Winter February 7, 2013

Estimating the Health and Economic Effects of Public Health Spending

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University of Michigan RWJF Health Policy Scholars Seminar • 07 February 2013

Acknowledgements

Research support provided by:

- Robert Wood Johnson Foundation's Changes in Healthcare Financing and Organization (HCFO) Initiative
- Robert Wood Johnson Foundation's Public Health Practice-Based Research Networks program
- National Institutes of Health Clinical and Translational Science Award

Preventable disease burden and national health spending

>75% of national health spending is attributable to chronic diseases that are largely preventable

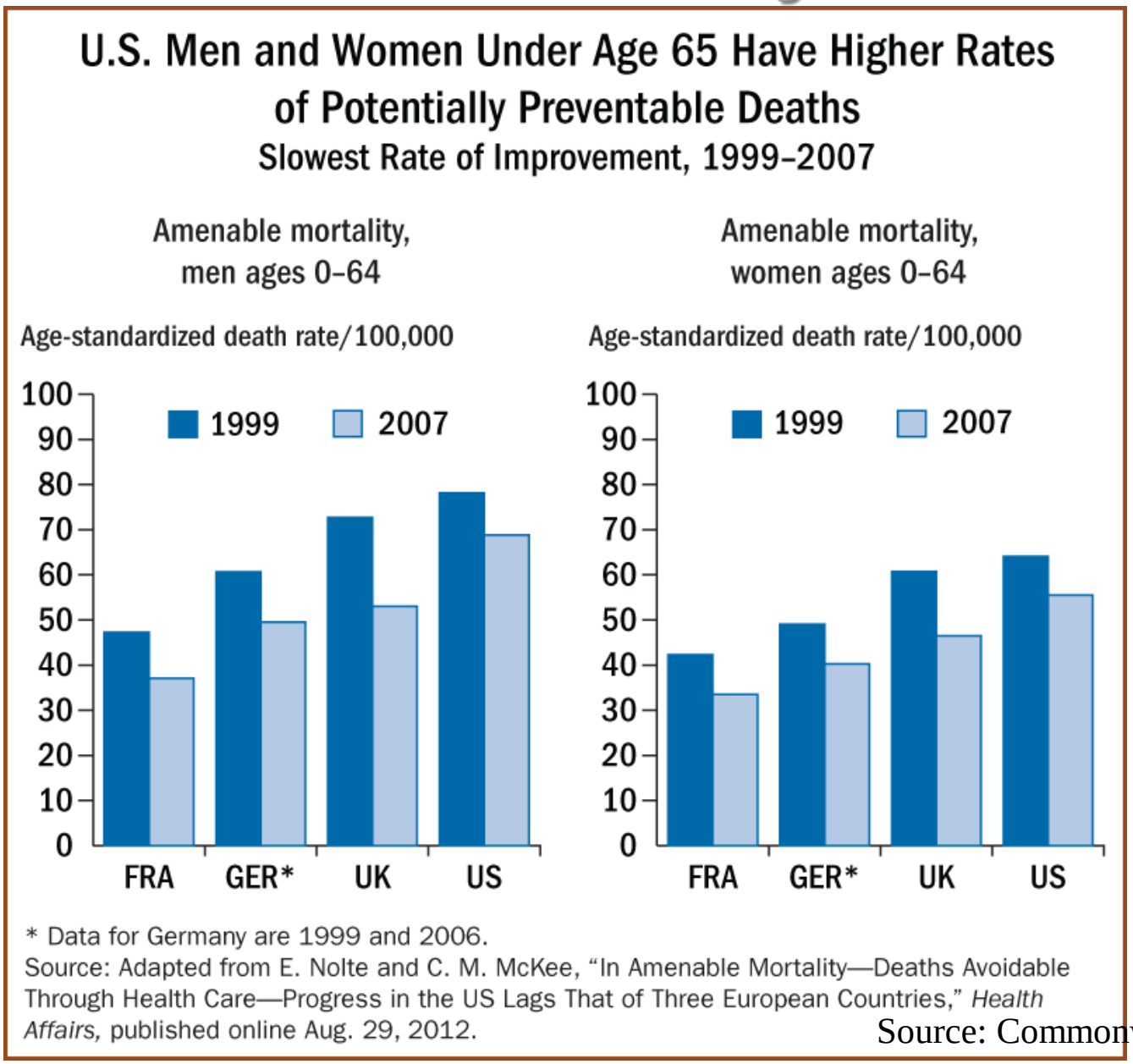
- 80% of cardiovascular disease
- 80% of diabetes
- 60% of lung diseases
- 40% of cancers

(not counting injuries, vaccine-preventable diseases)

≈5% of national health spending is allocated to public health and prevention

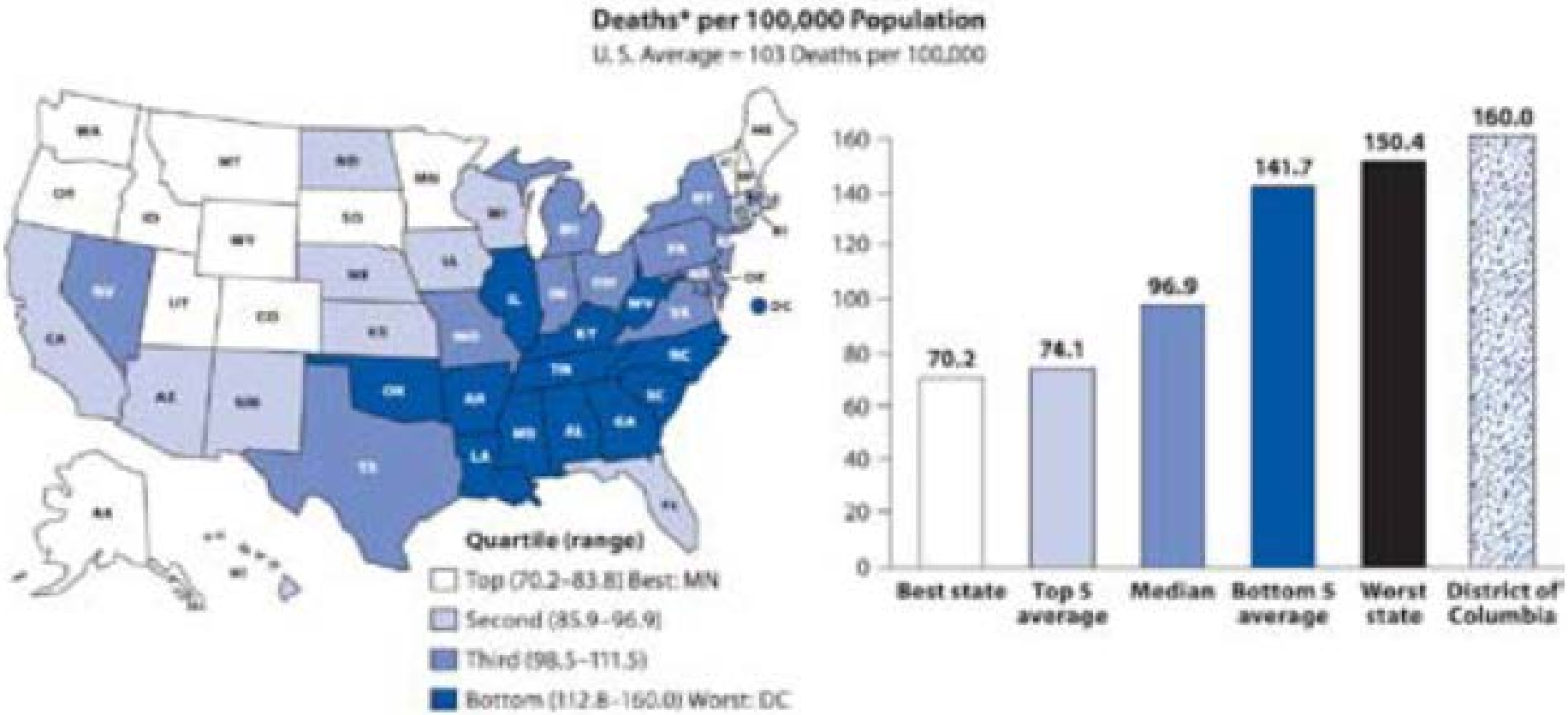
CDC 2011

Preventable mortality in the U.S.



