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Appendix B
Properties and Availability of the Union Army Life-Cycle Sample

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Sample Properties

The Life-Cycle Data on the Aging of the Veterans of the Union Army, cited by the authors in this volume, have been collected by the program project entitled "Early Indicators of Later Work Levels, Disease, and Death," funded by the National Institute on Aging (NIH P01 AG10120) and the National Science Foundation (NSF SBR 9114981). Generous support has also been provided by the National Bureau of Economic Research. The data were collected and coded by the Center for Population Economics (CPE) at the University of Chicago's Graduate School of Business, and by the Department of Economics at Brigham Young University, between 1991 and 2001. Further information on the development of the program project can be obtained from Larry T. Wimmer (author of ch. 1 in this volume), as well as from the CPE Web site: www.cpe.uchicago.edu/welcome/history.html. The data sets described below can be downloaded from the CPE's interactive data extraction system, located at http://www.cpe.uchicago.edu/data/data.html.

The Union Army Life-Cycle Sample consists of longitudinally linked observations for a sample of 39,616 white males mustered into the Union Army. A one-stage cluster sample, it consists of all enlisted men belonging to 331 randomly selected white infantry companies drawn from the 20,000-odd companies who fought for the Union in the Civil War (Dyer 1959). Due to budgetary considerations, data have not yet been collected on individuals belonging to 30 of the 331 companies in the original sample: 15 companies from Indiana and 15 from Wisconsin. The sample collected so far thus consists of 35,747 veterans from 303 Union Army companies. The remain-

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ing 30 companies' data will be collected and made available as described below. Since the demographic composition of the Union Army as a whole contained a disproportionate number of soldiers from Midwestern states relative to the general U.S. population (Smith 2000), this omission makes the database more geographically representative of the U.S. population.

A large fraction of the Northern military-age population served in the Union Army. Sixty-five to 98 percent of the cohorts born between 1838 and 1845 were examined for military service, and 48 to 81 percent of these cohorts served, the remainder being rejected for poor health. The men who served are representative of the Northern population of military age in terms of real estate and personal property wealth in 1860 (Fogel 1993).

Union Army veterans became eligible for pensions. This pension program was the most widespread form of assistance to the elderly prior to Social Security, covering 85 percent of all Union Army veterans by 1900 and 90 percent by 1910 (Costa 1998, 160). The program began in 1862 when Congress established the basic system of pension laws, known as the General Law pension system, to provide pensions to both regular and volunteer recruits who were severely disabled as a direct result of military service (see Costa, 197–212, for a history of the Union Army pension program). The Union Army pension program became a universal disability and old age pension program for veterans with the passage of the act of 27 June 1890, which specified that any disability entitled the veteran to a pension. Even though old age was not recognized by statute as sufficient cause to qualify for a pension until 1907, the Pension Bureau granted the minimum pension to those aged sixty-five or older unless they were "unusually vigorous." In 1912 the law changed yet again, granting larger pensions to veterans who had served for longer lengths of time and who met the age requirements. (For a review of changes in Civil War pension legislation, see Linares 2001).

The Pension Records contain complete medical examinations conducted by a board of three examining surgeons because those with severe chronic conditions were eligible for larger pensions, particularly if the disability could be traced to wartime experience. The surgeons rated the severity of specific conditions using detailed guidelines provided by the Pension Bureau. Several tests indicate that the population is representative of the general population circa 1900 in terms of mortality experience (Fogel 1993).

A variety of sources provide data on military, socioeconomic, and health characteristics for the men in the Life-Cycle Sample. Table B.1 lists the primary record types that served as sources for the linked Life-Cycle Sample. Linkage to the 1880 U.S. Census manuscript schedules is currently underway. No attempt was made to link veterans to the 1890 U.S. Census, since the majority of its schedules were destroyed by fire early in the twentieth century.

