The Illness-Poverty-Amenity Trap:

Evidence from 7 Million Seniors

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June 2019

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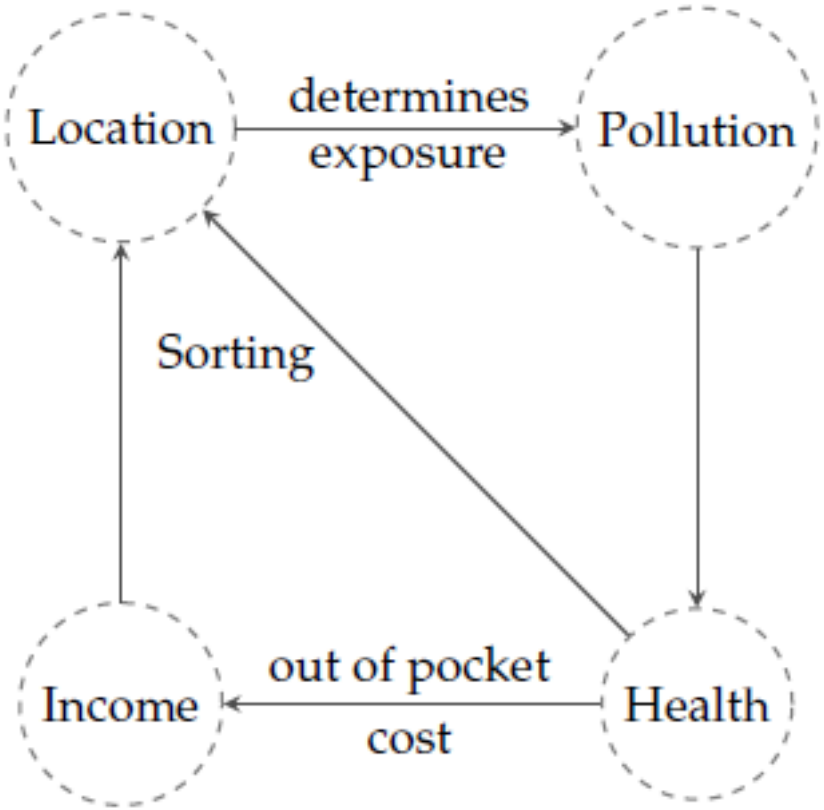

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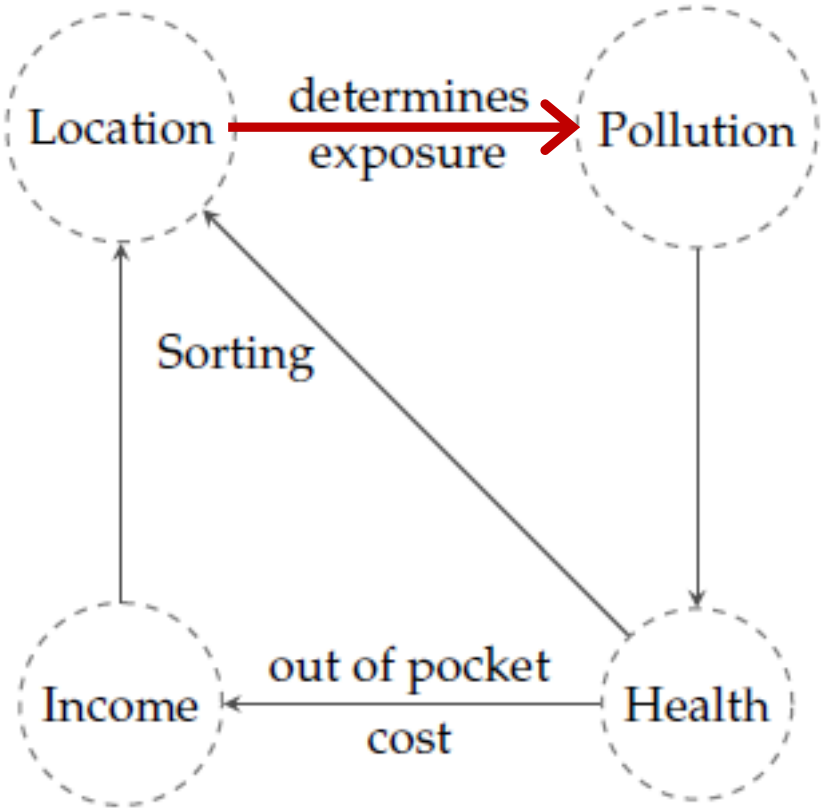

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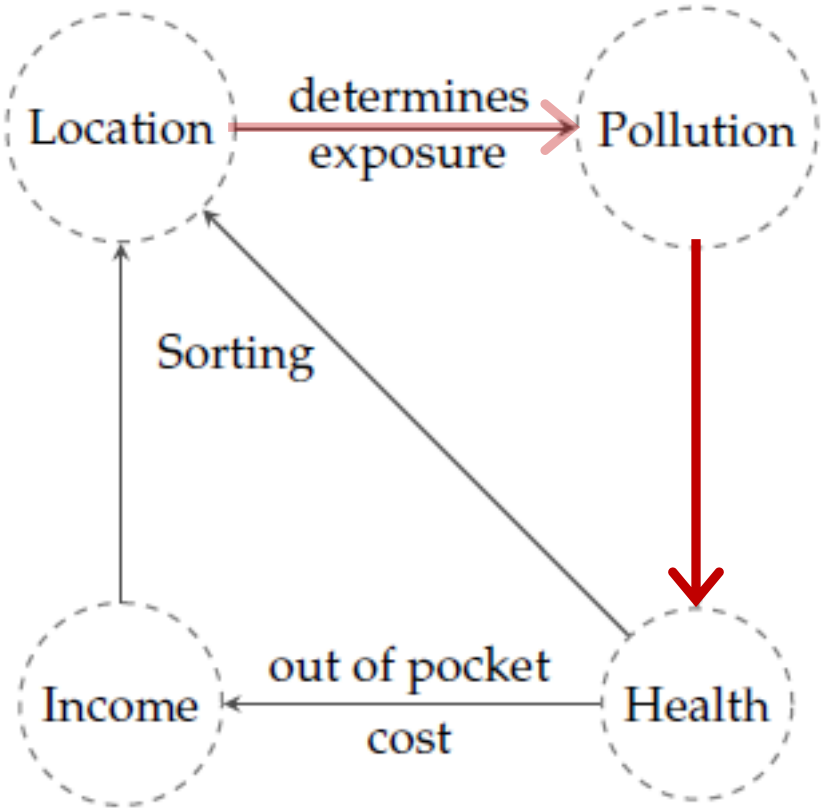

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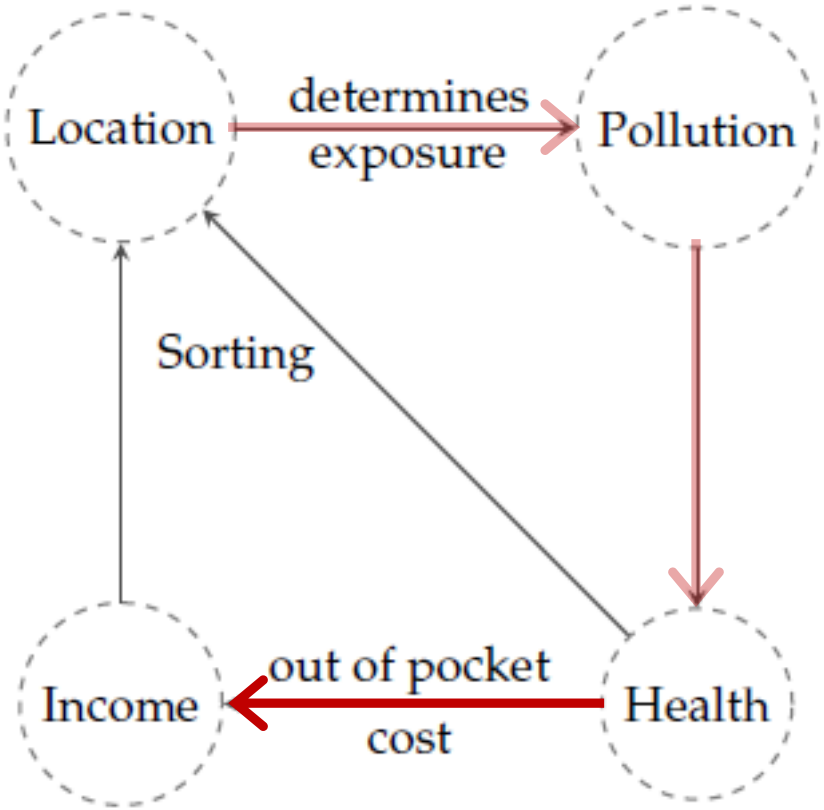

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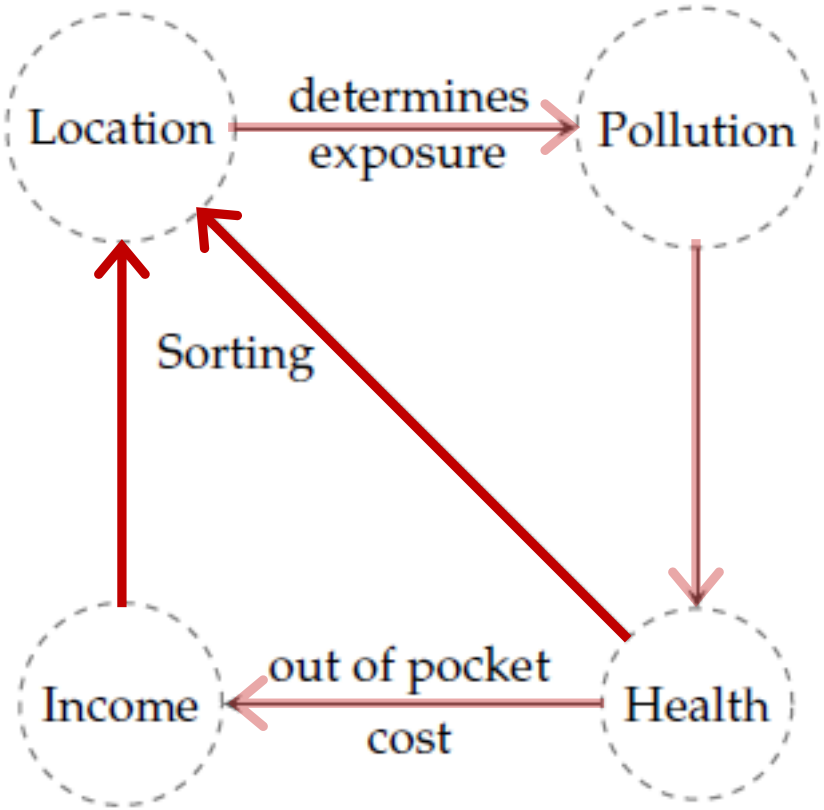

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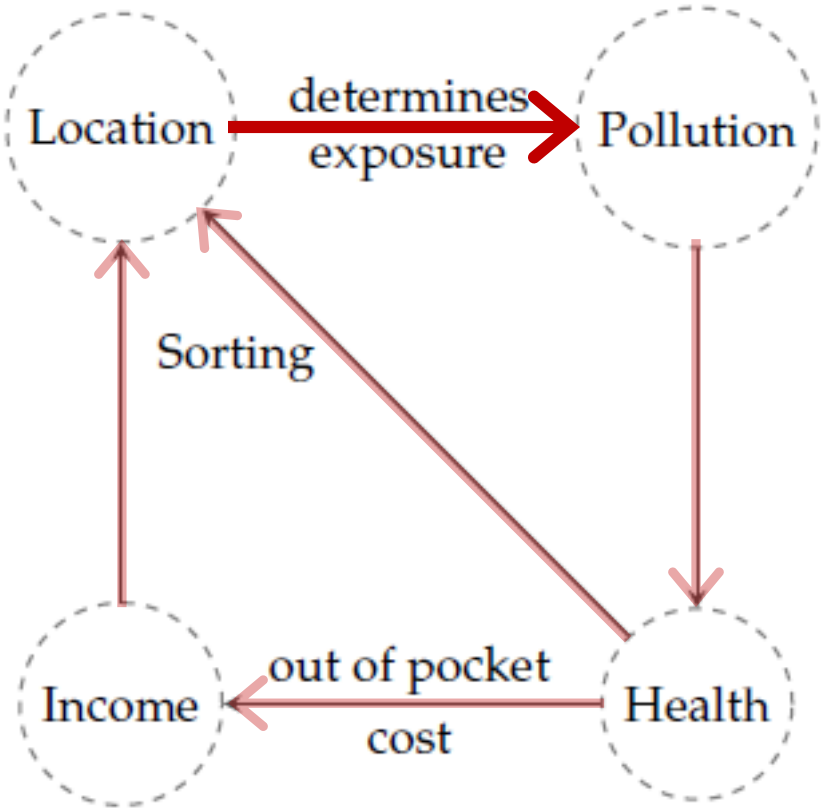

