Health Technology II
Measures against large-scale epidemics：

(2nd of 4 lectures)
Individual behavior changes that affect epidemic levels

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Goal of the class

To study the individual behavior changes, which affect epidemic levels, in terms of

(a) methods to quantify determinants of these changes and

(b) theories to explain these changes.

Today's Take-home messages

- Behavior change
  - Difficult
  - How to quantify?
  - Big or small? Compared to what?

- Theory is important
  - To read a paper
  - To analyze issues
  - To write your original paper

Road Map

I) Review of 1st Lecture

II) Methods to quantify determinants of individual behavior changes

III) Theories to explain individual behavior changes

IV) Discussion

V) Next Week

Discussion Points for Class 1
(Note: (?) indicates limited evidence as of today)

A) How applicable is the basic SIR model for the COVID19?

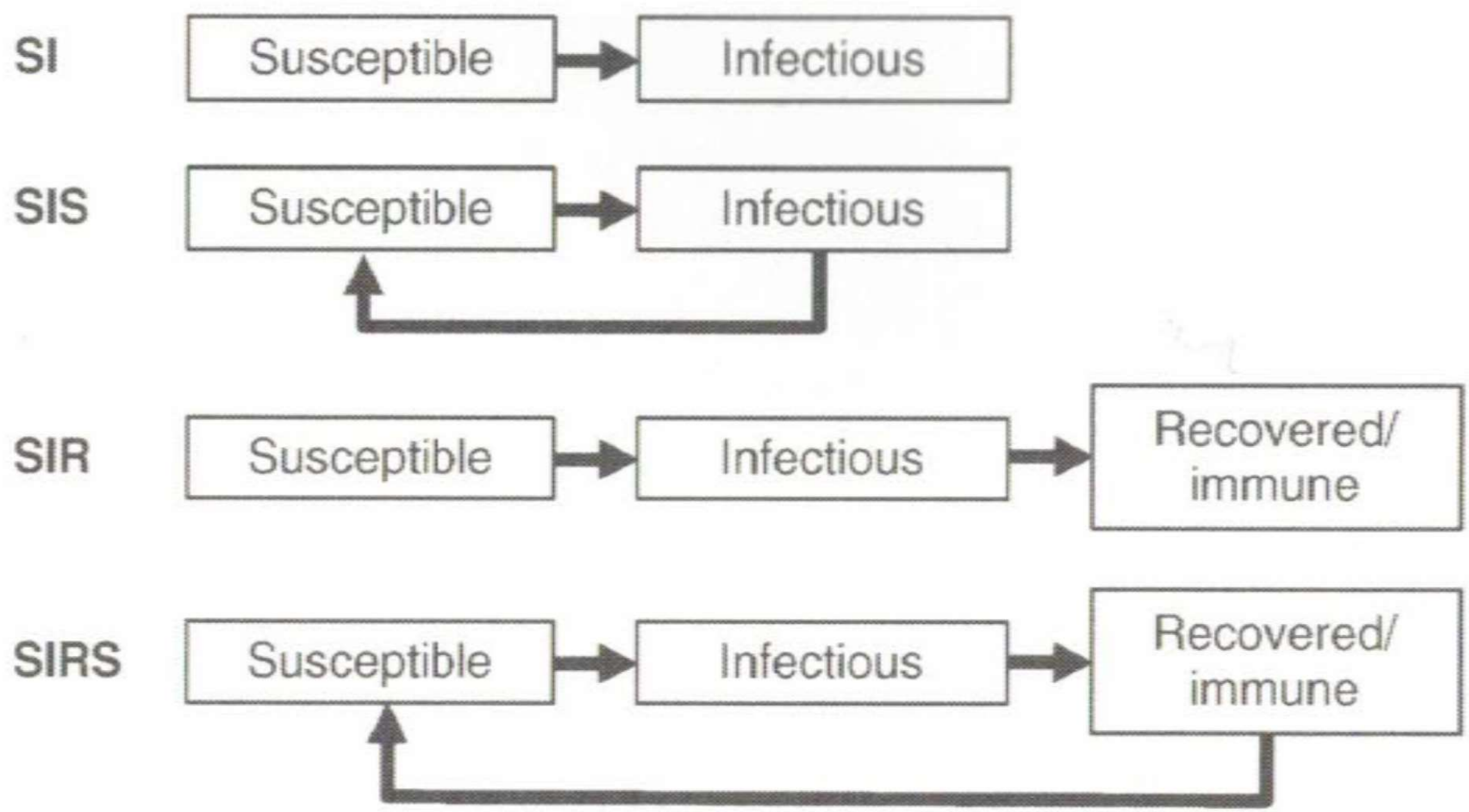
- Infection w/out symptoms → Spread speed↑, Hard to trace infected (under-count "S" in the SIR model?)

- Multiple infections (?, how much % of infected?)
  → Herd Immunity more difficult, i.e., longer time to reach herd immunity ?
  → Not SIR model but SIRI or the mix of these models? (See next slide)

- Poor antibody response (?, how much % of infected?)
  → Vaccine effectiveness↓ or the vaccine development would be difficult ?
  → Herd Immunity more difficult, i.e., longer time to reach herd immunity ?
  → Not SIR model but the mix of SIS, SIR and SIRS models?

B) What are obstacles to use math-models in policy-making in Japan?

Common structures for models used to describe the transmission of infections. (source: Vyunncyky 2020, p.16) (same as slide #27 in CLASS 1)



Basic Backgrounds of the COVID-19 (as of May 28, 2020)

(source: WHO website https://www.who.int/emergencies/diseases/novel-coronavirus-2019)

- Global impacts
  - 5.6 M Confirmed cases, 0.25M deaths
- Japan’s case
  - 16,683 Confirmed cases, 867 deaths

- No vaccine/treatment confirmed

→ Primary prevention (to reduce infection risk)