Not every individual in the Life-Cycle Sample could be linked to all record types. Successful linkage depended on a variety of factors, including

Table B.1 Principle Data Sources for the Union Army Life-Cycle Sample

Source	Abbreviation
Main sources	
Descriptive books of Union Army regiments	RR
Carded Medical Records, Union Army	CMR
Military Service Records, Union Army	MSR
Pension Records, Union Army	PEN
U.S. Census of 1850, manuscript schedules	C50
U.S. Census of 1860, manuscript schedules	C60
U.S. Census of 1870, manuscript schedules	C70
U.S. Census of 1880, manuscript schedules	C80
U.S. Census of 1900, manuscript schedules	C00
U.S. Census of 1910, manuscript schedules	C10
Regimental histories	RH
Supplemental sources	
Public health records	PHR
Muster-out rolls, Union Army	MO
Pension payout cards	PAY
Rejection records, Union Army	REJ
U.S. Census of Mortality, 1850, 1860, 1870, 1880	CMOR
Manual of American Water Works (Baker 1897)	WW
U.S. Army Morbidity and Mortality Reports, 1829–75	MM
State censuses, 1855, 1865, 1875	S55, S65, S75
General and Social Statistics of Cities, U.S. Census Bureau 1880, 1890, 1909, 1915–16	GSSC
Records of the Grand Army of the Republic	GAR

longevity, geographical location, and surname frequency. Linkage rates for the six primary record types are given in table B.2, which shows how linkage rates varied between the different record types. Because the 1850 and 1860 censuses lack adequate soundexes (phonetic indexes), linkages rates for these censuses are lower than they are for the 1900 and 1910 censuses. The linkage rate to the 1910 census is lower than that for 1900 because not all states in 1910 are soundexed.

Regression analysis of the probability of being linked to the seven record sources[1] revealed that most of the variance in the linkage rates was random noise. Characteristics that did predict linkage had a relatively small effect on the variance. In 1850 and 1860 farmers and farm laborers and the native-born were more likely to be linked because many of the foreign-born had not yet immigrated, and because it is easier to find men in rural than in urban areas. Being foreign-born decreased the probability of linkage by 0.26 in 1850 and by 0.14 in 1850. White-collar workers' probability of linkage to the 1860 census was smaller by 0.08 than that of farmers and farm laborers. The coefficients on other personal variables such as region of birth were

1. Full details of the regression analyses are available from Viechnicki (2002).

Table B.2 Linkage Rates for the Major Data Sources for the Life-Cycle Sample

Data Set	Number at Risk to be Linked	Number Linked	Percentage Linked
Military Service Records	35,571	34,775	98
Carded Medical Records	35,571	30,286	85
Pension Records	30,277[a]	24,185	79
U.S. Census of 1910	9,158[b]	6,376	70
U.S. Census of 1900	13,549[c]	11,049	82
U.S. Census of 1860	27,737[d]	11,278	41
U.S. Census of 1850	26,978[e]	9,794	36

[a]All recruits who survived the war were considered at risk for linkage to pension.

[b]In 1910, 9,158 veterans from the primary sample were alive.

[c]In 1900, 13,549 veterans from the primary sample were alive.

[d]Excludes veterans who were foreign-born and had not immigrated by 1860.

[e]Excludes veterans who were foreign-born and had not immigrated by 1850.

small. Among veterans at risk of being linked to the 1900 and 1910 censuses, a veteran was more likely to be linked if he lived in a rural area (defined as a county with no city of at least 25,000 residents), was retired, or lived in the North. Professionals were more likely to be linked, while laborers were less likely. Older veterans were also less likely to be linked.