Source: Commonwealth Fund 2008

Geographic variation in preventable mortality



Source: Commonwealth Fund 2008

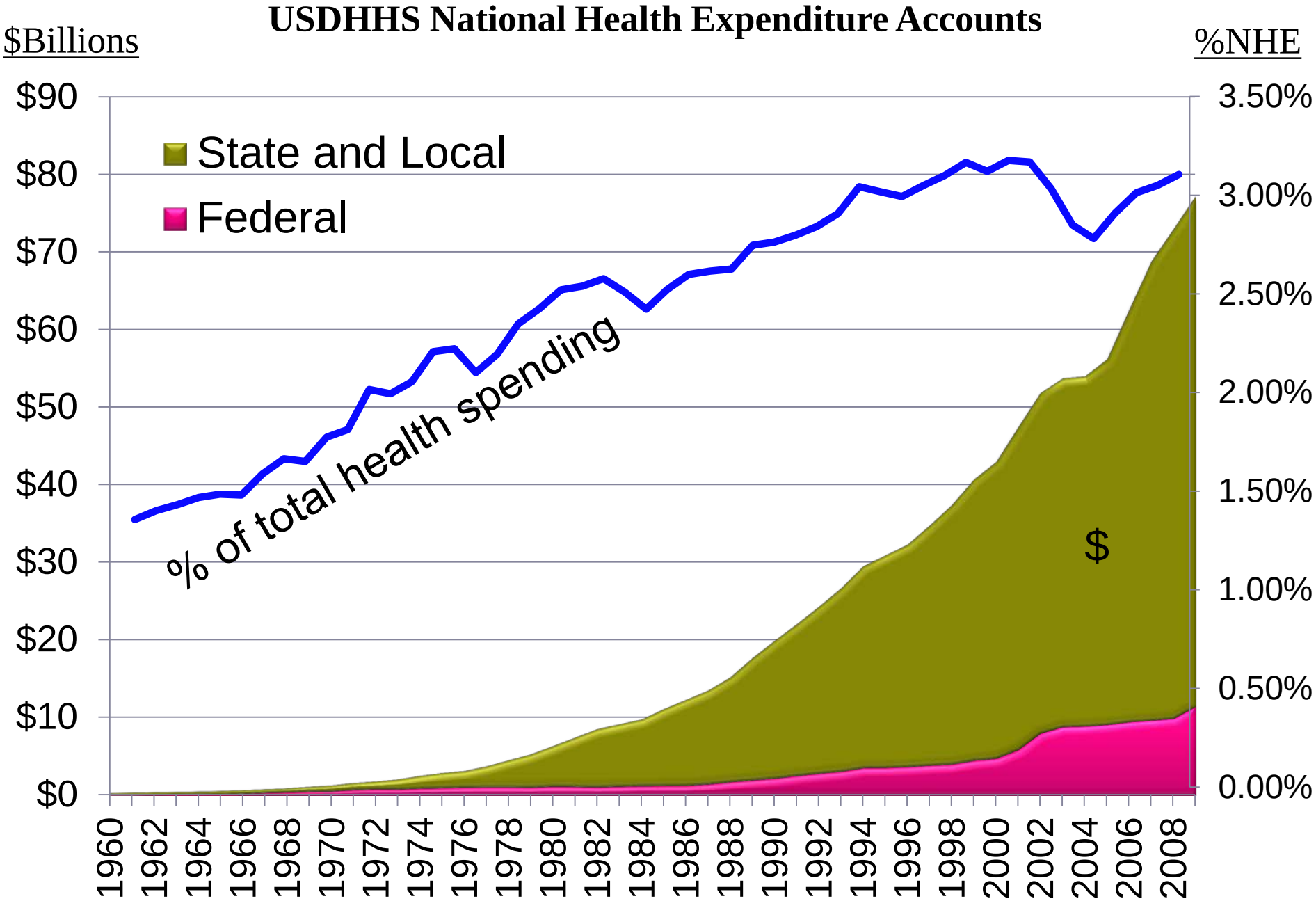
Public health activities

Organized programs, policies, and laws to prevent disease and injury and promote health on a population-wide basis

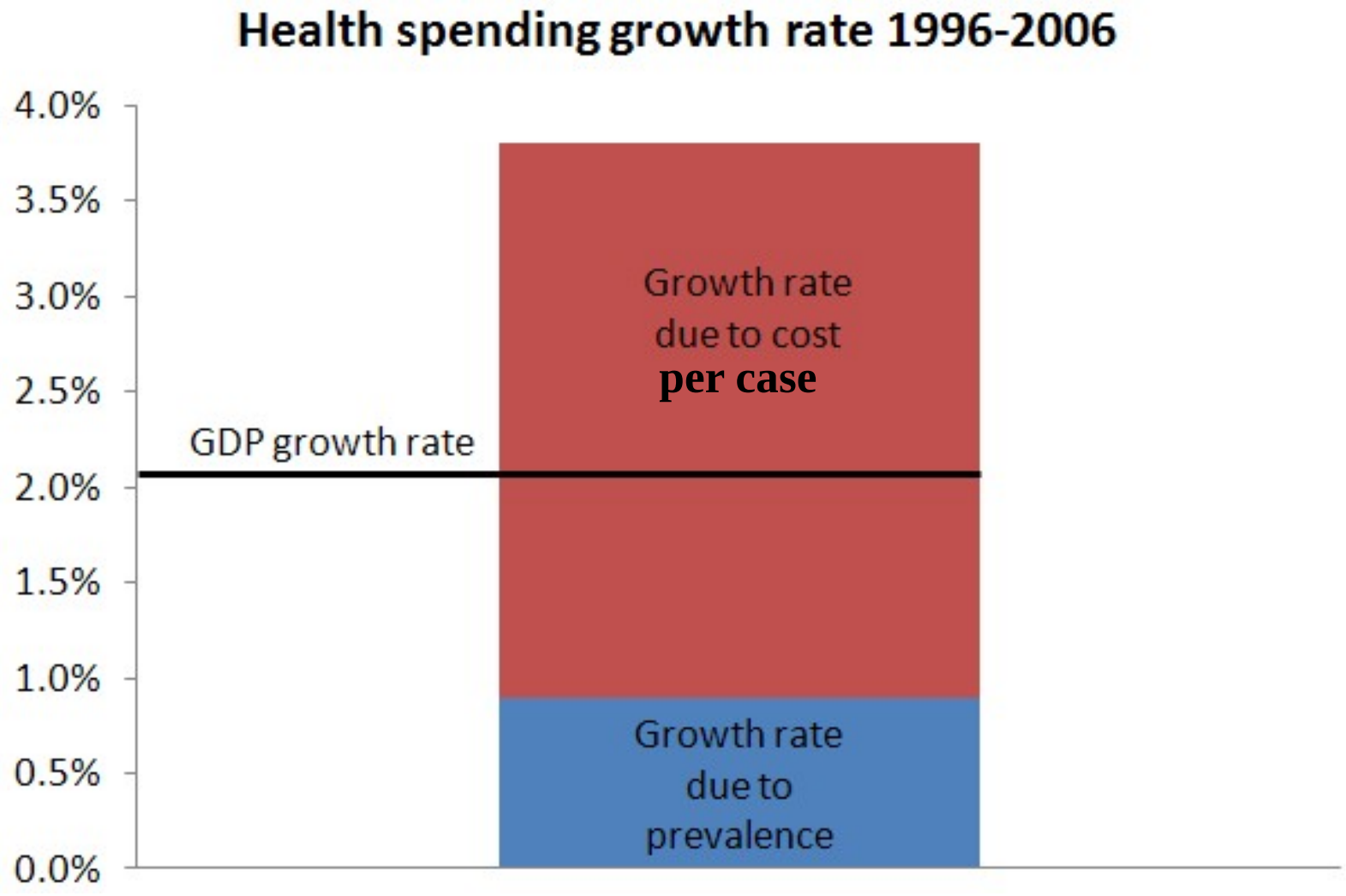
- Epidemiologic surveillance & investigation
- Community health assessment & planning
- Communicable disease control
- Chronic disease prevention
- Health education
- Environmental health monitoring and assessment
- Enforcement of health laws and regulations
- Inspection and licensing
- Inform, advise, and assist school-based, worksite-based, and community-based health programming

…and roles in assuring access to medical care

Public health's share of national health spending



Factors driving growth in medical spending



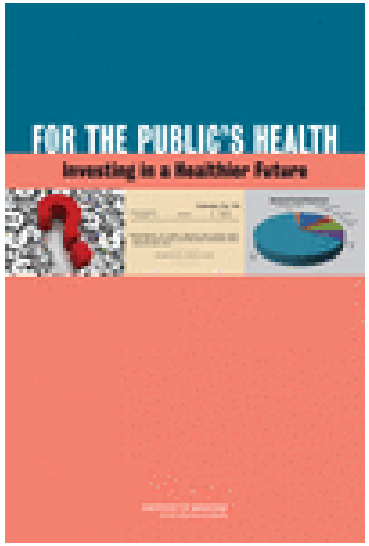
Roehrig et al. Health Affairs 2011

Public Health in the Affordable Care Act

- $15 billion in new federal public health spending over 10 years (cut by $5B in 2012)
- Public Health and Prevention Trust Fund
- Incentives for hospitals, health insurers to invest in public health and prevention

2012 Institute of Medicine Recommendations

- Double current federal spending on public health
- Allow greater flexibility in how states and localities use federal public health funds
- Implement national chart of accounts for tracking spending levels and flow of funds
- Expand research on costs and effects of public health delivery



Institute of Medicine. For the Public's Health: Investing in a Healthier Future. Washington, DC: National Academies Press; 2012.