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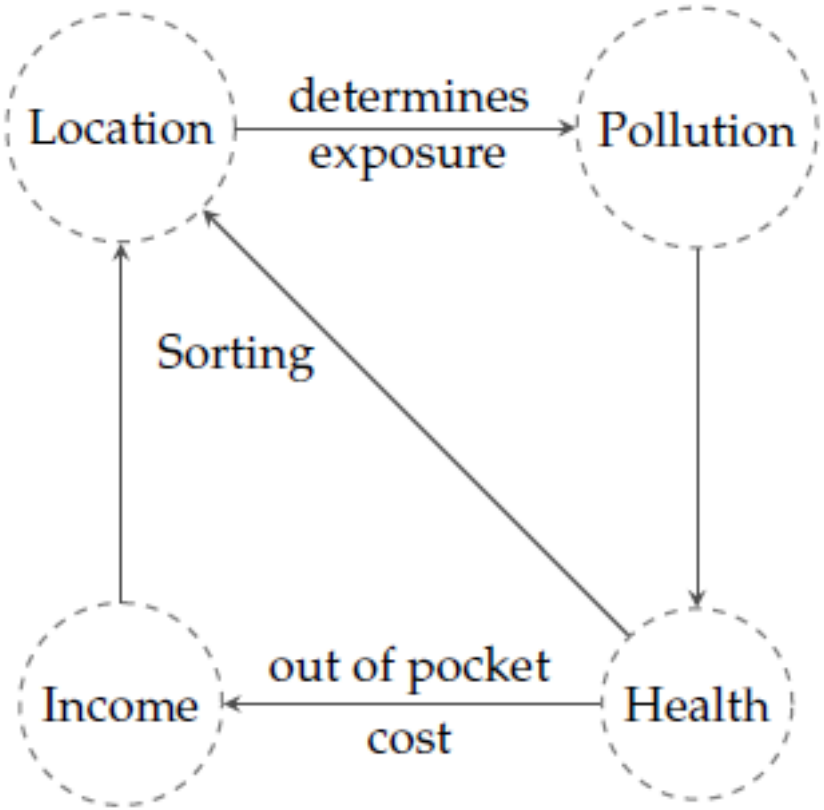

Studying Seniors is Important

- 20% of the U.S. population by 2030
- Annual taxpayer-financed Medicare spending >$600 billion
- Most vulnerable age group to pollution and heat stress

  e.g. U.S. EPA attributes 78% of all premature deaths avoided by air pollution regulations to people 65+

Connecting three literatures

1. Intergenerational poverty trap

   Becker and Tomes (JPE 1979), Loury (ECMA 1981), Benabou (EER 1994), Galor and Ziera (REStud 1993), Durlauf (JEG 1996), Azariadis and Stachurski (HEG 2005), Durlauf and Seshadri (NBER 2018), Chetty et al. (QJE 2018)

2. Residential sorting based on preferences and income

   Tiebout (JPE 1956), Epple and Platt (JUE 1998), Epple and Sieg (JPE 1999), Sieg et al. (IER 2004), Smith et al. (JEEM 2004), Banzhaf and Walsh (AER 2007), Bayer, Keohane and Timmins (JEEM 2009), Kuminoff (JEEM 2009), Kuminoff, Smith and Timmins (JEL 2013), Hamilton and Phaneuf (JEEM 2015), Depro, Timmins and O'Neil (JAERE 2015)

3. Health impacts of local pollution, climate, and health care

   Pope et al. (JAMA 2002), Graff-Zivin and Neidell (JEL 2013), Underwood (Science 2017), Bishop, Ketcham and Kuminoff (NBER 2018), Deryugina and Molitor (NBER 2018), Zhang et al. (PNAS 2018), Finkelstein, Gentzkow and Williams (2019)

This Research

We develop a conceptual model of residential sorting, pollution exposure and health and use it to define mechanisms that could generate an illness-poverty-amenity trap. Then we test for the presence of those mechanisms using Medicare administrative records on more than 7 million U.S. seniors from 2001-2013, finding evidence of an IPA trap.

Preferences and health

Utility for retiree *i* at age *t* in location *j*: $U_{ijt} = u(b, q, g_{jt}; h_{it})$, where

b = numeraire private good

q = housing quantity

g_{jt} = local amenities (e.g. air pollution, climate, health care quality)

h_{it} = stock of health

Evolution of the health stock: $h_{it+1} = f(h_{it}, g_{jt}, m_{it}, t, \varepsilon_{it})$, where

m_{it} = medical expenditures

ε_{it} = idiosyncratic health shock

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h_{it} = stock of health

Budget constraint: $y_i - m(h_{it}) = \hat{y}_i = b - p_j q$

y_i = permanent income (e.g. pension, social security)

$m(h_{it})$ = medical expenditures determined by health

$p_j q$ = housing expenditures at the local price (p_j)

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Repeated Static Optimization Problem

$$\max_{j,b,q} U\left(b, q, g_{jt}; h_{it}\right)$$

Budget constraint: $y_i - m(h_{it}) = \hat{y}_i = b - p_j q$

Evolution of the health stock: $h_{it} = f\left(h_{it-1}, g_{jt-1}, m_{it-1}, t-1, \varepsilon_{it-1}\right)$

Note: we follow the vast majority of residential sorting literature in abstracting from forward-looking behavior; e.g. w.r.t. health.

Indirect utility & single-crossing

Indirect utility: $V(g, p, \hat{y}, h) = U[y - p \cdot q(g, p, \hat{y}, h), q(g, p, \hat{y}, h), g, h]$

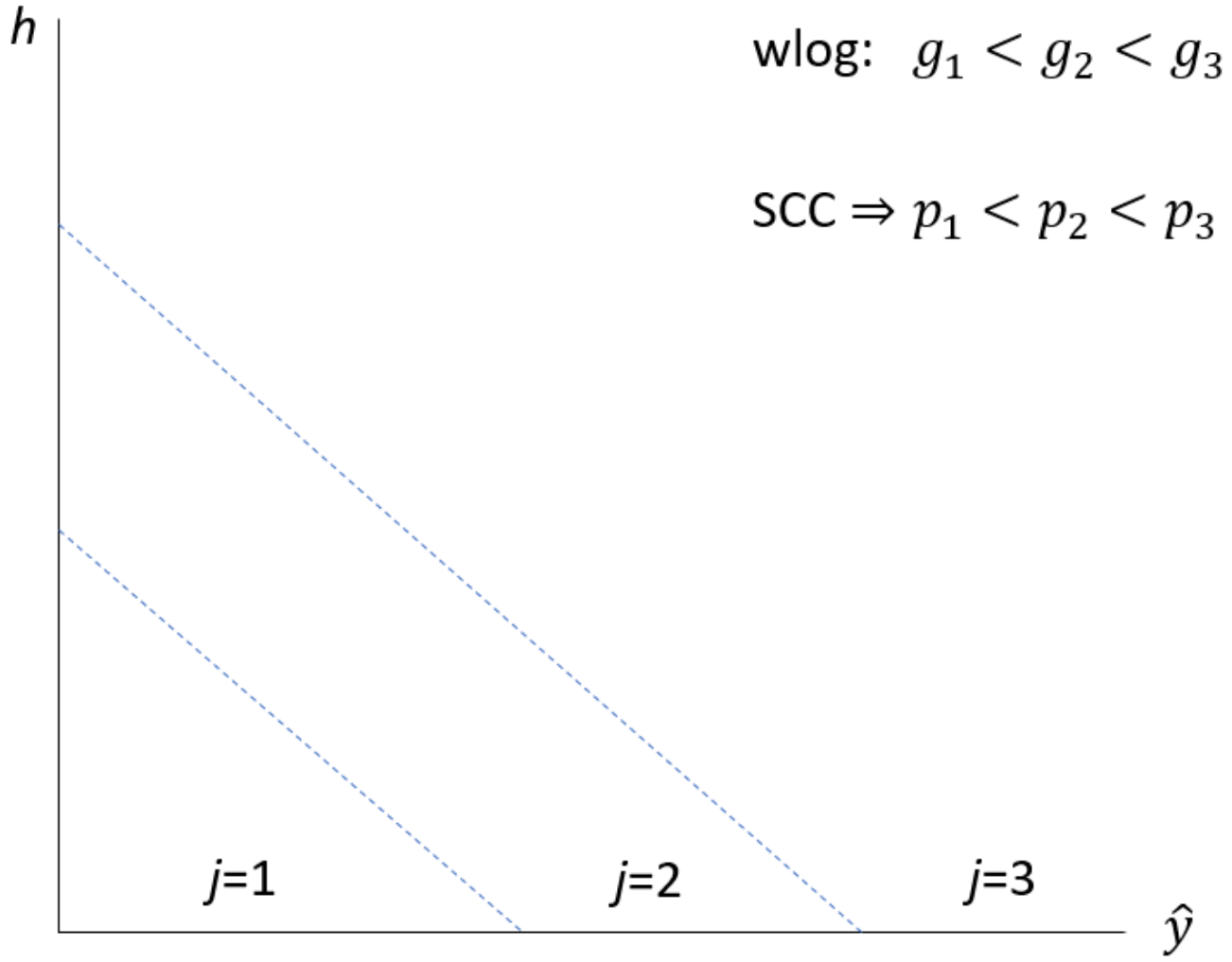
Indirect indifference curve: $M(g, p, \hat{y}, h) = -\dfrac{\partial V(g, p, \hat{y}, h)/\partial g}{\partial V(g, p, \hat{y}, h)/\partial p}$

Single crossing condition: $M(\cdot)$ is strictly increasing in $(\hat{y}|h)$ and $(h|\hat{y})$

$\Rightarrow$ Sorting equilibrium will reflect "stratification" by income and health with "ascending bundles" in price-amenity space.

Proof: Epple and Sieg (JPE 1999)

Stratification by health and income



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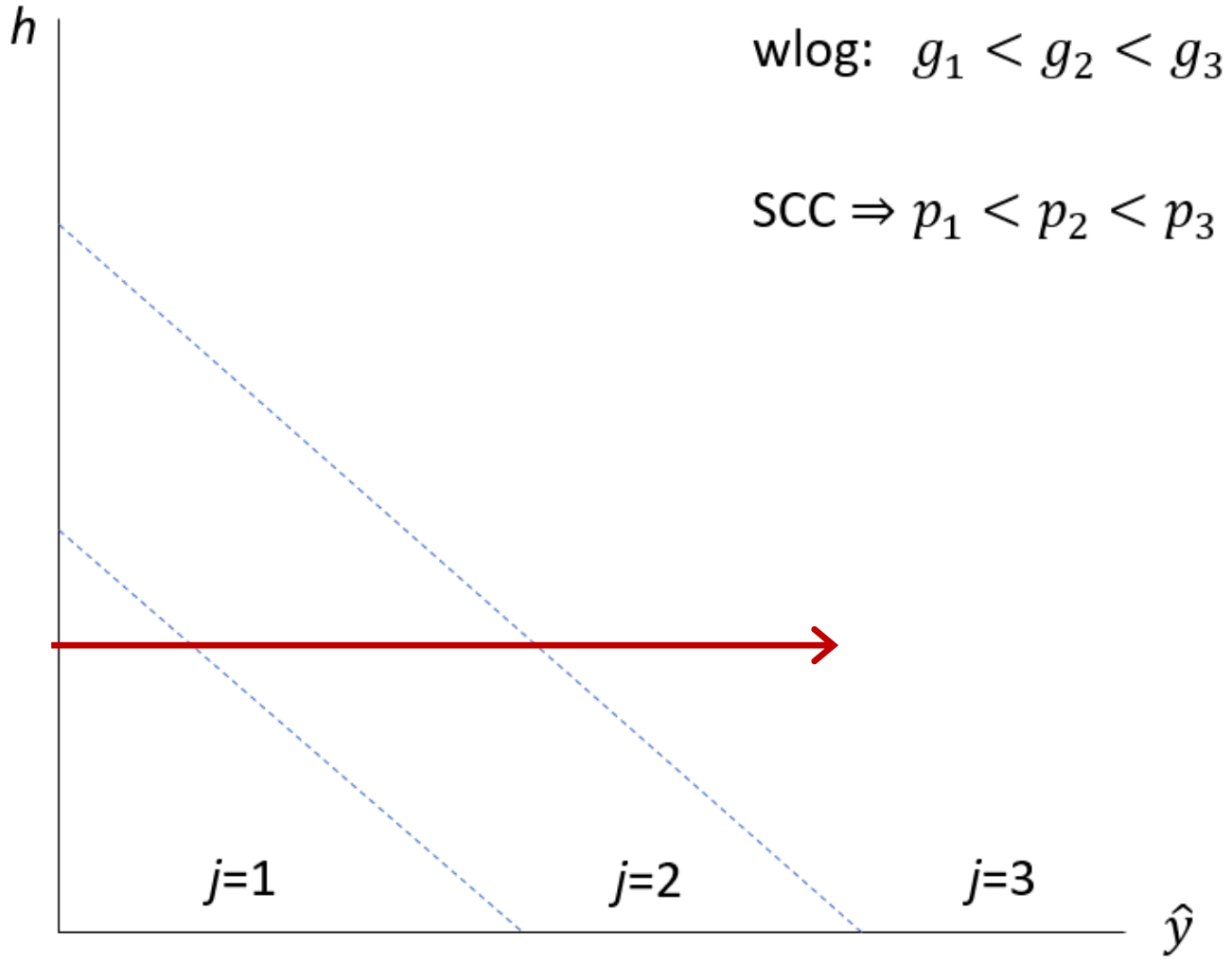

