

Learning About Aging from Past Populations

Dora L. Costa
MIT and NBER

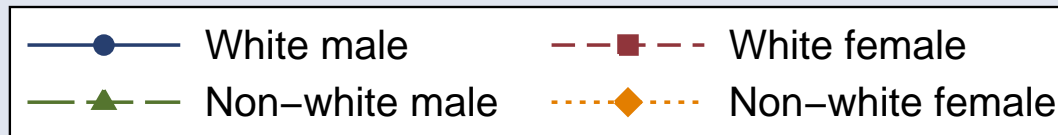
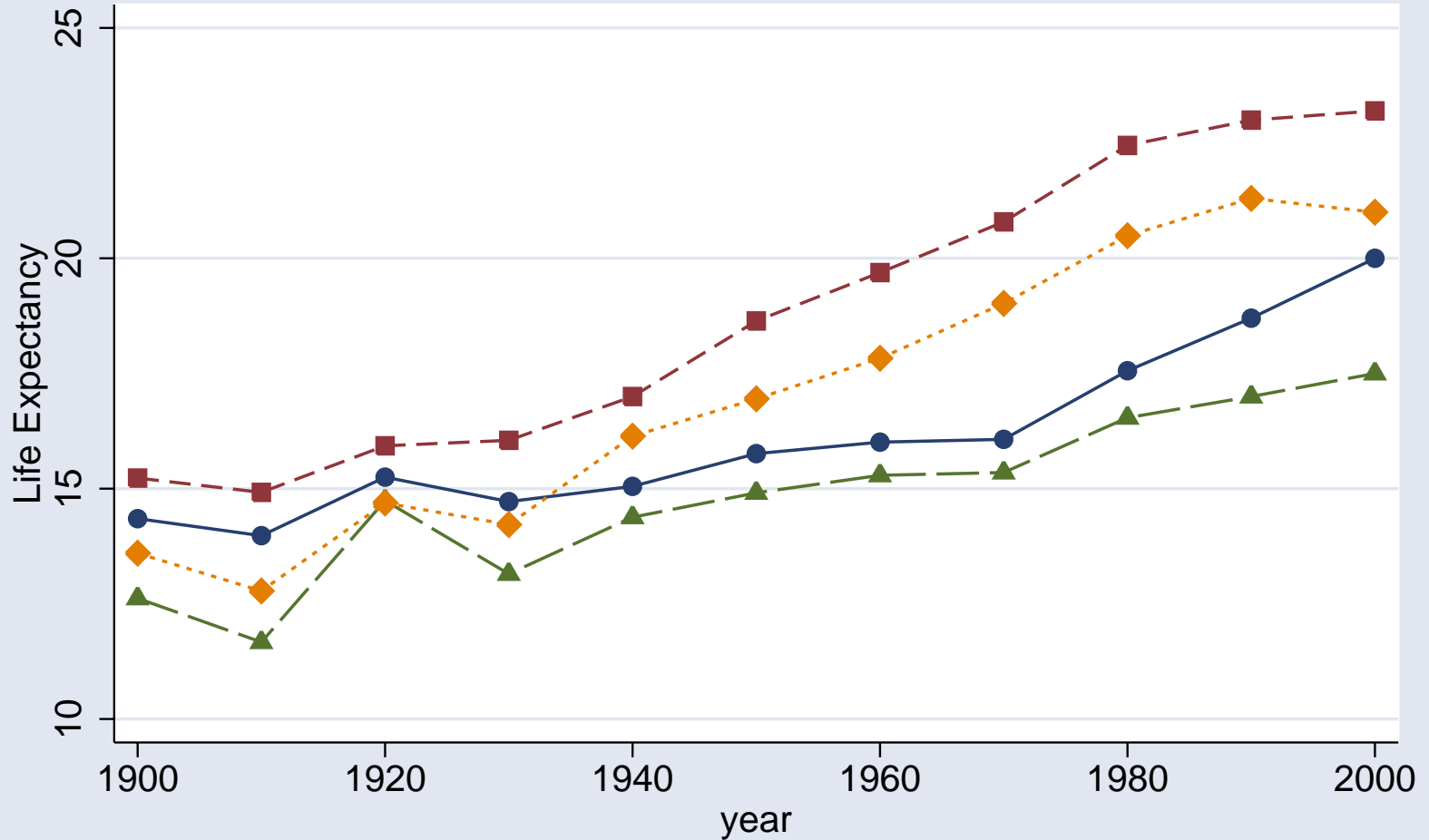
Outline

- The decline in death, disability, and chronic disease rates
- Data on past populations
- Potential explanations for the decline
- Infectious disease
- Occupational stress
- SES
- Early life conditions
 - Death and the city
 - Death and season of birth
- Conclusion

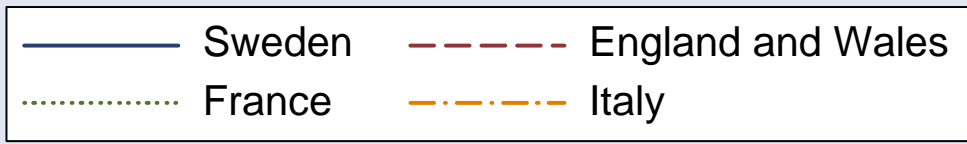
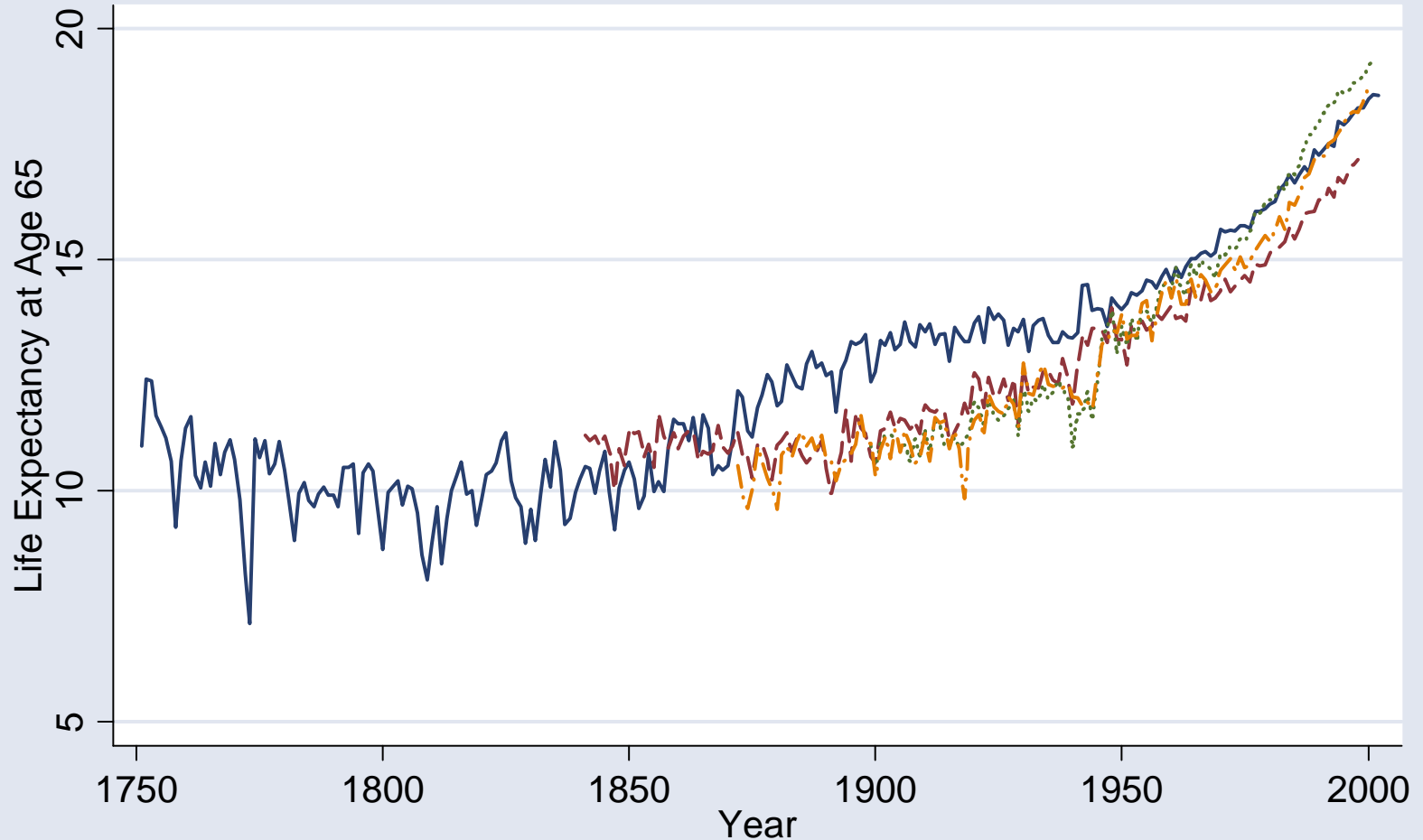
How many Americans become oldest-old (age 85)?

- 1900: 13% of all 65 year olds
- 2000: 42% of all 65 year olds
- life-expectancy rising at increasing rate over the 20th century
- observe increase in other OECD countries too

US Life Expectancy, Age 60, White and Non-white



Life Expectancy at Age 65, Selected Countries



Are the Old Now Less Disabled?

- In last 20-30 years, on the whole yes (Freedman, Martin, and Schoeni 2002 review)
- Disability decline accelerating among 65+ (Manton, Corder, and Stallard 1997; Manton and Gu 2001):
 - 1982-89: 1.1% per year disability decline
 - 1989-94: 1.5%
 - 1994-99: 2.1%
- Functional limitation trends similar

Are Chronic Conditions Now Less Prevalent?

- Clinician reports show continuous improvements since 1970s (Waidmann, Bound, and Schoebaum 1995)
- Self-reports show increases in 1980s and 1970s (e.g. Freedman and Martin 2000)
 - More awareness chronic conditions?
 - Chronic conditions less debilitating?

What has happened over the entire century?

- Need historical data

Types of Historical Data

- Aggregate mortality data
- Cross-sectional data with retrospective mortality information (e.g. census used by Ferrie 2003)
- Group-level longitudinal data (create from census micro-samples, e.g. Lleras-Muney 2002)
- census linkage, Steckel (1988), Preston, Hill, and Drevenstedt (1998)
- Robert Fogel's Union Army Data
 - Longitudinal micro-data
 - <http://www.cpe.uchicago.edu/>

Robert Fogel's Union Army Data

- ~36,000 white soldiers
 - Military records, pension records (including detailed medical records) linked to 1850, 1860, 1880, 1900, and 1910 censuses
- ~6,000 black soldiers
 - Military records and pension records
 - Will link to detailed post-war medical records and censuses

What has happened over entire century?

- Costa (2002): declines in functional limitation of 0.6% per year between 1910 and 1990s
 - Evidence for recent acceleration
- Costa (2000): average decline in chronic respiratory problems, valvular heart disease, arteriosclerosis, and joint and back problems 0.7% per year, 1900s-1970s/1980s

Are Chronic Conditions Less Debilitating?