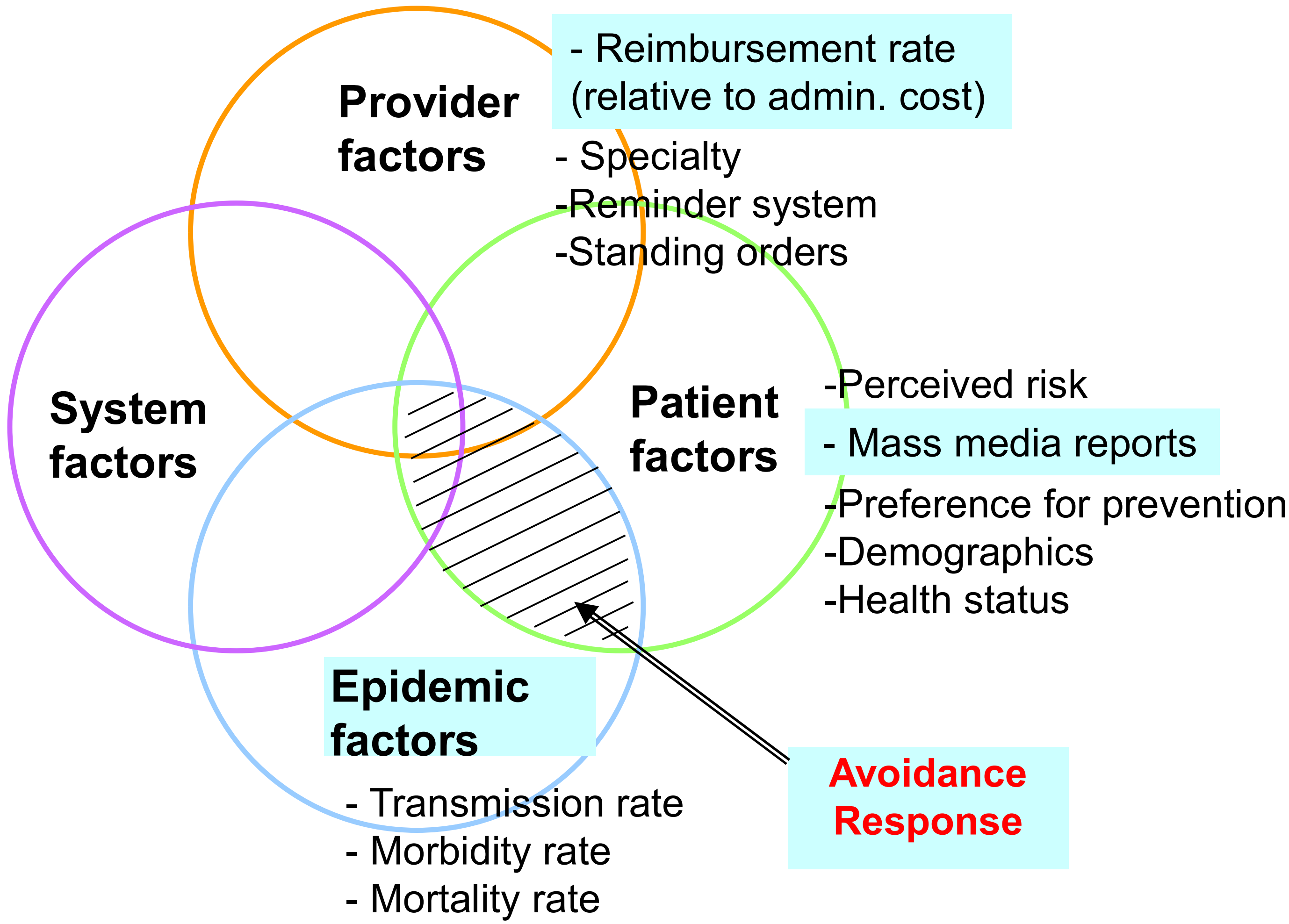
- Behavior change to mitigate the negative impacts of COVID-19
  - Social distancing

Basic Measures against the COVID-19

- Primary prevention (to reduce infection risk)
  - Behavior change to mitigate the negative impacts of COVID-19
    - Social distancing (*Long-term* commitment like *obesity prevention*)
    - Vaccination (*One-time* commitment; Simple??: available after spring 2021?)
  - (Q for students) Other examples in COVID-19?
    - Antibody test?
    - Smart phone appli.?
- Secondary prevention (if close contact w/ infected)
  - Detect early enough to improve outcome
- Tertiary Prevention
  - Treatment after infected & w/ serious symptoms

Conceptual Framework of Preventive Behavior: Case of Infectious Disease

(Task Force on Community Preventive Services, MMWR 1999)

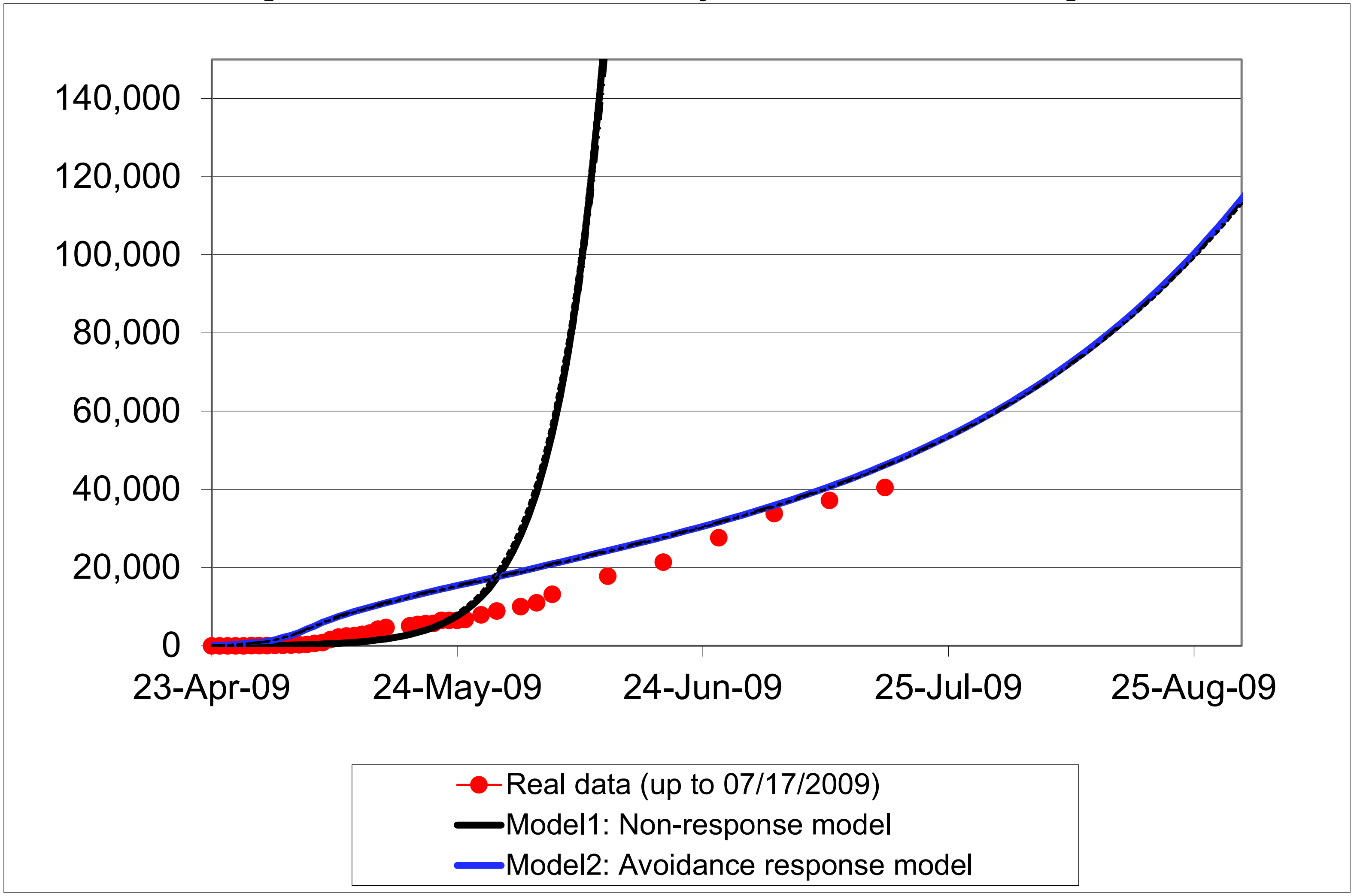


Test Validity of Avoidance Response Model:

novel H1N1 influenza epidemic path in the U.S.

from April 23 to August 31, 2009 (day 86)

[Cumulative laboratory confirmed cases]



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Seasonal influenza
Disease burden in the U.S.