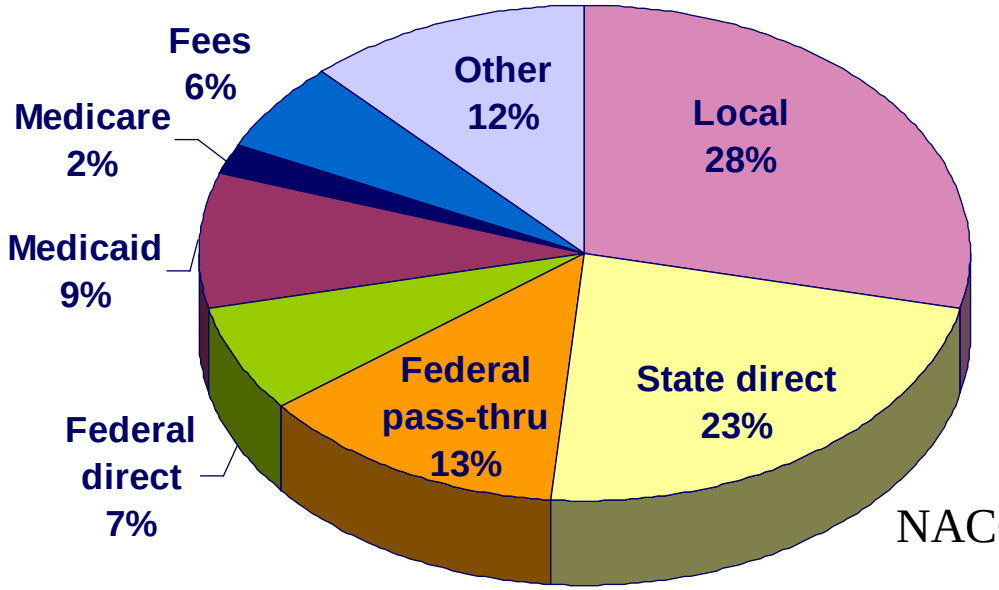
Some research questions of interest…

- How does ***public health*** spending vary across communities and change over time?
- What are the health effects attributable to changes in public health spending?
- What are the medical cost effects attributable to changes in public health spending?

The problem with public health spending

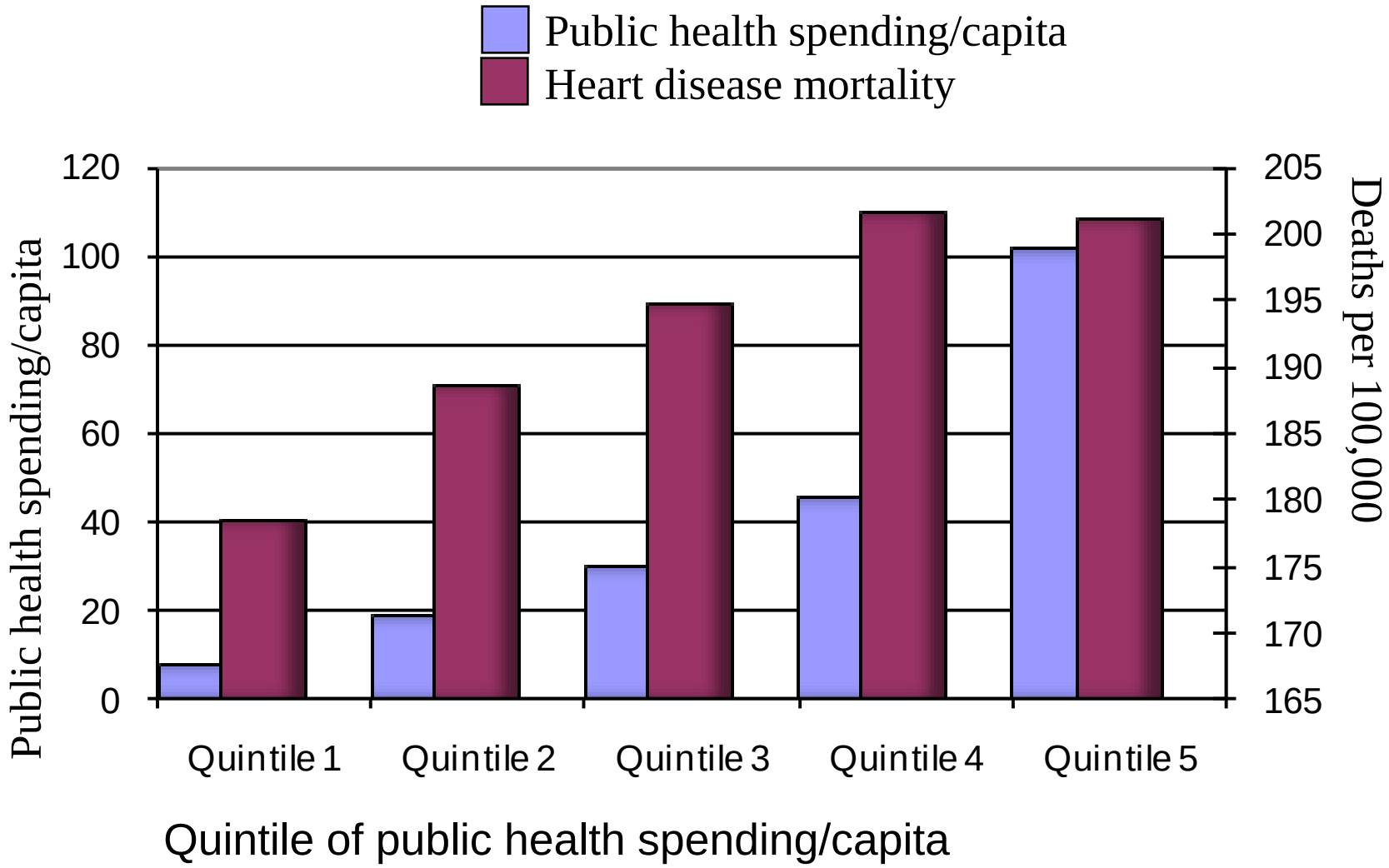
- Federal & state funding sources often targeted to communities based in part on disease burden, risk, need
- Local funding sources often dependent on local economic conditions that may also influence health
- Public health spending may be correlated with other resources that influence health