- Costa (2002): 24% of decline in functional limitations due to decreases in debilitating effects of chronic disease, 37 % due to reduced chronic disease, and remainder unknown

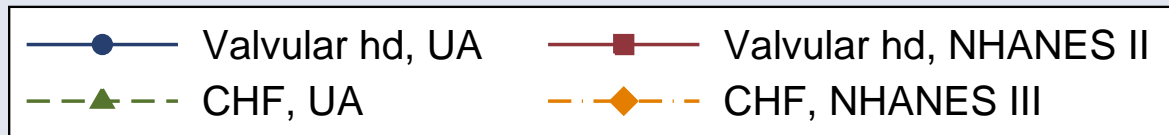
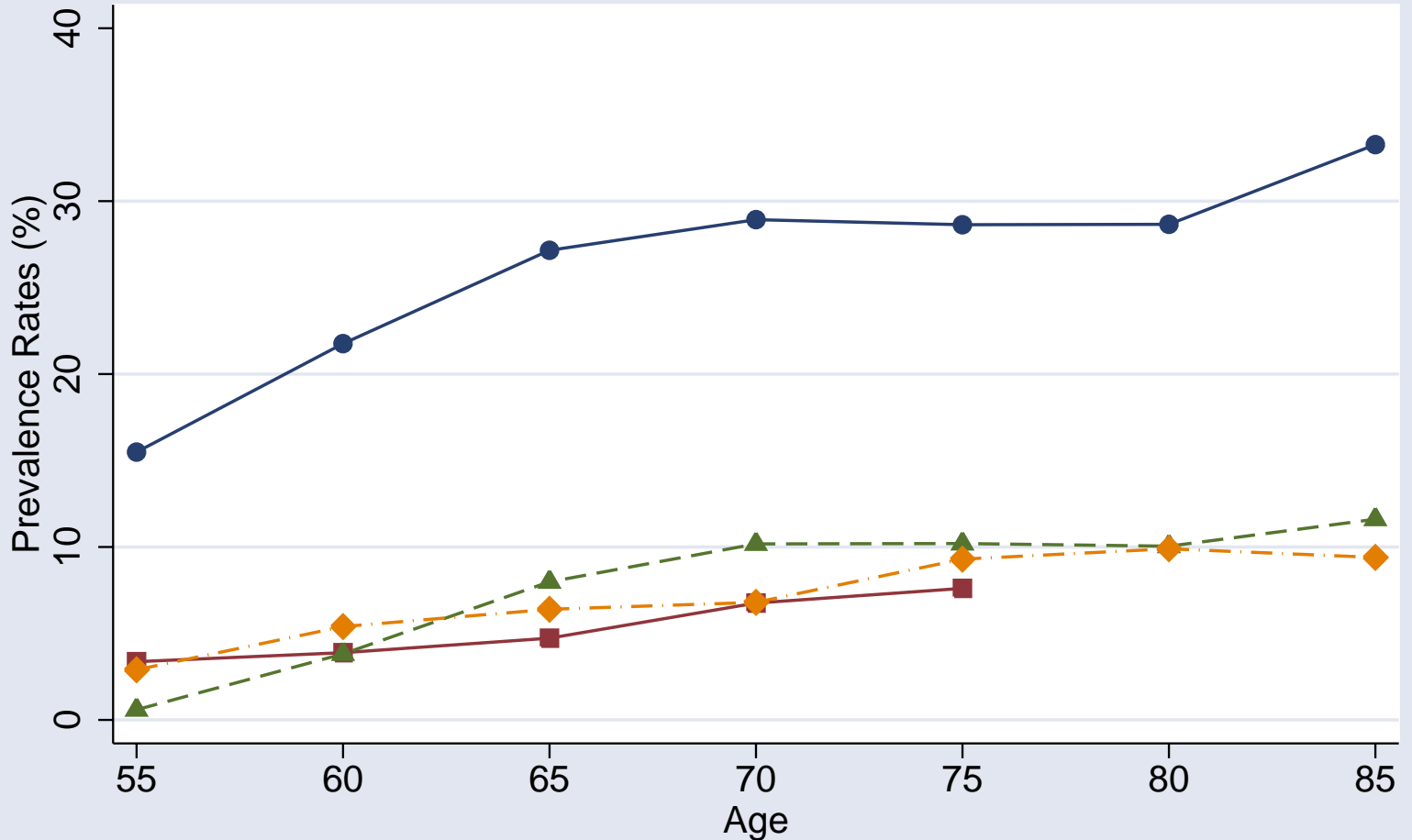
Prevalence Rates, Age 60-74 (Costa 2000, 2002)

	UA	NHANES I & II	NHANES III
Decreased Breath	15.4		8.3
Adventitious Sounds	29.1		4.0
Valvular HD	26.9	3.6	
CHF	10.0		7.0
Joint problems	55.0		35.2
Back problems	49.5		30.2

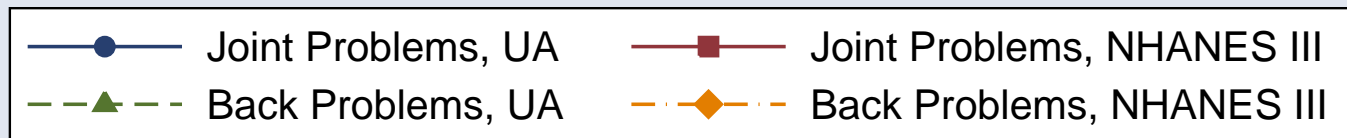
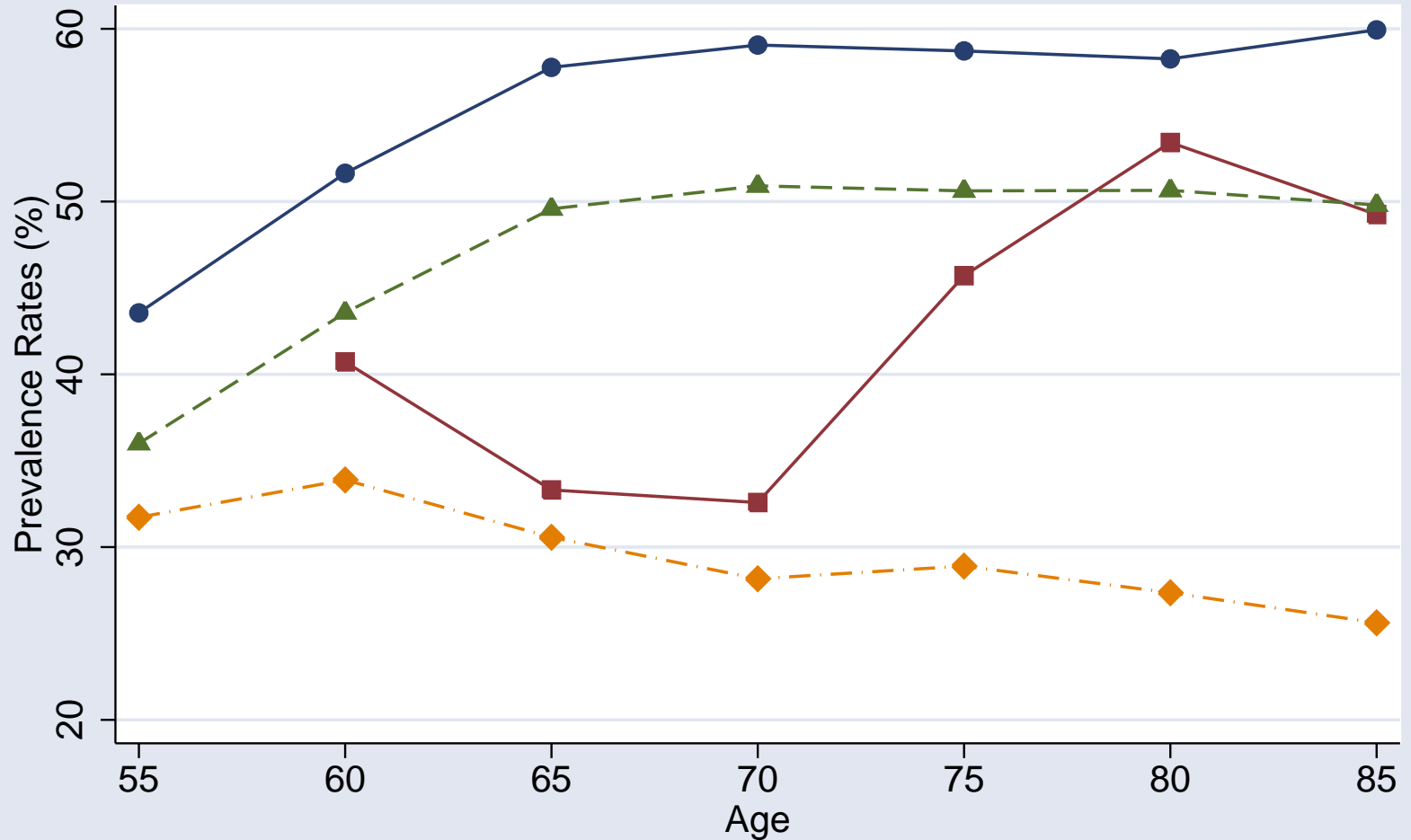
Functional Limitation Rates (%), Costa (2002)

	Age 50-64		Age 60-74	
	Union Army	NHANES III	Union Army	NHANES III
Difficulty bending	44.4	7.5	53.8	16.1
Difficulty Walking	28.5	10.4	36.6	13.8
Paralysis	4.8	0.9	6.1	2.7
Blind in >= 1 eye	3.4	1.5	4.5	3.1
Deaf in >=1 ear	3.2	1.4	4.1	2.7

Heart Disease Rates by Age, UA and NHANES



Musculoskeletal Prevalence Rates and Age, UA and NHANES



Why have elderly longevity and health increased?

- Early work (1950s and early 1970s): mortality for everyone has declined as abolish deaths due to infectious disease and infectious disease has declined because of
 - Declining virulence of pathogens
 - Public health reforms
 - Advances in medical technology
 - Rising living standards

Why Have Elderly Health and Longevity Increased? (Continued)

- McKeown (1976): decline mortality for everyone because nutrition improves
- Fogel (1997): net nutrition (good nutritional intake can be poor if have infections) leads to stronger constitutions at all ages

Why Have Elderly Health and Longevity Increased? (Cont)

- Elo and Preston (1992) : infectious disease at any point in life-cycle can have long-term scarring effects, e.g. rheumatic fever and valvular heart disease or inflammatory infection and arteriosclerosis
- Ewbank and Preston (1990): health habits as well as public health matter to mortality decline

Why Have Elderly Health and Longevity Increased (Cont.)

