THE EFFECT OF HERNIAS ON THE LABOR PARTICIPATION

OF CIVIL WAR VETERANS

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Comments Welcome[4]

ABSTRACT

We incorporated health into a labor supply model and studied the worker's decision to retire when he is confronted with a health problem. We argue that both contemporary health and lagged health have the potential to affect the worker's current labor force decision. We tested our predictions using the Union Army Census Data by linking the 1900 Census to the 1910 Census and by selecting 1,796 veterans who were in the labor force in 1900 and still alive by 1910. Among those veterans, 370 worked in less manually demanding professions in 1900, and 1,426 worked in more manually demanding professions in 1900. We use groin hernia status as a proxy for health conditions of the veterans, because hernias are considered to be debilitating and persistent, and there was no reliable cure available during the historical period.

Controlling for demographic characteristics, we found weak evidence of the influence of hernias on the labor force decision of the Civil War veterans. In the first specification where only the zero-one indicators of past and contemporary hernia prevalence are considered, having hernias in 1900 marginally increase the odds of retirement in 1910 by 10%. In the second specification, categorical dummies representing hernia ratings in 1900 and 1910 enter the regression. Relative to those with median ratings (between 0.25 and 0.5), patients having ratings of the least severe degree (between 0.1111 and 0.1667) in 1900 or in 1910 were more likely to retire and less likely to stay in the labor force by 1910. Age and monthly pension awards are both significantly positive predictors for retirement. There existed strong regional effects on retirement for veterans the West and the Midwest regions, relative to those residing in the Northeast Region. We did not find any difference in the propensity to retire between veterans in the less versus those in the more manually demanding occupations.

These findings suggest that the presence of a groin hernia does not influence labor force decisions as much as age, wealth, and regional factors do. One possibility could be that what modern medical practice believes to be "debilitating", as in the case of hernias, may only be in fact "discomforting." As a result, retirement was not so much influenced by this condition. Another possibility could be that older veterans in our sample endured hernias as long as hernias did not pose a mortal threat. In this case, contracting hernias and the worsening of hernias would not cause a reduction in earnings from exiting the labor force, although it would induce a reduction in welfare from the disutility of coping with the pain and possibly from rising medical costs.

I. INTRODUCTION

The health status of the elderly and its impact on labor supply and on the quality of life before and after retirement is an empirical issue that can be best addressed by high-quality panel data, i.e., data that contain comprehensive health and work information over time. One of the most frequently used contemporary data sets for research in this area is the Health and Retirement Study (HRS) (Blau and Gilleskie 1997; Dwyer and Mitchell 1998; Bound et al., 1998; Chan and Stevens 1999, Gustman and Steinmeier 2000; Coile and Gruber 2000b; and Mitchell and Phillips 2000). Other popular contemporary data sets include the Retirement History Study (RHS) (Gustman and Steinmeier 2000), the National Health Interview Survey (NHIS), and the National Health and Nutrition Examination Survey (NHANES II) (Costa 1994). The health information recorded in those data sets suffers two major shortcomings. First, the overall measurement of health is a dichotomous indicator of self-assessed health status derived by classifying responses of "excellent", "very good", "good", "fair", and "poor" (Blau and Gilleskie 1997, and Mitchell and Phillips 2000; Costa 1994). Second, the doctor-diagnosed conditions are coded as zero-one dummy variables, with a one indicating the prevalence of a certain condition, and a zero indicating no such condition (Mitchell and Phillips 2000; Costa 1994).

Bound et al. (1991) identifies four potential problems with self-reported global health, the main problem being that the judgments are subjective, and that responses may not be independent of the very labor market outcomes an investigator hopes to explain, introducing endogeneity into the explanatory variable. The zero-one condition dummies provide a more objective indicator of health status. However, those dummy variables do not account for the severity of the conditions experienced, so that all conditions are weighted equally. Co-morbidity, i.e., the prevalence of two or more conditions, does alleviate the lack of severity measure

between conditions by purging away the correlation between any two of them (Costa 1994), although severity within each condition is still left unmeasured.