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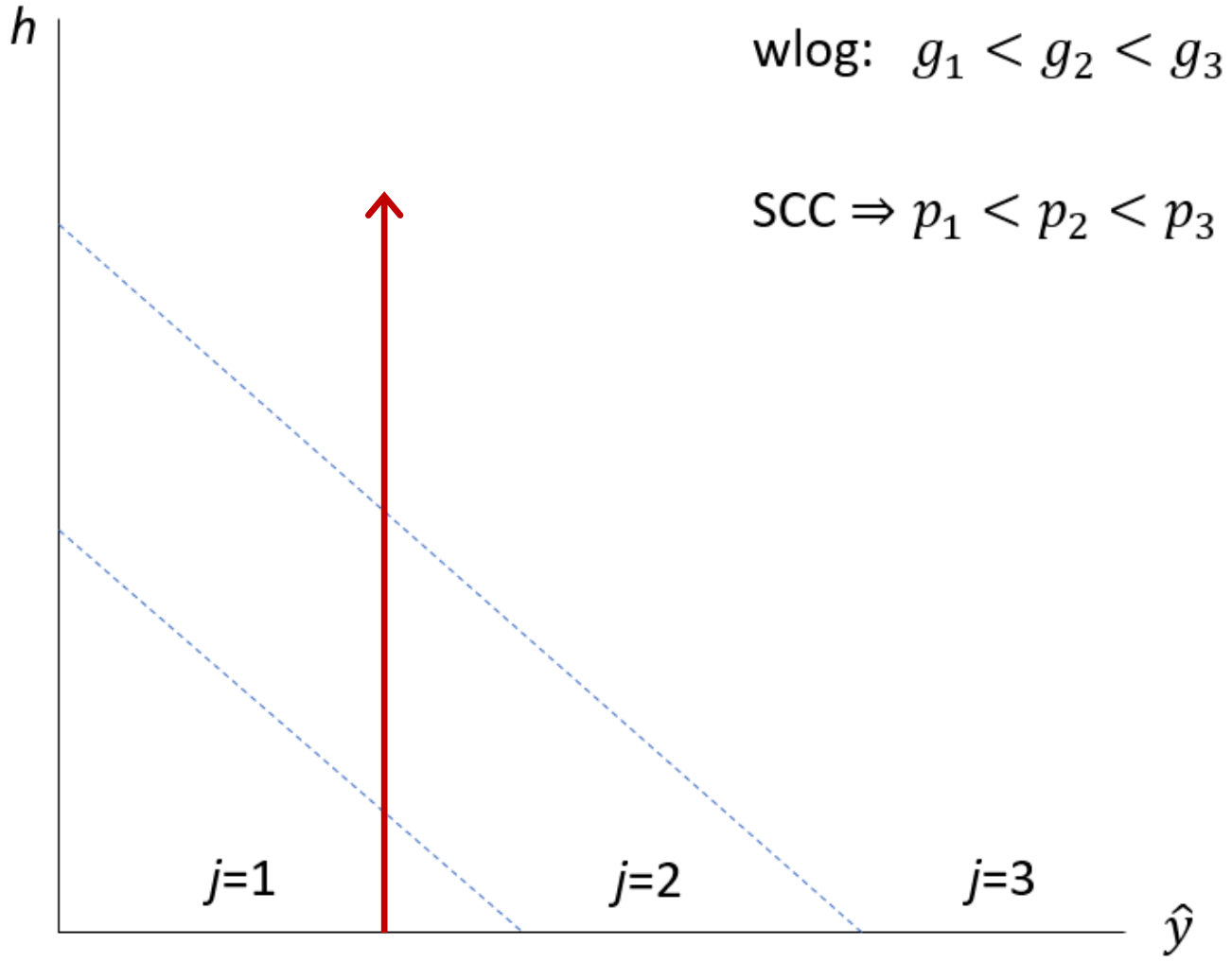
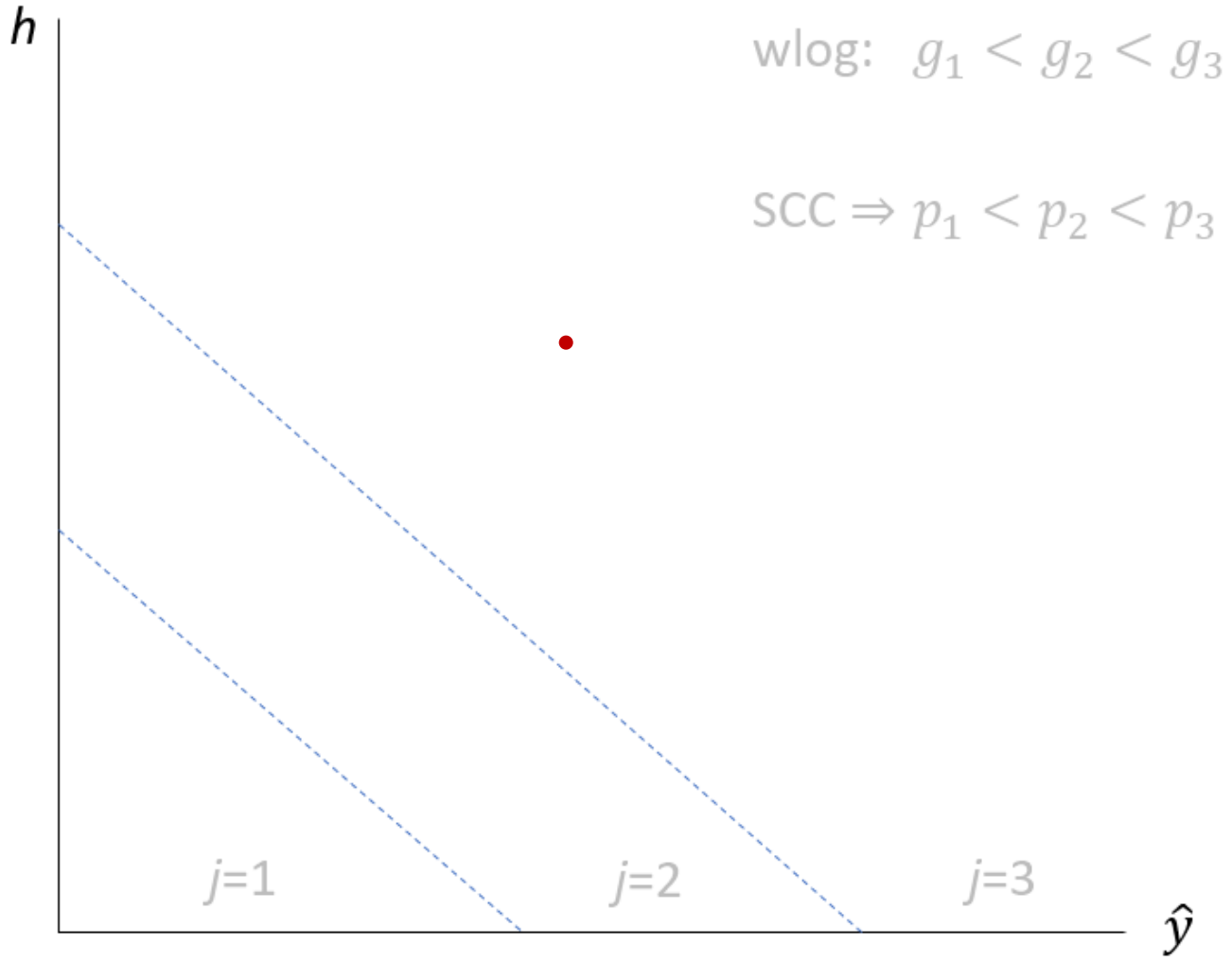


Health dynamics and the IPA trap



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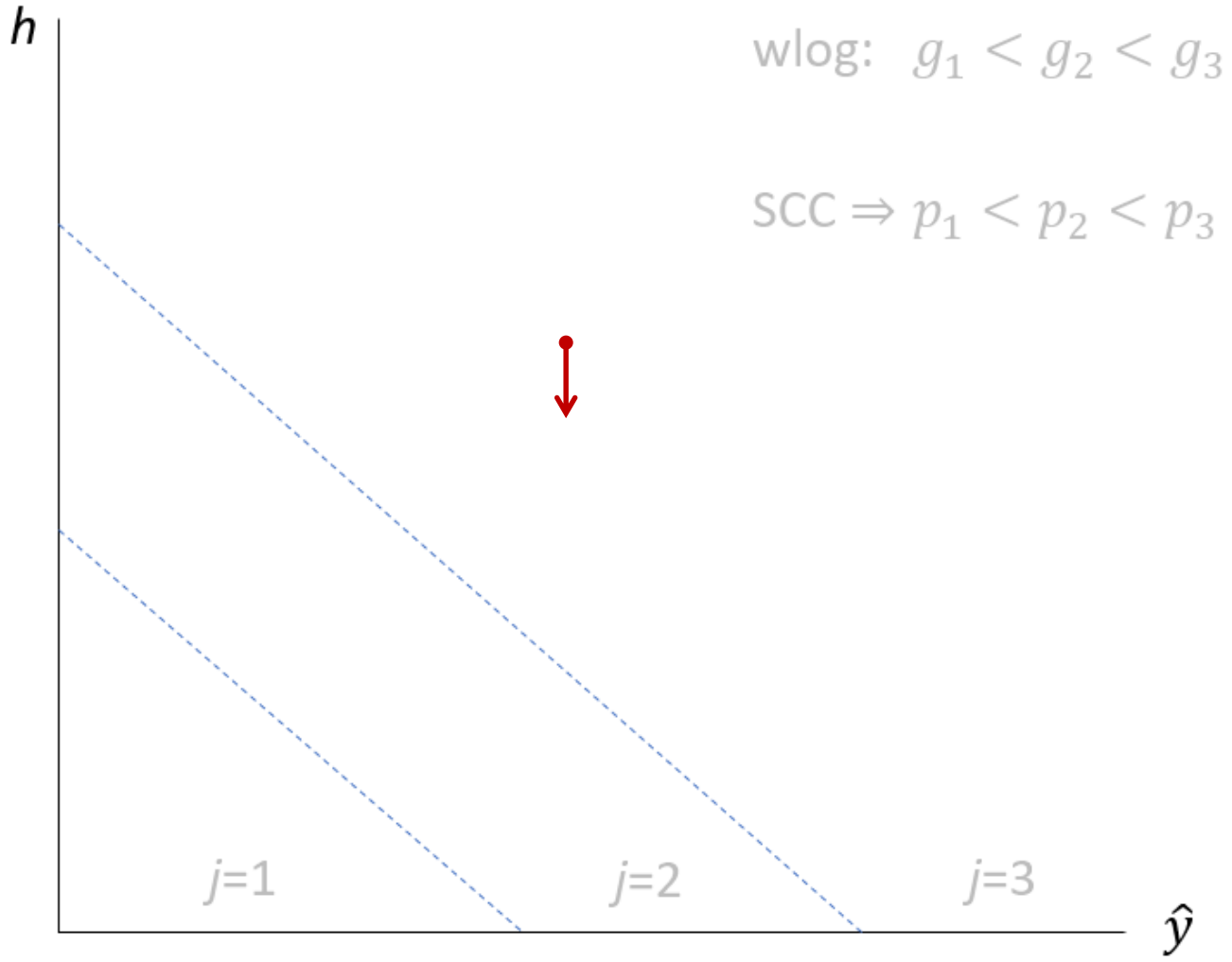

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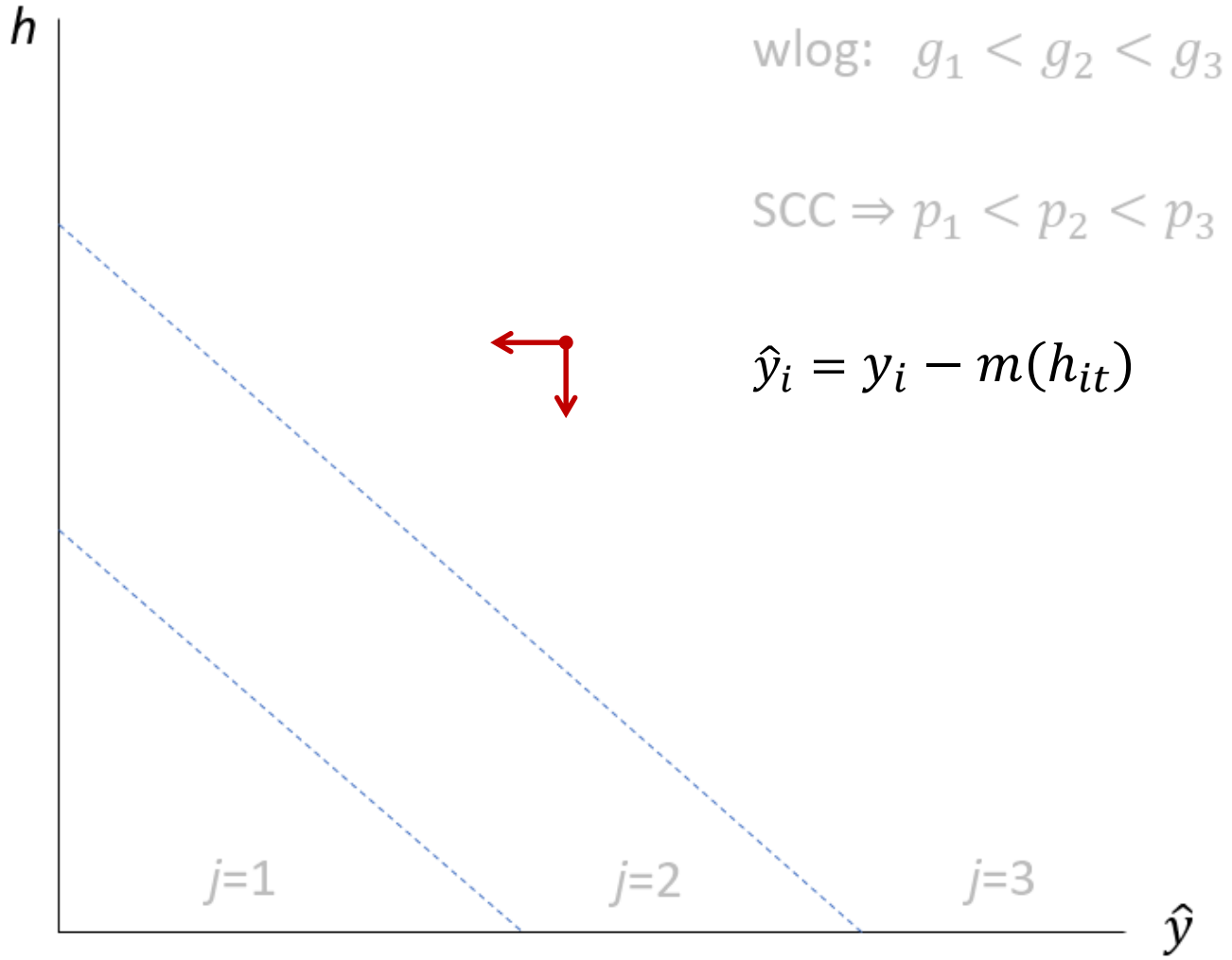