- Barker (1992; 1994): aging begins before and at birth
 - Anthropological markers of maternal and infant deprivation (e.g. birth weight, ponderal index, ratio of placental weight to birth weight, weight at age one, etc.) predict later onset of hypertension, coronary heart disease, cerebral hemorrhage, and type II diabetes
 - Evidence from Britain, Sweden, Finland, and India

What Can Historical Micro-Data Tell Us? Can Examine:

- effects of untreated infectious disease
- socio-economic status in the past
- occupational stress in non-mechanized world
- effects of poor prenatal and postnatal conditions

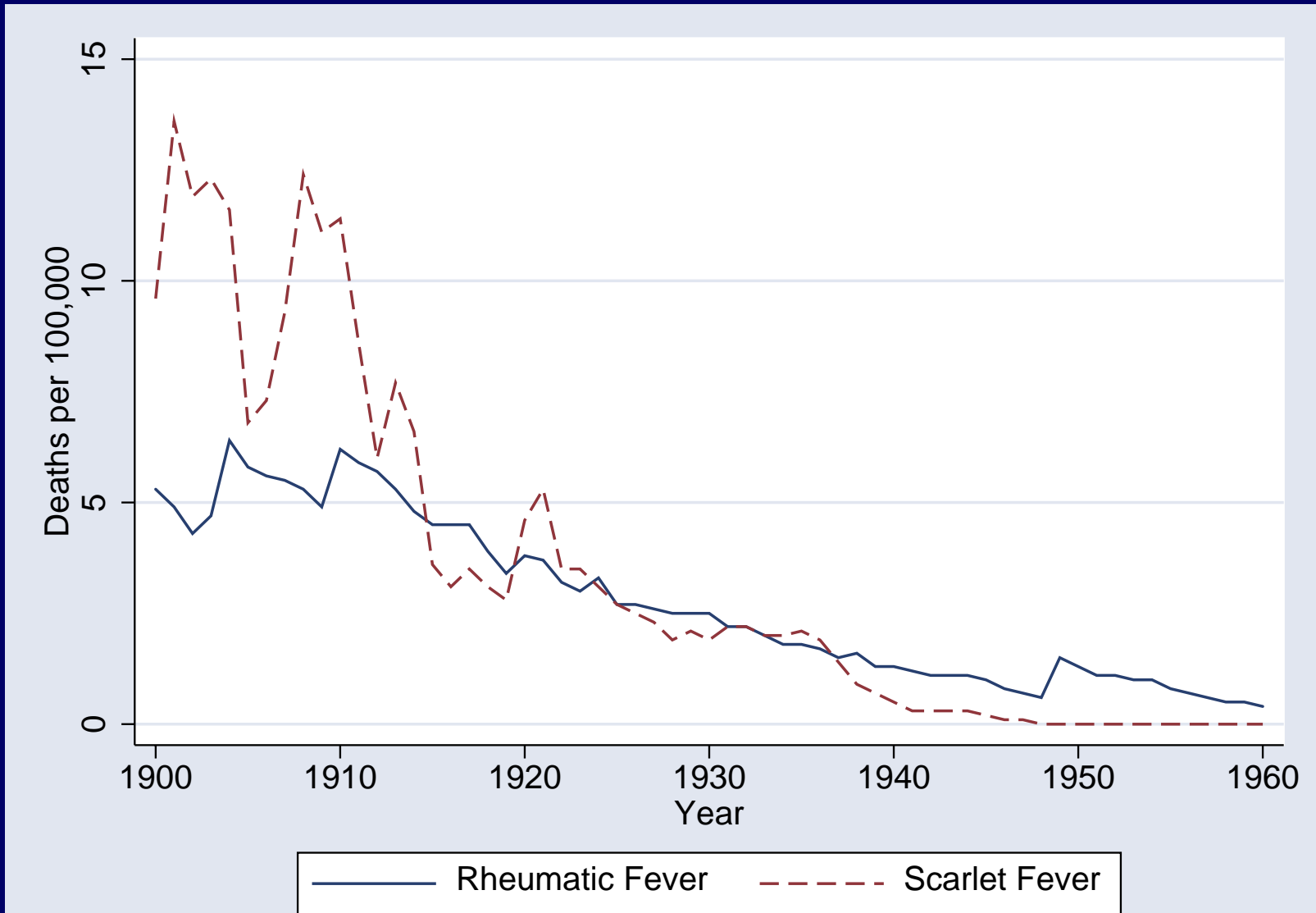
What Union Army Can Tell Us

- Can examine morbidity and mortality effects of:
 - Infectious disease while in the army
 - Wealth in 1860
 - Occupation
 - Proxies for poor prenatal and postnatal conditions (size of city of early residence, season of birth)

A World of Infectious Disease

- Typhoid, Diarrhea, Cholera, Measles, Rheumatic Fever, Scarlet Fever, Diphtheria, Whooping Cough
- Extremely high infant mortality rates, especially in large cities, highest in summer when diarrheal diseases most prevalent

Deaths from Rheumatic Fever and Scarlet Fever



Case Fatality, Case, and Death Rates, Scarlet Fever, MA, MI, NY, 1840-1945

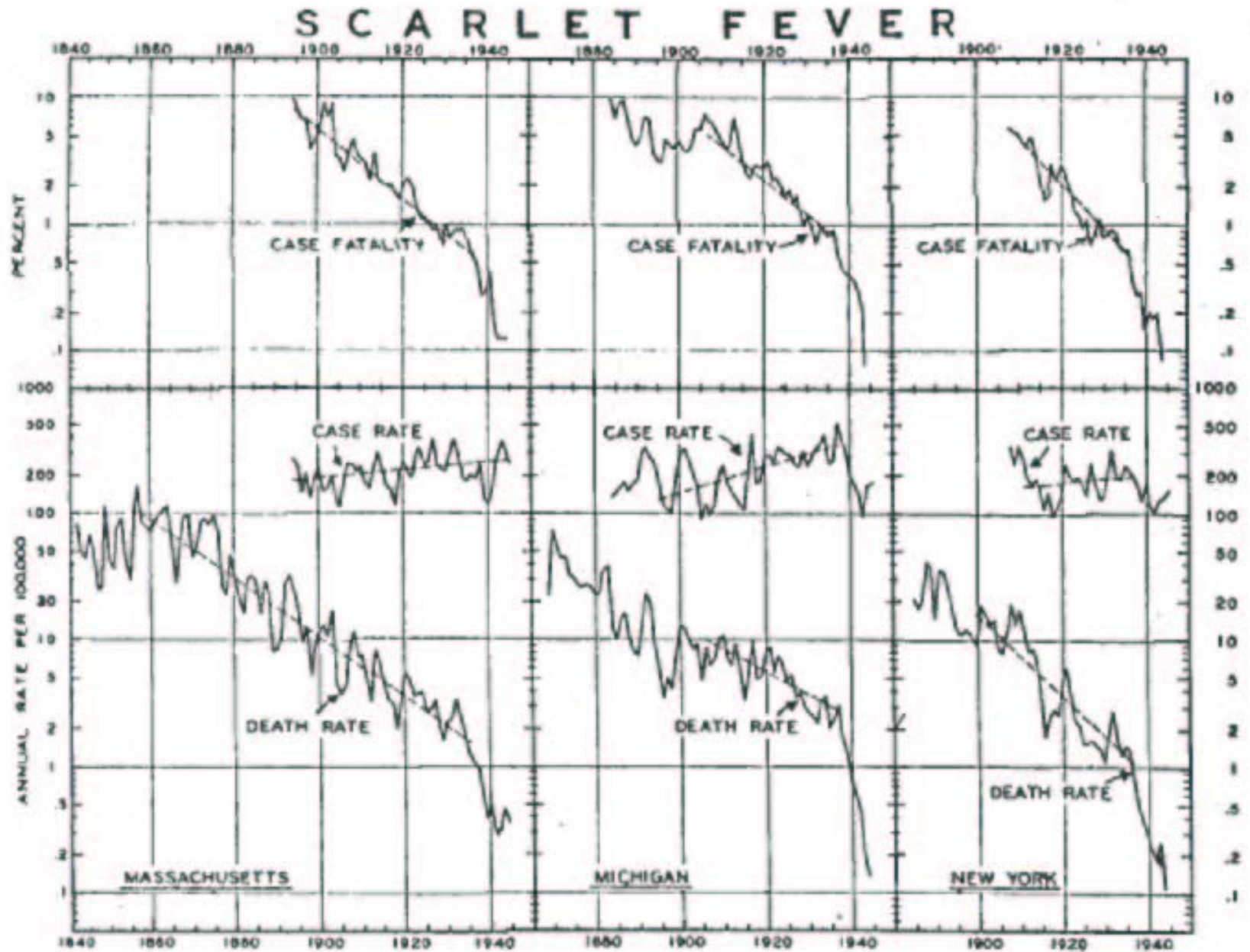
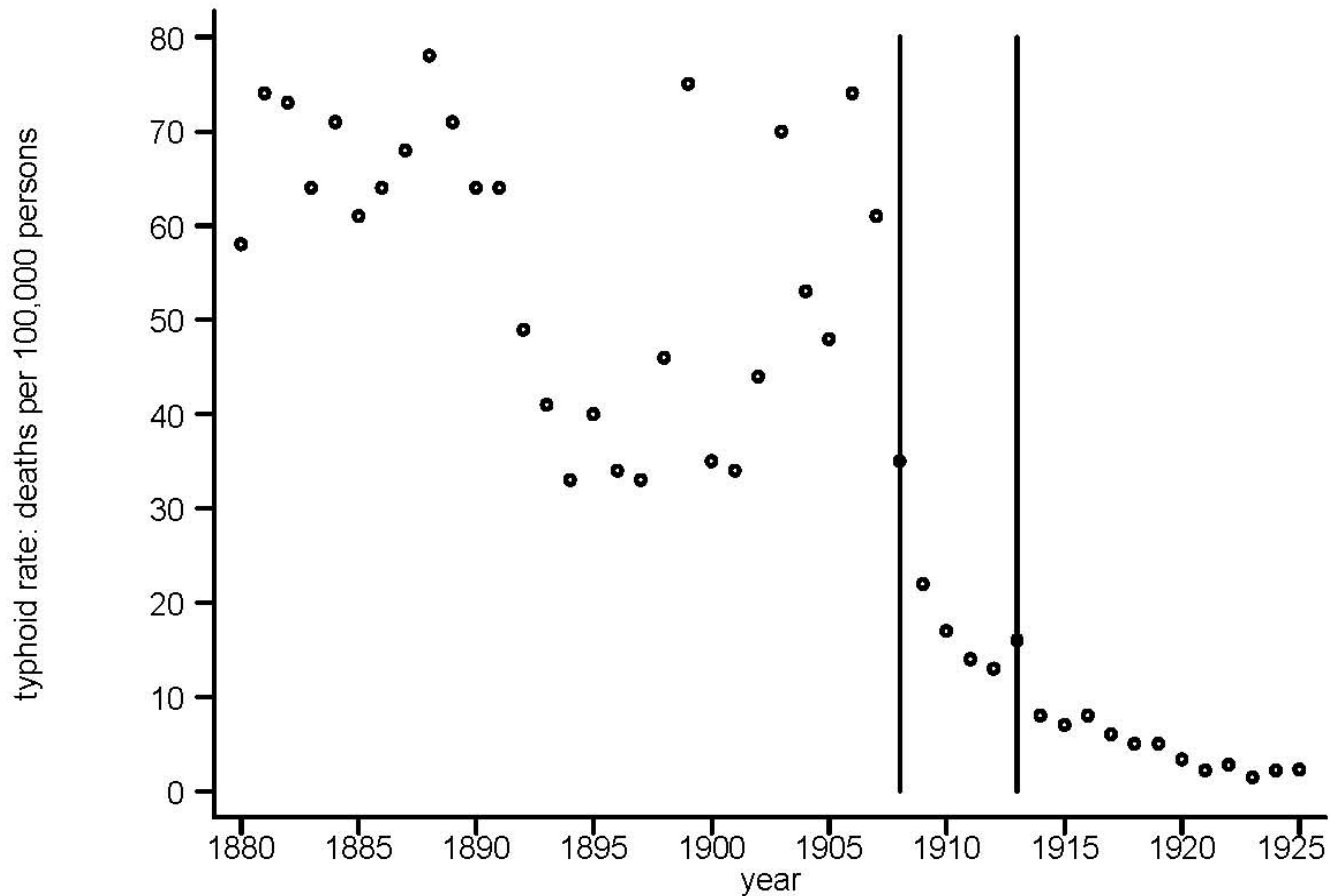