- Influenza and pneumonia (I&P)
  - ranked 6th among all causes of death for those age 65 years and older and for those age 1-4 years
  - ranked 7th among all age groups in 2003.

- Elderly (65+) account for 90% of deaths

- Children were twice as likely to be treated as adults
  - no difference in mean cost: $200 per person (in 2003)

- Medicare reimbursement for excess hosp:
  - $1 billion per epidemic (1989 – 1991)

Seasonal/pandemic flu disease burden in the U.S.

The President's Council of Advisors on Science and Technology 2010

	Seasonal flu (every year)	Pandemic flu (2009-10)	Spanish flu (1918)
Total infected	6%-36%	15%-25%	30%(~50%?)
Case fatality	< 0.1%	N/A	> 2%
Total death #	36,000 [8,000-51,000]	8,500 – 17,600 (Apr. 09-Feb. 10)	1.9million (if occurs now)
Total hospital.# (Dx = Flu & Pneumonia)	Prm Dx. 95,000 [19k-194k] All Dx.134,000 [31k-272k]	274,000 (Apr, 2009 - Apr, 2010)	9 million (if occurs now)

Flu Shot Coverage Rate (2009-10)

Healthy People 2020 goal: 90% for All adults with high-risk, *80%* for All children and adults without high-risk

Population	Recommendation By ACIP	2009-10 season coverage rate
Children 6-23 mo	All (2004)	43.7%
Children 24-59 mo	All (2006)	
Children ages 5yr to 18 yr	All (2008) *(by 2009-2010)*	
Adults (50+)	All (2000)	45.0%
Elderly (65+ yr)	All (Medicare coverage 1993-)	69.6%
High risk (18-49 yr)		38.2%

(*) Half of child vaccines provided "free" by Vaccines-for-children (VFC) program (1993-)

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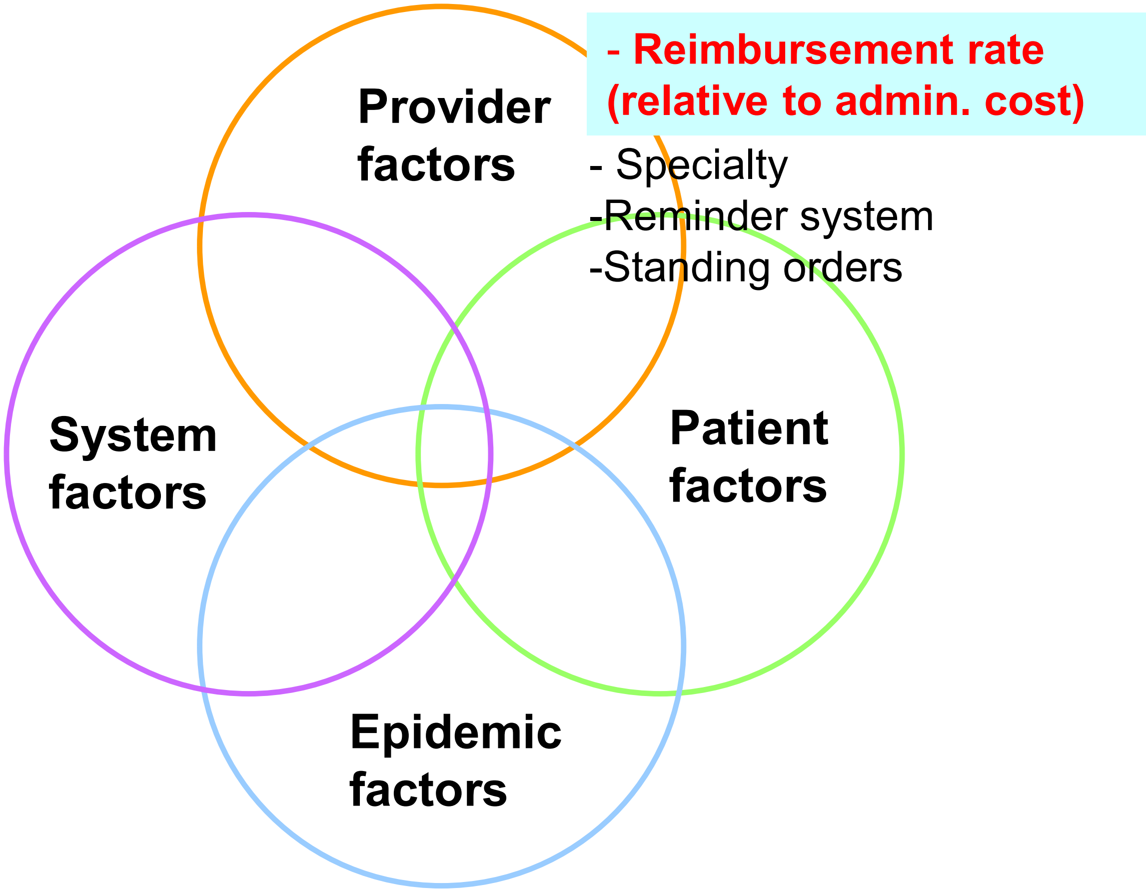