This paper focuses on the labor supply implication from hernias, a very specific chronic disability that can be extremely debilitating. We examine the retirement behavior of 1,812 older men between 1900 and 1910 in the merged data set linking the Union Army (UA) Surgeons' Certificates (SC) and Census files. The UA health data contain medical diagnoses written by qualified surgeons who performed comprehensive examinations over the UA veterans. They are longitudinal, because veterans could apply for the UA pension several times and could be examined at different point of his life. Compared to the contemporary health data, they more accurate, because symptoms of each disability are carefully documented which makes it possible for researchers to quantify its severity. A common approach taken by other projects that use the UA files is the inclusion of several zero-one disease indicators in the group of explanatory variables (See, for example, Costa 2000). In comparison to those approaches, our investigation is more focused. We transcribe descriptions of hernia symptoms such as the size, the subtype, the location, and the morbidity into measures that we can incorporate into a regression analysis. We then study the labor participation implication using those measures, in addition to using the zero-one hernia dummy variable. Since data collection has become more sophisticated and precise over time, our methodology demonstrates one way of utilizing large-scale medical information. A more ambitious next step will be to construct a health composite index from all the available severity measures within each disability as well as across all disabilities. This composite index will be much more superior to the traditional aggregate of zero-one disability dummy variables and will improve our prediction of the role of health in economic behavior.

The organization of the rest of the paper is as follows: Section II provides a medical background for the history and the treatment of hernias; Section III describes the UA sample and

discusses the representation of our sample; Section IV presents the methodology and analyzes the results; and Section V concludes.

II. MEDICAL BACKGROUND

Although humans have been afflicted with groin hernias throughout history, a thorough understanding of the anatomy of the inguinal canal wasn't achieved until the early nineteenth century. During this time, cadaver dissections and clinical studies lead to publication of detailed anatomic atlases and treatises on the subject of groin hernias (Rutkow 1998). Despite the greater understanding of anatomy, surgical repair of hernias at the time was troubled by recurrence of the hernia. Thus, treatment of hernias was still limited to the use of trusses, while surgery was only performed in cases of hernia strangulation. Since then, improvements in anesthesia, surgical technique, sutures, and prosthetic materials have led to earlier surgical intervention and better clinical outcomes.

Prevalence. A hernia is defined as an abnormal protrusion of organ or tissue out of the cavity in which it normally lies and into another space or potential space. Generally, the term hernia refers to the more common groin or inguinal hernia, though many other types exist and are described by their anatomic locations: epigastric, hiatal, obturator, umbilical, and ventral. Unfortunately, the epidemology of groin hernias is not well defined. Historically, it is estimated that 4.6% of the population were afflicted with hernias (Iason 1941). A more recent survey based on clinical exams revealed that men aged 25 or older had a hernia prevalence rate (excluding repaired hernias) of 18% and a lifetime prevalence rate (inclusive of repaired hernias) of 24% (Abramsonet al. 1978). In contrast, self-reported information from insurance enrollment questionnaires estimated the prevalence rate of men aged 25 to 34 to be 1%, but higher in men

aged 35-44 (1.8%), aged 45-54 (2.2%), and aged 55-64 years (3.9%) (Rubensteinet al. 1983). While some differences between the rates may be due to underestimation from self-reported surveys, the differences are large and representative of the disparity in the field.

Distribution. With respect to gender distribution, it is believed that the prevalence rate of groin hernias is higher in men than in women, though the exact ratio is not well known. An early twentieth century report from New York's Hospital for Ruptured and Crippled reported at 3.1:1 male to female ratio (Coley, 1910) A more recent study from Henry Ford Hospital in Detroit showed a 12:1 male to female ratio (Ponka 1980). A review of the hernia repairs performed over the last 50 years at Shouldice Hospital in Toronto revealed a 21:1 male to female ratio (Welsh and Alexander 1993). The relative frequency of groin hernias compared to other hernias is also not well known. Representative data from the Henry Ford Hospital showed that in men, inguinal hernias comprised 81% of all hernias while femoral (3%), combinations of inguinal/femoral (8%), umbilical (2%), incisional (4%), hiatal (2%), and epigastric (1%) comprised the rest. For women, the ratios were inguinal (35%), femoral (11%), combination inguinal/femoral (3%) umbilical (17%), incisional (18%), hiatal (15%), and epigastric (3%) (Ponka 1980).

Natural history. Patients with hernias can present with a wide range of symptoms. Some patients are asymptomatic and only have surgery to prevent future complications, while others present with strangulated hernias and require emergent surgery. For most patients, a protruberant hernia is discomforting, but heavy lifting or straining can cause moderate or severe pain. This discomfort leads to avoidance of heavy labor and strenuous exercise unless the hernia can be retained with a truss or surgically corrected. Hernias also have a possibility of developing complications such as incarceration (inability to be reduced) or strangulation (vascular supply to herniated bowel is compromised).