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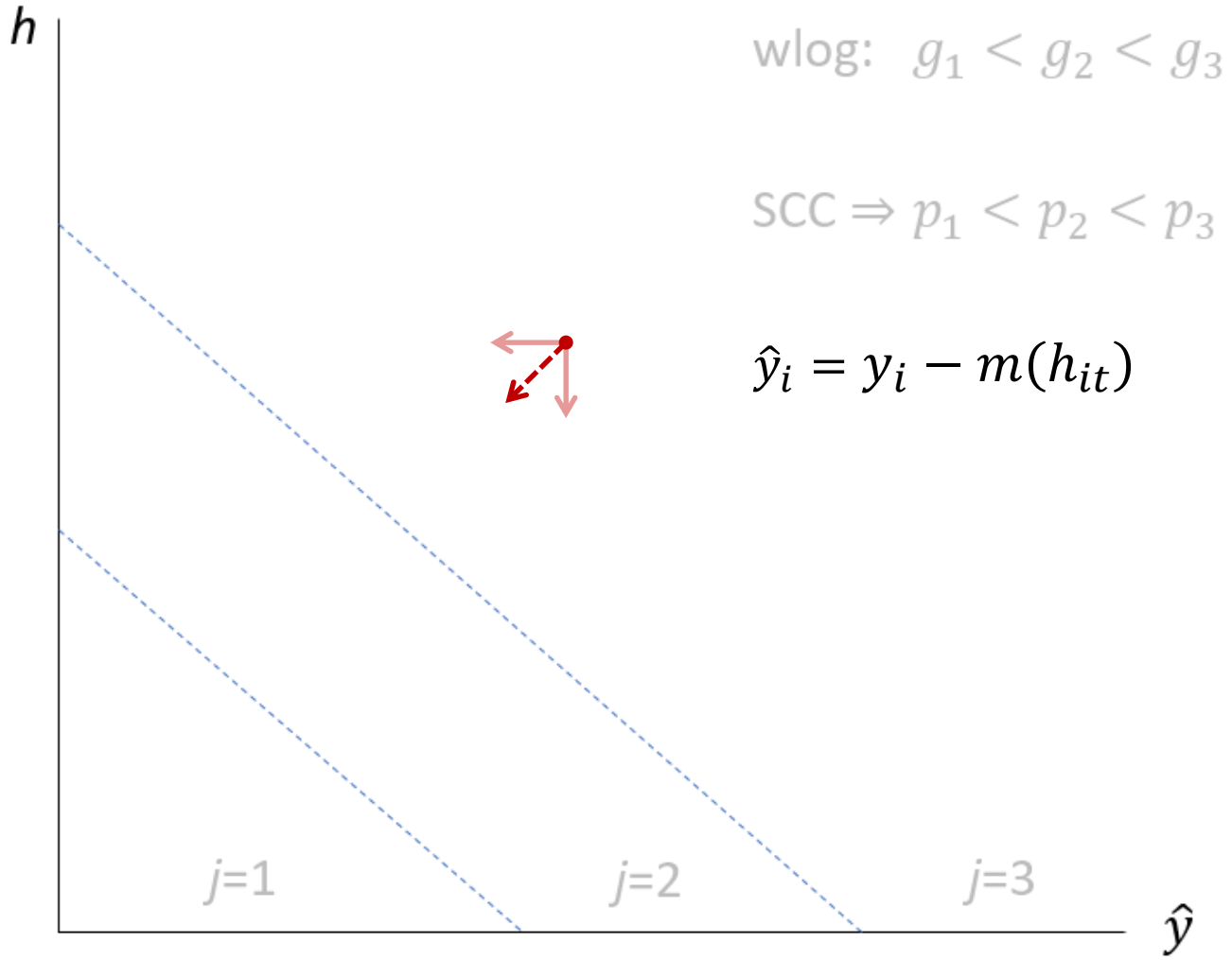

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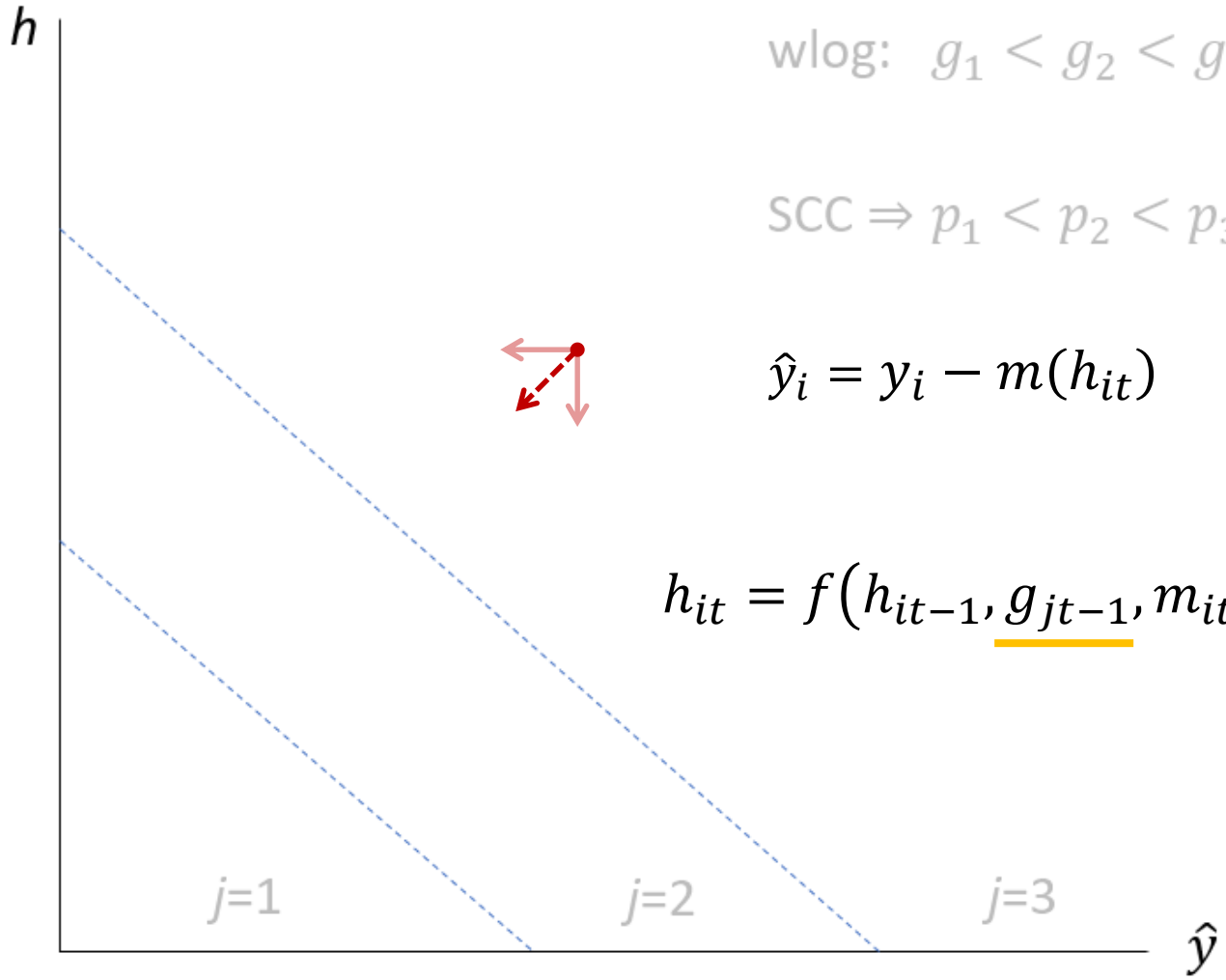

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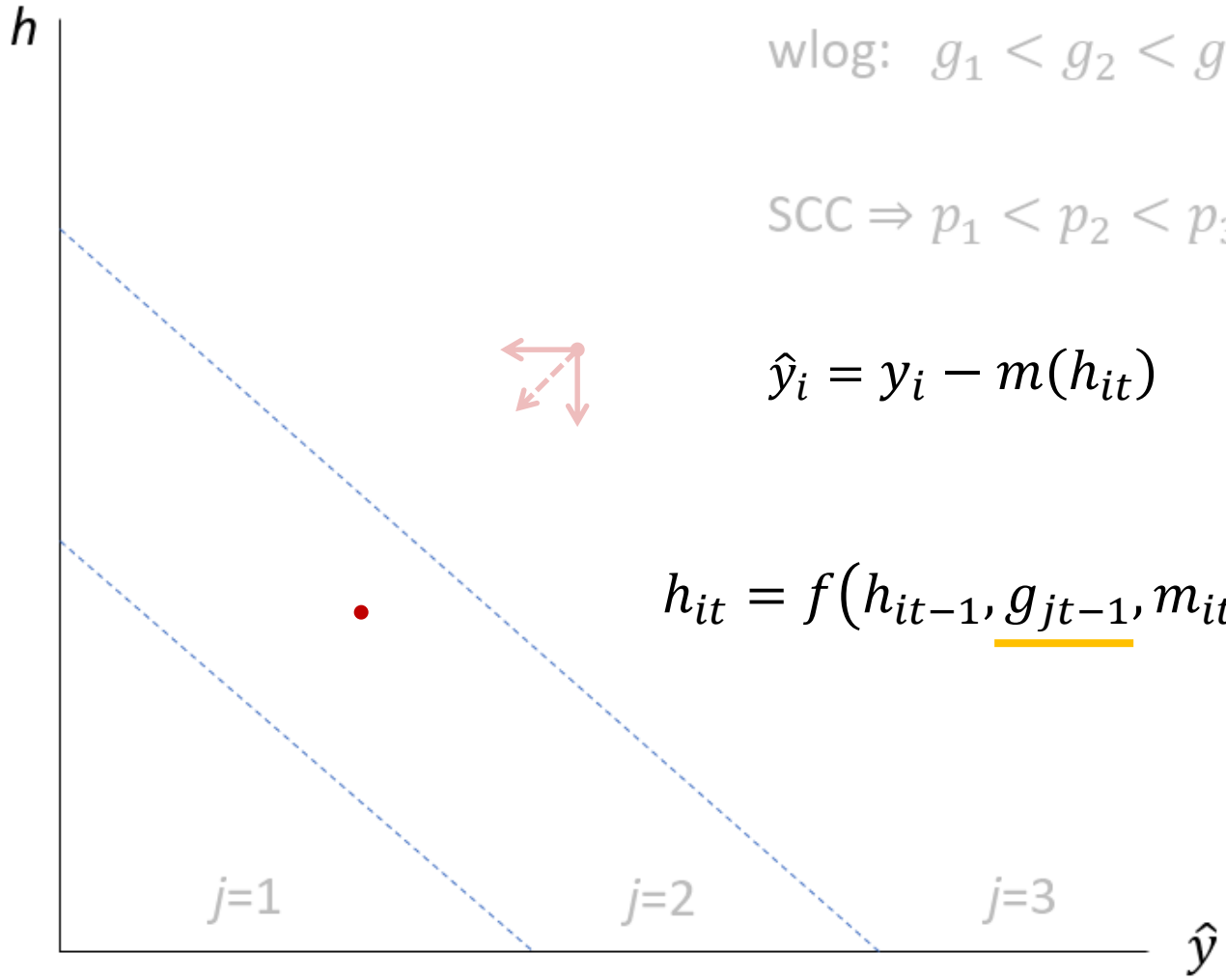

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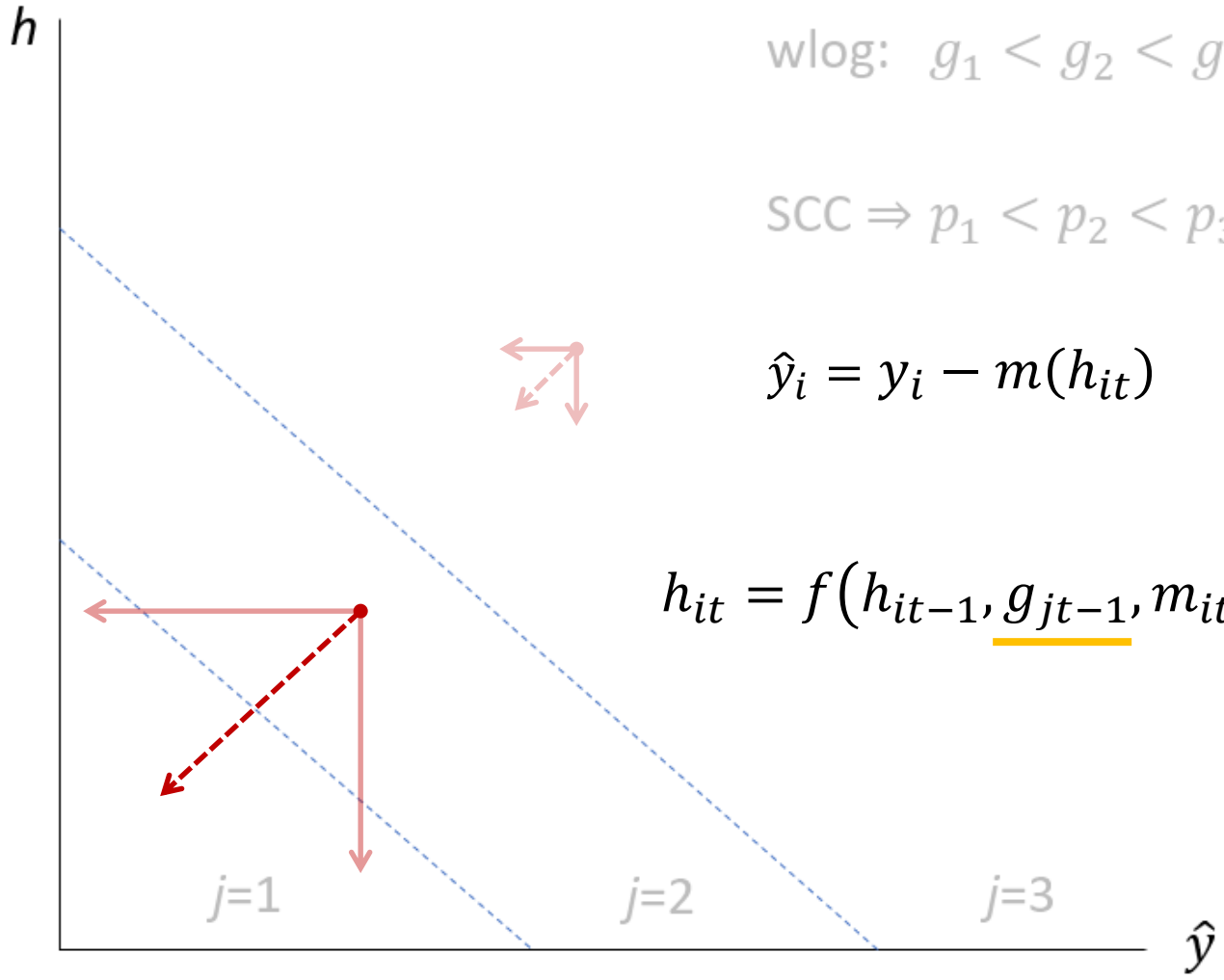