1) Medicaid reimbursement to administer vaccination

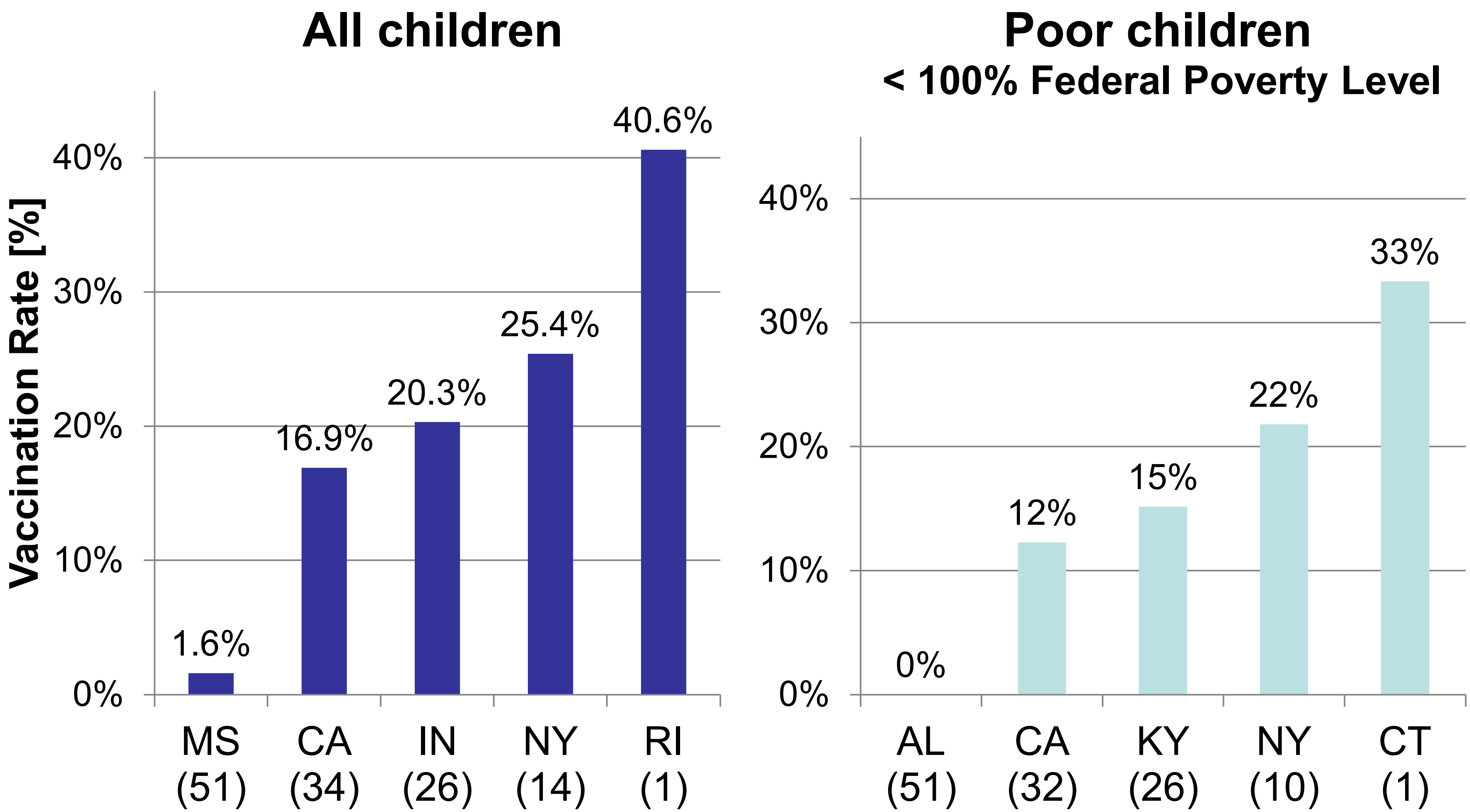
Background

- Medicaid reimbursement for administering vaccination
  - Min: $2.00 (NH etc); Max: $17.86 (NY) in 2005
  - Median: $8.40
- Provider cost: $20 to adm. one flu shot at pediatric clinic [2006 dollar value] (Yoo et al., *Pediatrics*, 2009)
  - *Physicians are losing money by giving flu shots*
  - Financial loss for VFC vaccination in all private pediatric practices [2006 dollars]

    2006-07 season
    - 20% vaccinated: Financial loss = $40 million
    - If 90% vaccinated: Financial loss = $208 million

(Yoo et al. *Pediatrics* 2009)

Child Full Vaccination Rate (6-23mo) 2005-06 season (state ranking)



1) Medicaid reimbursement to administer vaccination

Background

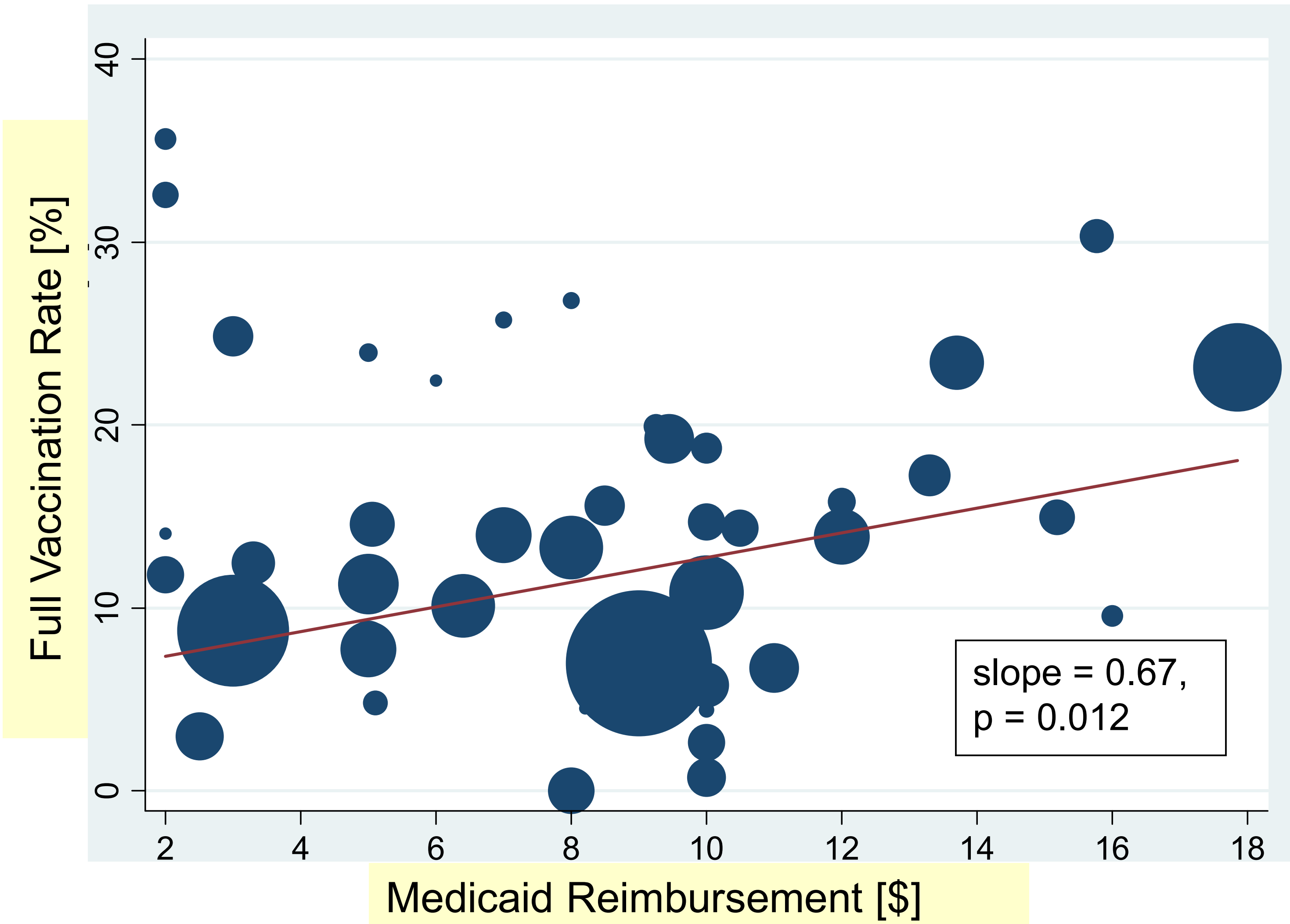
- Medicaid reimbursement for administering vaccination
  - Min: $2.00 (NH etc); Max: $17.86 (New York) in 2005
  - Median: $8.40 (<< actual private clinic cost $20 per shot)

- Across-states disparities in flu vaccination among Medicaid eligible (< 100% FPL) poor children aged 6-23 mo. (2005-06 season)
  - Min: 0% (Mississippi); Max: 33% (Connecticut)
  - Median: 26% (Kentucky)

→ Research question:

Can the state-variations in Medicaid reimbursement rate explain the state-variations in flu shot rate among Medicaid eligible poor child population?

