Inter-organizational Network Effects on the Implementation of Public Health Services

Glen Mays, PhD, MPH
University of Kentucky
glen.mays@uky.edu | @GlenMays
www.systemsforaction.org

UNIVERSITY OF KENTUCKY
Center for Public Health Systems and Services Research

Systems for Action
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How do we support implementation of population health improvement strategies?

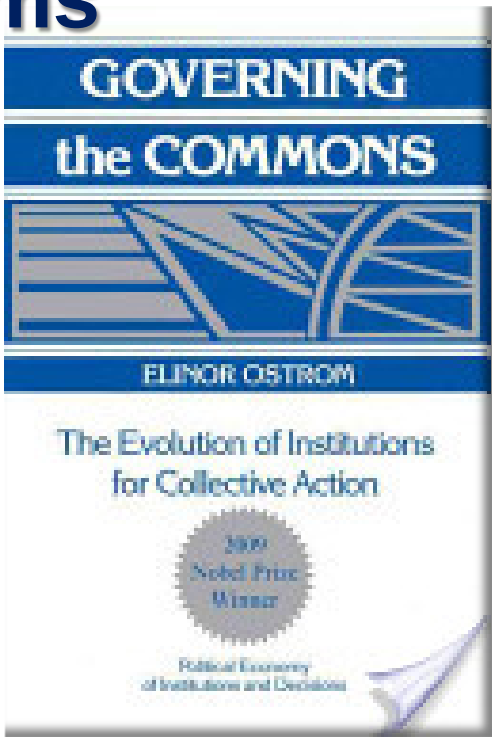
- Designed to achieve large-scale health improvement: neighborhood, city/county, region
- Target fundamental and often multiple determinants of health
- Mobilize the collective actions of multiple stakeholders in government & private sector

  - Usual and unusual suspects

  - Infrastructure requirements

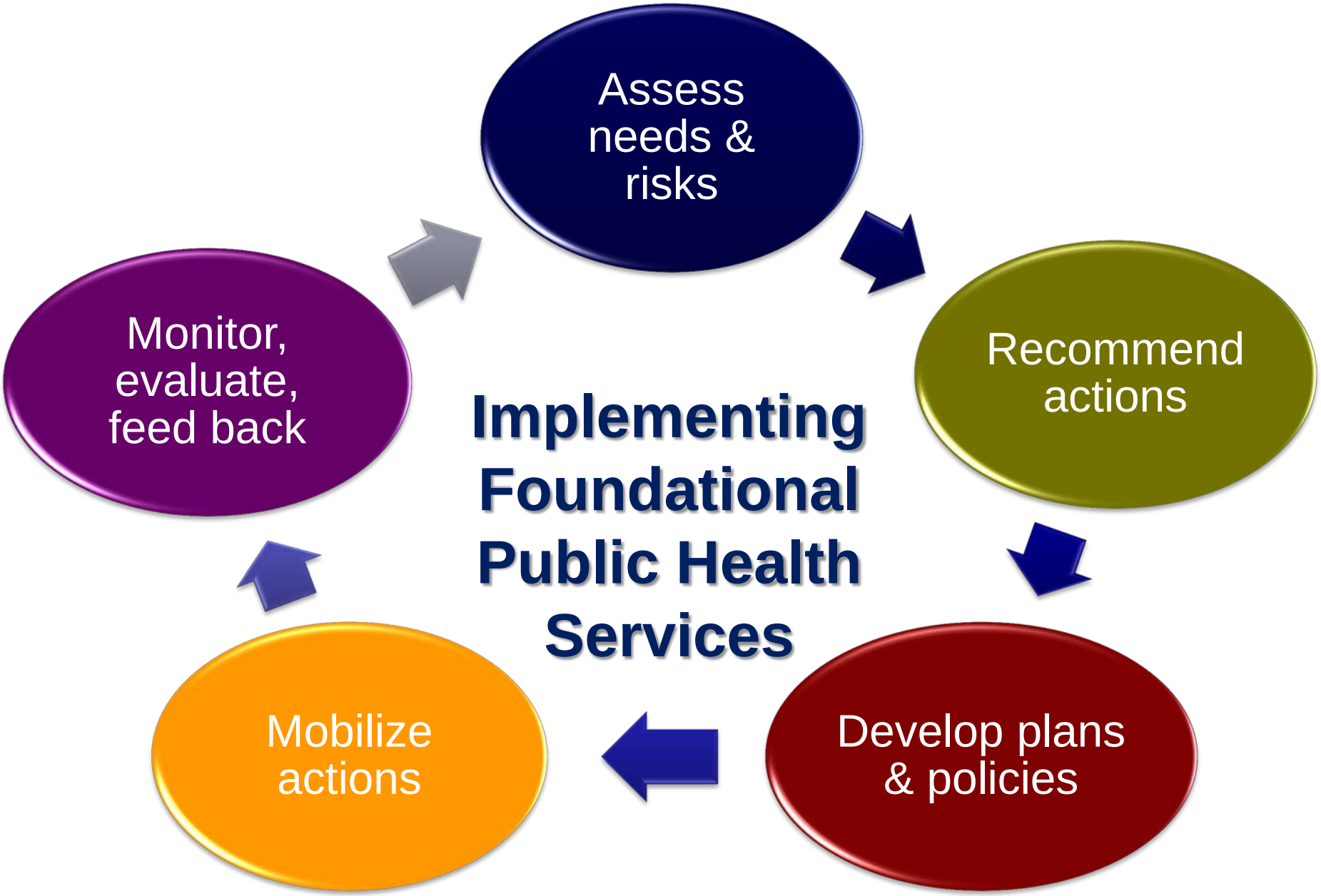
Mays GP. Governmental public health and the economics of adaptation to population health strategies. National Academy of Medicine Discussion Paper. 2014. http://nam.edu/wp-content/uploads/2015/06/EconomicsOfAdaptation.pdf

Fundamental challenge: overcoming collective action problems



- Incentive compatibility → public goods
- Concentrated costs & diffuse benefits
- Time lags: costs vs. improvements
- Uncertainties about what works
- Asymmetries in information
- Difficulties measuring progress
- Weak and variable institutions & infrastructure
- Imbalance: resources vs. needs
- Stability & sustainability of funding

Ostrom E. Collective action and the evolution of social norms. ***Journal of Economic Perspectives*** 14(3): 137-58.