Sources of Local Public Health Agency Revenue, 2005

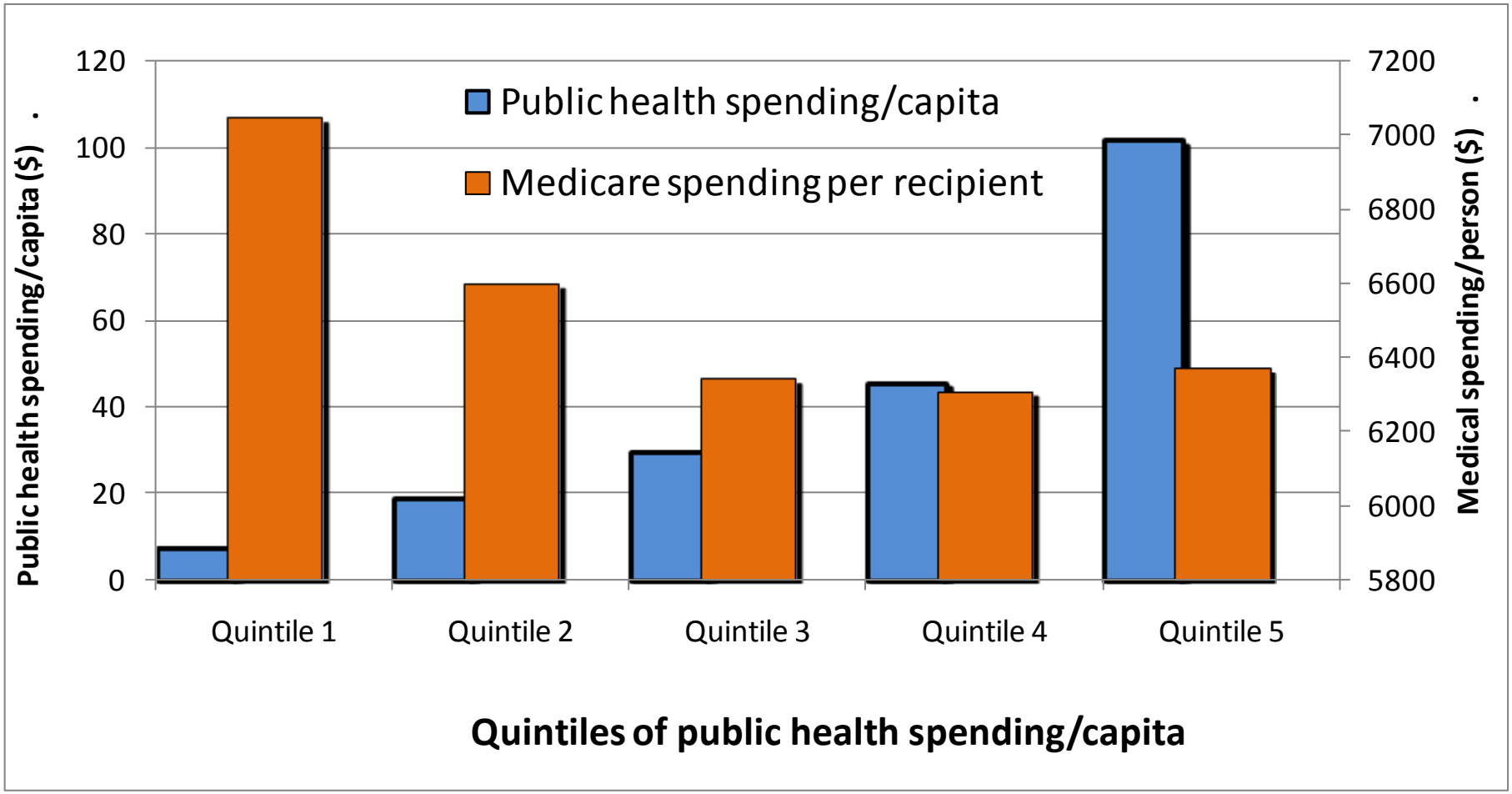


NACCHO 2005

Example: cross-sectional association between PH spending and mortality

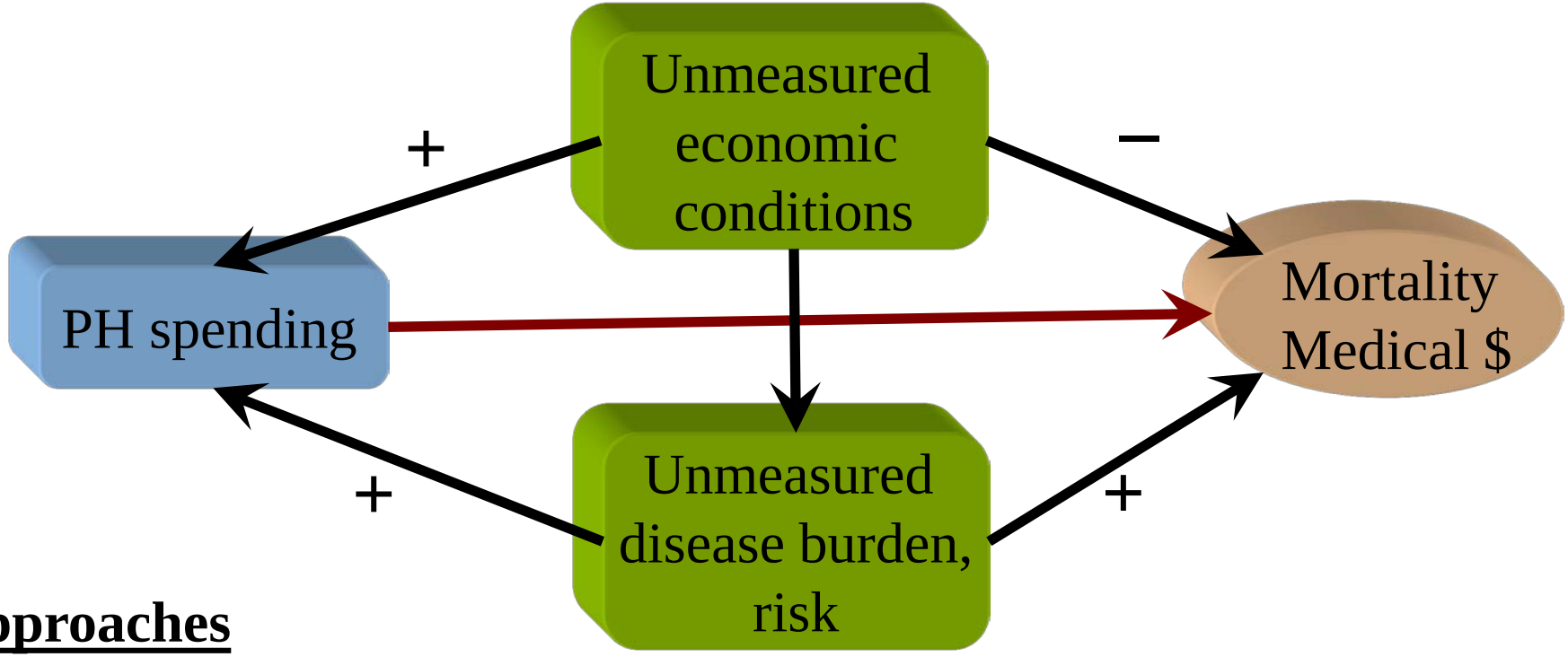


Example: cross-sectional association between PH spending and Medical spending



Mays et al. 2009

Analyzing spending effects



Approaches

1. Cross-sectional regression: control for **observable** confounders
2. Fixed effects: also control for **time-invariant**, **unmeasured** differences between communities
3. IV: use exogenous sources of variation in spending
4. Discriminate between causes of death amenable vs. non-amendable to PH intervention

Data used in empirical work

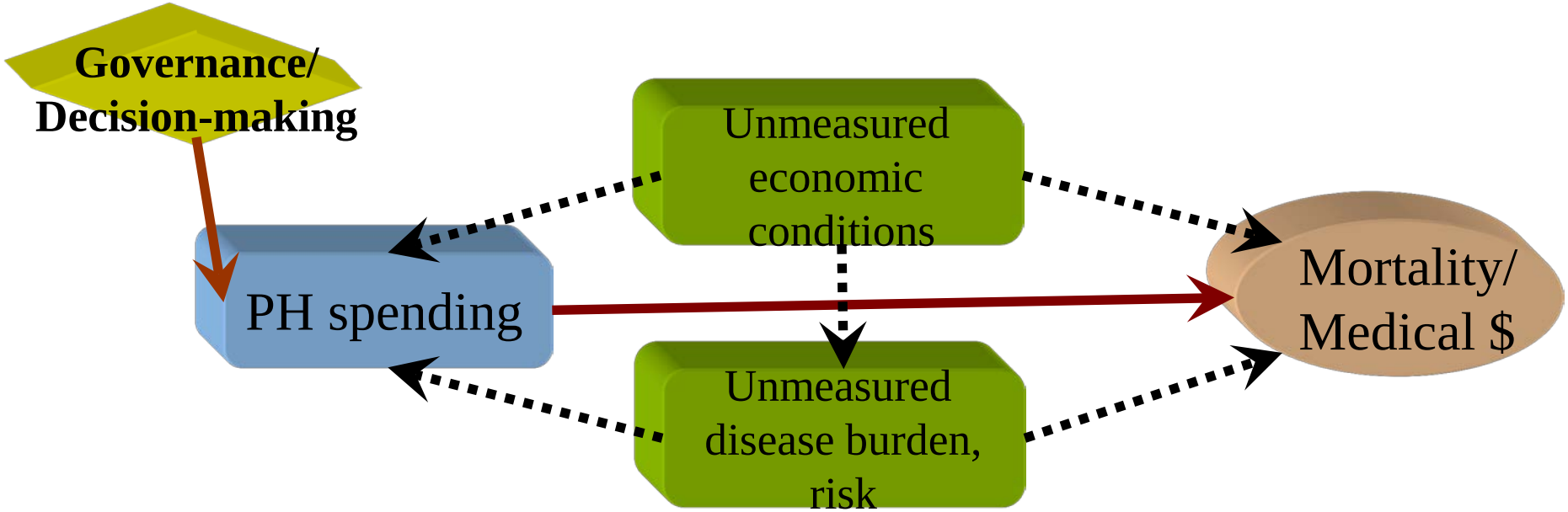
- NACCHO Profile: financial and institutional data collected on the national population of **local public health agencies** (N≈2800) in 1993, 1997, 2005, 2008, 2010
- Residual state and federal spending estimates from US Census of Governments and Consolidated Federal Funding Report
- Community characteristics obtained from Census and Area Resource File (ARF)
- Community mortality data obtained from CDC's Compressed Mortality File
- ***HSA-level*** medical care spending data from CMS and Dartmouth Atlas (Medicare claims data)