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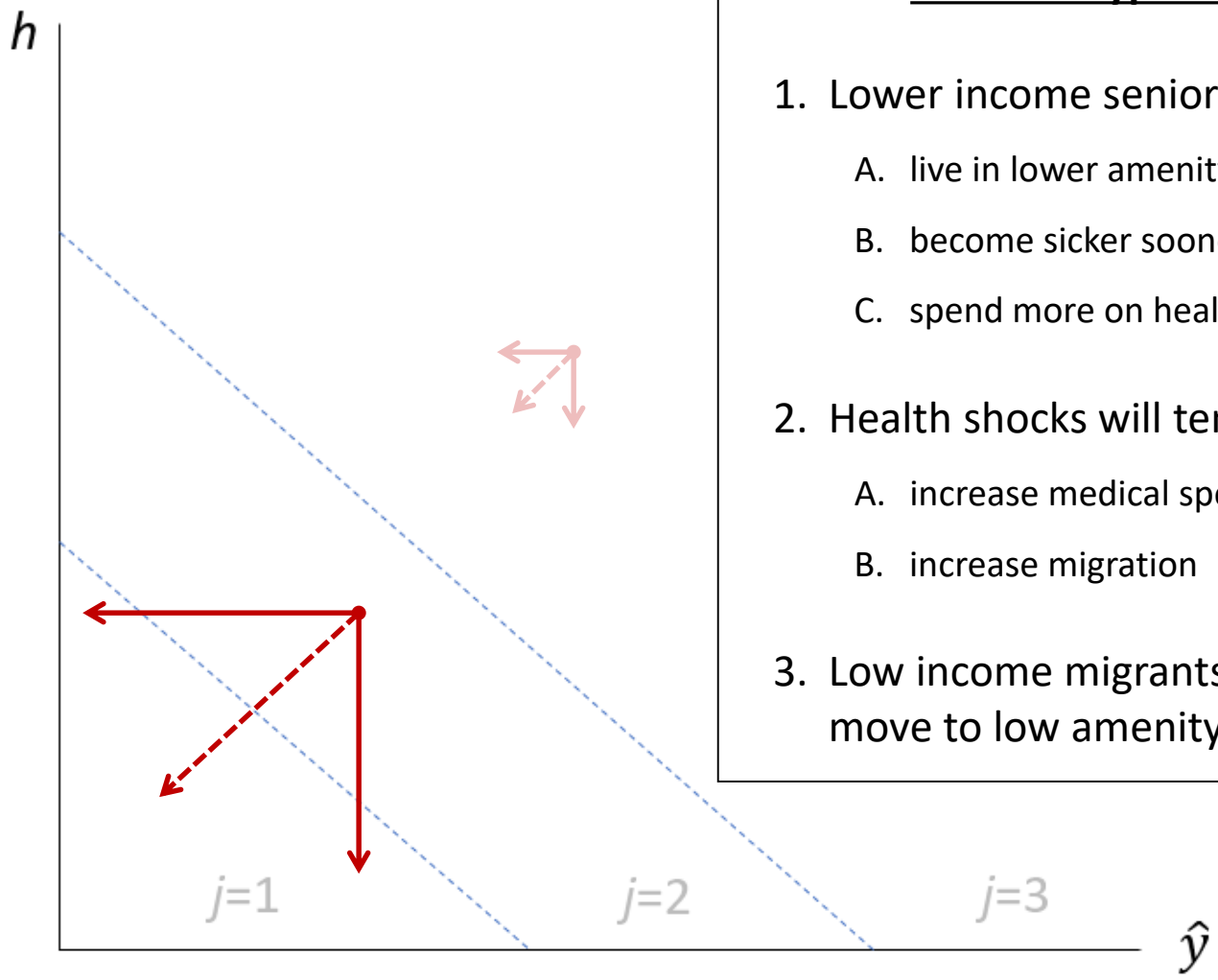


Testable Hypotheses

1. Lower income seniors will tend to:
   A. live in lower amenity areas
   B. become sicker sooner
   C. spend more on health care
2. Health shocks will tend to:
   A. increase medical spending
   B. increase migration
3. Low income migrants will tend to move to low amenity places

Data: Medicare administrative records

A random 10% sample of all Medicare A,B enrollees from 2001-2013 (over 7 million people over age 65)

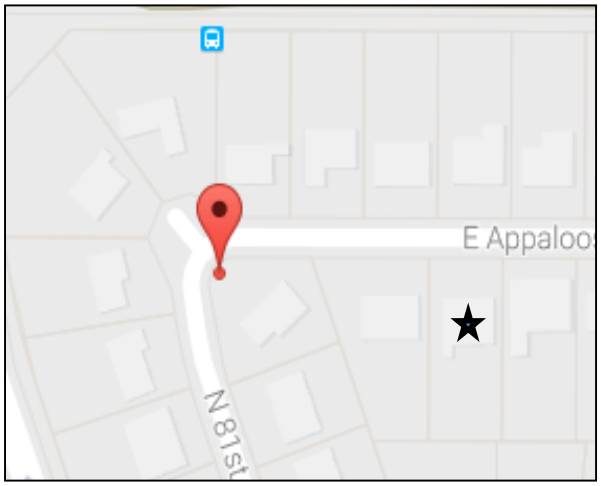
- Demographics: race, gender, birth date, death date, Medicare expenditures (gross and out-of-pocket [OOP]), Medicaid subsidy (2006-2013), state buy-in Medicaid proxy (2001-2013)

- First diagnosis of 30+ chronic medical conditions: acute myocardial infarction, anxiety, asthma, atrial fibrillation, bipolar disorder, breast cancer, cataract, chronic kidney disease, chronic obstructive pulmonary disease, colorectal cancer, congestive heart failure, dementia, depression, diabetes, endometrial cancer, fibromyalgia, glaucoma, hip fracture, hyperlipidemia, hypertension, hypothyroidism, ischemic heart disease, lung cancer, obesity, osteoporosis, peripheral vascular disease, prostate cancer, rheumatoid arthritis, schizophrenia, stroke

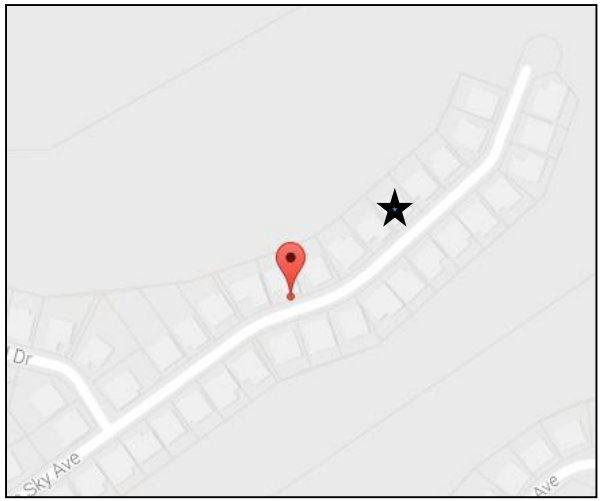
- Residential ZIP+4 codes: Census block group data on education, income, housing stock and neighborhood demographics

Residential locations defined by ZIP+4 centroids

- Over 35 million residential ZIP+4 codes in U.S., 1 for every 3.3 households
- Examples: apartment building floor, one side of one street on a city block



Ketcham



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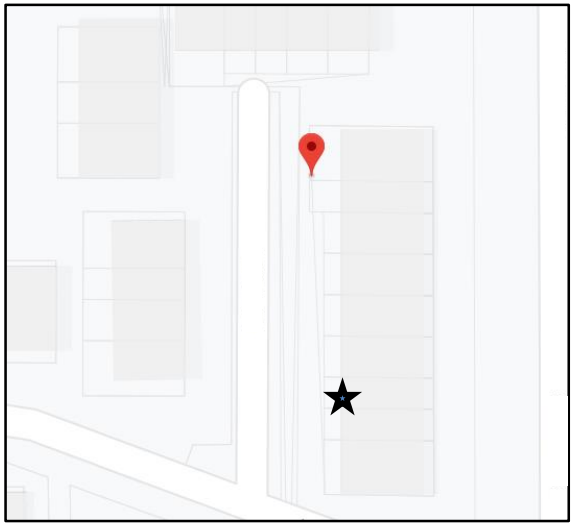
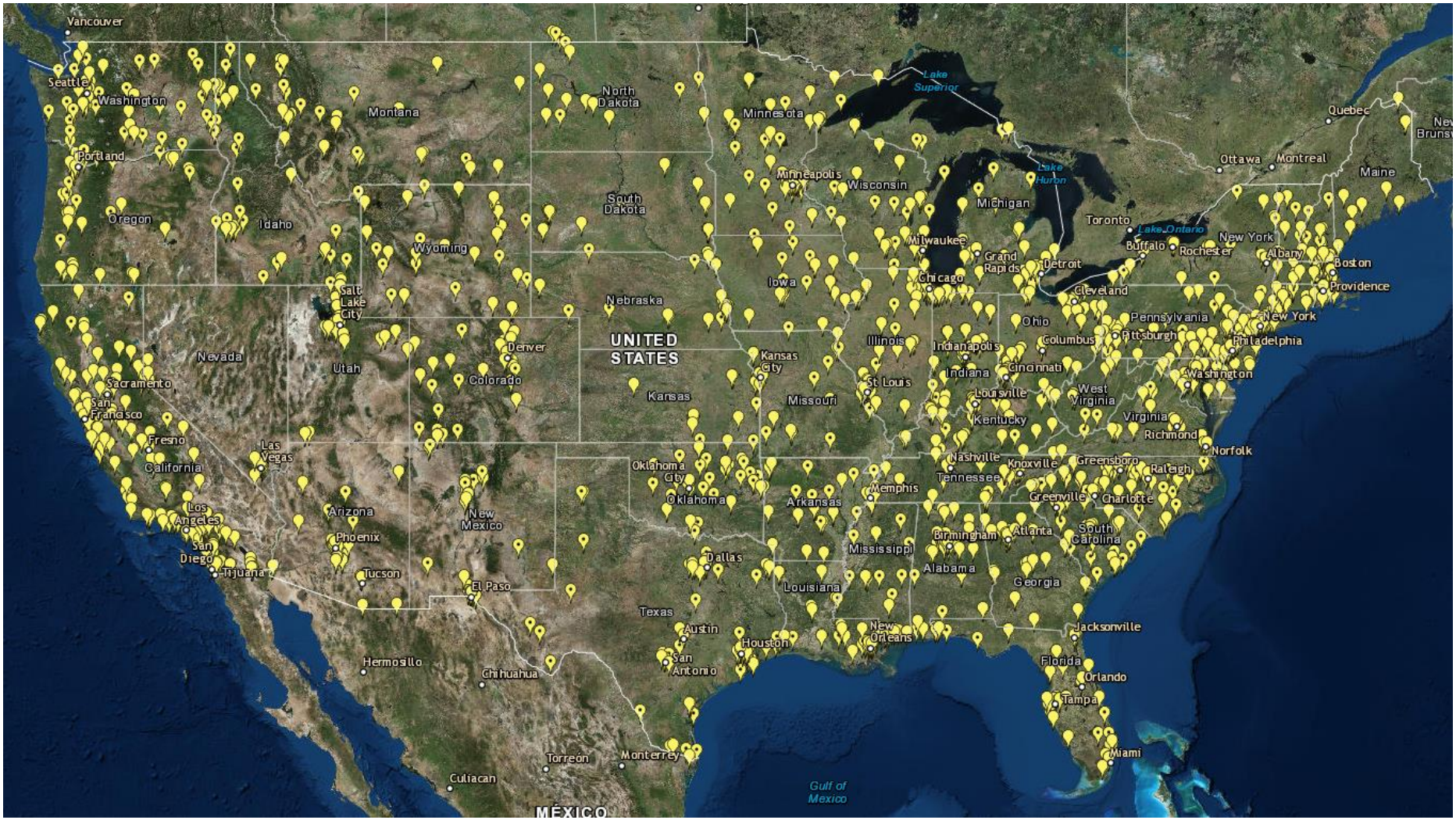
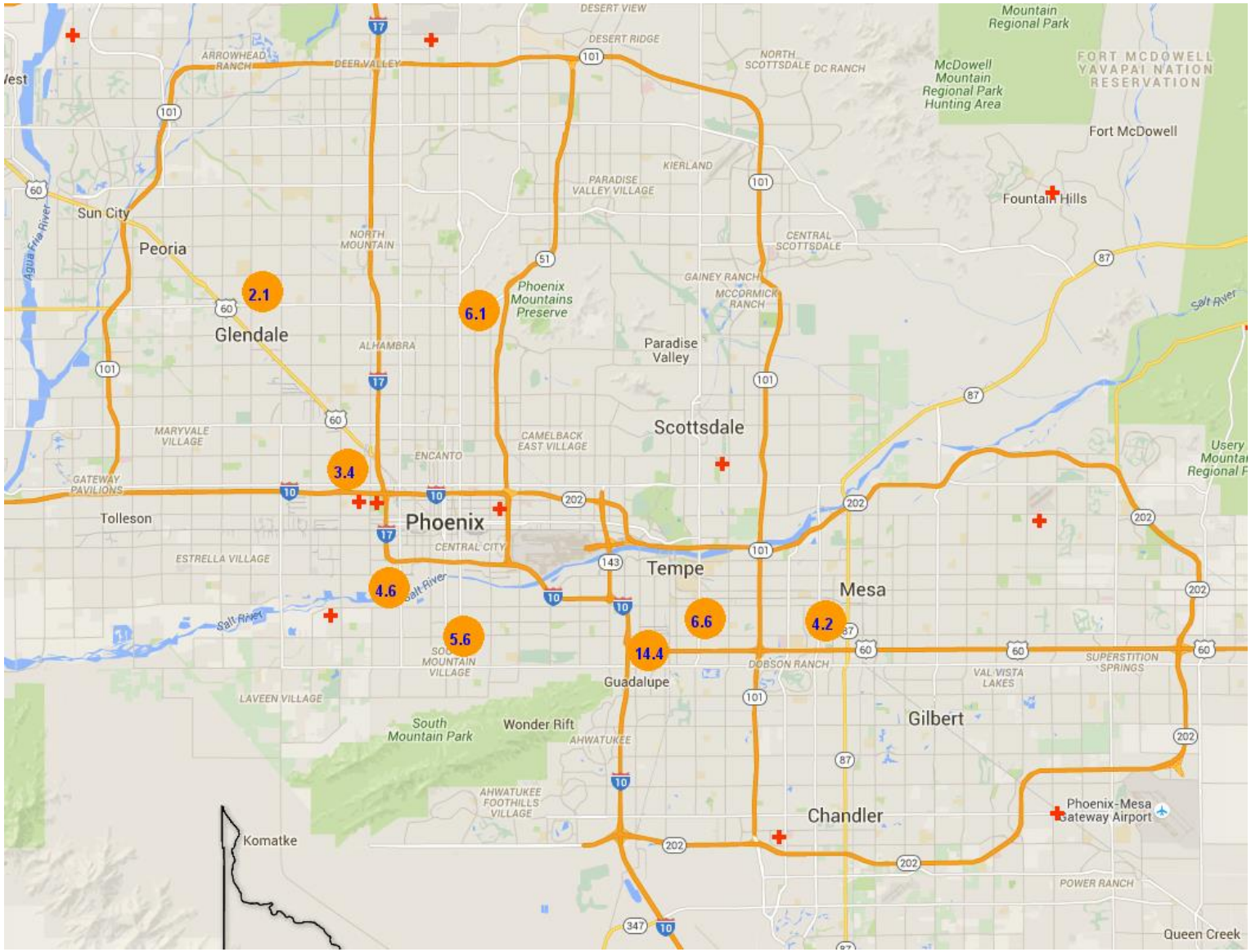