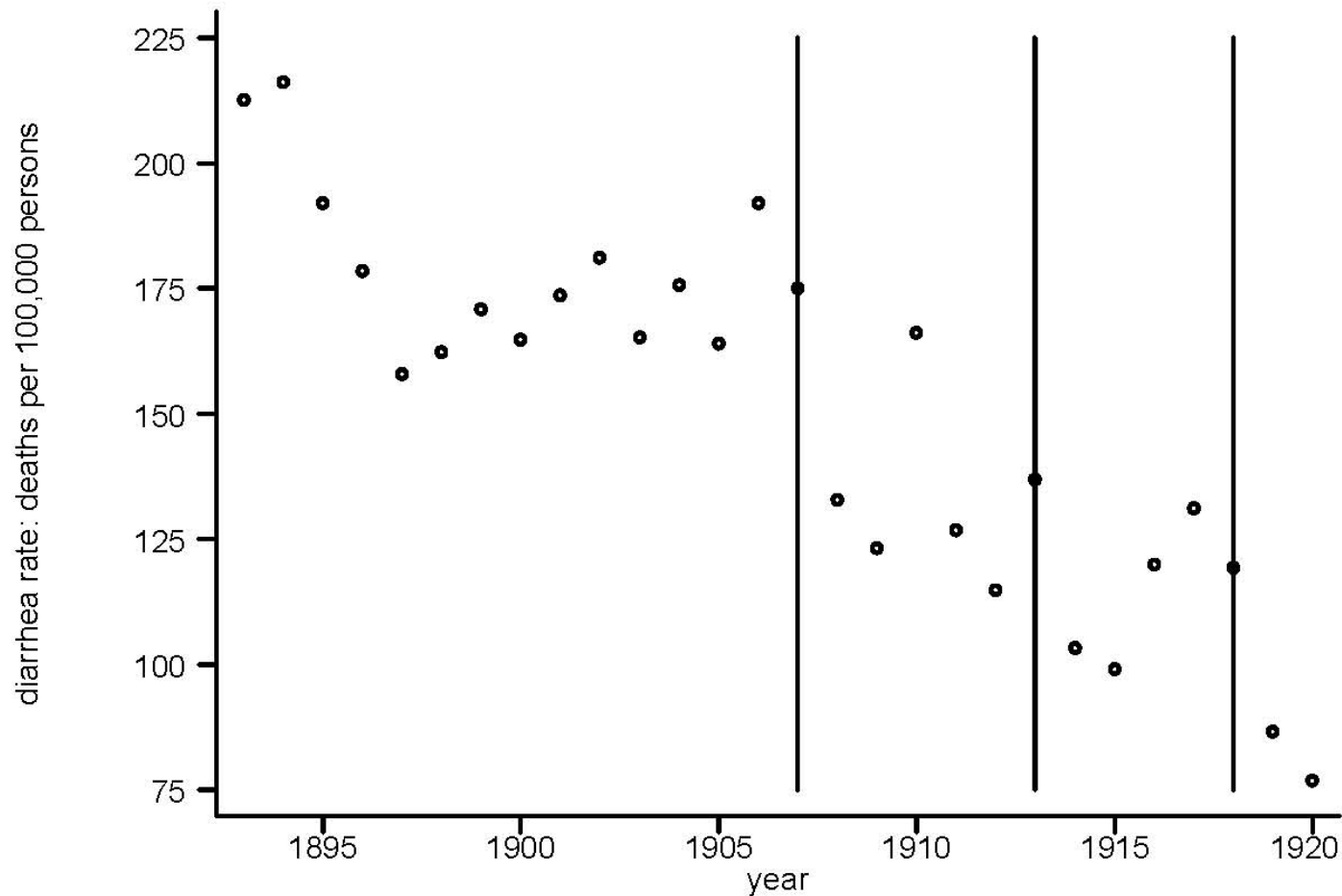
Table 1: Incidence and History of Rheumatic Fever, Scarlet Fever, and Heart Disease Among White Children (Rates per 1000), 1928-31 and 1935-36

	Ever Had, Living	Ever Had, Living and Dead	Annual Incidence in Survey Year
Rheumatic Fever, 1935-36			
Age 20-24	6.9	8.5	0.3
Age 15-19	5.3	6.0	0.4
Under age 15	3.2	3.4	5.6
Scarlet Fever, 1928-31			
Age 20-24	118.7		
Age 15-19	129.7		
Scarlet Fever, 1935-36			
Age 15-19	112.0		2.1
Under age 15	78.0		10.8
Heart Disease, 1935-36			
Age 20-24			0.8
Age 15-19			0.8
Under age 15			0.9

Typhoid Death Rates, Philadelphia, 1880-1925 (Troesken 2004)



Diarrhea Death Rates, Pittsburgh, 1893-1920 (Troesken 2004)



Are survivors of infectious disease permanently scarred?

- permanent scarring effect (e.g. rheumatic fever): positive relationship
- correlation between insults and omitted variable: positive relationship (e.g. birth weight and poverty)
- full or partial immunity (e.g. typhoid): negative relationship
- mortality selection: negative relationship

Union Army Morbidity Results (Costa 2000)

- Wartime rheumatic fever increases probability of valvular hd, CHF, joint problems, and back problems at age 60-74
- Wartime malaria increases joint, back, and respiratory problems
- Wartime respiratory infections and tb increase chance of later respiratory problems
- Measles increases probability of valvular heart disease and respiratory problems

Increase in Probability Condition Due to Wartime Disease, UA Men 60-74 (Costa 2000)

	Valv. HD	CHF	Joint Prob.	Back Prob.	Resp. Prob.
Rheum Fever	.08	.10	.20	.13	
Malaria			.15	.11	.14
Resp Inf					.12
TB					.22
Measles	.11				.20

Explaining Decline Chronic Disease

- 18% of decline in combined category of respiratory problems, valvular heart disease, CHF, arteriosclerosis, and joint and back problems accounted for by reduced infectious disease rates

Wartime Disease and Older Age Mortality, UA Men 50-64 (Costa 2003) and 60-74 (Costa and Lahey 2004)

- Wartime diseases don't predict all-cause mortality, but
- Wartime respiratory infection predicts mortality from respiratory disease
- Wartime rheumatic fever predicts mortality from heart disease
- Wartime TB predicts mortality from infectious disease
- Wartime diarrhea predicts mortality from stomach ailments

A World of Occupational Stress

- Manual jobs dominate:
 - In 1900 38% of labor force farm or farm workers and 70% of male, non-farm labor force manual
 - In 1990 3% of labor force farm and 52% of male, non-farm labor force manual
- Manual jobs not mechanized
- Exposure to dust, fumes, and animal and industrial pollutants (both farmers and manual workers)

Plowing, 1868

office in Prince Street, near Broadway—one of the smallest houses in New York, and which looks more like the fire-proof vault of a great bank than the business office of the richest man in America. He is to be seen occasionally at this office, and on his way to and from it walk-

MR. WILLIAM B. ASTOR.—[PHOTOGRAPHED BY GEORGE.]

A sketch of a farmer plowing for the first time on a Kansas prairie. The heavy sub-soil plow requires three and four yoke of oxen to drag them through the tough, solid soil; and our illustration fully represents the difficulties of prairie plowing.



FLOWING ON THE PRAIRIES BEYOND THE MISSISSIPPI.—[SKETCHED BY THEODORE H. DAVIA.]

224
145

Plowing, 1910



Plowing, 1940



Increase in Probability Condition Due to Occupation, UA Men 60-74 (Costa 2000)

	Valv. HD	CHF	Joint Prob.	Back Prob.	Resp. Prob.
Professional or Proprietor, 1900					
Farmer, 1900			.07	.10	
Artisan, 1900				.11	.09
Laborer, 1900					.08
PP, 1860					
Farmer, 1860	.08			.13	.08
Artisan, 1860					
Laborer, 1860	.11			.14	.12

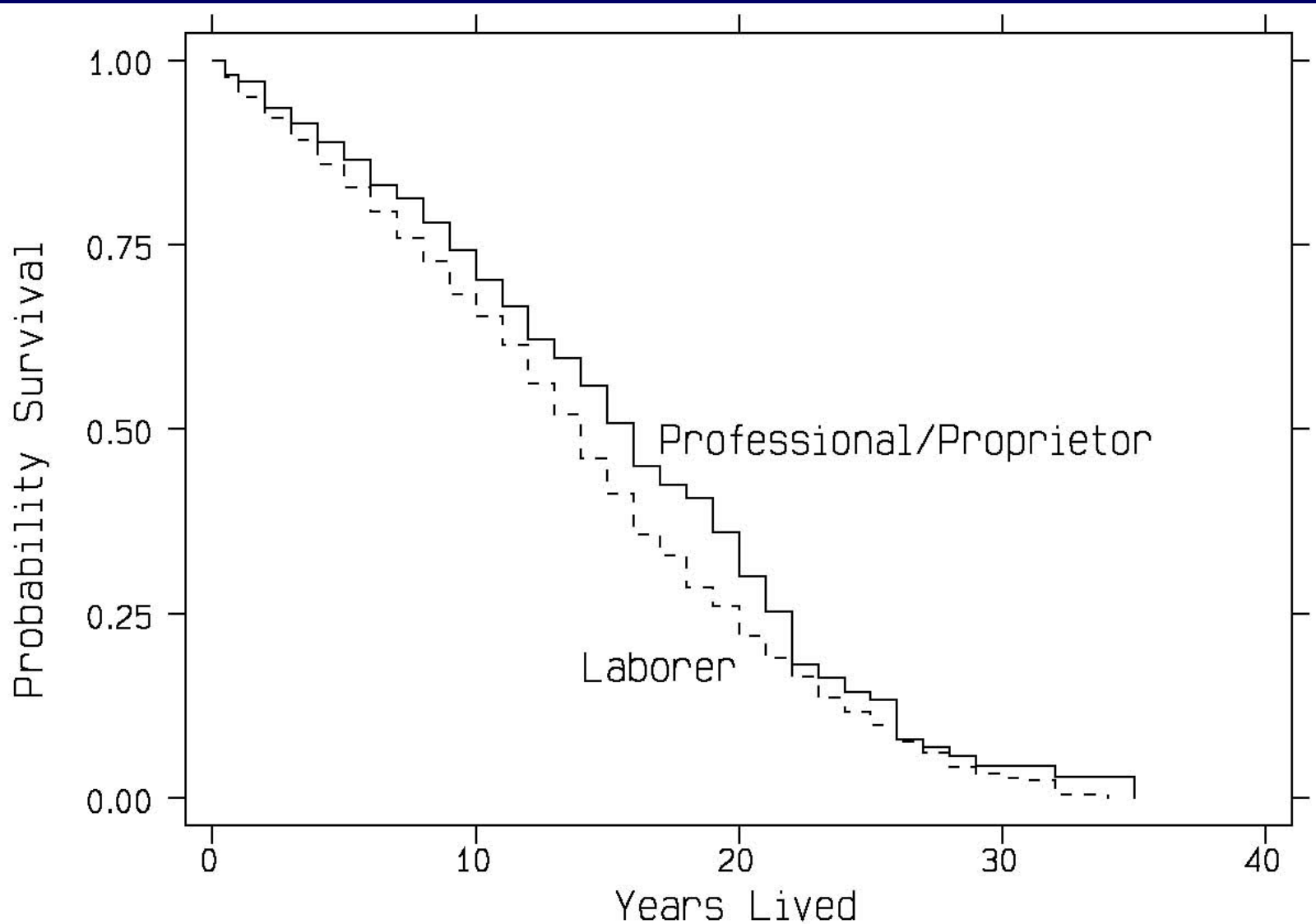
Explaining Chronic Disease Decline

- 29% of decline in combined category of respiratory problems, valvular heart disease, CHF, arteriosclerosis, and joint and back problems, 1910-1970s/80s, accounted for by shift from manual to non-manual occupations

Occupation and Mortality

- Laborers more likely to die than professionals or proprietors or farmers
- Excess deaths mainly due to heart disease
 - SES effect?
 - not broken down by work as for chronic conditions
- Effect small: if occupational shift from manual to non-manual then explains negligible fraction of mortality decline