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

Research questions of interest

- Which organizations contribute to the implementation of public health activities in local communities?
- How do these contributions change over time?

Recession | Recovery | Accreditation
ACA implementation

- How do changes in delivery system structures influence service delivery & population health?

Data: public health delivery systems

National Longitudinal Survey of Public Health Systems

- Cohort of 360 communities with at least 100,000 residents
- Followed over time: 1998, 2006, 2012, 2014**
- Local public health officials report:
  - ***Scope***: availability of 20 recommended public health activities
  - ***Network***: types of organizations contributing to each activity
  - ***Effort***: contributed by designated local public health agency
  - ***Quality***: perceived effectiveness of each activity

** Expanded sample of 500 communities<100,000 added in 2014 wave

Data: community & market characteristics

- **Area Health Resource File**: physician, hospital and CHC supply; population size and demographics, socioeconomic status, racial/ethnic composition, health insurance coverage
- **NACCHO Profile data**: public health agency institutional and financial characteristics
- **Medicare Cost Report**: hospital ownership, market share, uncompensated care
- **CDC Compressed Mortality File**: Cause-specific death rates by county

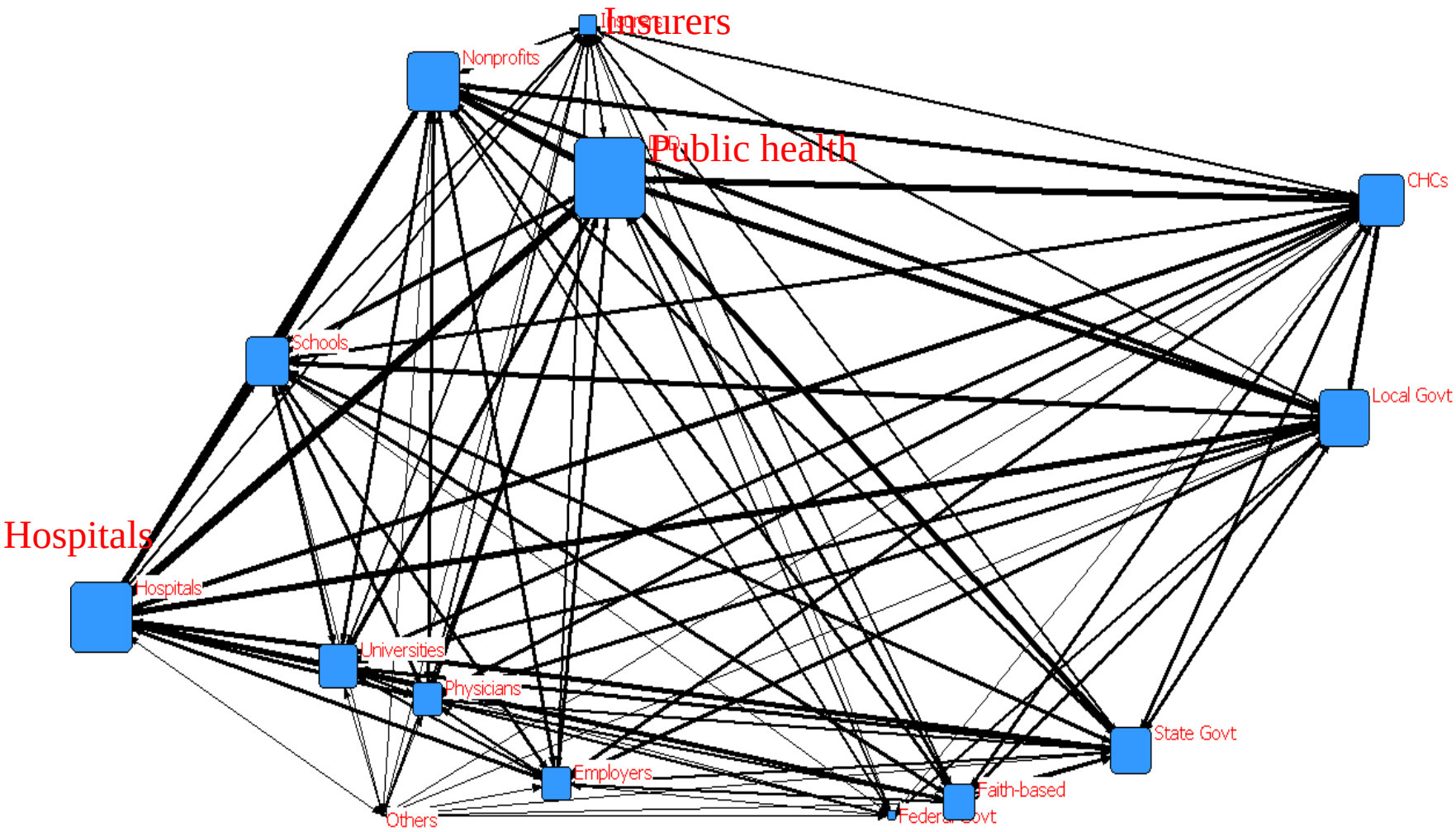
Cluster and network analysis to identify "system capital"

Cluster analysis is used to classify communities into one of 7 categories of ***public health system capital*** based on:

- ***Scope of activities*** contributed by each type of organization
- ***Density of connections*** among organizations jointly producing public health activities
- ***Degree centrality*** of the governmental public health agency

Mays GP et al. Understanding the organization of public health delivery systems: an empirical typology. *Milbank Q.* 2010;88(1):81–111.