Mathes

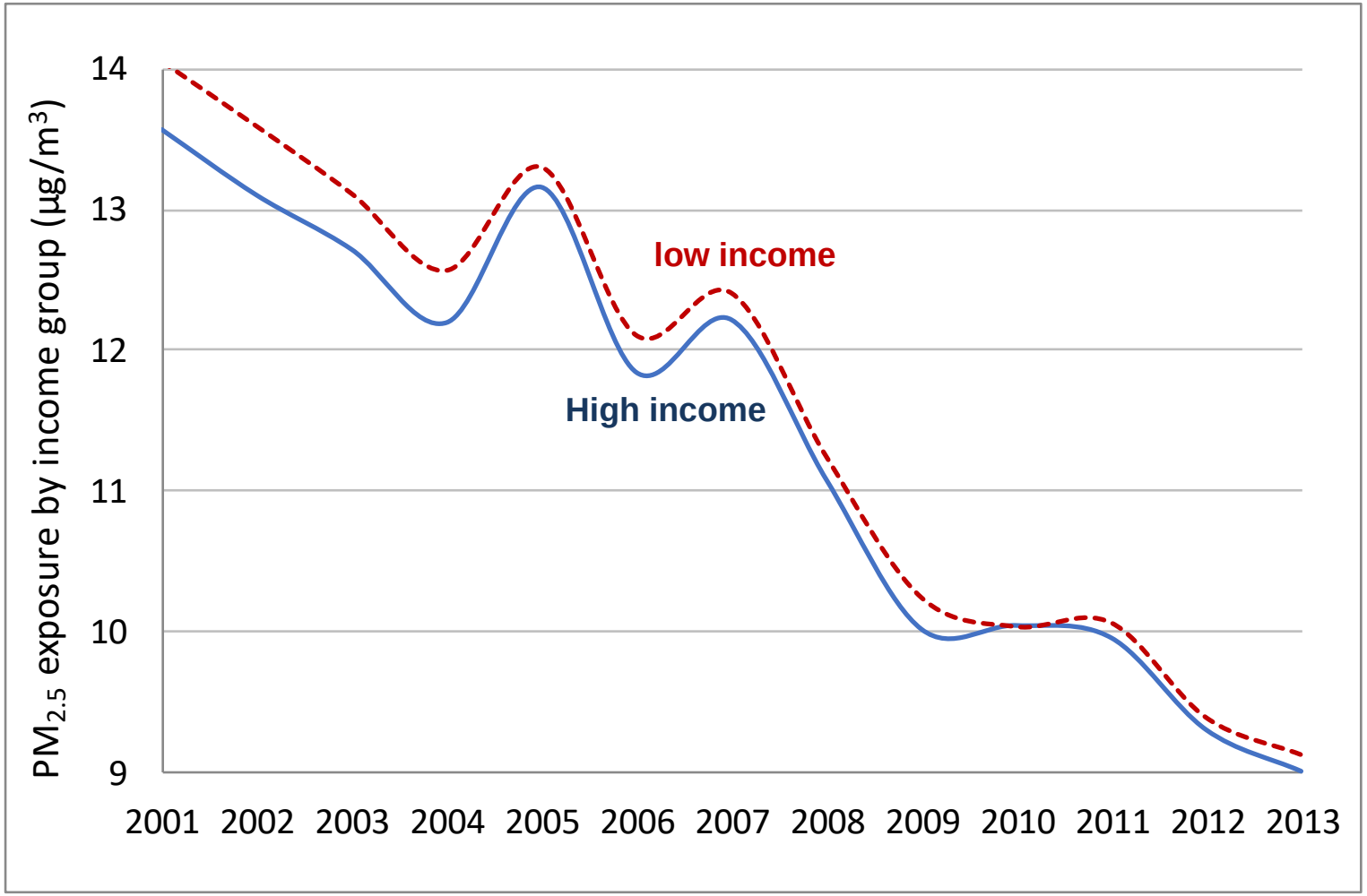
EPA's Air Quality Monitoring Network for $PM_{2.5}$



Inferring Exposures: ZIP+4 w/ Inverse Distance Weighting



H1.A: Low income seniors live in low amenity areas



- Low-income group has 5% higher exposure to $PM_{2.5}$ in 2001

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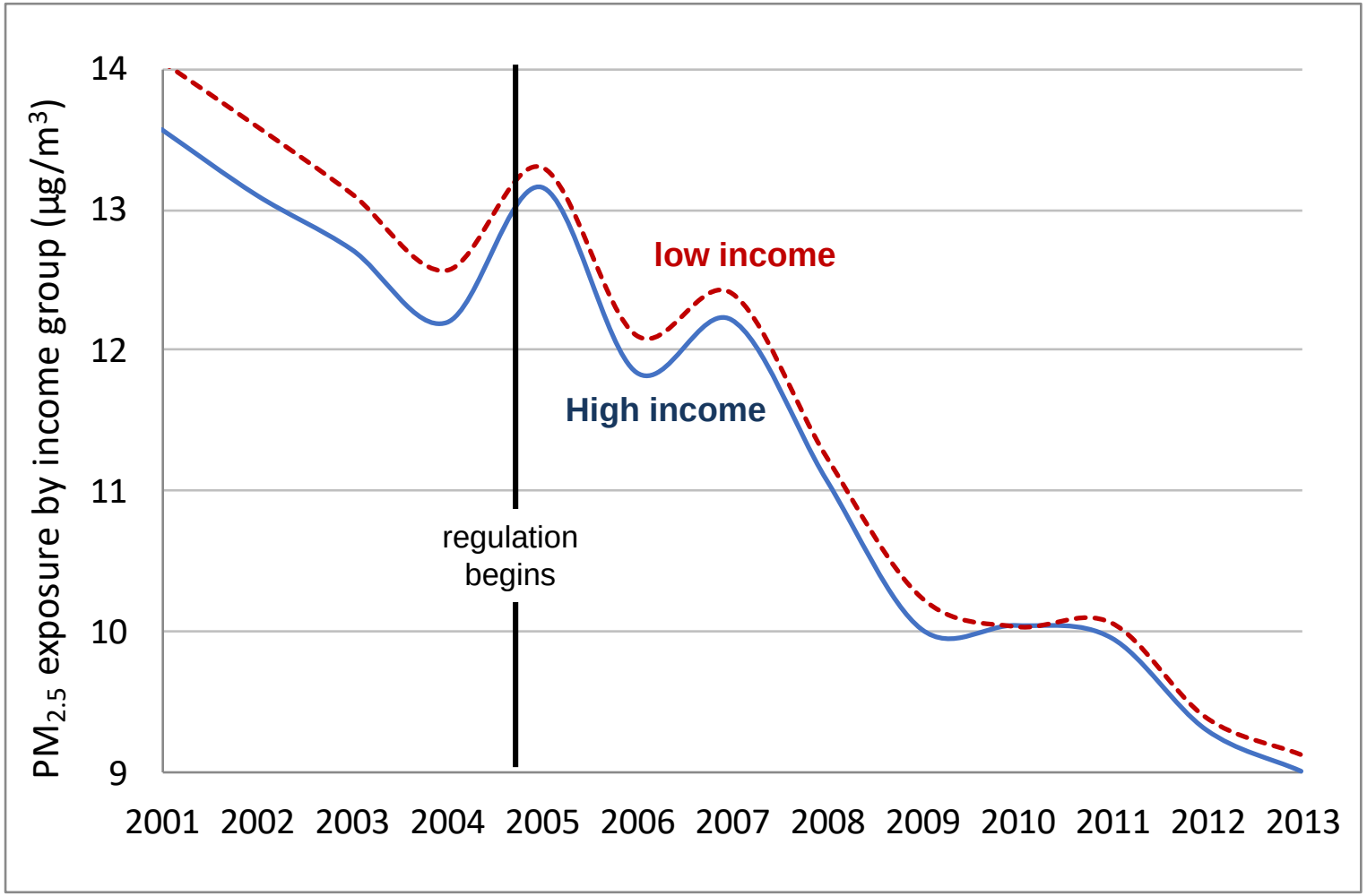


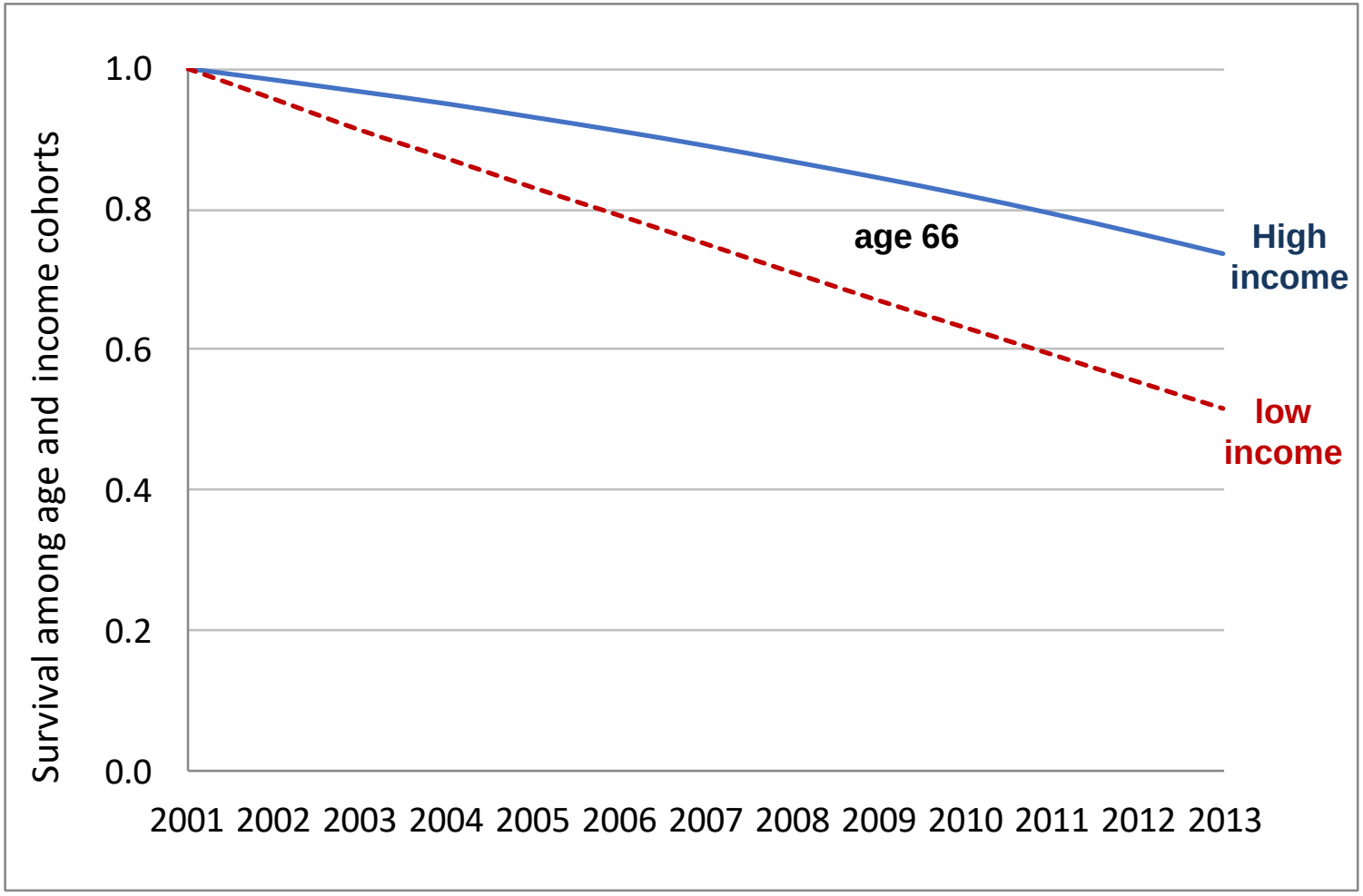
- $PM_{2.5}$ exposure gap narrowed after EPA strengthened regulations