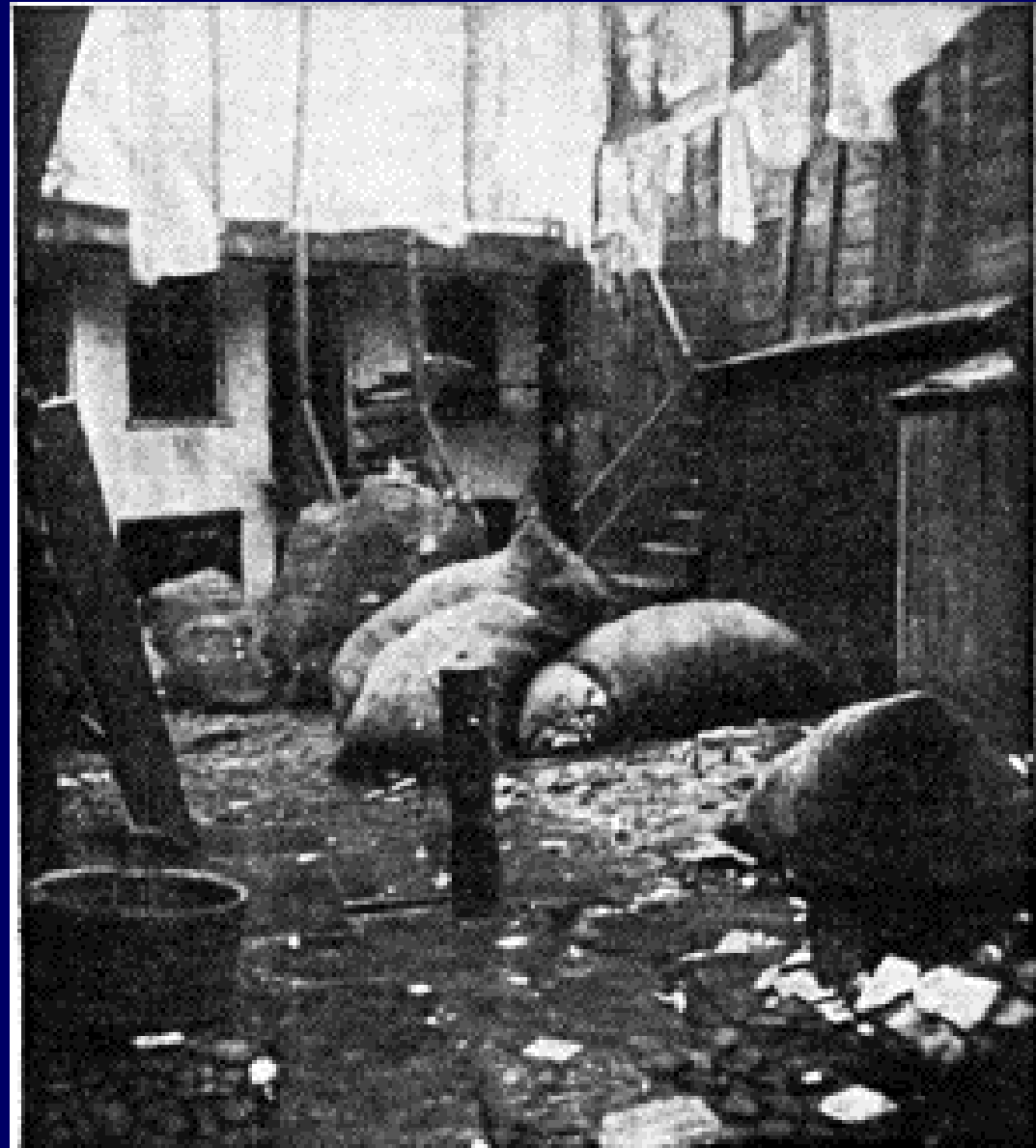
Occupation at Enlistment and Later Survivorship, Costa and Lahey (2004)



What Can Money Buy?

- better (and more) food and water
- less crowded, cleaner housing
- no work away from home for mother
- no work for children

NYC, 1890



BOTTLE ALLEY.

Boys Picking Over Garbage, Boston, 1909



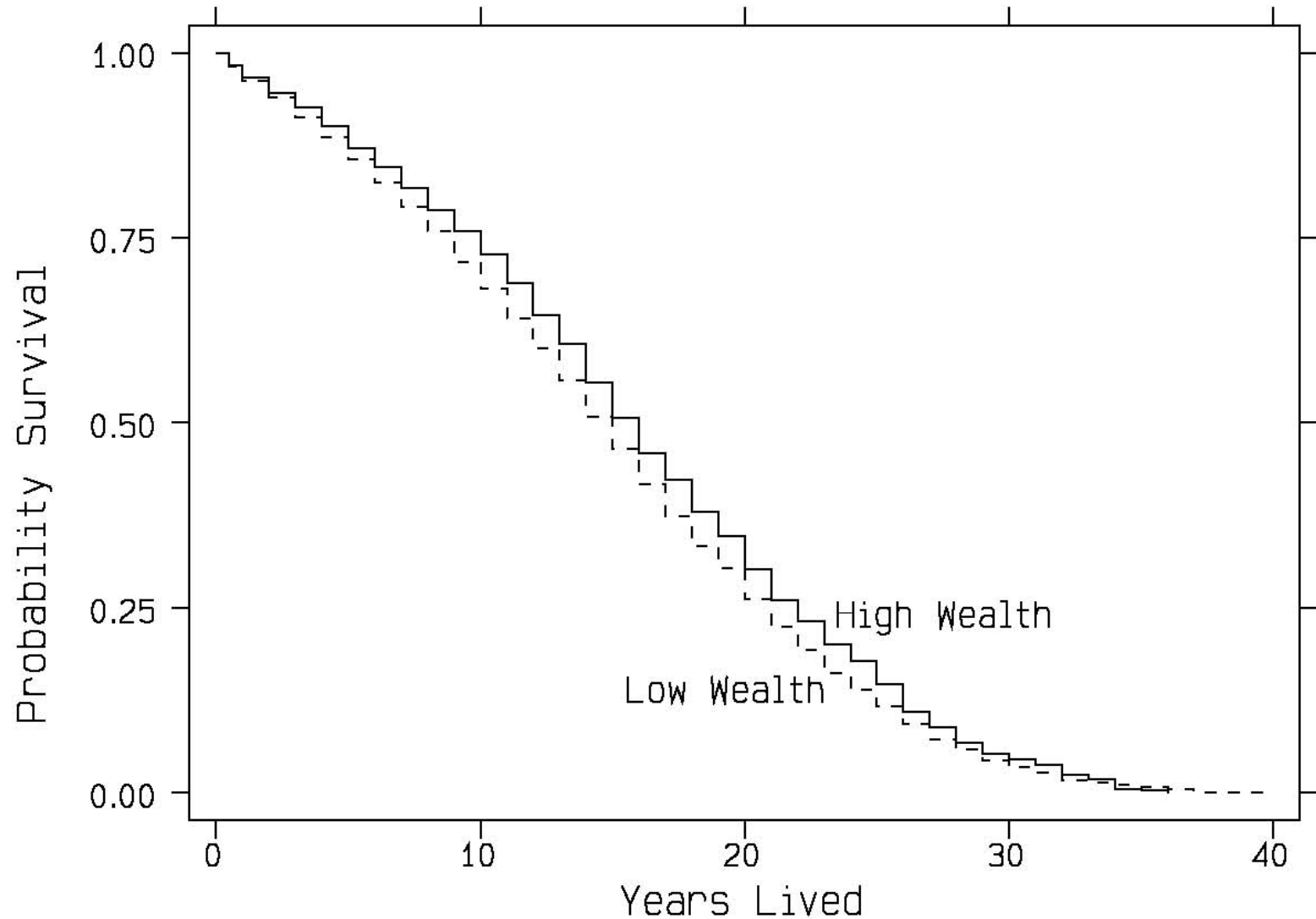
Working on feathers, NYC, 1911, "Dirty floor, vermin abounded, garbage standing uncovered"



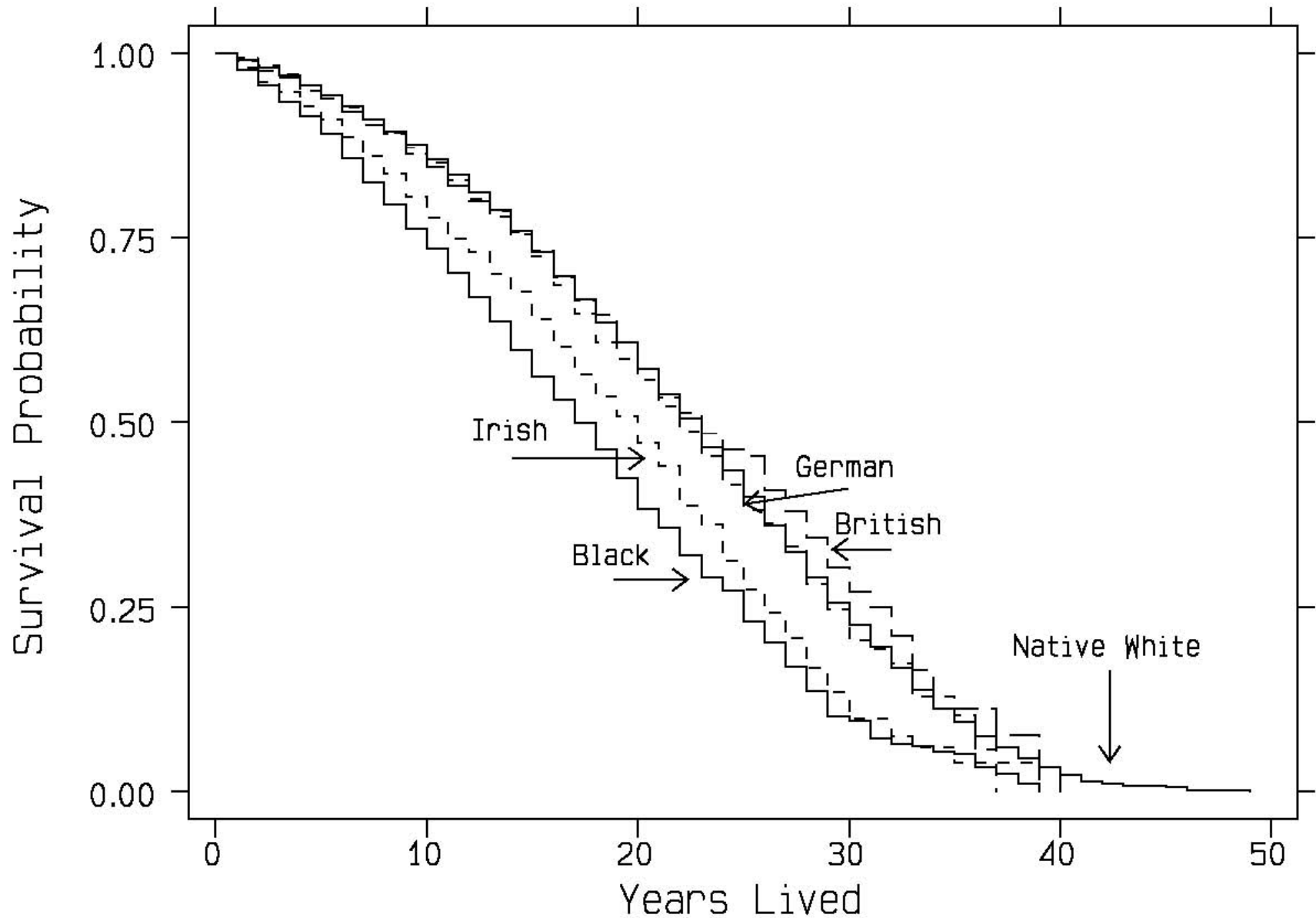
How much did SES matter in past?