Pension law determined the best predictors of linkage to the pension records. Deserters were ineligible, and until 1890 only a veteran with a war-related disability qualified for a pension. Veterans wounded in the war increased their probability of being linked to the pension records by 0.22 and deserters decreased their probability by 0.32. Substitutes and the foreign-born also had a lower probability of being linked to the pension records (about 0.14). Farmers were more likely to be linked to the pension records, but this increased their probability of linkage by only 0.11 relative to non-farmers. All other predictors had relatively little effect on linkage rates. Approximately 66 percent of all men with pension records have at least one examining surgeon's record. Linkage is much higher, though, if we exclude men who died during the war and have pension records only because their dependents filed for pension. After 1892, Surgeons' Certificates are available for roughly 83 percent of veterans who have pensions. Those without Surgeons' Certificates are men who were either so severely wounded or disabled during the war that they did not need to prove eligibility, or those who applied under the 1907 or 1912 laws on the basis of age and length of service.

In summary, regression analysis of linkage failures reveals that any selection bias issues raised by failure to link the Union Army recruits to the censuses, Pension Records, Surgeons' Certificates, or Military Service Records will have minimal impact; and what little bias may exist can easily be corrected by post-weighting where appropriate.

The records used to create the Union Army sample provide a wealth of information on soldiers' prewar characteristics, wartime experiences, and postwar health and socioeconomic status. In addition to these individual-level variables, ecological variables were also created to measure the severity of the disease environments in the localities in which the veterans lived at different points over the life course. The principal variables that have been collected for each veteran are listed in table B.3, together with their sources. As can be seen from panels A, B, and C of table B.3, the variables collected in the Union Army Life-Cycle Data set give an almost complete picture of the life history of each veteran, from the war until the veteran's death. For some veterans, prewar information is available as well.

Particular care has been focused on assessing the reliability of the medical information contained in the Pension Bureau's Surgeons' Certificates, which record physical examinations of the veterans in the sample. Analysis reveals that the examining surgeons' records provide reliable indicators of the health status of Union Army veterans. During an examination, a veteran would undergo several subexams, each of which targeted a specific organ or system. The number of subexams increased sharply after 1890, when the law waived the requirement that only war-related disabilities qualified for a pension, and declined after 1912, when many men sought increases in their pensions on the basis of age and length of service rather than changes in disability (cf. Linares 2001). Injury was the most common subexam until 1889. Between 1890 and 1903 the more common conditions examined were cardiovascular, rheumatism, respiratory, and gastrointestinal. From 1904 to 1914, genitourinary problems are added to the list of more common conditions. After 1914, eye problems become common, as would be expected in an aging population. Subexams served as regular check-ups and were not examined only when a recruit claimed to have a specific condition. The examining surgeons were particularly careful in screening for cardiovascular, gastrointestinal, respiratory, spleen, kidney, and liver problems. The same recruits were examined for the same basic problems across their life cycles. On average, 70 percent of subexams in an examination were the same types of subexams as in a previous examination, suggesting that the examining surgeons were consistent in their work. Consistency falls after 1914 as recruits develop more age-related problems, again suggesting that there are no systematic biases in the work of the examining surgeons.

The examining surgeons rated conditions in terms of how disabling each was, and these disability ratings appear to reflect accurately the severity of the related conditions. In a case study of the determinants of hernia ratings, Song (2000) finds that symptoms alone explained 44 percent of the variation in hernia ratings. The incremental ratings on each type of hernia are consistent with hernia severity. For example, relative to hernias in advanced stages of development that were more morbid, having a reducible hernia decreased the rating by 0.034 and having a hernia that could be held effectively