Summary statistics

	Traditional Medicare (A,B)
number of individuals	7,356,473
mean age at entry	71
number of years in the sample	8
ever moved (%)	18
died before December 31, 2013	41

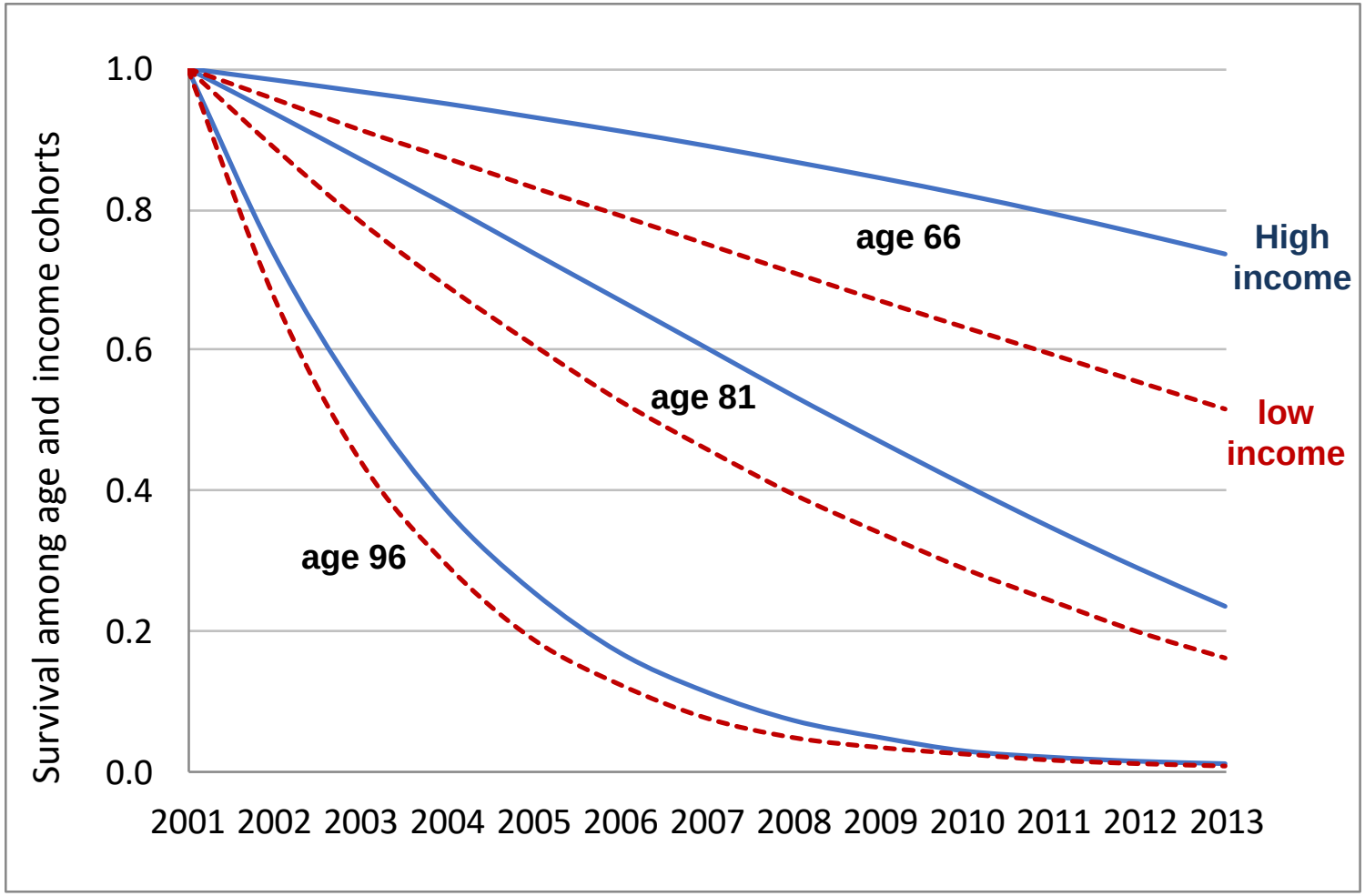
- 2010 Medicare spending per capita = $11,852
  - Taxpayer subsidy = $10,044
  - Out-of-pocket spending = $1,728
  - OOP spending is 7% of seniors' median income ($25,757)

H1.B: Low income seniors become sicker faster



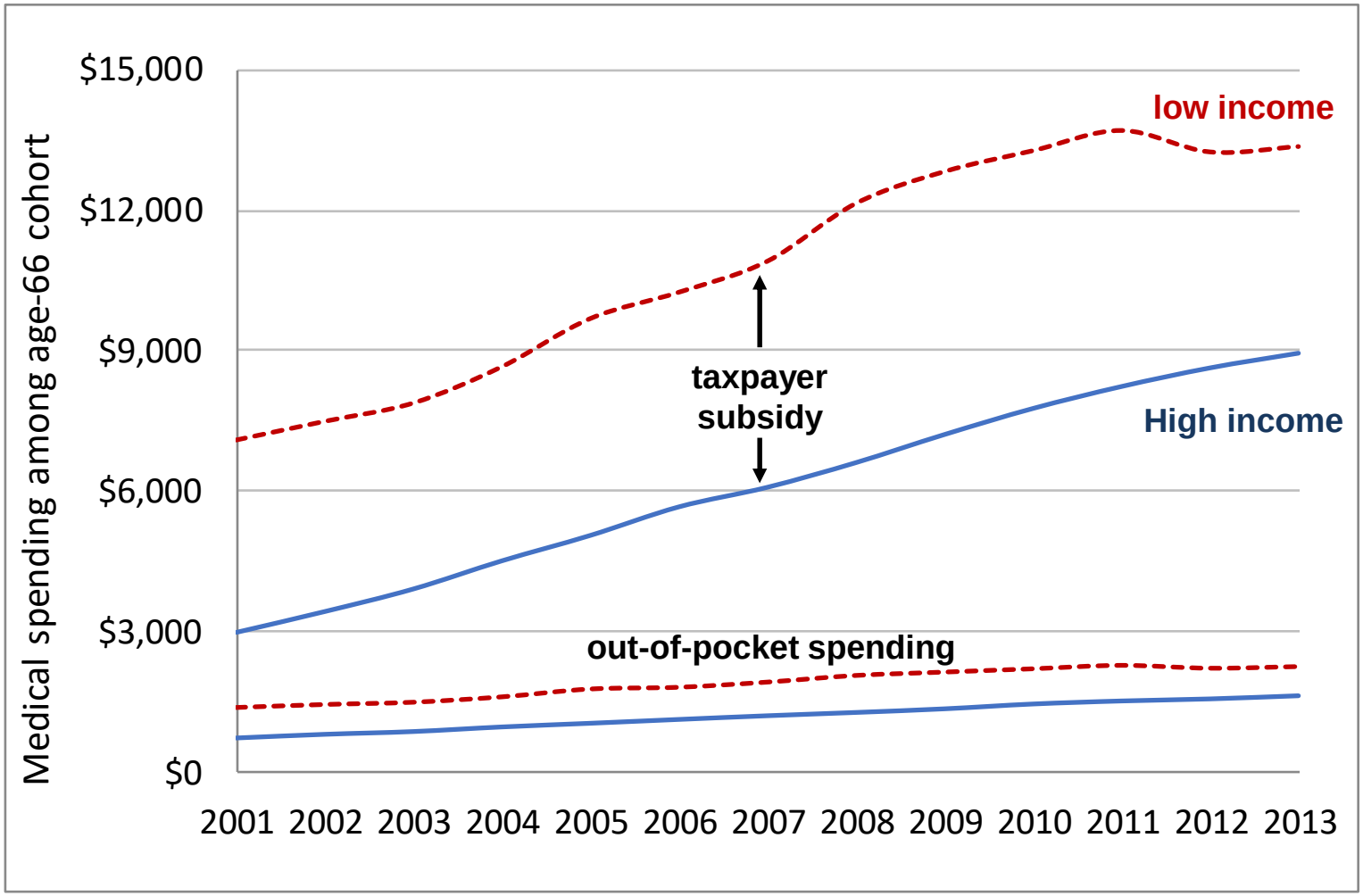
- Cohort of 269,056 people who were 66 years old in 2001 (10.6% low income)
- State buy-in used as a proxy for Medicaid status (corr > 0.9 after 2006)

H1.B: Low income seniors become sicker faster



- Low-income groups have higher mortality within every age cohort

H1.C: Low income seniors spend more on health care



- Annual average OOP differential ranges from $590 to $760

H2.A: Health shocks increase medical spending

$$\Delta m_{ijt} = \beta_t \Delta h_{ijt-1} + \gamma_t x_{ijt-1} + \omega_{jt-1} + \varepsilon_{ijt}, \quad \text{where}$$

Δm_{ijt}	=	annual change in out-of-pocket medical spending
Δh_{ijt-1}	=	new chronic condition diagnoses
x_{ijt-1}	=	integer age x gender dummies, race dummies
ω_{jt-1}	=	residential county in year *t-1*
ε_{ijt}	=	orthogonal error

- Regression coefficients and fixed effects evolve flexibly over time
- Identification comes from within-person health shocks.

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Δm_{ijt} = annual change in out-of-pocket medical spending

$\boldsymbol{\Delta h_{ijt-1}}$ = **new chronic condition diagnoses**

acute myocardial infarction
anxiety
asthma
atrial fibrillation
bipolar disorder
breast cancer
cataract
chronic kidney disease
chronic obstructive pulmonary disease
colorectal cancer
congestive heart failure
dementia
depression
diabetes
endometrial cancer
fibromyalgia
glaucoma
hip fracture
hyperlipidemia
hypertension
hypothyroidism
ischemic heart disease
lung cancer
obesity
osteoporosis
peripheral vascular disease
prostate cancer rheumatoid
arthritis schizophrenia
stroke

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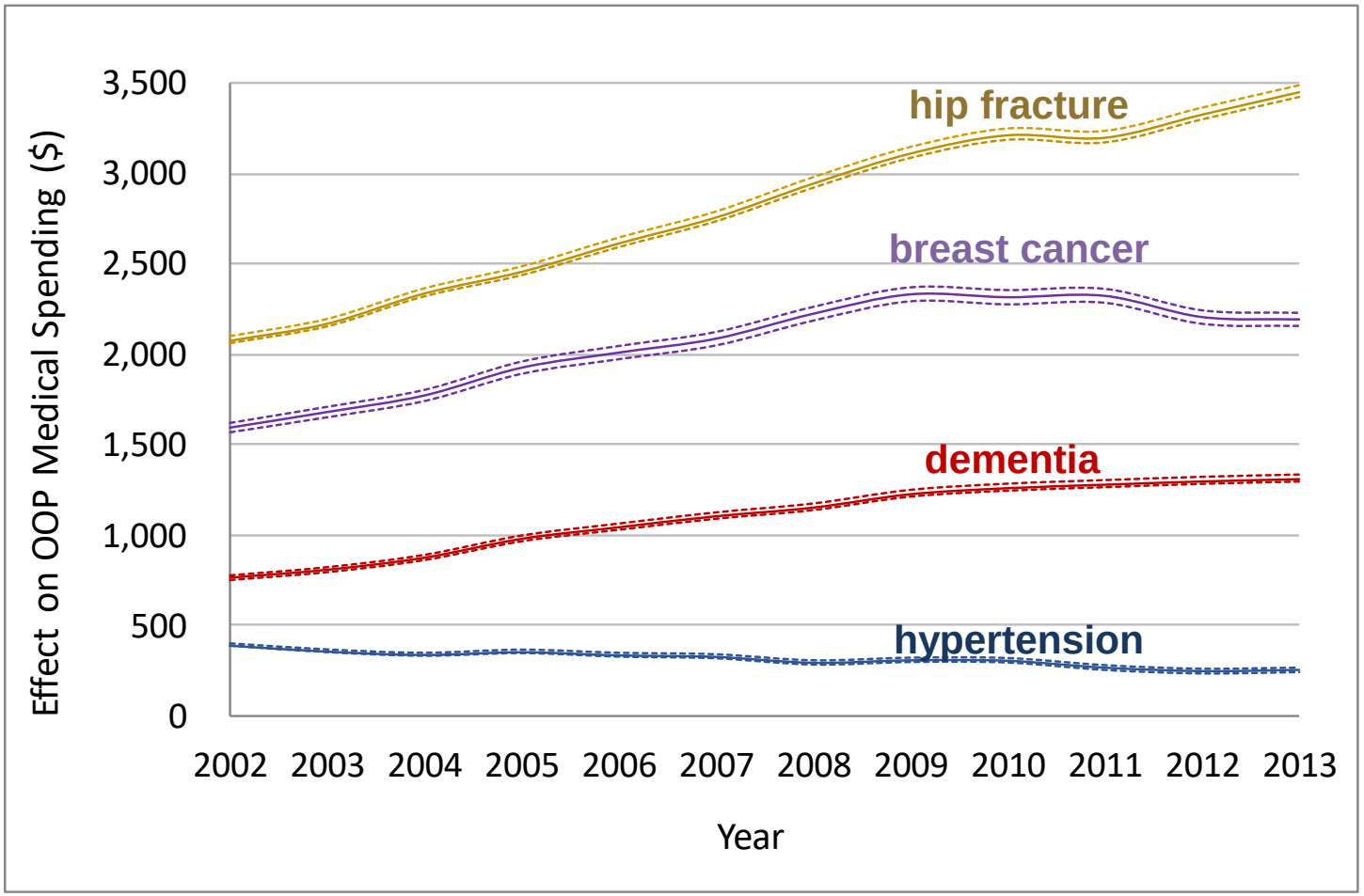