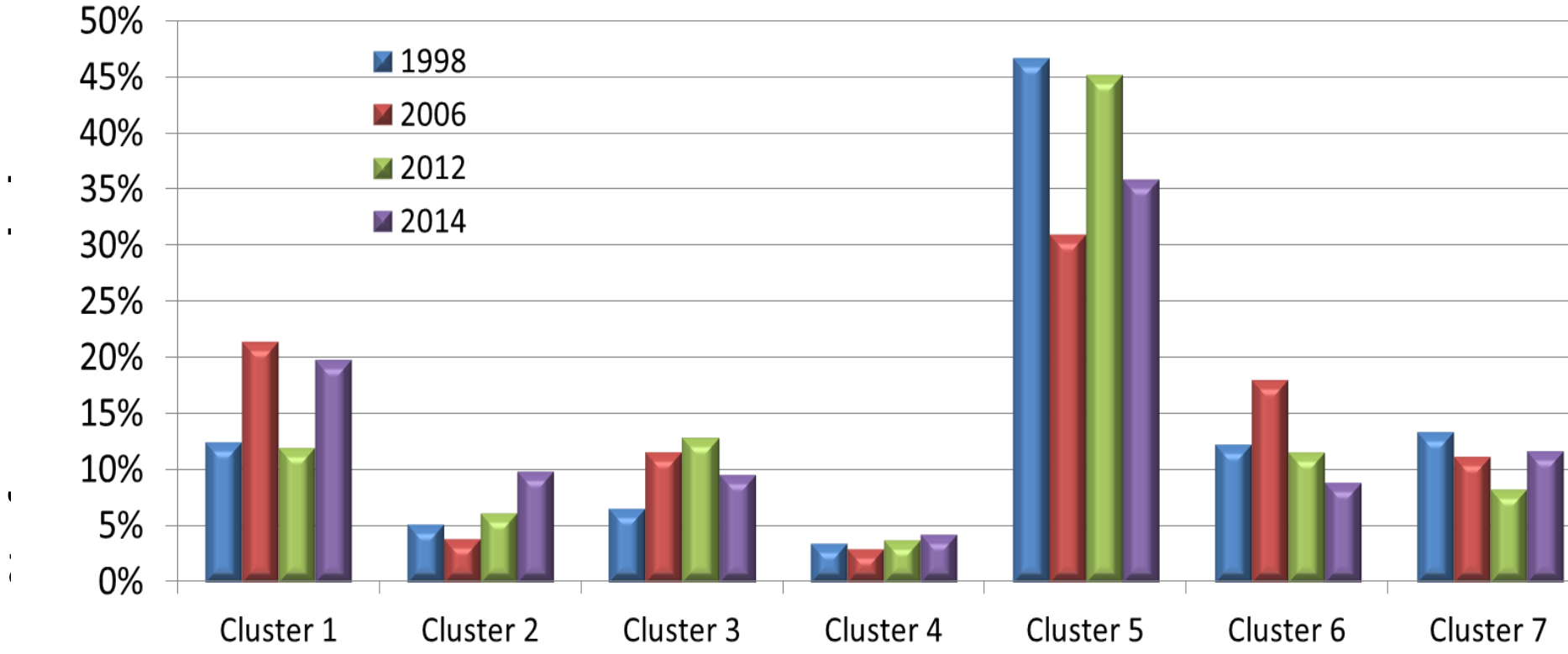
Average public health system structure in 2014



Node size = degree centrality

Line size = % activities jointly contributed (tie strength)

Prevalence of Public Health System Configurations 1998-2014



	Cluster 1	Cluster 2	Cluster 3	Cluster 4	Cluster 5	Cluster 6	Cluster 7
Scope	High	High	High	Mod	Mod	Low	Low
Centrality	Mod	Low	High	High	Low	High	Low
Density	High	High	Mod	Mod	Mod	Low	Mod

Comprehensive
(High System Capital)

Conventional

Limited

Changes in system prevalence and coverage

System Capital Measures	1998	2006	2012	2014	2014 (<100k)
Comprehensive systems					
% of communities	**24.2%**	**36.9%**	**31.1%**	**32.7%**	**25.7%**
% of population	**25.0%**	**50.8%**	**47.7%**	**47.2%**	**36.6%**
Conventional systems					
% of communities	50.1%	33.9%	49.0%	40.1%	57.6%
% of population	46.9%	25.8%	36.3%	32.5%	47.3%
Limited systems					
% of communities	25.6%	29.2%	19.9%	20.6%	16.7%
% of population	28.1%	23.4%	16.0%	19.6%	16.1%

Estimating network effects

Dependent variables:

- ***Health outcomes***: premature mortality(<75), infant mortality, death rates for heart disease, diabetes, cancer, influenza
- ***Resource use***: Local governmental expenditures for public health activities

Independent variables:

- ***Network characteristics***: network density, organizational degree centrality, betweenness centrality
- ***Delivery system structure***: comprehensive, conventional, or limited public health delivery systems