Analytical approach

- Dependent variables
  - Age-adjusted mortality rates, conditions sensitive to public health interventions
  - Medical care spending per recipient (Medicare as proxy)
- Independent variables of interest
  - Local PH spending per capita, all sources
  - Residual state spending per capita (funds not passed thru to local agencies)
  - Residual federal spending per capita
- Analytic strategy for panel data: 1993-2008
  - Fixed effects estimation
  - Random effects with instrumental variables (IV)

Analytical approach: IV estimation

- Identify exogenous sources of variation in spending that are unrelated to outcomes
  - Governance structures: local boards of health
  - Decision-making authority: agency, board, local, state
- Controls for unmeasured factors that jointly influence spending and outcomes



Analytical approach

- Semi-logarithmic multivariate regression models used to test associations between spending, service delivery, and outcomes while controlling for other factors

$$Ln(PH\$_{ijt}) = \beta Agency_{ijt} + \delta Community_{ijt} + \lambda State_{jt} + \mu_j + \varphi_t + \varepsilon_{ijt}$$

$$Ln(Mortality_{ijt}) = \alpha Ln(\widehat{PH\$}_{ijt-1}) + \beta Agency_{ijt} + \delta Community_{ijt} + \lambda State_{jt-1} + \mu_j + \varphi_t + \varepsilon_{ijt}$$

$$Ln(Medical\$_{ijt}) = \alpha Ln(\widehat{PH\$}_{ijt-1}) + \beta Agency_{ijt} + \delta Community_{ijt} + \lambda State_{jt-1} + \mu_j + \varphi_t + \varepsilon_{ijt}$$

Sensitivity analyses using 1, 5, and 10 year lag structures

Analytical approach

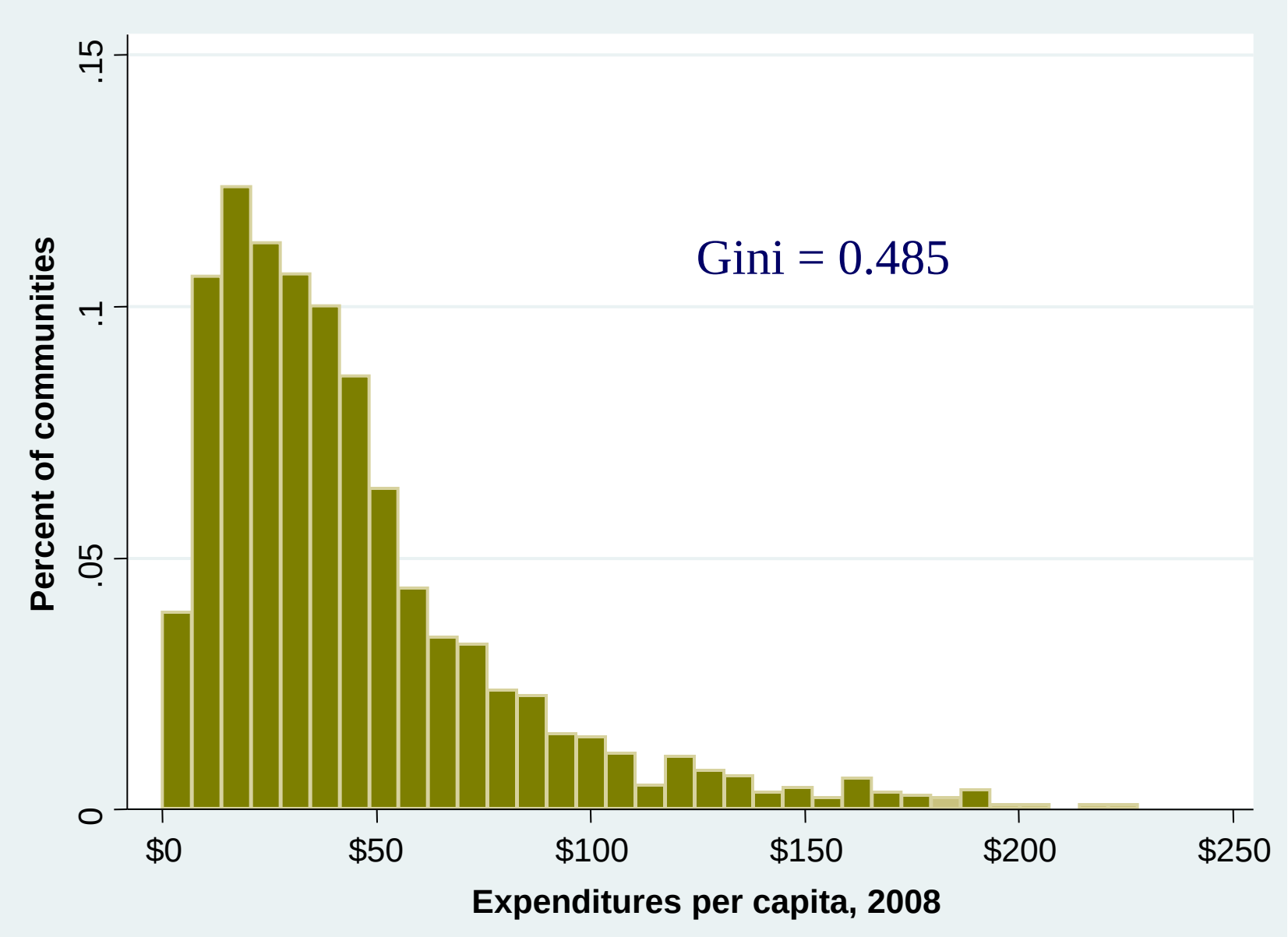
Other Variables Used in the Models

- ***Agency characteristics***: type of government jurisdiction, scope of services offered, ***local governance and decision-making structures***