- Woodbury (1926): within large cities large differences in infant mortality rates by income
- Chapin (1924): large different mortality rates those with taxable property and those without
- SES little effect on mortality: Steckel (1988), Preston and Haines (1991)
- SES effect on mortality by cause: Ferrie (2003)
- SES effects increased with knowledge germ theory of disease? Ewbank and Preston (1990)

Household Wealth in 1860 and Older Age Survivorship, UA, Costa and Lahey (2004)



Race, Ethnicity, and Survivorship, UA (Costa 2004)



Poor prenatal and early postnatal conditions

- Costa (forthcoming; 1998), Goldin and Margo (1989): US live birth weights in past high by today's standards (high stillbirth rates)
- But, not all intrauterine growth retardation manifested in low birth weights (Roseboom et al 2001)
- By young adult ages population in past shorter, lighter, and, controlling for BMI, higher waist-hip ratio (Costa 2004)

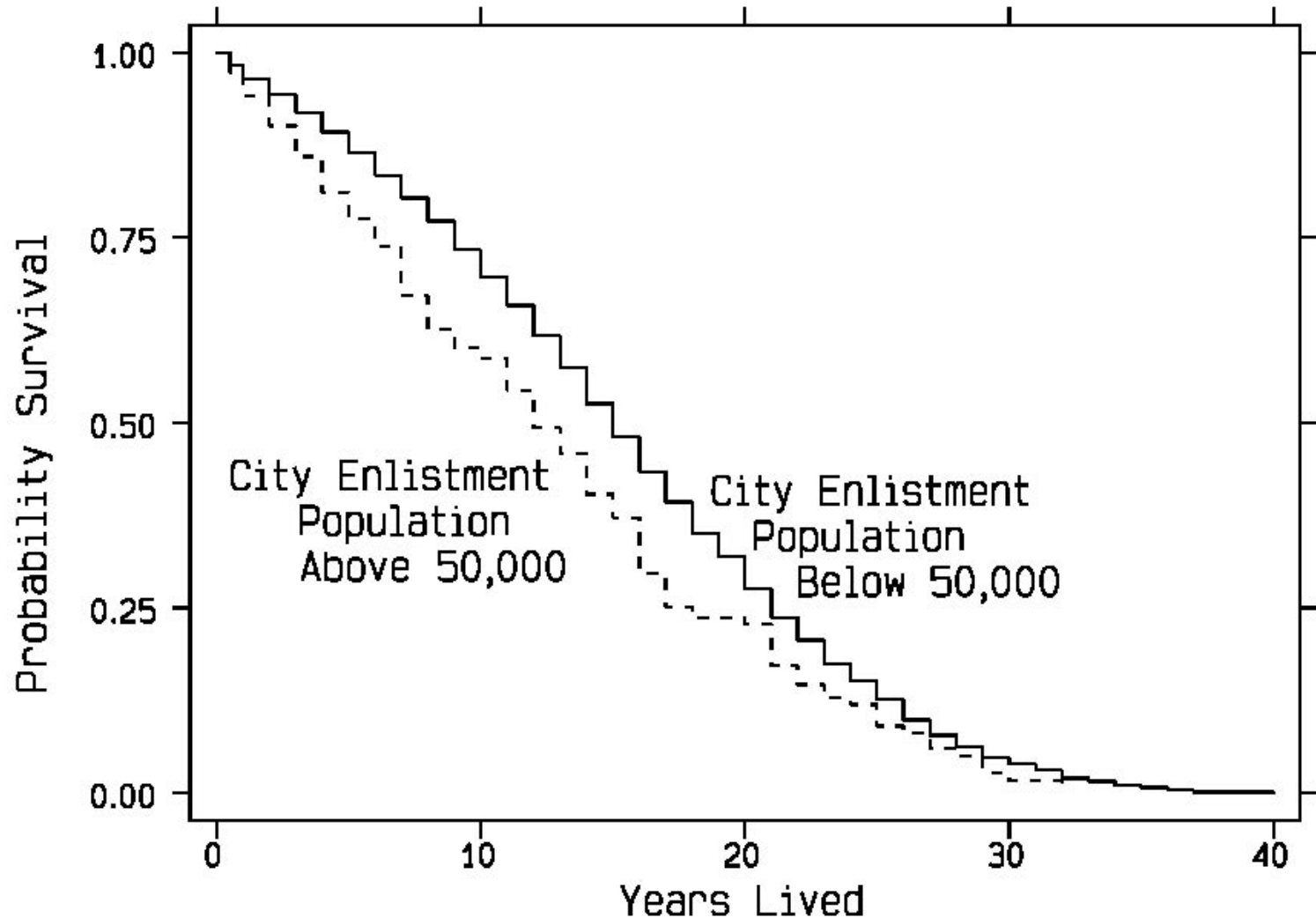
Proxying for Early Life Conditions

- Place of early life residence
 - Mid-19th century: largest cities deadliest
 - NY state: 229/1000 white children under age 5 died in urban areas vs 192/1000 in rural areas (Haines 1977)
 - End-19th century: largest cities no longer deadliest, medium size cities are worse because had not invested in sanitation infrastructure (Haines forthcoming)
 - Urban mortality penalty shifts to smaller and smaller size city class over time
 - By 1940 no longer an urban mortality penalty
 - Urban penalty associated with gastro-intestinal and respiratory disease (sanitation and crowding)

Cities and Mortality, White UA (Costa and Lahey 2004)

- If enlisted in city of 50,000+ (one of 13 largest cities) then 1.2 times as likely to die from all-cause mortality at ages 60-74 than man who enlisted in city of less than 2500 controlling for later residence
 - 1.6 times as likely to die of heart disease
 - 2 times as likely to die of respiratory disease
 - 2.5 times as likely to die of parasitic disease (insignificant)
- No mortality effect of being in one of 100 largest cities in 1900

Figure 2: Survival Probabilities Over Time by Size of City of Enlistment, Union Army Veterans Age 60-74 in 1900



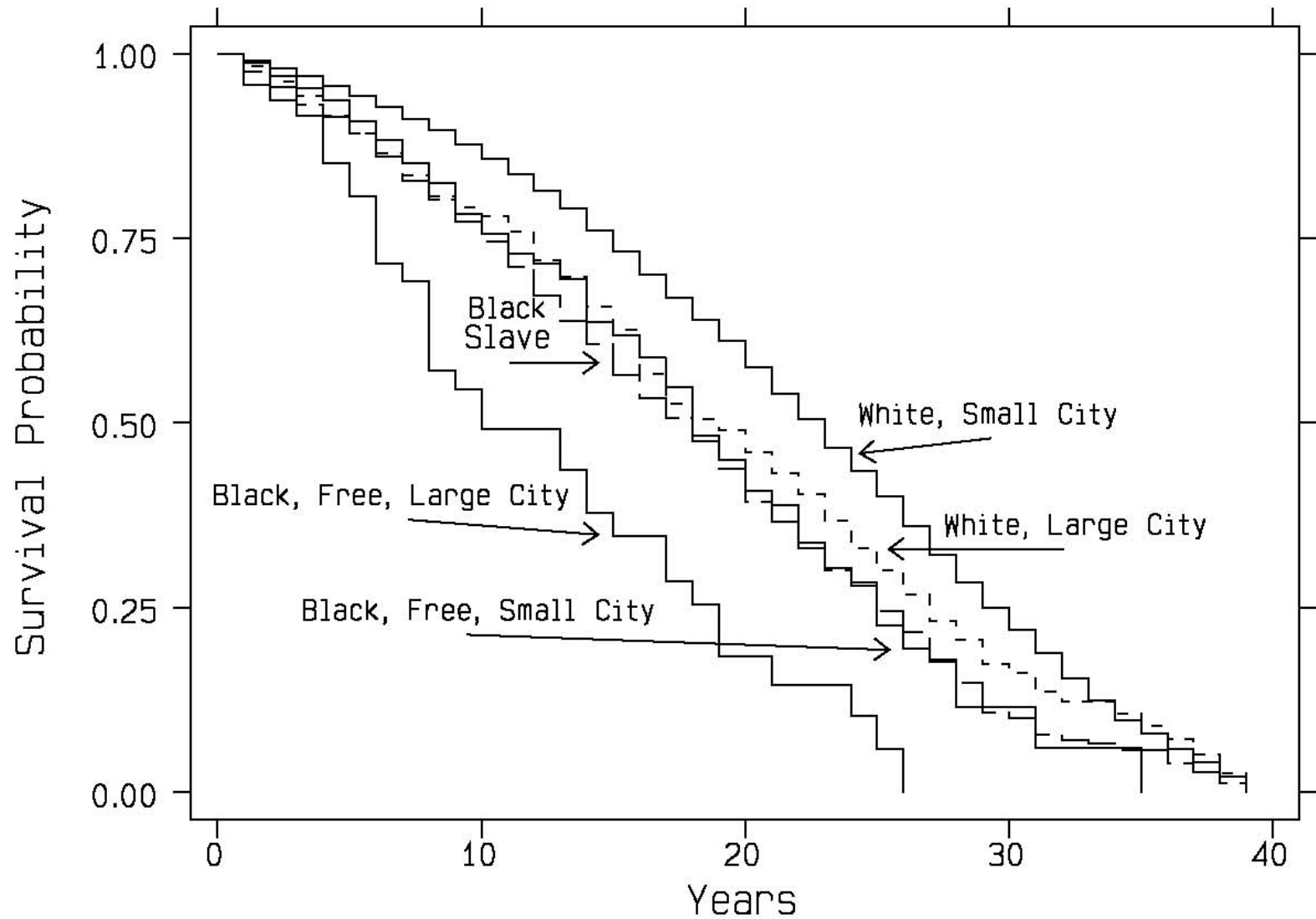
Mortality Effects for Whites (Costa 2003)

- Compare UA with NHANES I mortality follow-up, men 50-64
- If reduced death from acute and infectious disease could explain 13 percent of difference in survival rates between two samples
- If no urban penalty and no scarring effects from infectious disease then could explain another 13 percent of difference in survival rates