Estimating delivery system effects

Statistical Model

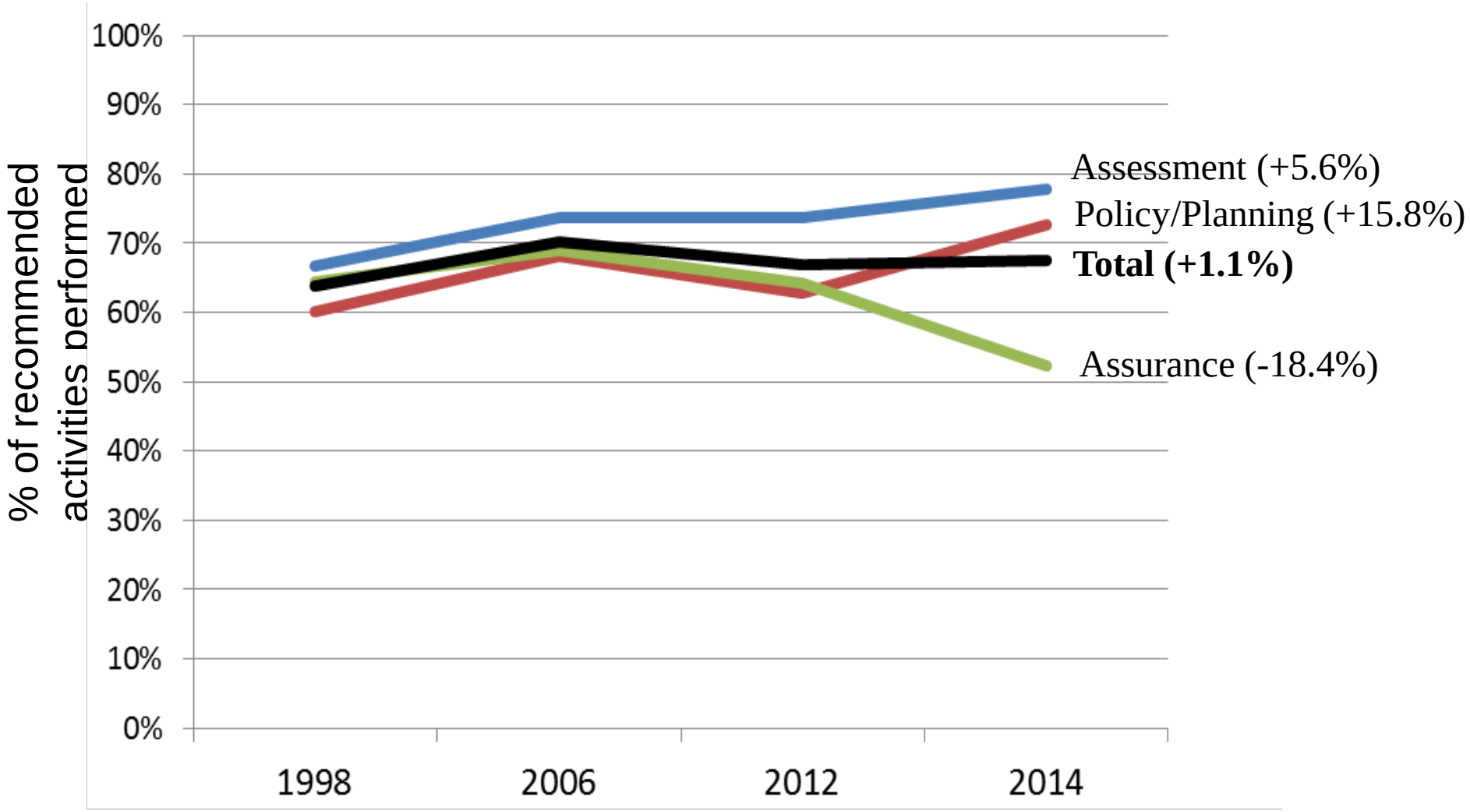
- Log-transformed Generalized Linear Latent and Mixed Models
- Account for repeated measures and clustering of public health jurisdictions within states
- Instrumental variables address endogeneity of system structures

$$\Pr(System_{z,ijt}=1) = \sum \alpha_z Governance_{ijt} + \beta_1 Agency_{ijt} + \beta_2 Community_{ijt} + \mu_j + \varphi_t + \varepsilon_{ijt}$$

$$Ln(Outcomes|Cost_{ijt}) = \sum \alpha_z (\widehat{System}_z)_{ijt} + \beta_1 Agency_{ijt} + \beta_2 Community_{ijt} + \mu_j + \varphi_t + \varepsilon_{ijt}$$