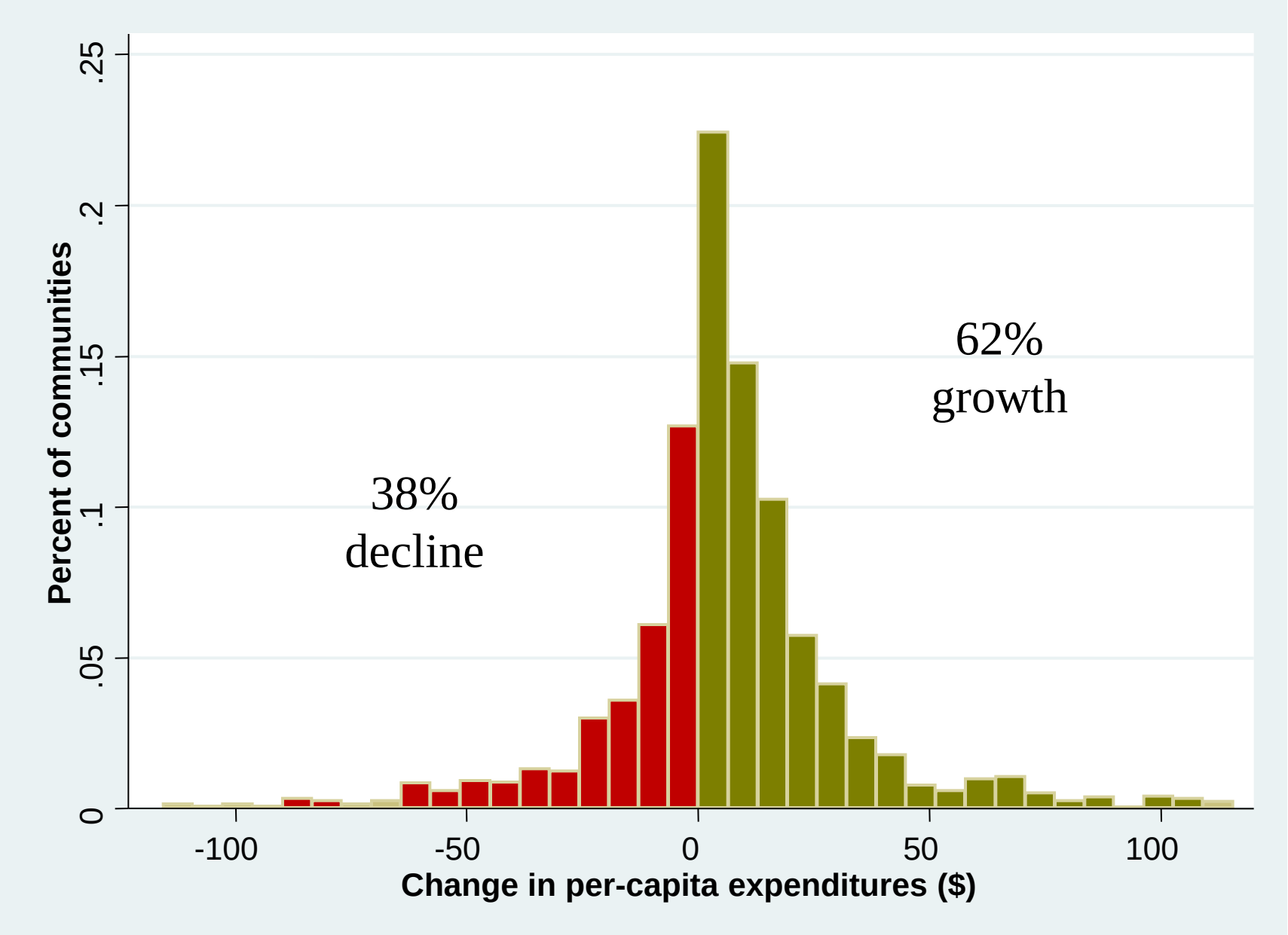
- ***Community characteristics***: population size, rural-urban, poverty, income per capita, education attainment, unemployment, age distributions, physicians per capita, CHC funding per low income, health insurance coverage, local health care wage index

- ***State characteristics***: Private insurance coverage, Medicaid coverage, state fixed effects

Variation in Local Public Health Spending



Changes in Local Public Health Spending 1993-2008



Determinants of Local Public Health Spending Levels: IVs

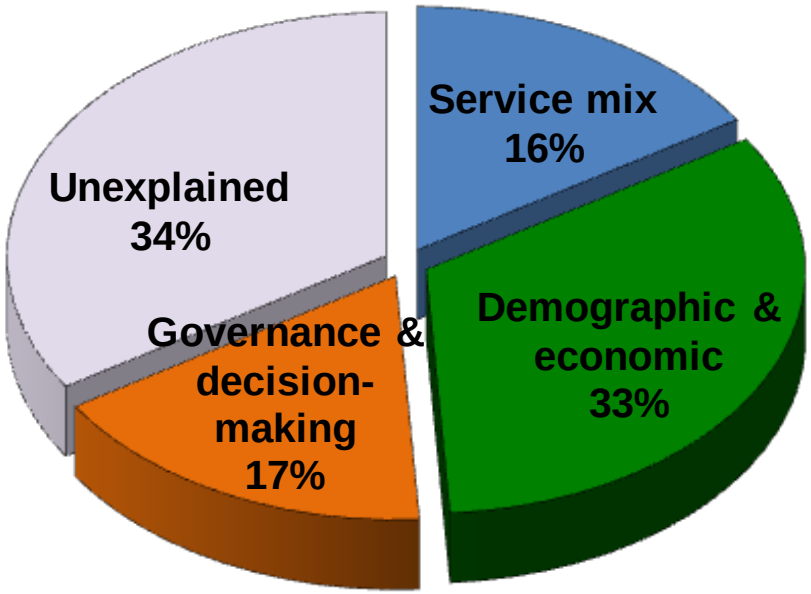
Governance/Decision Authority	Elasticity Coefficient	95% CI
Governed by local board of health	0.131**	(0.061, 0.201)
State hires local PH agency head†	-0.151*	(-0.318, 0.018)
Local govt approves local PH budget†	-0.388***	(-0.576, -0.200)
State approves local PH budget†	-0.308**	(-0.162, -0.454)
Local govt sets local PH fees	0.217**	(0.101, 0.334)
Local govt imposes local PH taxes	0.190**	(0.044, 0.337)
Local board can request local PH levy	0.120**	(0.246, 0.007)

$F=13.4 \quad p<0.001$

log regression estimates controlling for community-level and state-level characteristics. *p<0.10 **p<0.05 ***p<0.01

†As compared to the local board of health having the authority.

Determinants of Local Public Health Spending Levels



- Delivery system size & structure
- Service mix
- Population needs and risks
- Efficiency & uncertainty

Mays et al. 2009

Multivariate estimates of public health spending effects on mortality 1993-2008

	Cross-sectional model		Fixed-effects model		IV model	
Outcome	**Elasticity**	**St. Err.**	**Elasticity**	**St. Err.**	**Elasticity**	**St. Err.**
Infant mortality	0.0516	0.0181 **	0.0234	0.0192	-0.1437	0.0589 ***
Heart disease	-0.0003	0.0051	-0.0103	0.0040 **	-0.1881	0.0292 **
Diabetes	0.0323	0.0187	-0.0487	0.0174 ***	-0.3015	0.0633 **
Cancer	0.0048	0.0029 *	-0.0075	0.0240	-0.0532	0.0166 **
Influenza	-0.0400	0.0200 **	-0.0275	0.0107 **	-0.4320	0.0624 **
Alzheimer's	0.0024	0.0075	0.0032	0.0047	0.0028	0.0311
Residual	0.0007	0.0083	0.0004	0.0031	0.0013	0.0086

log regression estimates controlling for community-level and state-level characteristics

*p<0.10 **p<0.05 ***p<0.01

Effects of public health spending on medical care spending 1993-2008

Change in Medical Care Spending Per Capita Attributable to 1% Increase in Public Health Spending Per Capita

Model	Elasticity	Std. Error
Fixed effects	-0.010	0.002 **
Instrumental variables	-0.088	0.013 **

log regression estimates controlling for community-level and state-level characteristics

*p<0.10 **p<0.05 ***p<0.01

Effects of public health spending on medical care spending 1993-2008

Change in Medical Care Spending Per Capita Attributable to 1% Increase in Public Health Spending Per Capita

Model	N	Elasticity	S.E.
One year lag	8532	-0.088	0.013***
Five year lag	6492	-0.112	0.053**
Ten year lag	4387	-0.179	0.112

log regression estimates controlling for community-level and state-level characteristics

*p<0.10 **p<0.05 ***p<0.01

Projected effects of ACA public health spending

- 10% increase in public health spending in average community:

Public health cost	$594,291	
Medical cost offset	-$515,114	(Medicare only)
LY gained	148	
Net cost/LY	$534	

Conclusions

- Local public health spending varies widely across communities
- Communities with higher spending experience lower mortality from leading preventable causes of death
- Growth in local public health spending appears to offset growth in medical care spending

Implications for Policy and Practice

- Mortality reductions achievable through increases in public health spending may equal or exceed the reductions produced by similar expansions in local medical care resources
- Increased federal investments may help to reduce geographic disparities in population health and bend the medical cost curve.
- Gains from federal investments may be offset by reductions in state and local spending

Limitations and next steps

- Aggregate spending measures
  - Average effects
  - Role of allocation decisions?
- Mortality – distal measures with long incubation periods
- Medical care spending relies on Medicare as a proxy measure (20% of total medical $)
- Ongoing exploration of lag structures
- Next step: Medicaid spending

What is Public Health Services & Systems Research?