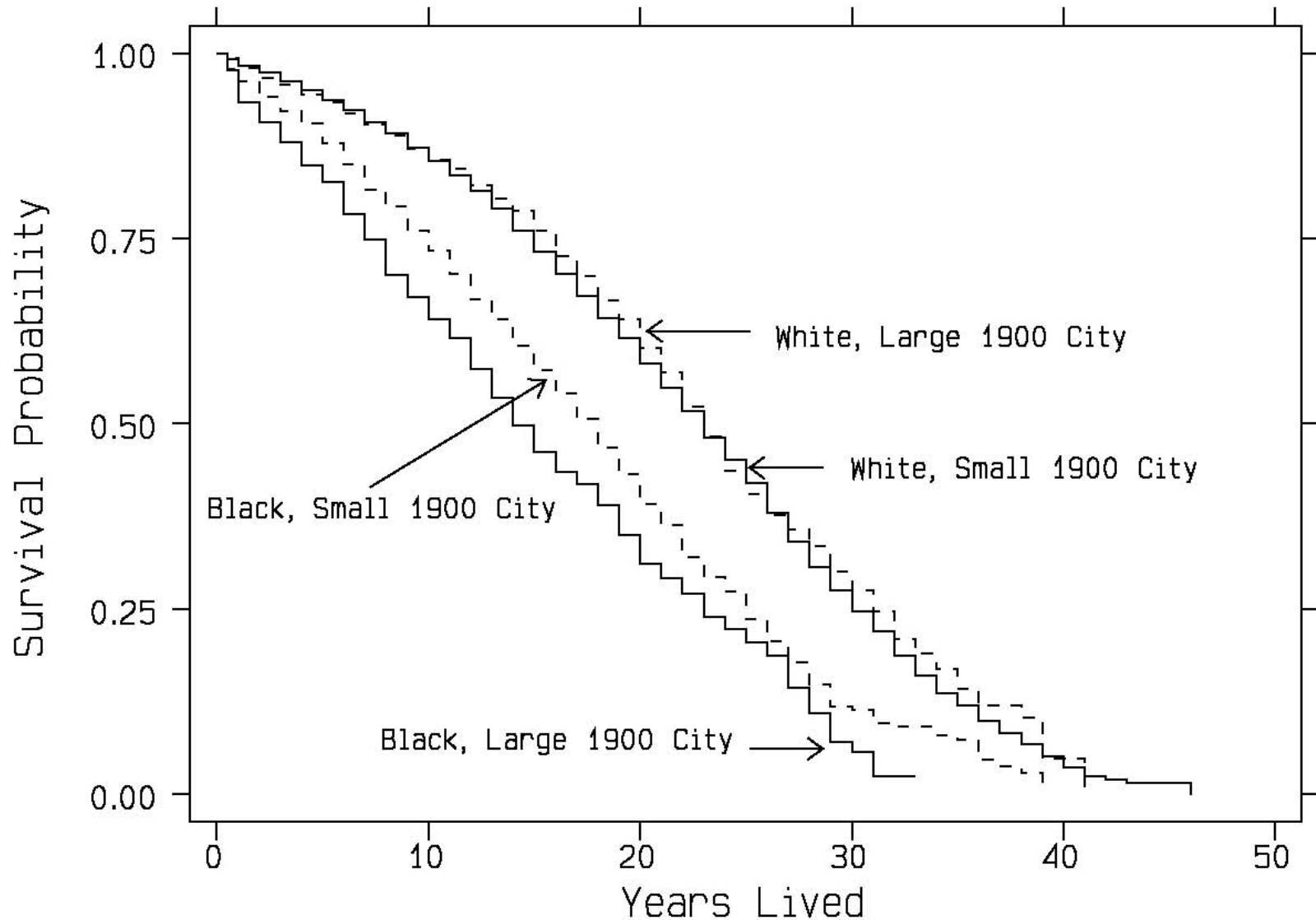
Cities and Mortality, Black UA

- Growing up in large northern cities may have had even greater scarring effects for blacks than for whites
 - e.g. during 1832 cholera epidemic case rate twice as high among blacks as among whites
- Living in large city at older ages increases black older age mortality
 - Decline in black child mortality lags white decline because sanitation extended later
 - Higher mortality both infectious and parasitic disease and chronic disease related to infection (e.g. syphilis)

Survivorship and City of Enlistment, UA by Race (Costa 2004)



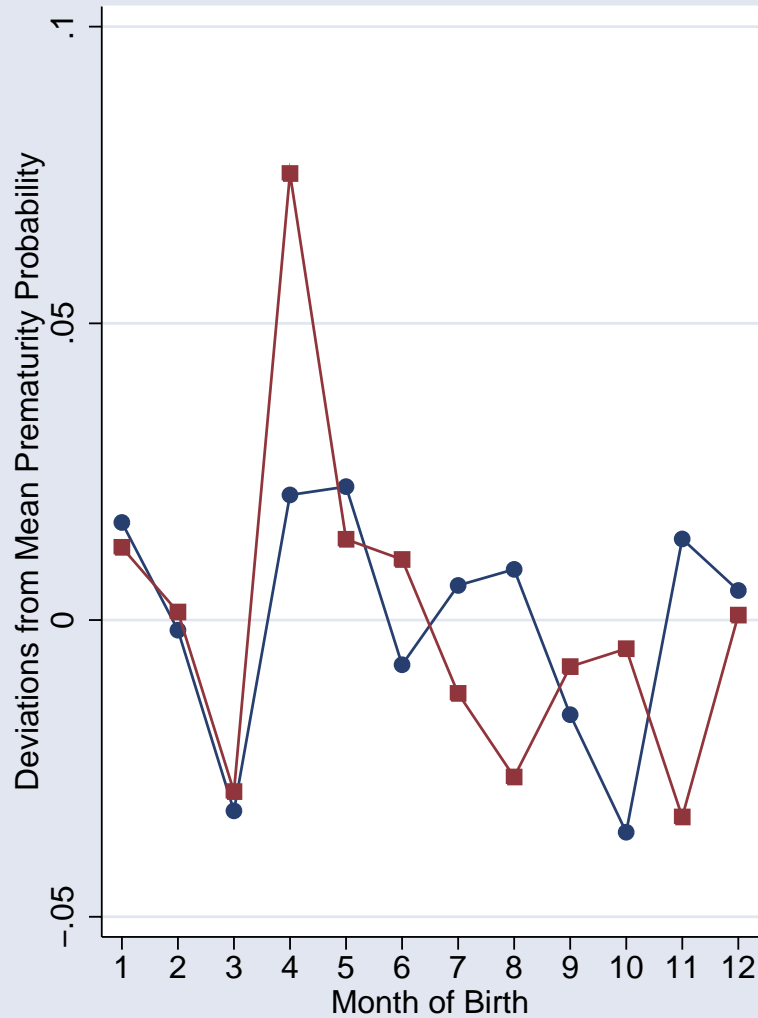
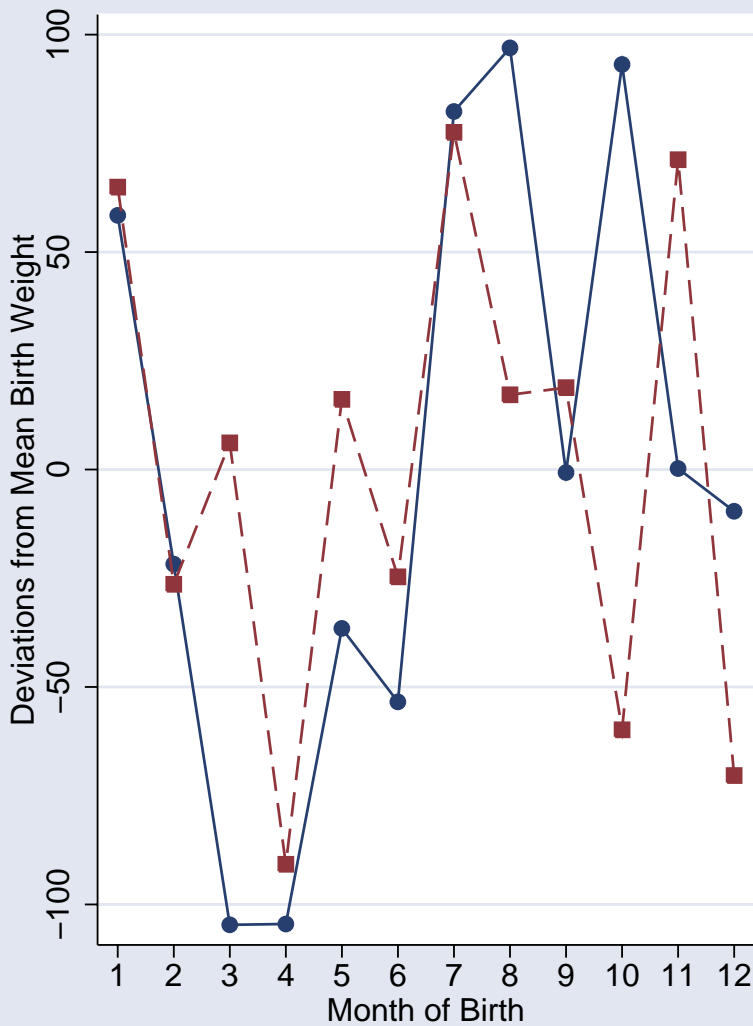
Survivorship and City of Residence in 1900 by Race, UA (Costa 2004)



Proxing for Early Life Conditions with Season of Birth

- Maternal nutrition in winter
 - Vitamin levels at lowest levels in spring in 1930s study
 - Respiratory disease in winter might also affect in-utero health
 - Birth weights at JHU, 1895-1935, lowest in spring (Mar-May) and prematurity rates highest in 2nd quarter (Apr-June)
 - Note: birth weight pattern shifted in 1950s and now lightest babies born in summer

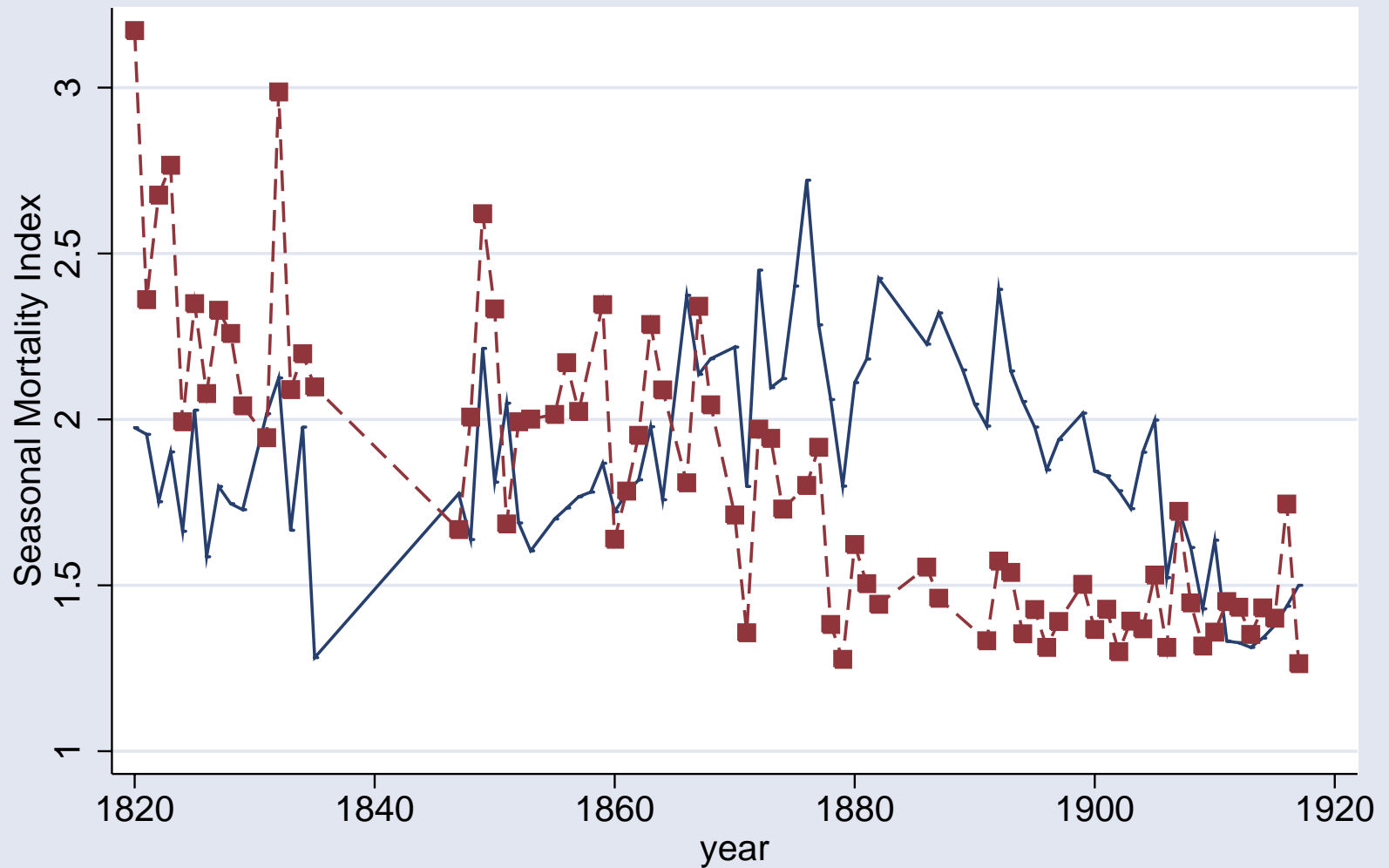
Birth Weight and Prematurity Probability Deviations, JHU 1895-1935 (Costa and Lahey 2004)