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

Implementation of recommended public health activities 1998-2014

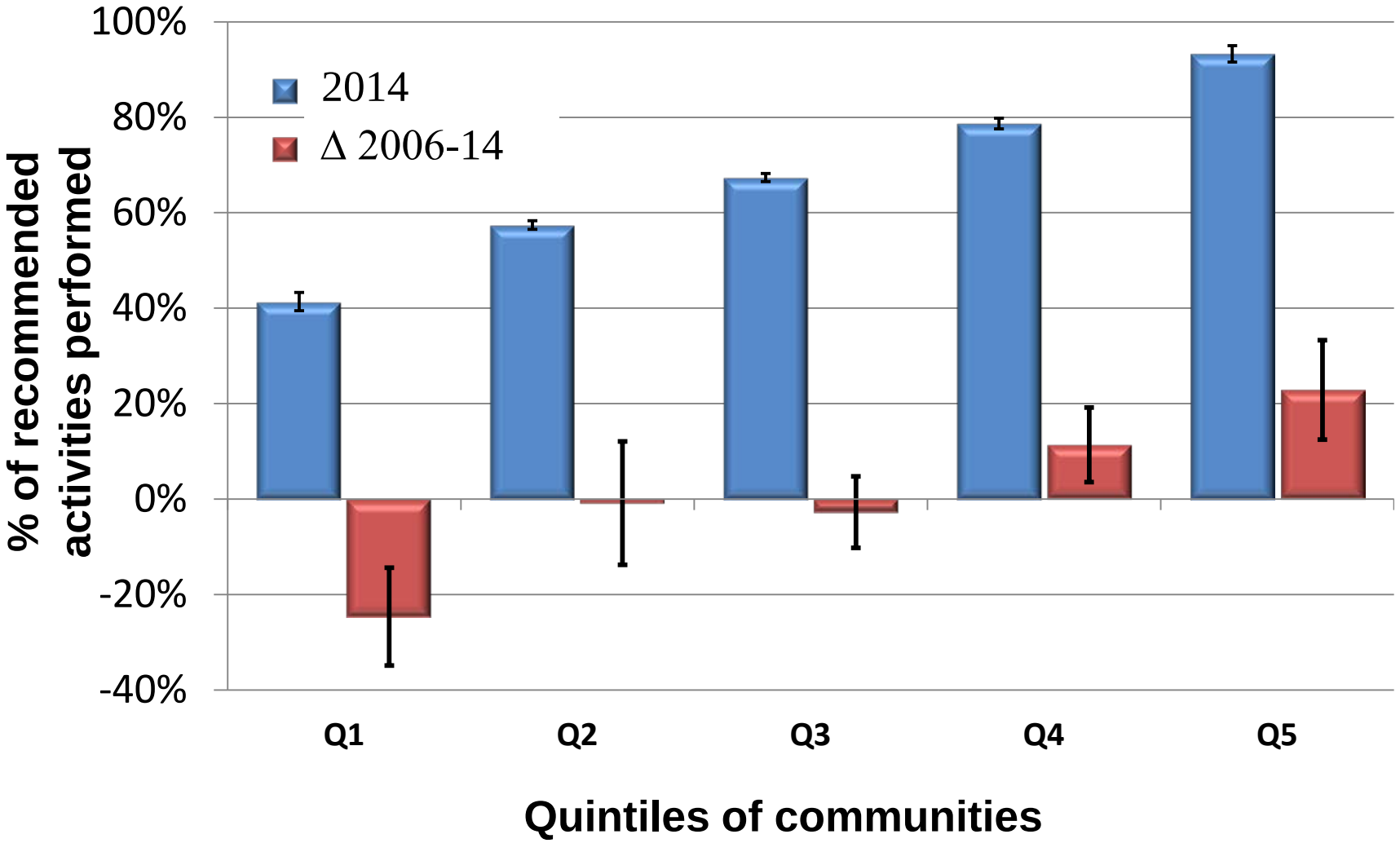


Implementation of recommended activities 1998-2014

	Public Health Activity	1998	2014	% Change
1	Community health needs assessment	71.5%	86.0%	20.2%**
2	Behavioral risk factor surveillance	45.8%	70.2%	53.2%**
3	Adverse health events investigation	98.6%	100.0%	1.4%
4	Public health laboratory testing services	96.3%	96.5%	0.2%
5	Analysis of health status and health determinants	61.3%	72.8%	18.7%**
6	Analysis of preventive services utilization	28.4%	39.4%	38.8%**
7	Health information provision to elected officials	80.9%	84.8%	4.8%
8	Health information provision to the public	75.4%	83.8%	11.1%*
9	Health information provision to the media	75.2%	87.5%	16.3%**
10	Prioritization of community health needs	66.1%	82.3%	24.6%**
11	Community participation in health improvement planning	41.5%	67.7%	63.0%**
12	Development of community health improvement plan	81.9%	86.2%	5.2%
13	Resource allocation to implement community health plan	26.2%	43.2%	64.9%**
14	Policy development to implement community health plan	48.6%	57.5%	18.4%*
15	Communication network of health-related organizations	78.8%	84.8%	7.6%
16	Strategies to enhance access to needed health services	75.6%	50.2%	-33.6%**
17	Implementation of legally mandated public health activities	91.4%	92.4%	1.0%
18	Evaluation of public health programs and services	34.7%	38.4%	10.8%**
19	Evaluation of local public health agency capacity/performance	56.3%	55.0%	-2.4%
20	Implementation of quality improvement processes	47.3%	49.6%	5.0%
	Composite availability of assessment activities (1-6)	66.7%	77.6%	16.4%**
	Composite availability of policy development activities (7-15)	60.2%	72.5%	20.4%
	Composite availability of assurance activities (16-20)	64.4%	52.8%	-18.0%*
	Composite availability of all activities (1-20)	63.8%	67.6%	6.0%*