State-level Reimbursement Rate and Full-Vaccination Rate among Poor Children§ in 48 States† (adj. with 15 factors) (Yoo et al., *Pediatrics 2010*)



§ : Poor Children: Less than 100% Federal Poverty Level (FPL)

†: We excluded children in two states (Tennessee, Delaware) and D.C. due to lack of data

Size of circles weighted with state poor child population size)

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(Yoo et al. *Pediatrics* 2009)

1) Medicaid reimbursement rate

Discussion

(Yoo et al., *Pediatrics,* 2010)

(Conclusion)

after adjusting 13 individual-level and 2 state-level variables, during 3 seasons (2005-06 through 2007-08)

$10 ↑ in Medicaid reimbursement rate assoc. with 6-9% ↑ **in** flu shot rate at the state-level

among the nationally-representative Medicaid eligible poor children (6-59 mo),

(Potential causality relationship)

Higher reimbursement → Providers vaccinate more aggressively, e.g., patient reminder/recall, staff training

1) Medicaid reimbursement rate

Policy Implications

(Yoo et al., *Pediatrics,* 2010)

VFC coverage for vaccine (purchase) may not be enough.

↑ in Medicaid reimbursement rates to *administer vaccination* is one policy option

to ↑ flu vaccine coverage levels among US poor children.

(*) Media coverage includes *USA Today, U.S. News & World Report, Bloomberg BusinessWeek, UPI, Reuters, ABC News, MSNBC, Fox News, Yahoo!, Healthday, e!Science News, News-Medical.Net, Softpedia, Health News on healthfinder (U.S. Department of Health and Human Services)* and others.

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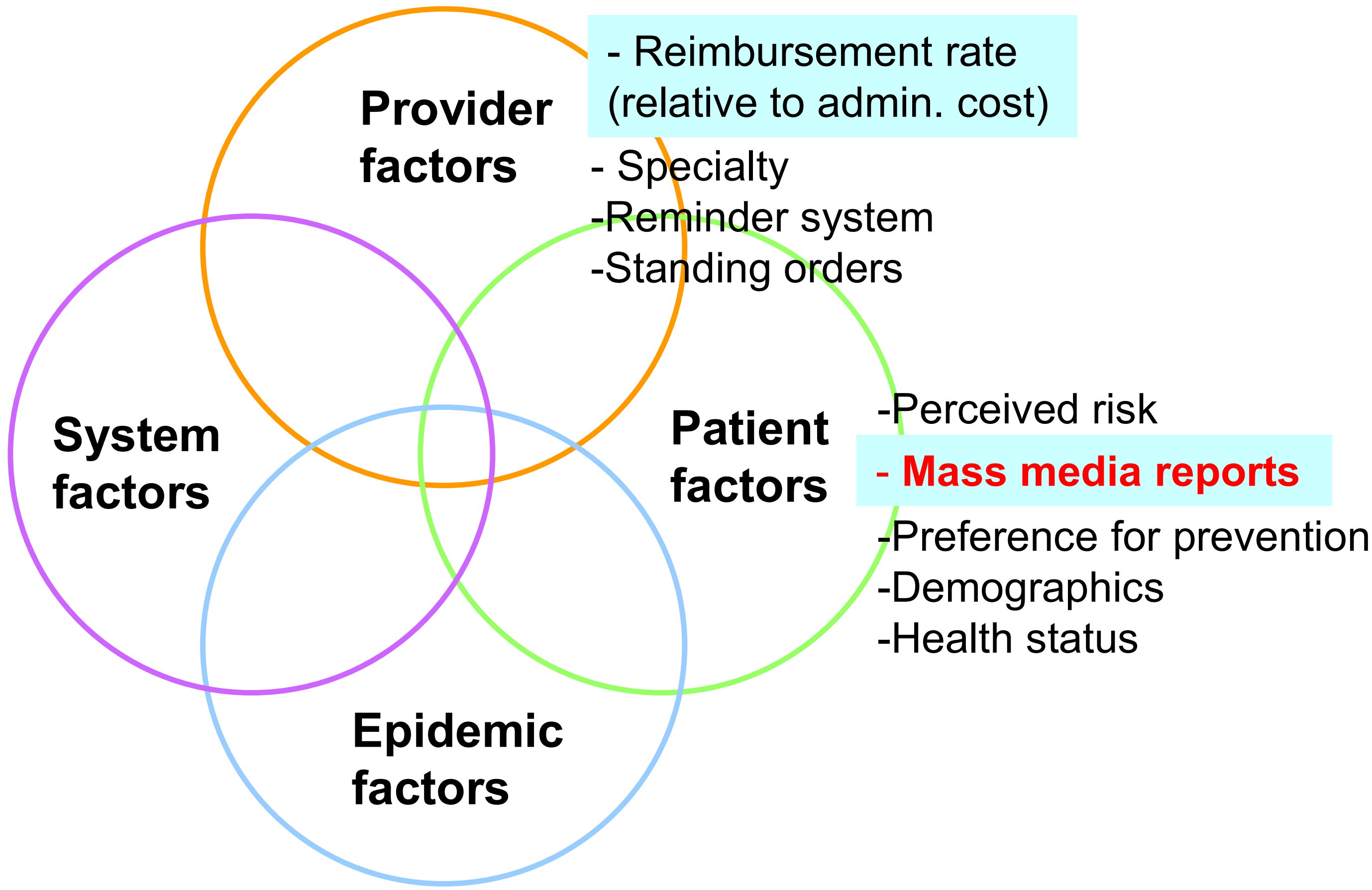

Background / Objective

Mass media effect on preventive care:

- Celebrity campaign on colon cancer screening on *NBC Today's Show* → the colonoscopy rate ↑ by 38% (Cram et al, 2003)
- Limited literature examining assoc. b/w mass media report on influenza and influenza vaccination receipt

  - Descriptive studies - Local population

  (Gnanasekaran et al. 2006, Daley et al. 2006; Ma et al. 2006)

Objective: To measure the association b/w mass media coverage on flu-related topics and influenza vaccination, RE timing and annual vaccination rates, among nationally-representative Medicare elderly.

Data / Study Population

Medicare Current Beneficiary Survey Data (1999-2001)

- Assoc. claims data to identify exact vaccination timing (Sep. 1st - Dec. 31st)

Nationally representative community dwelling elderly aged 65+

- N=7,372 - 7,462 (Weighted N = 24-25 million)

Exclusion criteria

- Medicare managed care plans enrollees (absence of claims data to identify exact vaccination timing)
- Skilled nursing facility (> 30 days)

Methods

- Cross-sectional multivariate survival analyses (using generalized gamma models)
  - during each of 3 flu vaccination seasons (Sep. 99–Dec. 01)

- Outcome variable: Daily vaccine receipt.