Table B.3 Principle Variables in the Union Army Life-Cycle Sample

	Source	Variable
	A. Preservice characteristics	
For individual and his family	C50, C60, RR, PEN	Year of birth
		Age at enlistment
		Height at enlistment
		Geographic origin (urban/rural, county/state/region)
		Place of birth and enlistment
		Date of enlistment (early/middle/late in war)
		Household wealth in 1850, 1860
		Ethnicity of parents
		Family size in 1850, 1860
		Birth order among surviving siblings
		Migration history of parental family
		Literacy of individual and family members
Ecological variables	C50, C60, S55, S65, PHR, CMOR, MM, WW	Causes of mortality and morbidity in nation as a whole
		Causes of morbidity and mortality in locality from early childhood to recruitment
		Nature of water supply and sewage system
Rejection data	REJ	Causes of rejection
		Relation of rejection to above
	B. Wartime experiences	
Morbidity and mortality	RR, CMR, MSR, PEN	Illnesses and hospitalizations (cause, duration, treatment, outcome)
		Battle injuries
		Other accidents and trauma
Potential stress	RR, MSR, CMR, MO, PEN, RH	Rank
		Combat experience
		Casualties in company
		Wounded, fired-on, in-zone (number of battles for each)
		Severity of each battle
		Movements of company between battles
		Prisoner of war (when, where, duration, conditions)
		Tour of duty (duration, state of war, transfers)
		Service record (desertions or AWOL, citations for bravery, reprimands or punishments, promotions, demotions)
	C. Postwar history	
Health of veteran	PEN, PAY	Testimonial history of health before pension application
		Complaints of veteran at each examination by Pension Bureau surgeons
		Height, weight, pulse, respiration, urinalysis at each exam by surgeons
		Conditions diagnosed at each examination
		Date of becoming bedridden

Table B.3 (continued)

	Source	Variable
		Dates of admission to veterans' hospitals or homes and the diagnoses on entry
		Date and cause of death
Occupations and work	PEN, C70, C80, C00, C10	Occupations at each pension examination and in 1870, 1880, 1900, 1910
		Surgeon's estimates at each examination of degree of impairment from manual labor for each condition
		Pension Bureau's estimate of overall impairment for manual labor
		Months worked in 1900 and 1910
Personal and family structure and characteristics	PEN, PAY, C70, C80, C00, C10, GAR	Marriages, divorces, deaths of spouses, with dates of each
		Births and deaths of children, with dates
		Residences at pension examinations, and when receiving payments from Pension Bureau
		Household structure in 1870, 1880, 1900, 1910
		Grand Army of the Republic membership
Environmental factors	PHR, GAR, WW, GSSC	Strength of GAR presence in locality
		Water supply and sewerage characteristics in town of residence
		Weekly infectious disease rates in town of residence
		Public spending on police, fire prevention, public health infrastructure, and recreation

Notes: C50, C60, C70, C80, C00, C10 = censuses of 1850, 1860, 1870, 1880, 1900, 1910; CMOR = Census of Mortality; CMR = Carded Medical Records; GAR = Records of Grand Army of the Republic; GSSC = General and Social Statistics of Cities; MM = Army Morbidity and Mortality Reports; MO = Muster-out Rolls; MSR = Military Service Records; PAY = Pension payout cards; PEN = Pension Records; PHR = Public Health Reports; REJ = Rejection Records Sample; RH = Regimental Histories; RR = Regimental Records; S55, S65 = State censuses of 1855 and 1865; WW = Water Works Data.

by a truss decreased the rating by 0.053. Larger hernias received higher ratings. Double hernias received higher ratings than single hernias. Controlling for nonmedical variables does not change the coefficient estimates on the medical variables, nor does it increase the explanatory power of the regression. Year of application, political party affiliation of the state, and whether the state was a swing state have no significant impact on hernia ratings. Filing with attorneys and filing under laws that were passed in later years decreased hernia ratings, because only those who were particularly healthy filed later and filed with an attorney. Hernia symptoms and ratings are also consistent across different groups of examining surgeons. Among hernia patients who had subsequent medical examinations in states or cities other than where they had their first examination, there is no evidence of regional discrepancies in hernia diagnoses and hernia ratings. The Pension

Bureau appears to have administered the Union Army pension program in a just manner and the examining surgeons appear to have carried out their duties accurately and fairly.