Inequities in Implementation

Delivery of recommended public health activities, 2006-14

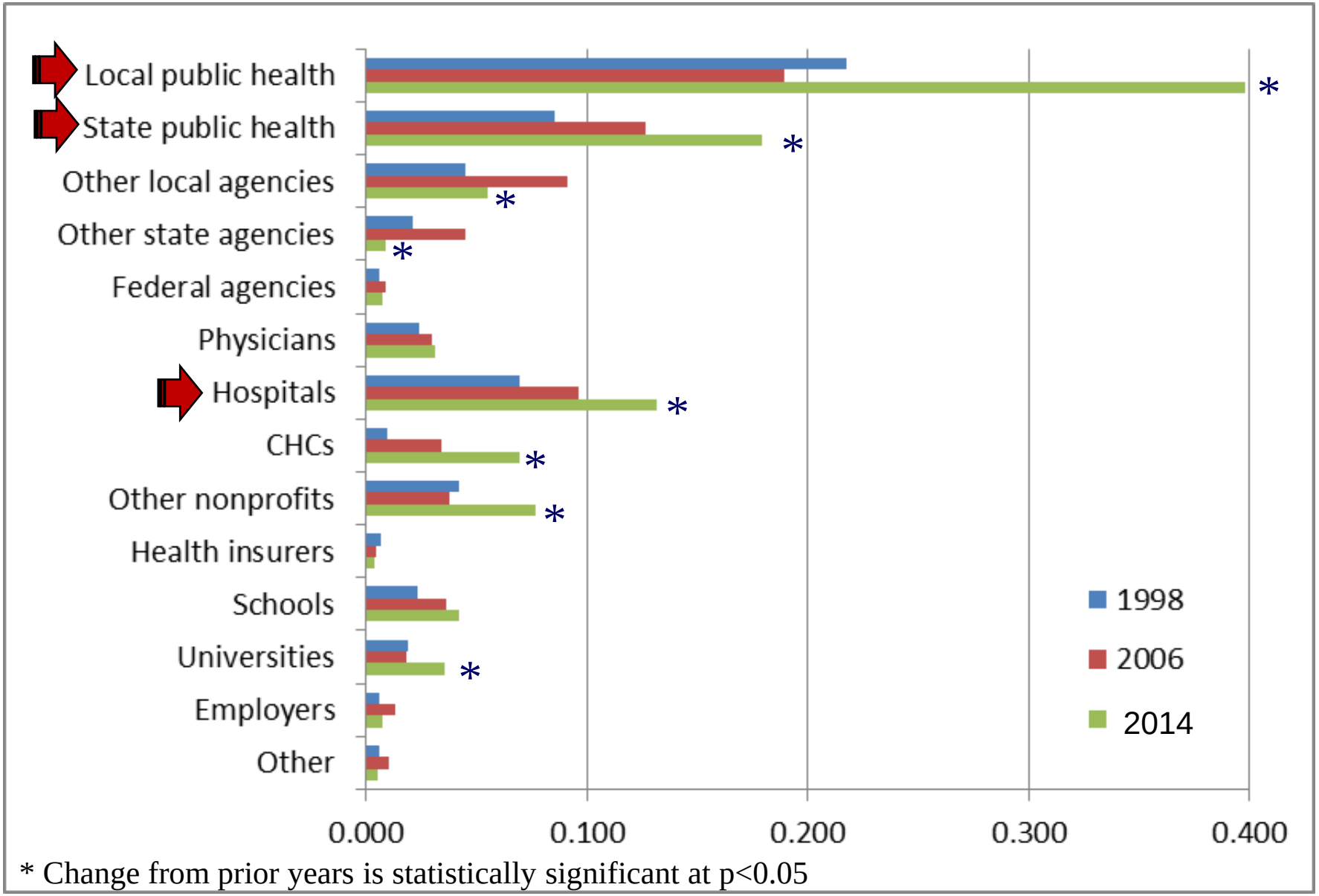


Organizational contributions to recommended public health activities, 1998-2014

% of recommended activities performed

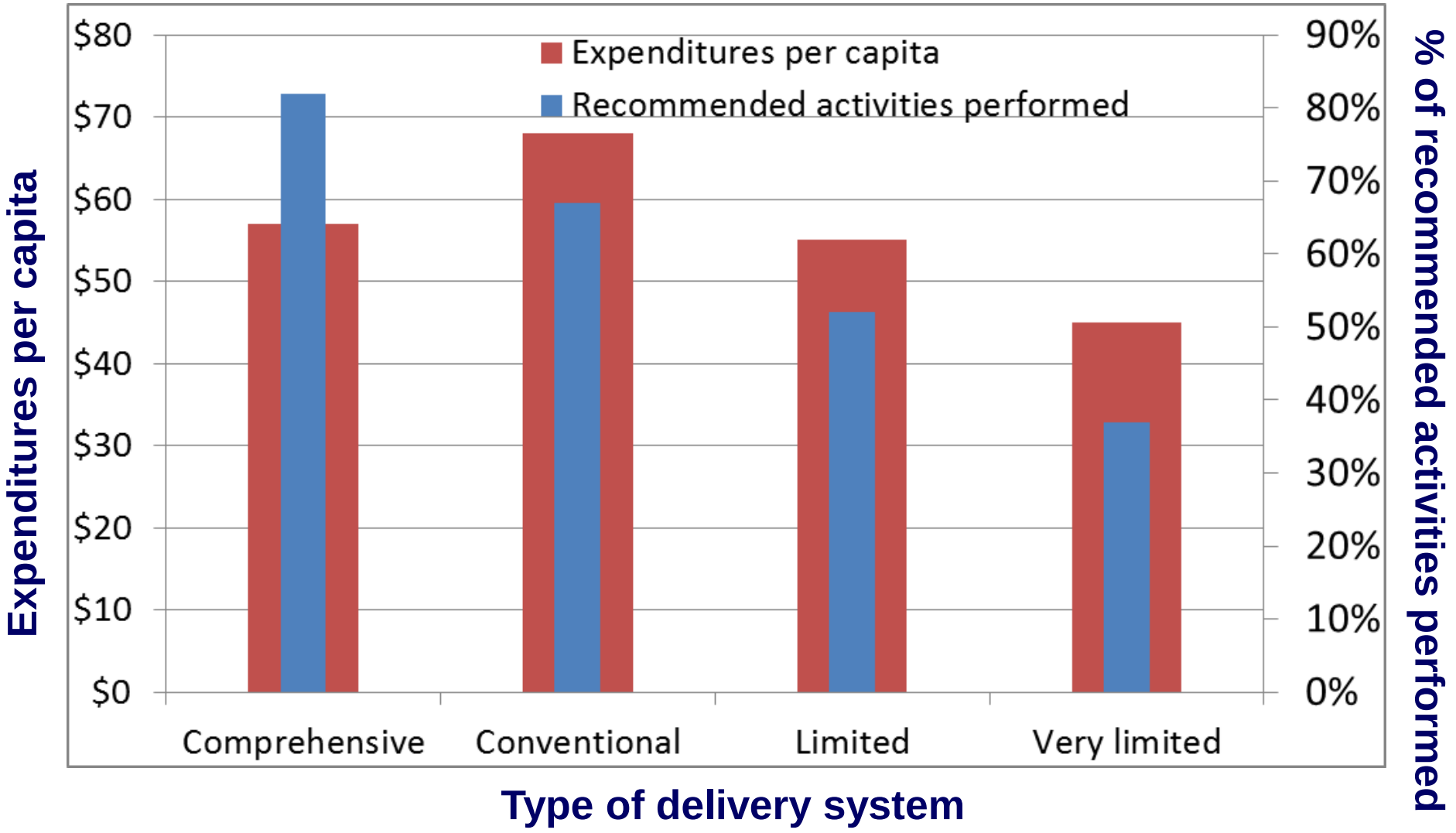
Type of Organization	1998	2006	2012	2014
Local public health agency	60.7%	66.5%	62.0%	67.4%
Other local govt agencies	31.8%	50.8%	26.3%	32.7%
State public health agency	46.0%	45.3%	36.4%	34.0%
Other state govt agencies	17.2%	16.4%	13.0%	12.7%
Federal agencies	7.0%	12.0%	8.7%	7.1%
Hospitals	37.3%	41.1%	39.3%	47.2%
Physician practices	20.2%	24.1%	19.5%	18.0%
Community health centers	12.4%	28.6%	26.9%	28.3%
Health insurers	8.6%	10.0%	9.8%	11.1%
Employers/business	25.5%	16.9%	13.4%	15.0%
Schools	30.7%	27.6%	24.9%	24.7%
Universities/colleges	15.6%	21.6%	21.2%	22.2%
Faith-based organizations	24.0%	19.2%	15.7%	16.8%
Other nonprofits	31.9%	34.2%	31.6%	33.6%
Other organizations	8.5%	8.8%	5.4%	5.4%

Bridging capital in public health delivery systems
Trends in betweenness centrality