- Key explanatory variables: The number of daily media reports prior to the vaccine receipt (day-8 ~ day-14)
  - Television program transcripts (*ABC, CBS, FOX, NBC*)
  - Newspaper (*USA Today*), wire service (*AP*) articles
  - including keywords of “influenza/flu” and “vaccine shortage/delay”.
  - Weighted at state-level (TV rating, Newspaper circulation number)

Key Findings

(Yoo et al., *Health Services Research,* 2010)

# of reports (*USA Today* and 4 TV networks) assoc. with

- *Earlier* vaccination timing (e.g. 2-4 days) and/or
- ↑ in overall annual vaccination rate (e.g., 2-8%)

Greater effects

- Reported in a headline rather than in text only
- Including additional keywords: vaccine shortage/delay
- TV network > *USA Today*, Wire services

Policy Implications

(Yoo et al., *Health Services Research,* 2010)

- Flu vaccination campaign through major mass media
- Effect would be greater if accounting for non-elderly population
- Shifting vaccination timing (2-4 days) in 10+ million population will have substantial impact on the pandemic disease burden

Media coverage (interviewed by) *KCSN radio station* in California and *DOTmed News*)

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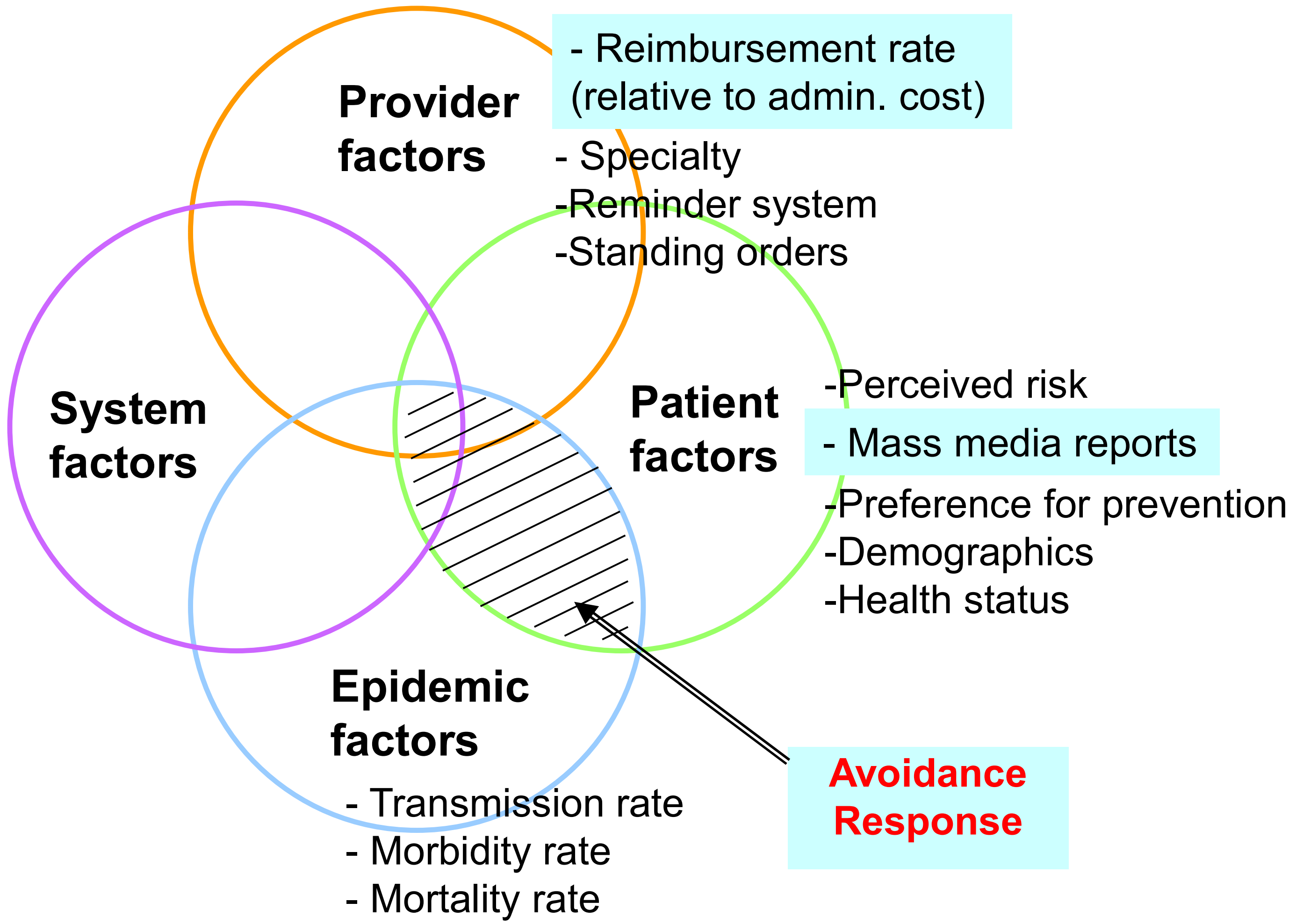
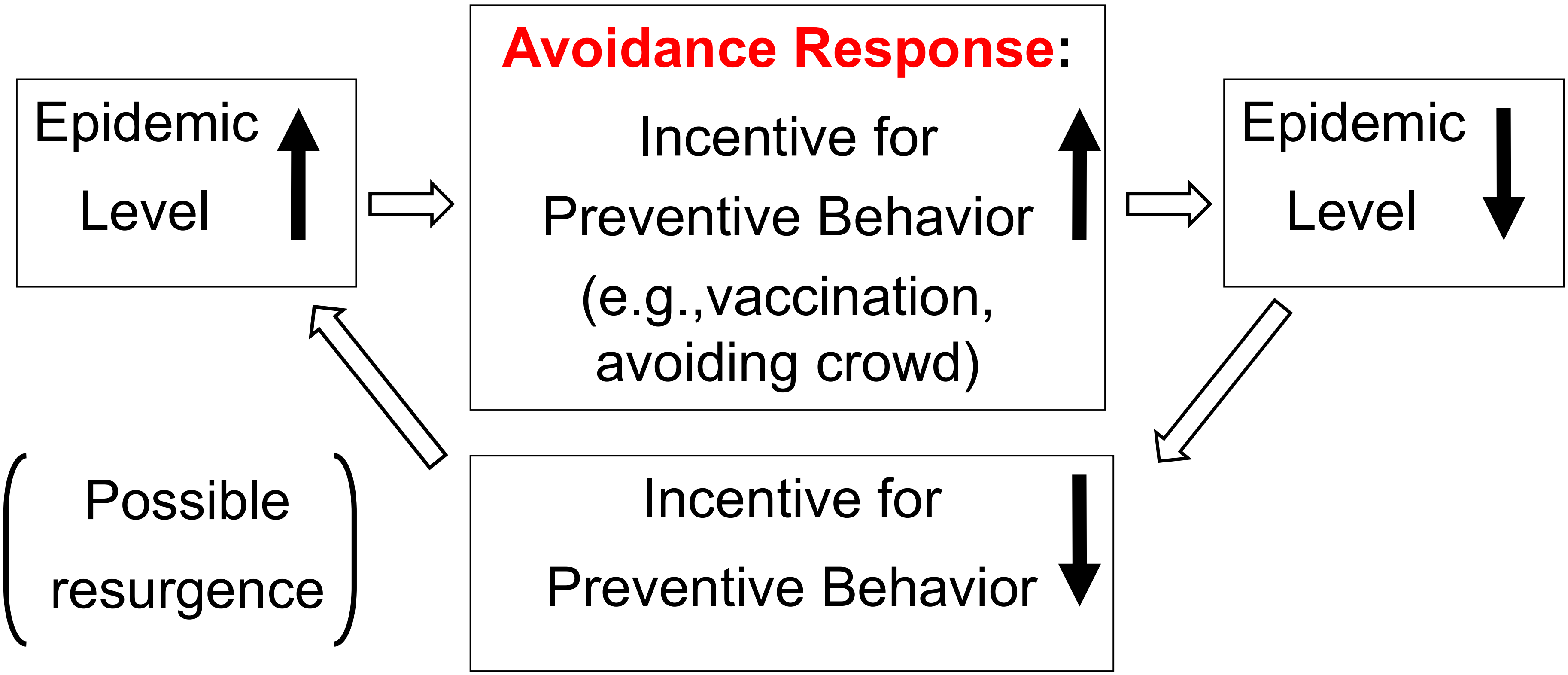


Mutual (cyclic) Interaction between Epidemic Level and Incentive for Preventive Behavior

(Philipson 1996)



“Effects of ongoing epidemic and vaccine supply on the annual influenza vaccination rate and vaccination timing among the Medicare elderly: 2000-2005”

Byung-Kwang Yoo, et al.