- Point estimates and 95% CI's from annual regressions of 3 to 4 million people
- In 2010, median income among people 65+ was $25,757

H2.A: Health shocks increase medical spending

- Large effects for cancer and diseases that impair mobility

Average effect on OOP spending from 2002 to 2013 ($)	
2,809	hip fracture
2,679	lung cancer
2,216	colorectal cancer
2,056	breast cancer
1,918	endometrial cancer
1,712	prostate cancer
1,279	stroke
1,250	heart attack
1,095	Alzheimer's disease and related dementias
731	ischemic heart disease

- Small effects for vision impairments (cataract, glaucoma), and conditions treated with generic drugs (hypertension, hyperlipidemia)

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H2.B: Health shocks increase migration

$$\{j \neq j-1\} = \beta_t \Delta h_{ijt-1} + \gamma_t x_{ijt-1} + \omega_{jt-1} + \varepsilon_{ijt}, \quad \text{where}$$

$\{j \neq j-1\}$= 1 *iff* person *i* moved in year *t*

Δh_{ijt-1} = new chronic condition diagnoses

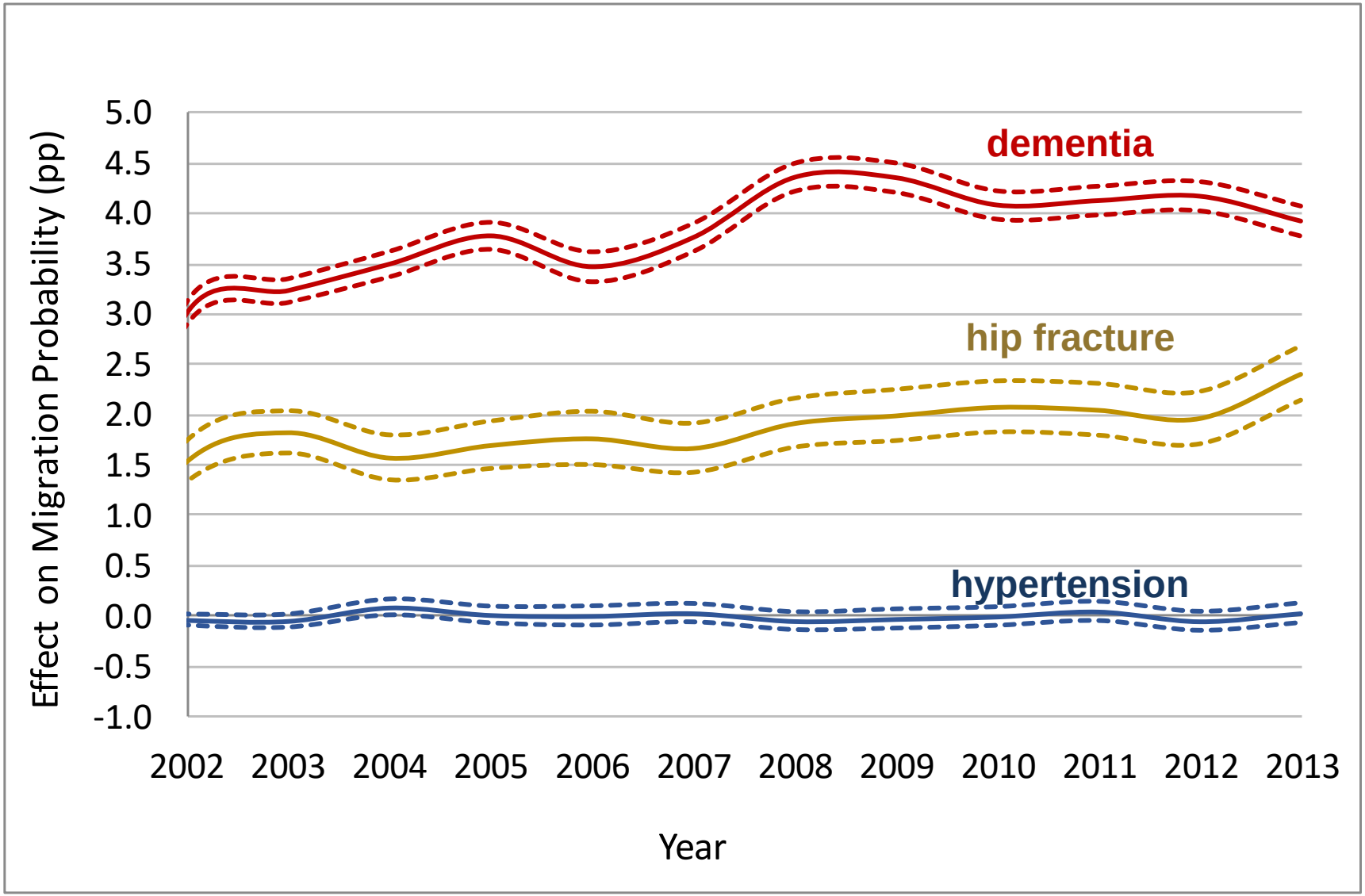
x_{ijt-1} = age x gender dummies, race, Medicaid eligibility

ω_{jt-1} = residential county in year *t-1*

ε_{ijt} = orthogonal error

- Regression coefficients and fixed effects evolve flexibly over time
- Identification comes from within-person health shocks

H2.B: Health shocks increase migration



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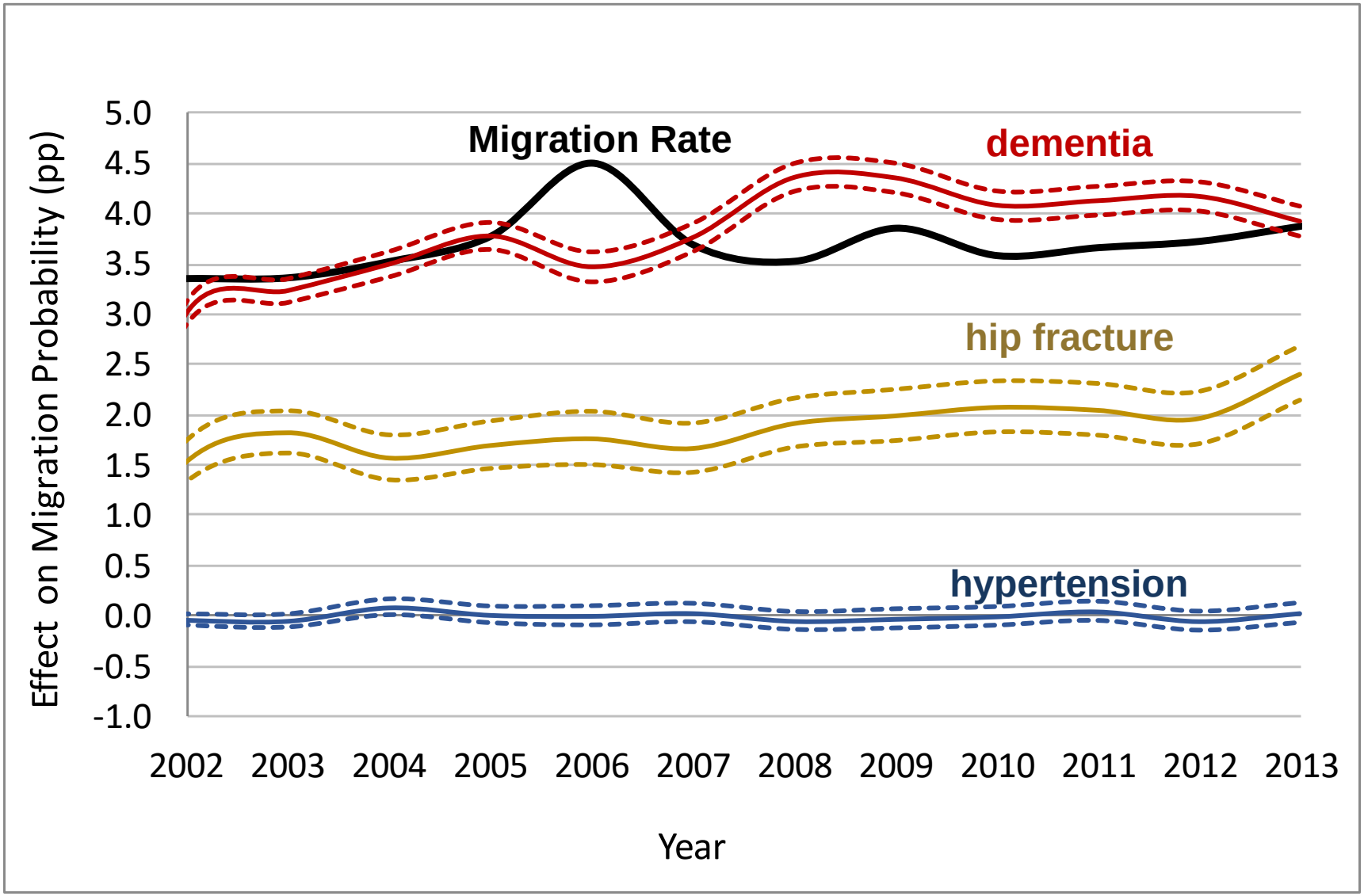

H2.B: Health shocks increase migration

- Largest effects for diseases that impair cognition and/or mobility

Average effect on annual migration from 2002 to 2013 (pp)	
3.5	Alzheimer's disease and related dementias
2.3	schizophrenia
2.2	bipolar disorder
1.7	hip fracture
1.2	stroke
1.0	major depression
0.5	heart attack
0.4	chronic kidney disease
0.4	chronic obstructive pulmonary disease
0.2	ischemic heart disease

- Null effects for cancers, vision impairments (cataract, glaucoma), and conditions with mild symptoms (hypertension, hyperlipidemia)

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- Null effects for cancers, vision impairments (cataract, glaucoma), and conditions with mild symptoms (hypertension, hyperlipidemia)

H3: Low income migrants go to lower amenity areas

$$\Delta PM_{it} = \alpha PM_{it-1} + \gamma\{y_{it} \leq y^*\}\{age_{2001}\} + \delta x_{ijt} + \varepsilon_{ijt}, \text{ where}$$

ΔPM_{it} = change annual average residential $PM_{2.5}$ exposure

$\{j \neq j-1\}$ = 1 *iff* person *i* moved in year *t*

$\{y_{it} \leq y^*\}$ = low-income indicator (based on state buy-in)

x_{ijt-1} = age dummies, year dummies

ε_{ijt} = orthogonal error

- Identified by differences in pollution at destination locations among high and low income groups of the same age who emigrated from similarly polluted areas

H3: Low income migrants go to lower amenity areas

- Average move increases the income-pollution gap by 0.09 μg/m^3

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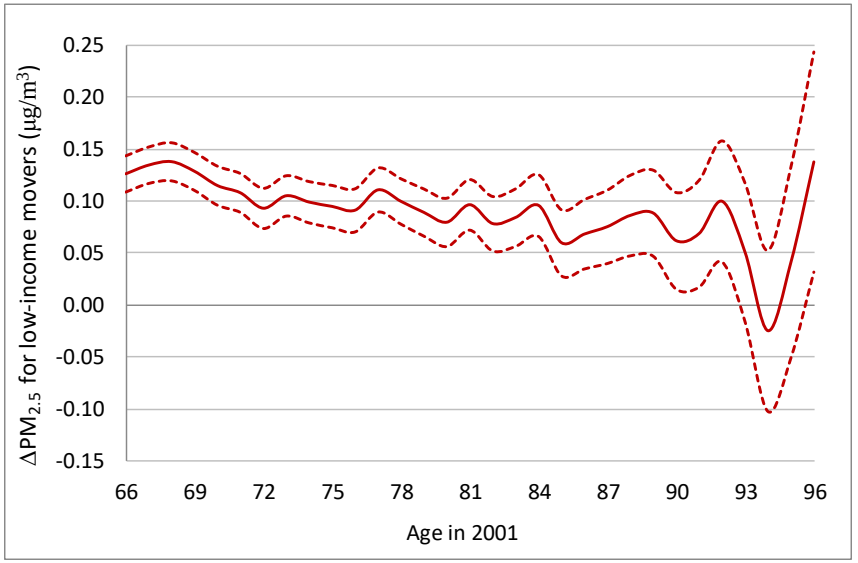

- Average differential of 0.09 µg/m^3 is equivalent to 17% of the pollution exposure gap that existed in 2001

Summary

- We extended the residential sorting literature to consider interactions between location choice, pollution exposure, illness and poverty

- Consistent with model predictions, we found that:

  - Lower income seniors live in more polluted areas, spend more on health care, and die sooner

  - Health shocks substantially increase medical spending and patient migration

  - Lower income migrants move to relatively dirtier areas

- Future research: structural model of "Tiebout (JPE 1956)-Grossman (JPE 1972)" interactions between residential location, pollution exposure, and health