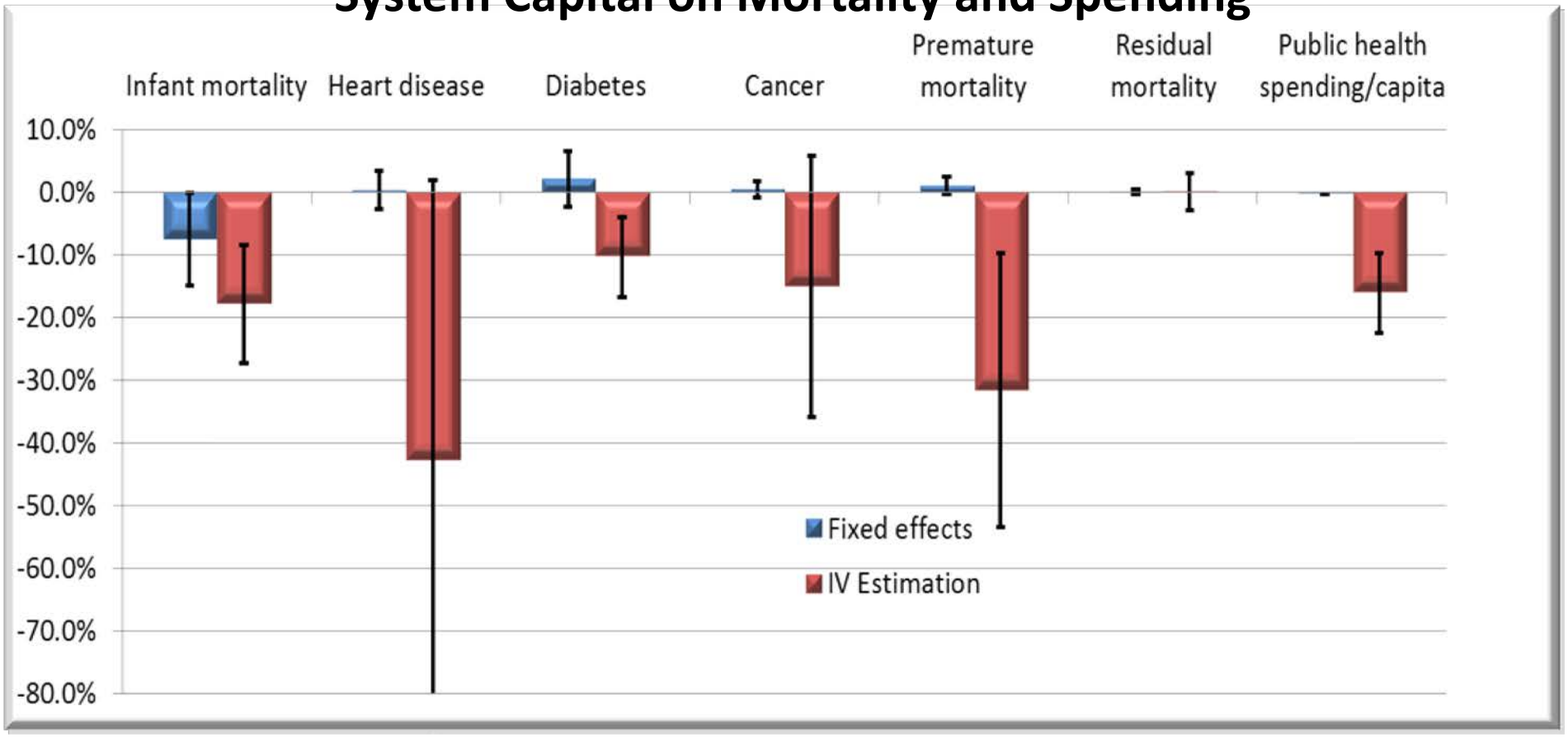
* Change from prior years is statistically significant at $p<0.05$

Comprehensive systems do more with less



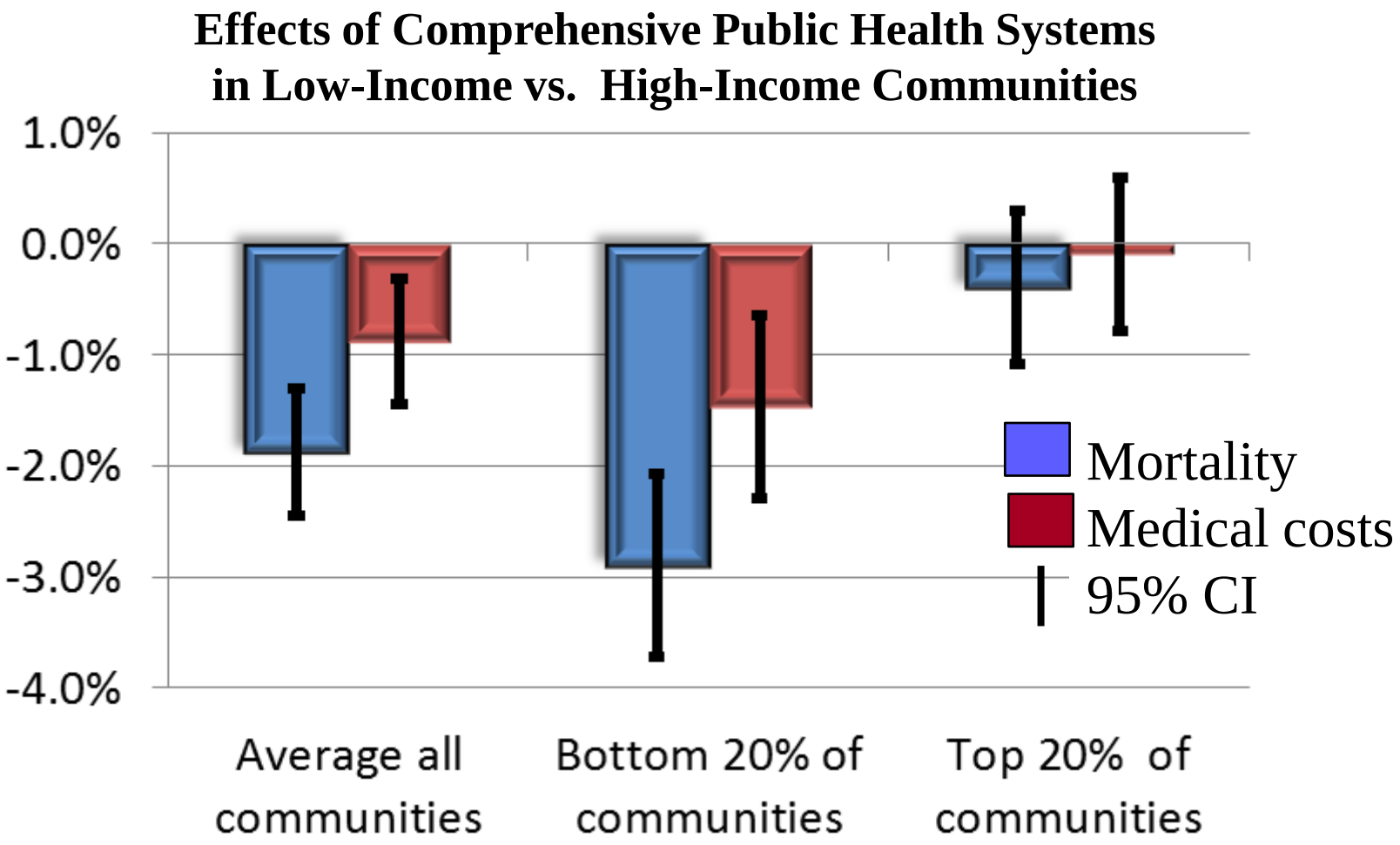
Health and economic impact of comprehensive systems

