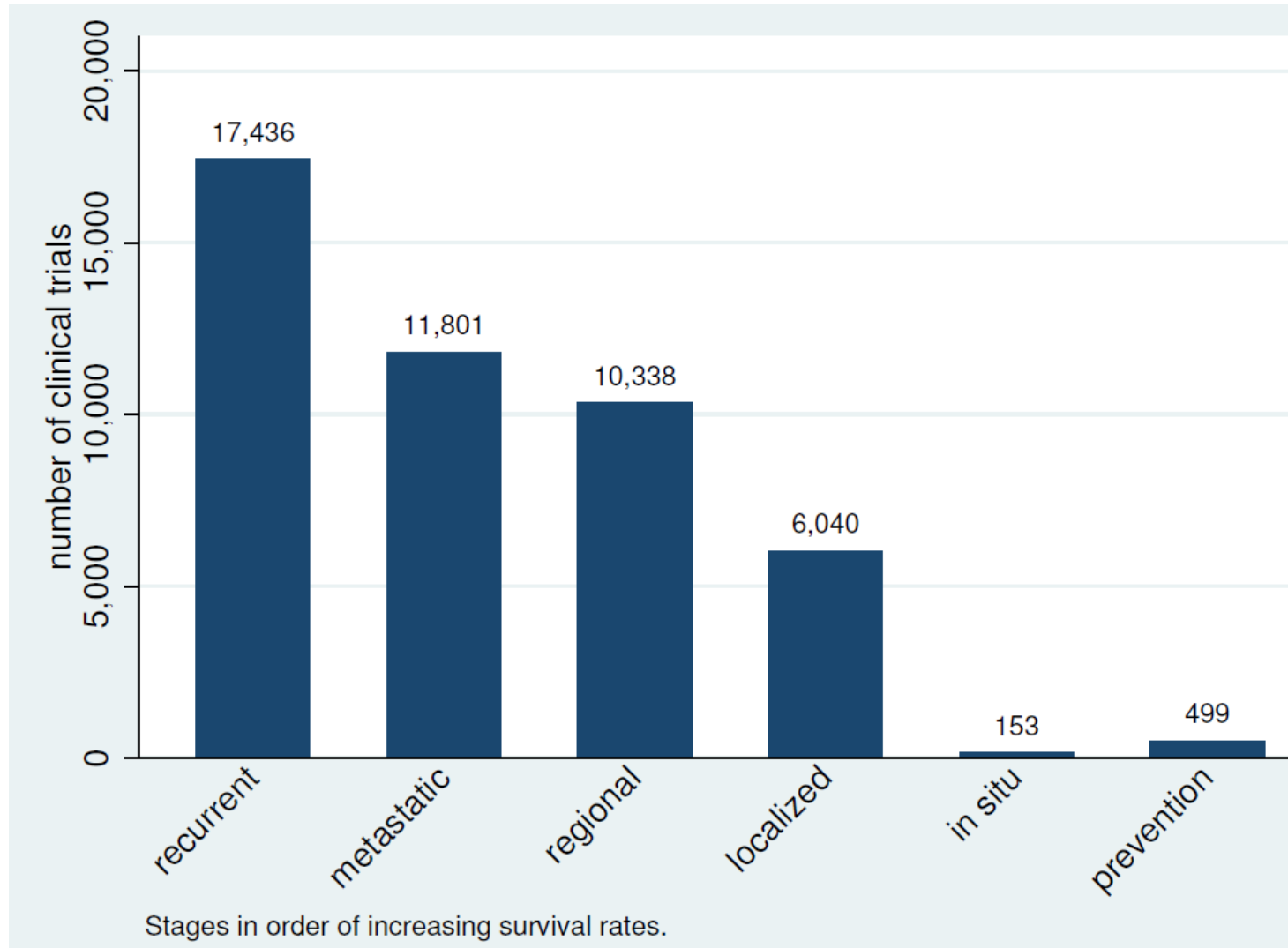
	(1) Celera mean	(2) Non-Celera mean	(3) difference [(1)-(2)]	(4) <i>p</i> -value of difference
publications in 2001-2009	1.239	2.116	-0.877	[0.000]
<b>1</b> (known, uncertain phenotype)	0.401	0.563	-0.162	[0.000]
<b>1</b> (known, certain phenotype)	0.046	0.073	-0.027	[0.000]
<b>1</b> (used in any diagnostic test)	0.030	0.054	-0.023	[0.000]
<i>N</i>	1,682	2,851		

Notes: See Table 1 in paper.

Taken at face value: Celera's IP led to economically and statistically significant reductions in subsequent R&D, on the order of 20-30 percent

# Effective Patent Length Also Affects Innovation

Budish, Roin, and Williams, Working Paper, MIT, 2014



# Summing Up...

- Like Newhouse (1992), technology growth on average improves survival and increases costs
- But this doesn't preclude considerable differences in diffusion at a point in time, leading to large variations in outcomes, spending, and productivity (as in macro; c.f. Eaton and Kortum, IER, 1999) across institutions and physicians
- Nor does this view preclude the endogeneity of technology; the path of science, like all things, responds to incentives

# Professor Dafny's Guide to Research in Health



## 1. Start with a question

- Do healthcare providers make strategic investments?
- Do healthcare providers differentiate vertically?

## 2. Start with a “shock”

- Medicare released a nationwide HMO report card in 1999
- Medicare implemented Part D (coverage for prescription drugs)
- The subprime mortgage market blew up

## 3. Start with a unique data source

# Truly Final Comments

- It is the Best of Times.....
  - Growing importance of the health care sector
  - New tools and methods
  - Outcomes really important (e.g., we are not explaining cereal prices)
- It is the Worst of Times...
  - Complex models can be very difficult to estimate
  - Access to confidential data can be difficult or impossible
- Some cause for hope:
  - Public use data has more health information (HRS, PSID)
  - Increasing use of “enclaves” for CMS data



## ***AEA Continued Education: Health Economics, January 5-7, 2015***

**Adriana Lleras-Muney, UCLA**  
**Jonathan Gruber, MIT**  
**Jonathan Skinner, Dartmouth**

### **Introduction and Overview: Basic facts on health and health care**

Adriana Lleras-Muney  
[alleras@econ.ucla.edu](mailto:alleras@econ.ucla.edu)

## **I. Socioeconomic Determinants of Health**

Adriana Lleras-Muney  
[alleras@econ.ucla.edu](mailto:alleras@econ.ucla.edu)

### **1. The Determinants of Population Health**

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## II. Demand for Health Care and Insurance Markets

Jonathan Gruber  
[gruberj@mit.edu](mailto:gruberj@mit.edu)

### 1. Insurance Coverage in the U.S.: Background and Facts

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### **III. The Supply Side: Industrial Organization, Physician Incentives, and Productivity in Health Care**

Jonathan Skinner

[jon.skinner@dartmouth.edu](mailto:jon.skinner@dartmouth.edu)

#### **\* *Primary readings***

#### **1. Industrial Organization of Health Care Markets**

\* Cutler, David, and Fiona Scott-Morton, “Hospitals, Market Share, and Competition,” *JAMA*, 2013, 310: 1964-1970.

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