Treatment. Though the anatomy of the human inguinal region was well demonstrated in the early nineteenth century by surgeons and anatomists such as Astley Cooper (Cooper 1804

and Cooper 1807), Franz Hesselbach (Hesselbach 1806 and Hesselbach 1814), and Antonio Scarpa (Scarpa 1809 and Scarpa 1821), surgical repair of hernias were complicated by frequent recurrence (Bull 1890). Thus early remedies for hernias were non-surgical, which included the use of external binding bandages to prevent protrusion of hernias. Later refinements led to the use of trusses, which were formed binders capable of more direct pressure on the hernia site. Young patients could expect their hernias to be "cured" if the truss was worn regularly, whereas older patients could only expect temporary relief and were dependent on the truss indefinitely (Cooper 1804).

In 1889, William Halsted (Halsted 1889) and Edoardo Bassini (Bassini 1889) independently reported a hernia repair that reconstructed the inguinal floor by apposing the conjoined tendon with the posterior rim of Poupart's ligament. Both reported dramatically reduced recurrence rates (3-4% over 4 years) with their procedures compared to other methods available at the time. Later refinements in the hernia repair by McVay (McVay 1948) and Shouldice (Shearburn and Myers 1969) led to further improvements in recurrence rates of less than 1%. The traditional dogma of hernia repair was revised when Lichtenstein published his experience with 6,321 cases of hernia repair. He believed that traditional repair methods using sutures were anatomically rigid, and instead supported the use of a prosthetic mesh to butress the weak tissues. His patients had low recurrence rates (0.7%) and lower requirements for pain medications postoperatively (Lichenstein 1987).

While the therapy for hernias has evolved, the method of diagnosis and natural history hasn't changed much since hernias were anatomically understood in the early nineteenth century. This characteristic of hernias permits us to study the effects of hernias on labor participation during a period when most hernias were not repaired electively. This unique look at the effects of hernias without intervention can also give us insights into the beneficial effects of modern hernia therapy.

III. DATA

Sample. The data used in this study were from Civil War records stored at the United States National Archives. A random sample of 39,616 white male recruits with enlistment papers, henceforth referred to as the "Military File," was drawn from the National Archives, representing 331 companies mustered into the UA during the Civil War (Center for Population Economics 1998). Approximately 85% of those recruits, or 33,674 men, were also linked to the Pension Bureau data set, henceforth referred to as the "Pension File." At the time of this paper, we are able to obtain records on 28,530 recruits from the Pension File.[1] For those recruits in the Pension data, 9,114 were linked to the 1900 Census, henceforth referred to as the 1900 Census File, and 5,182 were linked to the 1910 Census, henceforth referred to as the 1910 Census File.[2] The bulk of the health information came from "Surgeon's Certificates File." This file stores details of the physical examinations of 16,713 pension applicants. The Pension Bureau surgeons conducted those examinations. An examination usually consisted of an inspection of the general organ system as well as an investigation of active medical problems. Components of the handwritten exam entries were transcribed into "disease variables" that captured the essential information about the exam findings.

Table III.1 presents the data availability under each variable of interest to our study. We group the variables into three categories pertaining to cohort, health, and socioeconomic status.

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[1] Data from Wisconsin, Indiana, New Mexico and California are still being cleaned and not included in the Military File. In addition to data from those 4 states, data from New Jersey is not included in the Pension File. Moreover, a prior pilot sample of 20 companies with the same geographical composition of recruits as the Military File is missing.

[2] The key to a successful link is the presence of soundexes for the Census constructed by a commercial genealogist. The soundexes can map a recruit's name to a possible candidate in the Census given the location of the recruit during the Census year. Also, the Civil War enrollment lists may give addresses that would aid in the location of individuals not found through the soundexes.

While the cohort information is easy to obtain[3], a fair amount of work is involved in the standardization of hernia variable, as well as in the categorization of occupations. We describe below how we construct health and occupational measures to fit the purpose of our study.

Table III.1: Variables and Data Sources

Variable	Construction	Source	Number of Observations
Cohort Information			
Birth Year	Enlistment Year Minus Enlistment Age	Military File	27,493 out of 28,530
Death Year	Original Data	Pension File Military File	27,493 out of 28,530, including deaths in the war & deaths recorded in pension applications
Health Information			
Hernia (Kind, Side, Class, Size, Rating)	Cleaned Hernia Data	Surgeons' Certificates File	16,652 out of 16,713
Socioeconomic Information			
Birth State (Native/Foreign)	Original Data	Military File	27,504 out of 28,530
Largest City Population in 1900 Residential County	Merged Data	1900 Census File	11,584 out of 11,606
1900 Residential State	Original Data	1900 Census File	11,584 out of 11,606
1900 Occupation	Original Data	1900 Census File	6,587 out of 11,606
1910 Occupation	Original Data	1910 Census	4,092 out of 6,635
1900 Literacy	Original Data	1900 Census	11,477 out of 11,606
1900 Household Relation	Original Data	1900 Census	11,306 out of 11,606
1900 Marital Status	Original Data	1900 Census	9,547 out of 11,606
Monthly Pension Amount in the Year before but Closest to 1910	Original Data	Pension File	13,857 out of 28,530