The examining surgeons' diagnoses and descriptions depended upon symptoms, signs, and conditions that did not require any diagnostic equipment. Cancer rates in the data are therefore underreported. Prevalence rates for other conditions such as hypertension are unknown because the examining surgeons had no way of diagnosing these. Considerable time has been devoted to understanding how to interpret many of the common conditions noted by the examining surgeons. Table B.4 compares some conditions in the Union Army Life-Cycle Sample among veterans aged sixty to seventy-four to men in the same age group in the 1988–94 National Health and Nutrition Examination Survey, and in the 1994 National Health Interview Survey, both based upon random samples of the noninstitutionalized population. Note the very high prevalence in the Union Army sample of heart murmurs, irregular pulse, and tachycardia. Some of this may reflect the more careful examinations of surgeons accustomed to direct observations as well as looser

Table B.4 Prevalence Rates of Chronic Conditions, Symptoms, and Signs, Men Aged 60 to 74

	UA, 1910	NHANES, 1988–94	NHIS, 1994
Decreased breath sounds	15.4	8.3	
Adventitious sounds	29.1	4.0	
Back problems	47.5	30.2	
Pain, tenderness, swelling in joints	54.1	35.2	
Heart murmur	38.7	3.8	1.7
Valvular heart disease (mitral or aortic origin murmurs)	27.4		
Congestive heart failure (edema, cyanosis, and dyspnea)	8.9	7.0	
Arteriosclerosis	9.2		4.7
Ever diagnosed stroke	0.6	5.2	
Irregular pulse	43.7	8.6	
Tachycardia	27.0		3.4
Varicose veins	10.1		3.4
Hemorrhoids	36.1		4.7
Poor circulation	4.1		1.4
Cataracts	6.6	16.1	
Blindness in at least one eye	4.9	3.1	
Deafness in at least one ear	4.5	2.7	
Paralysis	6.9	2.7	

Source: Costa (2000b).

Notes: UA = Union Army; NHANES = National Health and Nutrition Examination Survey; NHIS = National Health Interview Survey. Sample weights were used for NHANES and NHIS. With the exception of stroke, congestive heart failure, and cataracts, NHANES results are based upon physical exams. Stroke, congestive heart failure, and cataracts in NHANES are based upon a condition ever having been noted by a doctor. A condition is noted in NHIS if the person had the condition in the last twelve months. In UA a condition is noted if it was ever mentioned in an exam.

definitions. However, the high prevalence rates for irregular pulse, tachycardia, poor circulation, and varicose veins are consistent with the high prevalence rate of valvular heart disease. (The relationship between valvular heart disease and varicose veins or tachycardia is much looser than for irregular pulse or tachycardia.) The high prevalence of joint and back problems are consistent with analyses of skeletal remains from the American frontier, which report a high prevalence of degenerative joint disease (osteoarthritis), nonarthritic joint changes resulting from habitual postures, and fractures arising from traumas (e.g., Larsen et al. 1995). The increased specificity of diagnoses makes comparisons with modern data difficult for some conditions. The examining surgeons' use of hard arteries as a detection criterion for atherosclerosis provides evidence of peripheral arteriosclerosis, which may be evidence of either atherosclerosis (cholesterol and fatty plaques in the blood) or such other disease states as diabetes mellitus or systemic or local inflammation. Congestive heart failure could be defined either by using edema, cyanosis, and dyspnea as the diagnostic criteria or by using these criteria together with cardiomegaly and excluding respiratory conditions. For conditions such as cataracts or stroke, examining surgeons may have been more likely to note the final outcome (blindness or paralysis) rather than the cause. Nonetheless, even when prevalence rates cannot be compared with modern data, it is still possible to examine whether chronic conditions at older ages arose from infectious disease contracted while in the army, occupational stress, or such stresses as living in a large city at a young age.