American J of Public Health 2009

Funded by NIH/NIAID: 1K25AI073915-03

Background & Motivation

- Long-term Avoidance Response:
  - Higher epidemic → more preventive behavior
  - Flu vaccination: 1+ year time-lag
    - Yoo and Frick, 2005, *Health Economics*
    - Li et al, 2004, *HSR*

- Motivation
  - To examine short-term (weekly) *avoidance response* during even one influenza season
  - Natural experiment: Different epi activity (and period) at 9 census region levels in one season

Table 1. Influenza vaccination rates prior to and during and influenza epidemic period (†) among Medicare elderly

Flu Season (Epidemic start date §)	Vaccine supply problem	Vaccination rate based on claims data		
		From Sep.1 to epidemic start	After epidemic	(Total)
2000-2001 (Dec. 3)	Severe delay	37.2%	9.81%	47.0%
2001-2002 (Dec. 16)	Moderate delay	45.8%	2.66%	48.5%
2002-2003 (Dec. 15)	None	50.4%	0.54%	50.9%
2003-2004 (Oct. 12)	Relative shortage	34.5%	18.3%	52.8%
2004-2005 (Dec. 5)	Severe shortage	35.5%	7.93%	43.4%

(†) Defined at nine census region level [influenza survey laboratory data percent positive >= 5%], (§) Start at national level [influenza survey laboratory data percent positive >= 5%]

Results

Table 2. Effects of biweekly epidemic change (past 2 weeks) on the daily influenza vaccine receipt

season	Hazard Ratio (HR)	p-value	95%Confidence Interval
2004-05	1.05	<0.001	(1.02, 1.09)
2003-04	1.07	<0.001	(1.04, 1.10)
2002-03	1.29	<0.001	(1.19, 1.39)
2001-02	1.20	<0.001	(1.10, 1.31)
2000-01	1.21	<0.01	(1.09, 1.34)

Results

- Short-term (biweekly) avoidance response suggested in all 5 seasons
  - HR = 1.05 – 1.29 (p<.001)
  - Positive behavior: when the influenza epidemic level increased by 100% in the past 2 weeks, an individual was 5-29% more likely to receive an influenza vaccine during subsequent weeks.
  - Epidemic level measure: influenza survey laboratory data percent positive [%]

Conclusion and Policy Implications

- Individuals' seasonal flu vaccination patterns strongly assoc. with
  ongoing flu epidemic levels

- Policy Implications:
  - Vaccine demand prediction based on epi level
    - Short-term: vaccination reallocation across regions
    - Long-term: manufacturers' vaccine production plan
      - decomposing: normal component and epidemic-driven component

  - Constant efforts to vaccinate needed throughout influenza season

“Public Avoidance and the Epidemiology of novel H1N1 Influenza A”

Byung-Kwang Yoo, et al.

National Bureau of Economic Research (NBER) (*)

Working Paper, 2010, (www.nber.org/papers/w15752).

(*) *NBER* is the nation's leading nonprofit economic research organization. 16 of the 31 American Nobel Prize winners in Economics and 6 of the past Chairmen of the President's Council of Economic Advisers have been researchers at the *NBER.*

3 Aims

1) Test validity of a *avoidance response* simulation model
   - Comparison with the real U.S. pandemic data (up to July 17, 2009) [# of labo confirmed cases]

2) Forecast "baseline" pandemic path from April 2009 to Sep. 2010 in the US
   - Assuming no vaccination programs
   - Outcome: Proportion of cumulative infected (not labo-confirmed) among total population
   - Comparison among 3 Models

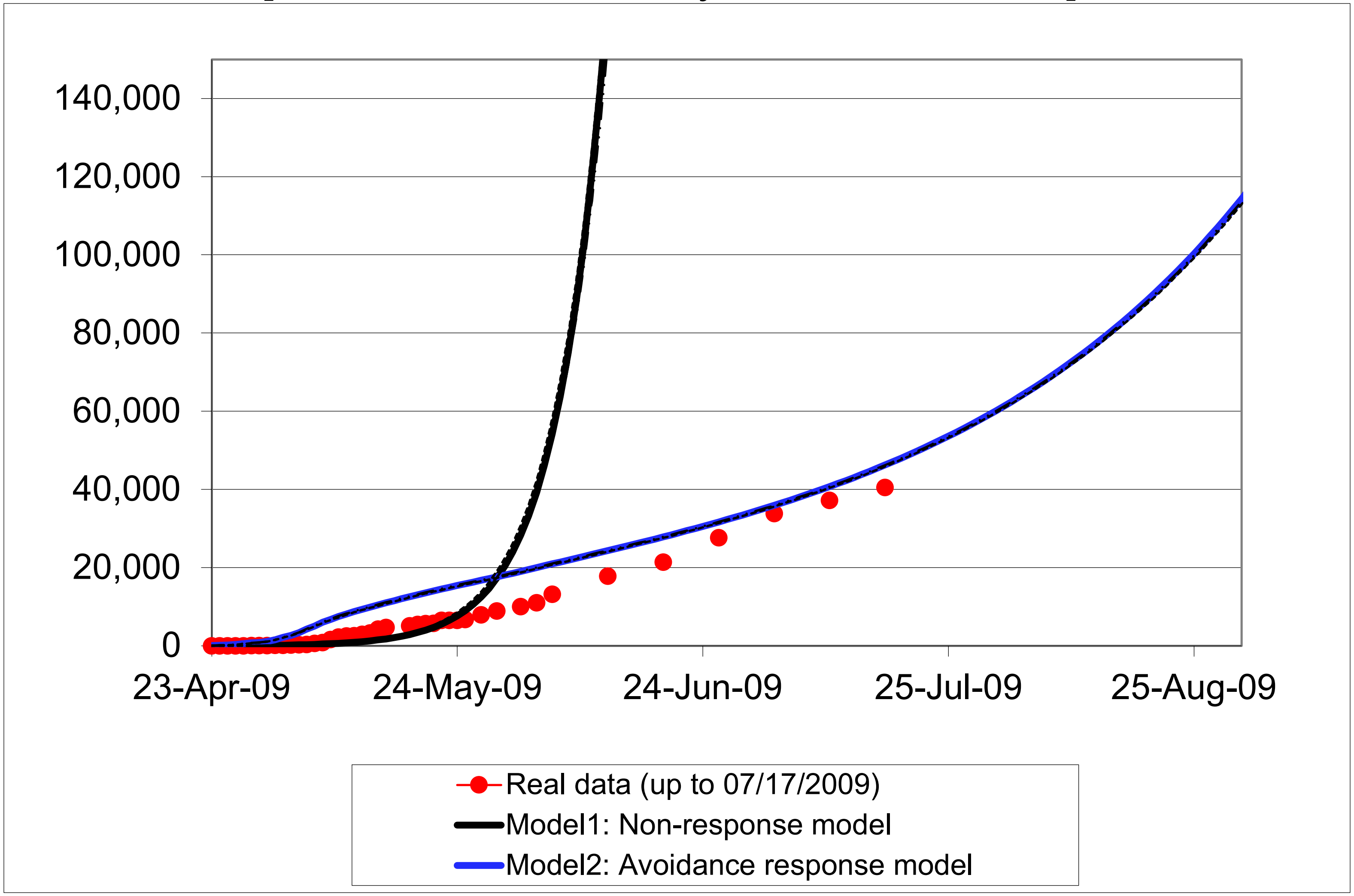
3) Evaluate effectiveness of vaccination programs
   - Outcome: Reduction in final (infected) size, Change in peak date