A field of inquiry examining the ***organization***, ***financing***, and ***delivery*** of public health services at local, state and national levels, and the ***impact*** of these activities on population health

Mays, Halverson, and Scutchfield. 2003

Public Health Services and Systems Research

PUBLIC HEALTH
Practice-Based Research Networks
National Coordinating Center

National Coordinating Center for PHSSR

Supported by The Robert Wood Johnson Foundation

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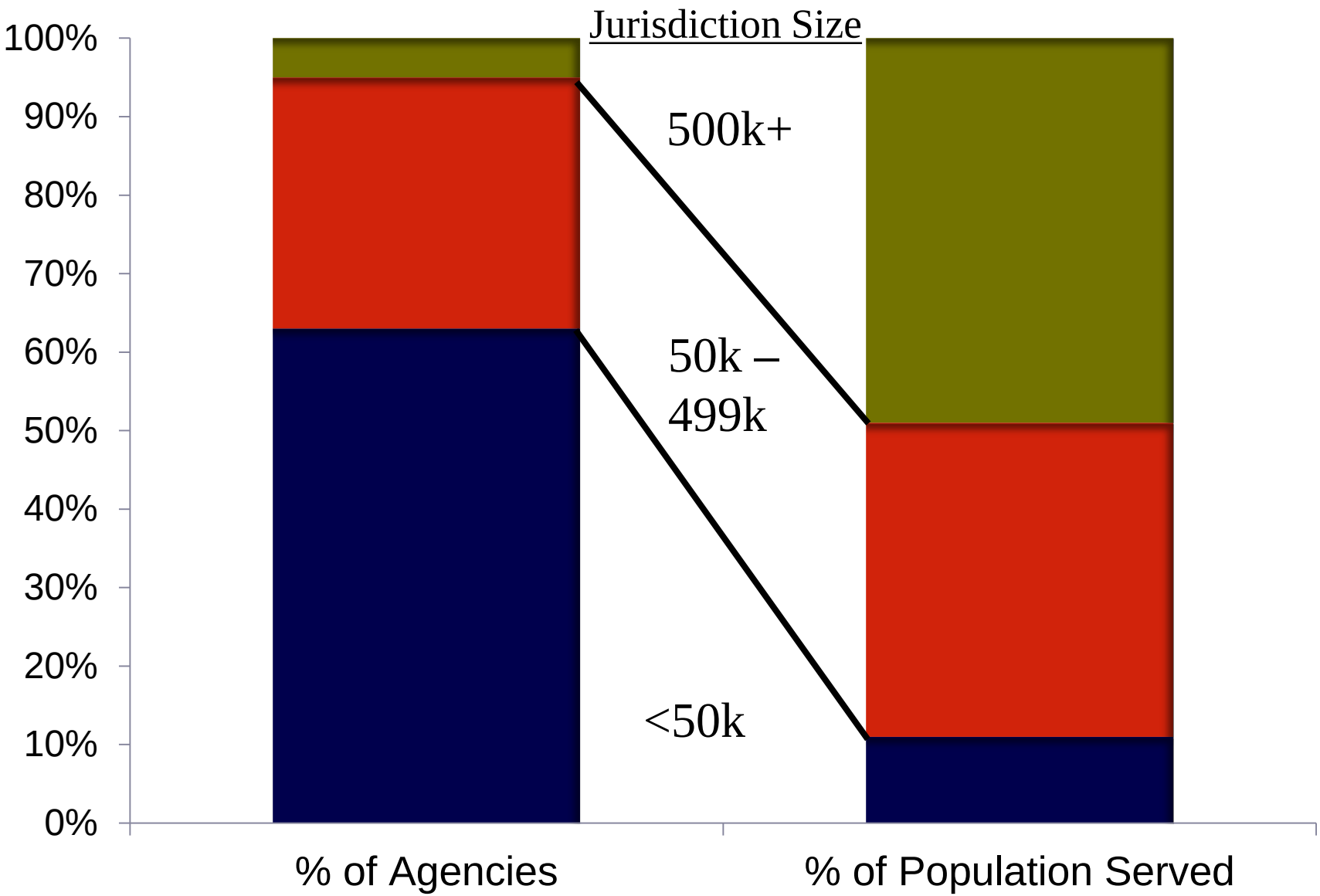
Related Studies

Some more questions of interest…

- How can we derive greater value from public health expenditures?
- Are there economies of scale and scope in the delivery of public health services?
- Can regionalization improve availability, efficiency & effectiveness of public health services?
- Who contributes to public health “production” and does this matter?

Local public health delivery systems



Source: 2010 NACCHO National Profile of Local Health Departments Survey

Sources of Scale and Scope Effects

Economies of Scale

- Spread fixed costs of public health activities
- Allow specialization of labor and capital
- Enhance predictability of infrequent events
- Pool surge capacity
- Learn by doing
- Internalize spill-over effects
- Network effects

Economies of Scope

- Use common infrastructure for multiple activities
- Cross-train workforce
- Realize synergies across activities
- Network effects

Analytic Approach

- Estimate the effects of ***scale*** (population served) and ***scope*** (array of activities delivered) on:
  - public health expenditures
  - health outcomes (preventable mortality)
- Address the potential endogeneity of scope, quality
- Simulate the effects of regionalizing jurisdictions that fall below selected population thresholds

  <25,000

  <50,000

  <100,000

  <150,000

Data used in empirical work

- National Longitudinal Survey of Public Health Systems
- Cohort of 360 communities with at least 100,000 residents
- Followed over time: 1998, 2006, 2012
- Measures:
  - ***Scope***: availability of 20 public health activities
  - ***Effort***: contributed by the local public health agency
  - ***Quality***: perceived effectiveness of each activity
  - ***Network***: organizations contributing to each activity
- Linked with data from NACCHO Profile
  - ***Scale***: population size served
  - ***Cost***: Local public health agency expenditures
  - Agency characteristics

Data used in empirical work

- Survey data linked with secondary sources of area characteristics (Census, ARF)
- Small sample of jurisdictions under 100,000 (n=36) used to evaluate prediction accuracy

Analytical approach

Cost Function Model (semi trans-log)

$$Ln(Cost_{ijt}) = \alpha_1 Scale_{ijt} + \alpha_2 Scale^2_{ijt} + \beta_1 Scope_{ijt} + \beta_2 Scope^2_{ijt} + \varphi_1 Quality_{ijt} + \varphi_2 Quality^2_{ijt} + \lambda X_{ijt} + \mu_j + \varphi_t + \varepsilon_{ijt}$$

Instrumental Variables Model

$$Scope_{ijt} = \theta Network_{ijt} + \lambda Agency_{ijt} + \delta Community_{ijt} + \mu_j + \varphi_t + \varepsilon_{ijt}$$

$$Quality_{ijt} = \theta Network_{ijt} + \lambda Agency_{ijt} + \delta Community_{ijt} + \mu_j + \varphi_t + \varepsilon_{ijt}$$

IVs: Network: degree centrality, average path length

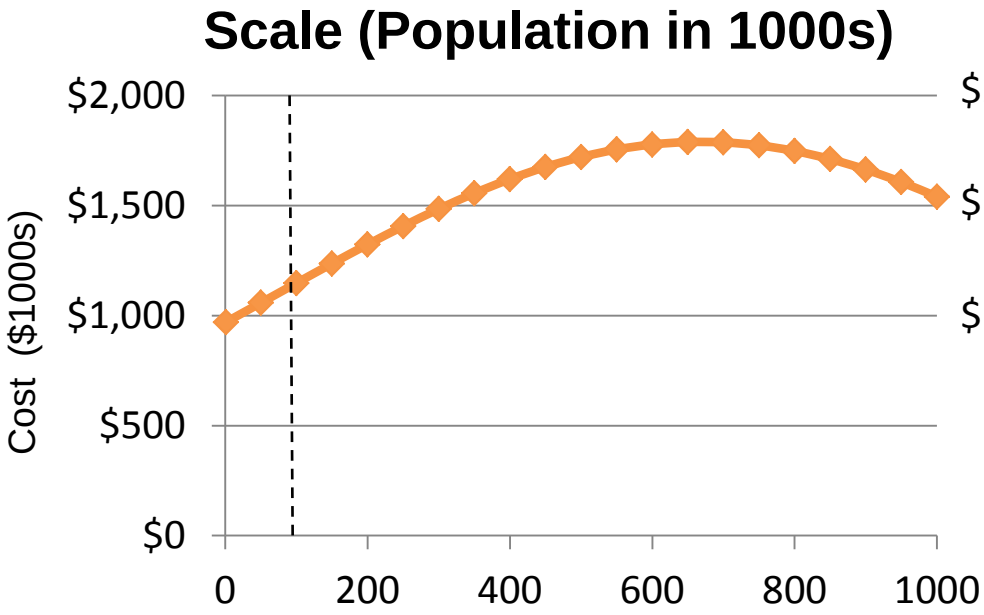
All models control for type of jurisdiction, governance structure, centralization, population density, metropolitan area designation, income per capita, unemployment, racial composition, age distribution, educational attainment, physician and hospital availability