Fixed Effects and IV Estimates: Effects of Comprehensive System Capital on Mortality and Spending



Models also control for racial composition, unemployment, health insurance coverage, educational attainment, age composition, and state and year fixed effects.
N=779 community-years **p<0.05 *p<0.10

Impact on equity: larger gains in low-resource communities



Log IV regression estimates controlling for community-level and state-level characteristics

Conclusions

- Comprehensive and highly-integrated public health systems appear to offer considerable health and economic benefits over time.
  - 30-45% more PH services implemented
  - 10-40% larger reductions in preventable mortality rates
  - 15% lower public health resource use
- Low-income communities are less likely to achieve comprehensive public health system capital, but they benefit disproportionately
- Failure to account for endogenous network structure can lead to biased estimates of impact

Policy and Practice Implications

Opportunities for building public health system capital and interorganizational networks:

- Hospital community benefit requirements
- CMMI State Innovation Models (SIMs)
- Accountable Communities initiatives
- Insurer and employer incentives
- Community development projects

For More Information

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Glen P. Mays, Ph.D., M.P.H.
glen.mays@uky.edu
@GlenMays

Email: systems4action@uky.edu
Web: www.systemsforaction.org
www.publichealthsystems.org
Journal: www.FrontiersinPHSSR.org
Archive: works.bepress.com/glen_mays
Blog: publichealtheconomics.org

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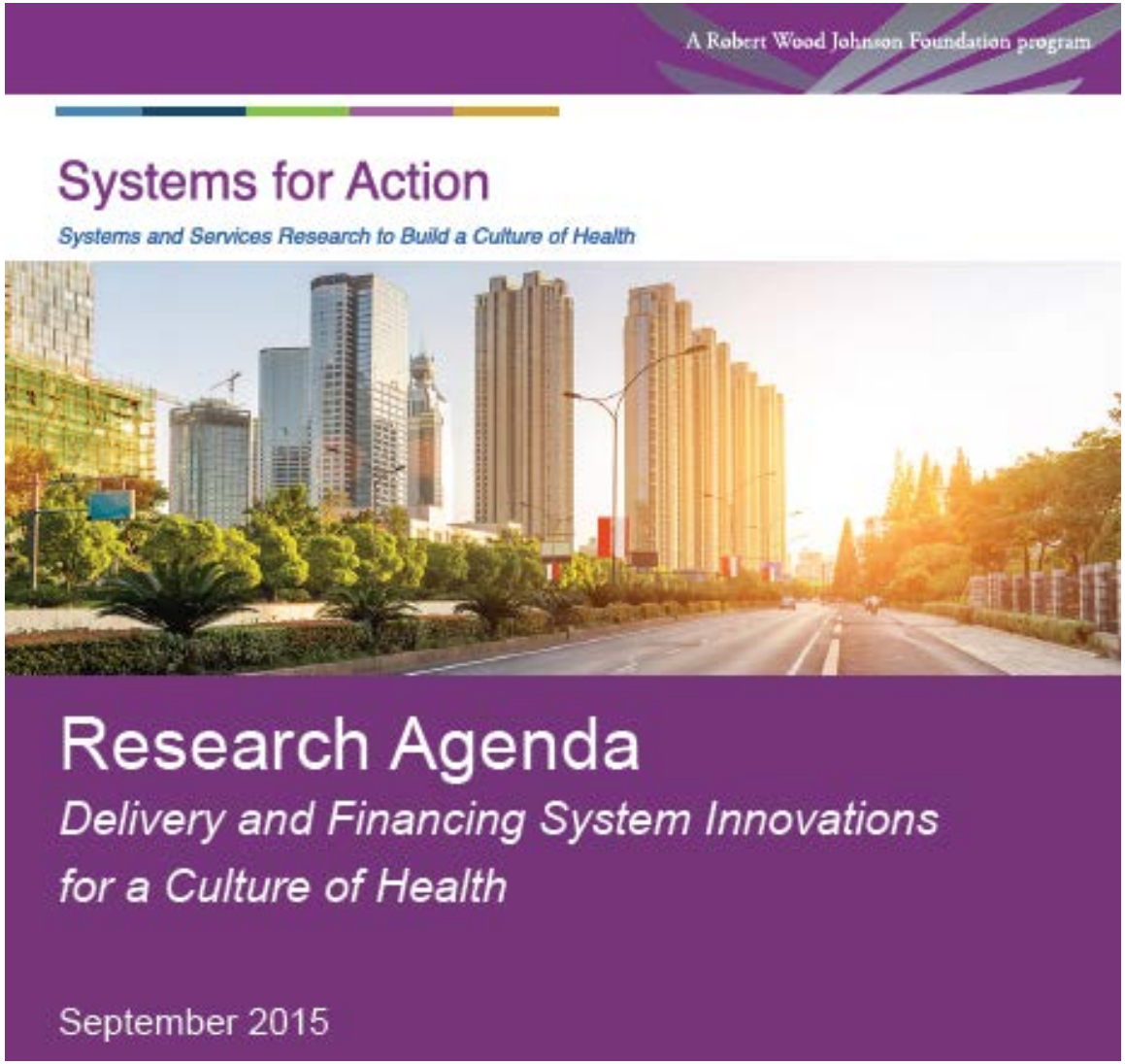
New research program focuses on delivery and financing systems



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