Analysis of the antecedents of the chronic conditions, symptoms, and signs recorded by the examining surgeons provides further confirmation of the reliability of the diagnoses. Contracting acute respiratory infections while in the army increased the probability of chronic respiratory problems at older ages; measles, the probability of chronic respiratory problems and valvular heart disease; typhoid fever, of valvular heart disease and irregular pulse; tuberculosis, of chronic respiratory problems; rheumatic fever, of valvular heart disease, arrythmias, congestive heart failure, joint problems, and back problems; and malaria, of joint problems (Costa 2000b). These relationships were expected from a reading of the medical literature (although the links between malaria and joint problems are not well established and therefore represent new findings). The infections likely to exert the larger effect on chronic disease rates in fact did so: rheumatic fever on joint problems, and tuberculosis on respiratory difficulties.

Subsidiary Data Sets

The individual-level information in the Union Army Life-Cycle Sample can be supplemented with a variety of aggregate-level and ecological variables. These variables have been collected in a series of auxiliary data sets distributed by the Center for Population Economics (CPE). The data sets described below are all available via the CPE data extraction system, at

http://www.cpe.uchicago.edu/data/data.html, under "Subsidiary Union Veterans Datasets."

The Regimental Histories Dataset focuses on the combat experiences of each Union Army company during the Civil War. It is drawn from Dyer's (1959) *Compendium of the War of the Rebellion.* This data set can be used to construct measures of wartime stress, military movement patterns, and regional disease environments for the veterans in the Union Army Life-Cycle Sample.

A number of subsidiary data sets record health conditions in different localities at different times. These can be linked to the Union Army Life-Cycle Sample to provide information on the disease environment in each veteran's region of residence over time. The earliest such data come from the United States Army's Morbidity and Mortality Reports for its military installations, which cover the period between 1829 and 1874. These reports provide quarterly case-rates and fatality rates for a series of infectious and chronic conditions for the regions of the country that contained military posts. The United States Census of Mortality from 1850, 1860, 1870, and 1880 can provide similar information on causes of death at the county level. Between 1899 and 1927, the American Public Health Association published case rates and fatality rates for infectious diseases in all U.S. cities possessed of more than 10,000 inhabitants. These three data sets thus provide measures of disease rates in various localities for most of the nineteenth century and the early twentieth century as well.

Several data sets describe the social and civic conditions of the towns and cities in which the veterans in the Union Army Life-Cycle Sample inhabited. The *Social and General Statistics of Cities,* published by the United States Census Bureau in 1880, 1890, 1909, and 1915–16, collects information on public infrastructure, expenditures, governance, and regulation for the period around the turn of the twentieth century. Baker's (1897) *Manual of American Water Works* is currently being computerized; by 2003, this data set will allow detailed information on water supply and sewerage to be accessed for every municipality in the United States that had a public water supply in 1897 (more than 4,000 such municipalities). Finally, the GAR Posts Dataset contains information about the number and location of Grand Army of the Republic posts for each U.S. county; it can be used to create measures of local influence for this most important Union Army veterans' organization.

Improvements and Extensions to the Life-Cycle Sample

Although the original data collection for the Union Army Life-Cycle Sample is essentially complete,[2] a series of improvements and extensions to

2. Linkage to the 1880 census, the last remaining record-type to be mined, was approximately 20 percent complete as of May 2002.

the sample are planned or underway. Chief among these improvements are the following steps. First, in order to allow comparisons of African American aging experiences to those of whites, a life-cycle sample of African American Union Army veterans is being collected from the National Archives. This sample will consist of longitudinally linked observations for a sample of 6,164 African American veterans, and will take the same form as the previous Union Army Life-Cycle Sample. Initial versions of the African American Sample will be available in the second half of 2003. Second, data from the thirty Union Army companies from the original Life-Cycle Sample that were not collected for budgetary reasons (discussed at the beginning of this appendix) will now be collected. The inclusion of these companies in the Union Army Life-Cycle Sample will make the resultant data into a random sample of Union Army infantry companies. Finally, in order to understand more clearly the relative health status of Union Army veterans as compared to the general population, a larger sample of rejection records from the Union Army service examination will be collected. Ten thousand rejection records will be collected and computerized from the National Archives. This sample will allow prevalence rates of various conditions to be estimated by recruitment district and year.

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