Proxying for Early Life Conditions with Season of Birth, Cont

- Season of birth determines what environment born into
 - Mortality peaked in summer from diarrheal disease
 - Summer mortality effect begins to dampen in second half of 19th century and disappears by 1920 (Conrad and Lentzer 2003)
 - Infant summer mortality peak also determined by infant feeding practices (Conrad and Lentzer 2003)

Seasonality Mortality Index, NYC, 1820-1920 (Conrad and Lentzer 2003)



— Children Under Age 1 - - - ■ - - - Children Age 1-2

Quarter of Birth and Mortality

- Doblhammer and Vaupel (2001): among 50+ if born in 2nd quarter instead of 4th in northern hemisphere live longer but if born in southern hemisphere pattern reversed

Changing Impact of Quarter of Birth (Costa and Lahey 2004)

- In UA data if born in 2nd or 3rd quarter relative to 4th, 9% increase in mean 10 year mortality rates
- In UA sample excess season of birth mortality due to heart and cerebrovascular (consistent with Barker findings)
- In 1960-80 data:
 - if born in 2nd quarter relative to 4th, 8% increase in mean 10 year mortality rates
 - If born in 3rd quarter relative to 4th, 4% increase in mean 10 year mortality rates

Table 6: Comparison of the Effects of Quarter of Birth on Ten Year Mortality Rates of 60-79 Year Olds, Union Army Veterans, 1900, and Native-Born Americans, 1960-1980

	UA Veterans		1960-1980	
	Coef	Std Err	Coef	Std Err
Dummy=1 if born in				
First quarter	0.020	0.022	0.003	0.005
Second quarter	0.042*	0.023	0.030 [†]	0.006
Third quarter	0.041*	0.023	0.013 [†]	0.006
Fourth quarter				
Observations	4927		128	
Pseudo R ² /R ²	0.036		0.984	

Explaining Mortality Decline

- Declining impact of season of birth accounts for 16-17% of mortality difference between UA and 1960-80 data
- Improvements in all measurable early life factors account for perhaps 30% of mortality decline UA and 1970

Underlying Causes Improvements in Early and Late Life Conditions

- Economic growth
 - Less dependent upon seasonal agricultural cycle
 - Shift from manual to white collar work
- Scientific knowledge and health habits
 - Decline in typhoid mortality even before public health investments (Troesken 2004)

Underlying Causes Improvements in Early and Late Life Conditions

- Public health investments
 - Troesken (2004), Costa and Kahn (2004), Bleakley (2002)
 - Poor and blacks biggest beneficiaries because had fewest self-protection options
 - Public willingness to invest because of fear of infection but expenditures undertaken by cities low relative to value of lives saved (Costa and Kahn 2004)

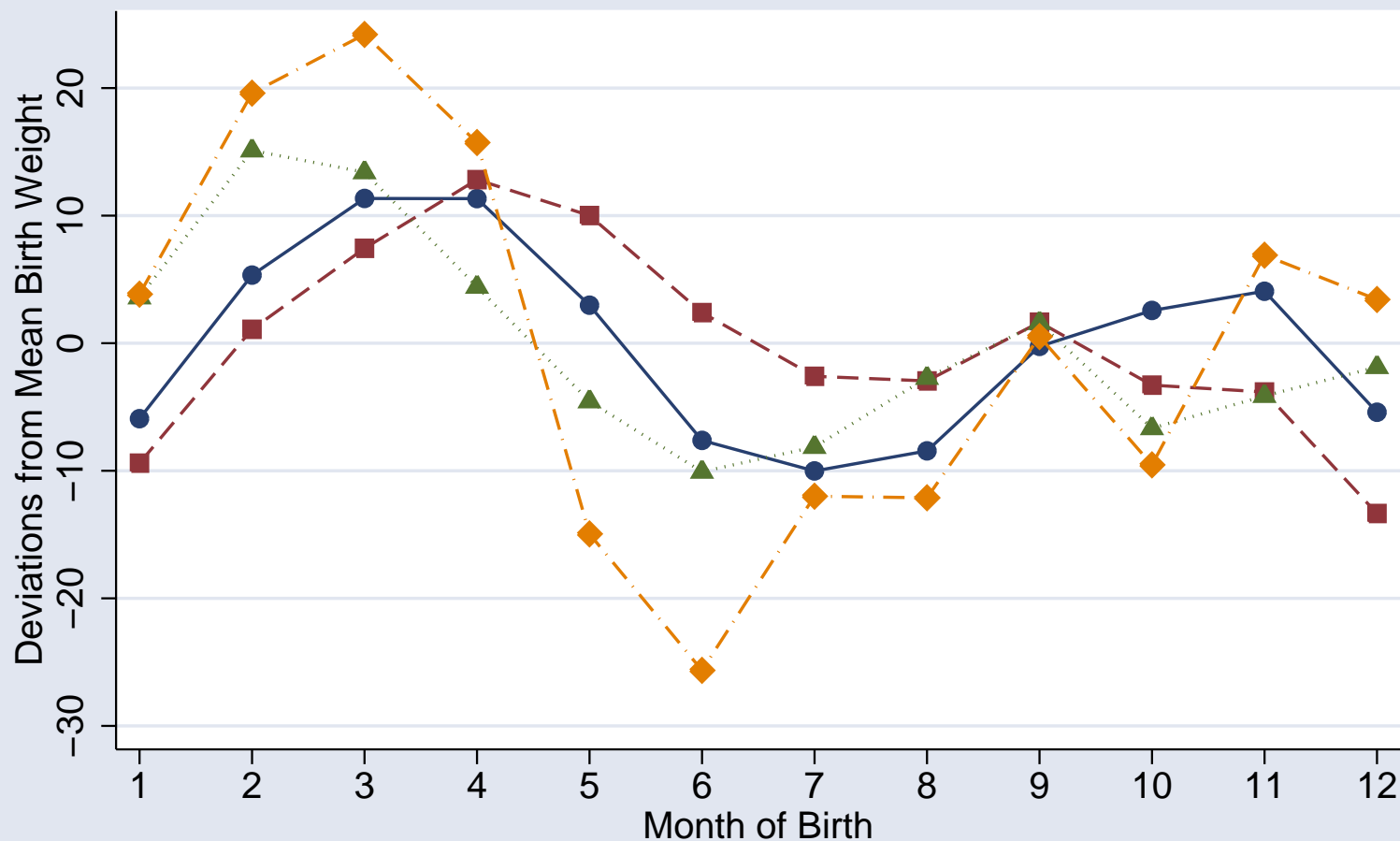
Underlying Causes Improvements in Early and Late Life Conditions

- Innovations in medical care
 - Declines in debilitating effects of chronic conditions
 - Hard to attribute declines to medical care, but some easy cases:
 - UA vs veterans in 1980s: as likely to ever have had hernia, but now easily curable (Fogel and Costa 1997)
 - Cataracts for UA vets meant blindness (Costa 2002)

Predicting Future Trends

- Baby-boomers particularly long-lived and healthy
 - No longer urban penalty, childhood infectious disease rare, food supply less dependent upon agricultural cycle
- After the baby-boom cohort, mortality/disability decline may slow down
 - Early life conditions still improving, but much smaller changes relative to past
 - Improvements will need to come increasingly from better medical care or health habits

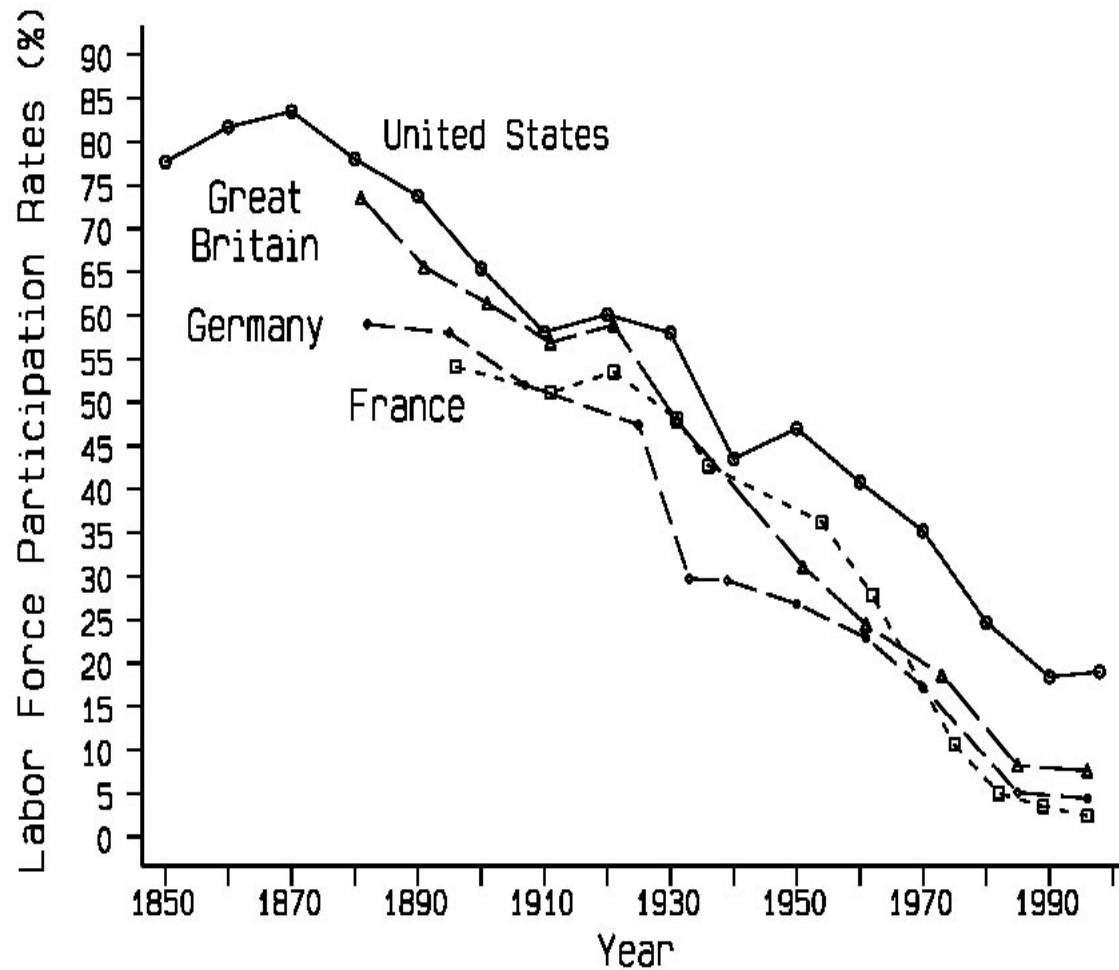
Birth Weight Seasonality, 1968-2000 (Costa and Lahey 2004)



Implications

- Predicted mortality trends both bad and good news for Social Security systems
 - Still need to absorb baby-boom cohort
- Will there be fiscal benefits to improving health?
 - Not clear improving health will lead to increased labor force participation nor that it will reduce demand for medical care (esp if some else pays for it)

LFP Rates, Men 65+ (Costa 1998)



Implications, Cont

- Should we still be investing in improving health?
 - Yes. Value of life is increasing. Income elasticity of value of life ~ 1.6 from 1940-80. Even marginal improvements in value of life have high value added, higher than large improvements in life expectancy at beginning of century (Costa and Kahn, forthcoming, 2004)

Per Person Value of Mortality Decline

	1900-20	1920-40	1940-60	1960-80	1980-2000
Age-adjusted mortality decline per year (deaths per 1,000,000)	3,709	3,621	4,458	3,001	1,671
Value decline per person (in 1,000s 1990 \$) per year	1,771	2,970	6,860	11,136	11,732
Increase national health care expenditures per person per year		102	369	1,045	1,824