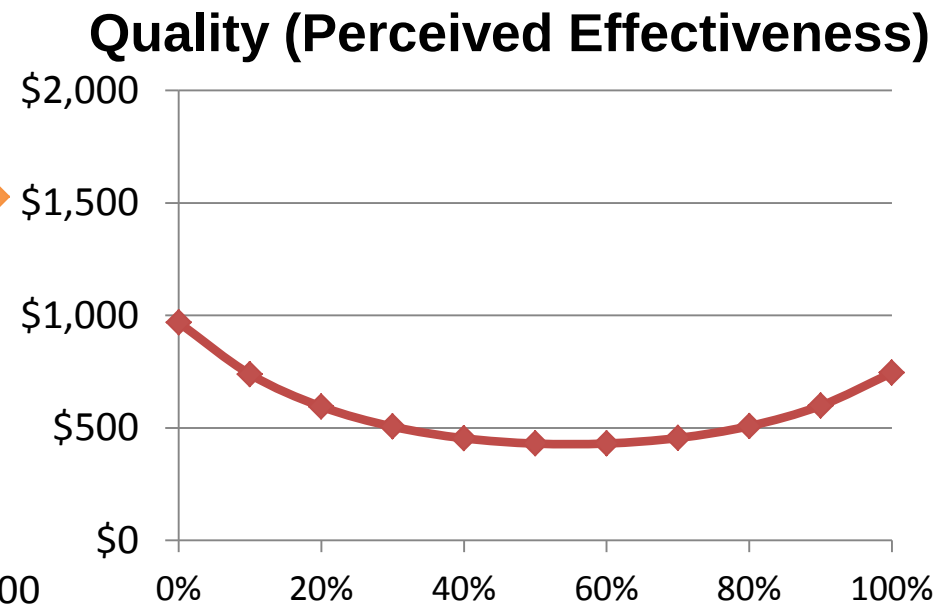
Results: Scale and Scope Estimates

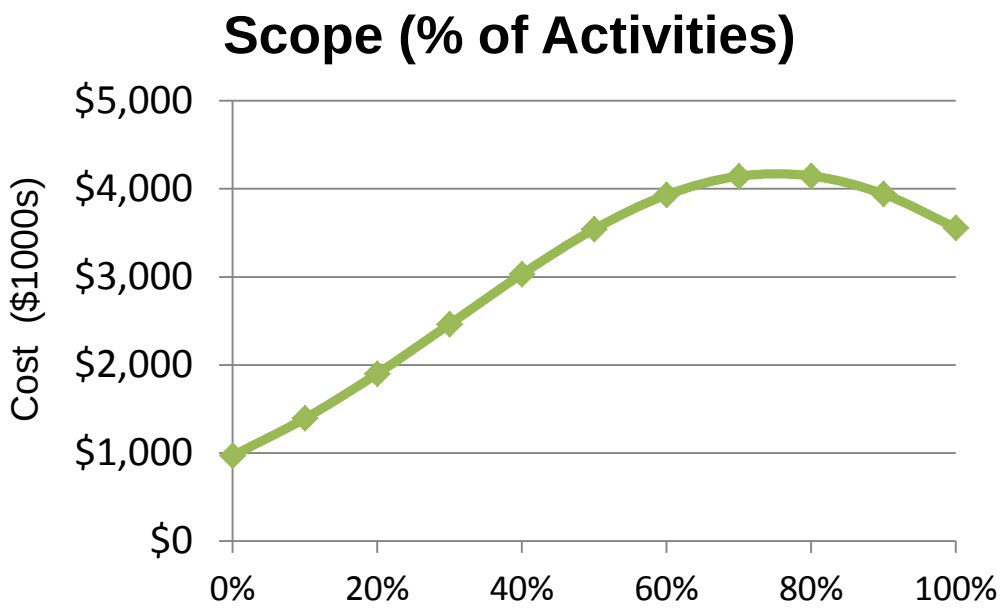
Variable	Partial Elasticity Coeff.	S.E.
Population size	0.0184	0.0029***
Population size squared	-0.0014	0.0002***
Scope	3.89	1.41***
Scope squared	-2.58	0.99***
Quality	-2.98	1.39**
Quality squared	2.72	1.23**

**p<0.05 ***p<0.01

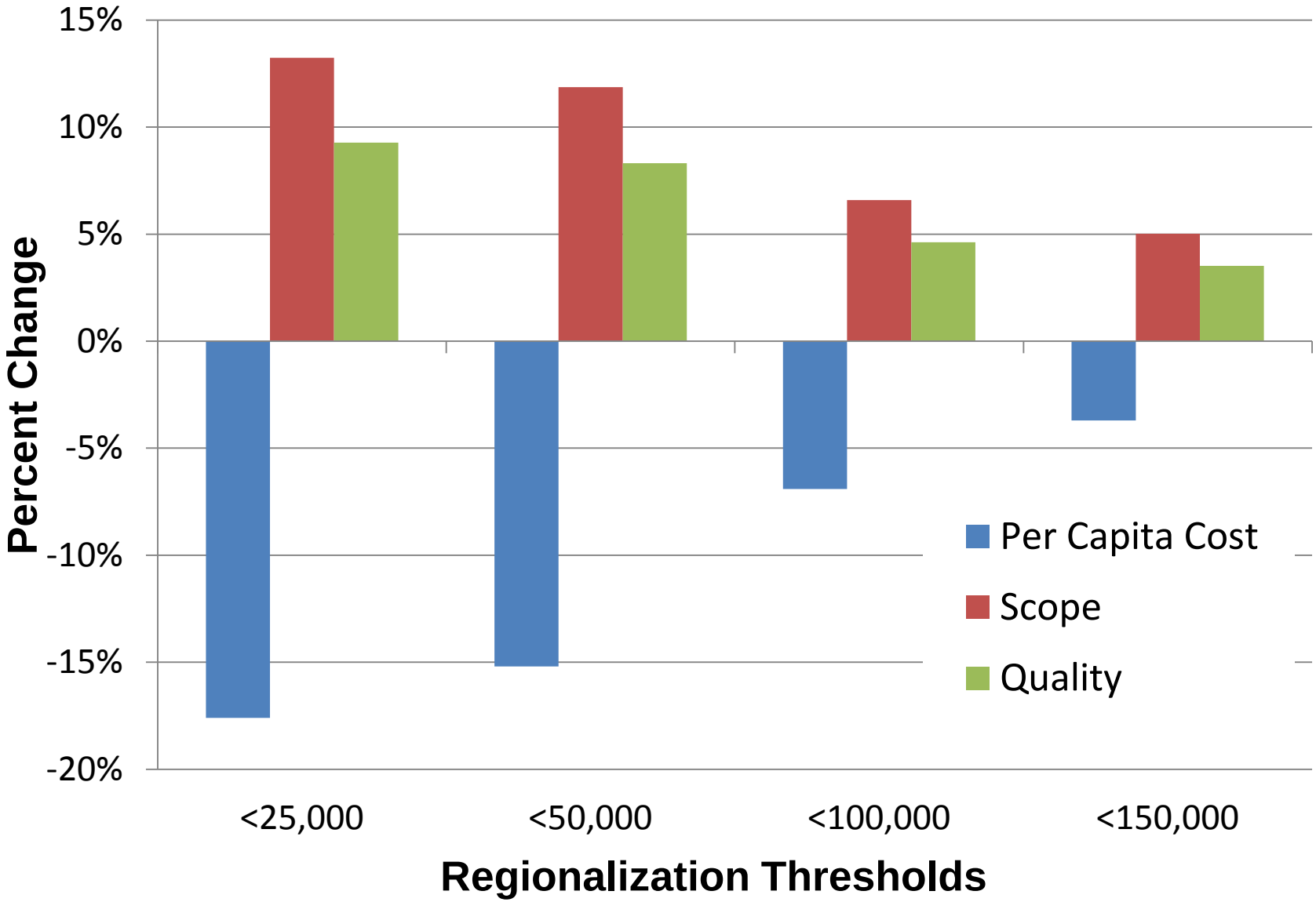
Results: Scale and Scope Estimates







Simulated Effects of Regionalization



Conclusions

- Significant scale and scope effects are apparent in local public health production
- Gains from regionalization may accrue through efficiency, scope, and quality
- Largest regionalization gains accrue to smallest jurisdictions
- If savings are re-invested in public health production, possibility of important health gains

Limitations and next steps

- Limited data on small jurisdictions
- Inability to observe existing “shared service” arrangements
- Aggregated cost data
- Lack of data on service volume/intensity