Aim 1: Test Validity of Avoidance Response Model:

novel H1N1 influenza epidemic path in the U.S.

from April 23 to August 31, 2009 (day 86)

[Cumulative laboratory confirmed cases]



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I) Review of 1st Lecture

II) Methods to quantify determinants of individual behavior changes

III) Theories to explain individual behavior changes

- Recommended textbooks
- Some theory examples

IV) Discussion

V) Next Week

Recommended Textbooks:

Social & Behavioral Sciences and Behavioral Economics

- Karen Glanz, Barbara K. Rimer, K. Viswanath, (2015) "Health Behavior: Theory, Research, and Practice (Jossey-Bass Public Health)" 5th Edition (ISBN-10: 1118628985, ISBN-13: 978-1118628980)

- Lisa F. Berkman, Ichiro Kawachi, Maria Glymour, (2014) "Social Epidemiology" 2nd Edition, (ISBN-10: 0199395330; ISBN-13: 978-0199395330)

Why Theory is Important?

	Disciplines	Goal
Theory	Economics, Sociology, Political Science, Psychology, Pathology	Generate hypothesis (causality underlying phenomenon)
Method	Econometrics, Statistics, Epidemiology, CEA/CBA, Risk adjustment	Test hypothesis (i.e., theory) - empirically analyzing "real-world" data, e.x. dY/dX=(+)
Topic	Obesity, mental health, long term care, patient/provider/ organization behavior	Interpretation for policy implication

General causality path

[Intervention]
→[mediator]
→[health-promoting behavior]

General causality path

[Intervention]
→[mediator]
→[health-promoting behavior]

<u>Examples of Intervention</u>

- Gov't recommendation (e.g., social distancing, avoid a crowd, wear a mask, etc. during the COVID-19)
- Education
- Demonstration

General causality path

[Intervention]
→[mediator]
→[health-promoting behavior]

Definitions of mediator (in comparison with moderator)

- a mediator variable is one that explains the relationship between the two other variables
- a moderator variable is one that influences the strength of a relationship between two other variables,

(Source: psych.wisc.edu/henriques/mediator.html)

General causality path

[Intervention]

→[mediator]

→[health-promoting behavior]

Example of mediator

- Self-efficacy (used in various theories, e.g., Health Belief Model)
  - Definition: Beliefs that one can perform the recommend health behavior (confidence)

How to measure Self-efficacy?

Most popular self-efficacy scale:

Schwarze's "Generalized self-efficacy scale"

- (Ref) Schwarzer R, Jerusalem M. Generalized self-efficacy scale. In: Weinman J, Wright S, Johnston M, editors. Measures in health psychology: a user's portfolio. Windsor:
 Nfer-Nelson; 1995. p. 35–7.

- 10-item Likert-type scale with items answered on a 4-point scale

Schwarze's "Generalized self-efficacy scale"

	Not at all true	Hardly true	Moderately true	Exactly true
I can usually handle whatever comes my way.				

Schwarze's "Generalized self-efficacy scale"

1. I can always manage to solve difficult problems if I try hard enough.
2. If someone opposes me, I can find the means and ways to get what I want.
3. It is easy for me to stick to my aims and accomplish my goals.
4. I am confident that I could deal efficiently with unexpected events.
5. Thanks to my resourcefulness, I know how to handle unforeseen situations.
6. I can solve most problems if I invest the necessary effort.
7. I can remain calm when facing difficulties because I can rely on my coping abilities.
8. When I am confronted with a problem, I can usually find several solutions.
9. If I am in trouble, I can usually think of a solution.

Another mediator example: Self-esteem

Most popular self-esteem scale:

Rosenberg's Self-esteem scale

- (Ref) Self-esteem scale: Rosenberg M. Society and the Adolescent Self-Image. Princeton, NJ , Princeton University Press, 1965.
- 10-item Likert-type scale with items answered on a 4-point scale

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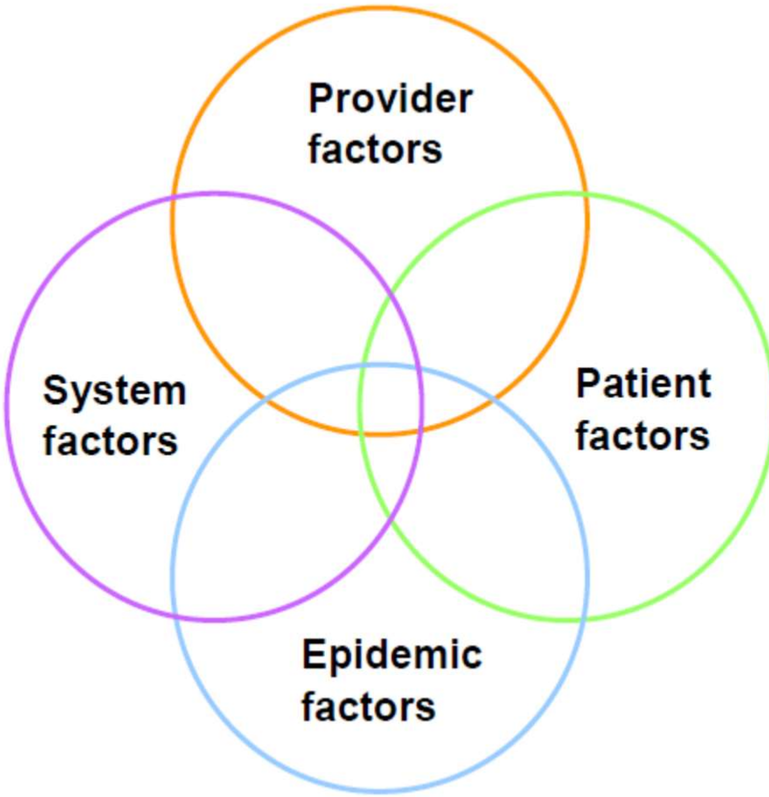
- How to replicate Yoo's influenza studies for the ongoing the COVID-19?
- How will Yoo's influenza studies' policy implications be applicable to those of the ongoing COVID-19?

V) Next Week

Discussion
A) How to replicate Yoo's influenza studies for the ongoing COVID-19?



- Which factor(s)?
- What hypothesis?
- Which theory used to justify your hypo.?
- Which data sets?
- How will the hypothesized results change the related policy?

Today’s Take-home messages

- Behavior change
  - Difficult
  - How to quantify?
  - Big or small? Compared to what?

- Theory is important
  - To read a paper
  - To analyze issues
  - To write your original paper

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Health disparity

Questions?