III.i.   Health Information

Hernia Variables. Out of the disease variables in the Surgeons Certificates, hernia variables were among the most robust because the clinical diagnosis of hernias has not changed significantly since the 19th Century. This allowed interpretation and standardization of the hernia

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[3] When the year of birth (YOB) cannot be found from the Pension File, the year was inferred by subtracting the age at enlistment from the year of enlistment. Among records with YOB, age of birth, and year of enlistment, the distribution of the differential between the calculated YOB and the recorded YOB in the Pension data centered at 0, with the majority of the mass clustered between –1 and 1 year (Song 1999). Year of death is useful, because many recruits still had several years to live after their last recorded medical exams.

findings without confounding issues such as differences in medical knowledge and medical language. Among hernia variables, three were chosen for their clinical significance: the anatomic location of the hernia (h_knd), the characteristics of the hernia (h_cls), and the size of the hernia (h_siz).

Table III.2

Transcription of Hernia Diagnoses

Examples of Original Descriptions Appearing in Surgeons' Certificates	Transcribed Answer Classes (AC)	Transcribed Middle Modifiers (MM)
Hernia Subtype		
2 Complete Hernias	Inguinal	Bilateral, Complete
Right Abdominal Rupture	Ventral	Right
Directly above Umblicus	Umbilical	None
Complete Right Femoral Hernia	Femoral	Right
Hernia Linea Alba	Epigastric	None
Rupture of Stomach	Hiatal	None
Complete Hernia	Non-specified	None
Hernia Morbidity & Truss Efficacy		
Left Tumor Descend into Scrotum If Not Hold by Truss	Truss Effective	Left
Left Hernia Requires More Force than Right to Be Reduced	Reducible	Bilateral
No Bandage Is of Any Use	Truss Not Effective	None
Inflamed	Inflamed	None
Adhesions Prevent Its Full Reducibility	Incarcerated	None
Left Hernia Strangulated	Strangulated	Left
Hernia Is Not Inflamed	Non-specified	None
Not Aneurysm	Non-classified	None
Hernia Size		
Left Three Cent Pieces	Less than One Inch	Left
Man's Two Fingers	One Inch	None
Quail Egg	Two Inches	None
Right Femoral 3 by 2 Inches	Three Inches	Right
Large Grapefruit	Four Inches	None
Pineapple	Six Inches	None
Man's Two Fists	Eight Inches	None
Right Very Large	Non-specified	Right
Veins 3 Times Normal	Non-classified	None
Hernia Location		
MM Bilateral	Double	
MM Right	Single	
MM Left	Single	

After the initial transcription and classification of the freeform exam findings into disease variables, finer classification was performed using "disease outlines." The outlines contained a

multi-level system for classifying the many disease observations into a workable and clinically relevant number. At the base of the outline for each variable was the Answer Class (AC), which contained the major medical finding. Two supplemental categories added more detailed to the AC. The Middle Modifier (MM) contained anatomic or descriptive information while the Severity Modifier (SM) contained severity information. Furthermore, the many other variations in spelling, word orientation, and synonyms could be coded with a similar description. This compacted the many freeform observations into a few, clinically relevant and easily workable categories. Two special AC codes were created for ambiguous data. When the medical description by the Pension Bureau surgeons indicated the presence of an abnormal exam finding or disease, but the specific finding or disease was indeterminate, then the observation would be coded as "unspecified." When the observation was too vague for medical interpretation or significance, it was coded as "unclassified." Table III.2 demonstrates the standardization process with examples under each diagnostic dimension.

Table III.3 summarizes the number of cases from the last step of transcription for 2,350 hernia patients and 6,395 patient-exam pairs in the Surgeons' Certificates File. The most common hernia subtype is hernia at the inguinal region, which covers ninety percent of the patients. The less usual, but still representative subtypes are ventral where a hernia is abdominal incisional, umbilical where a hernia protrudes through the abdominal wall under the skin at the umbilicus, and femoral where a hernia passes through the femoral ring. Two very rare subtypes are an epigastric hernia which is a hernia cutting through the linea alba above the navel, and a hiatal hernia which is a hernia becoming a part of the stomach through the hiatus. Under the category "hernia morbidity and truss efficacy," "truss effective" refers to a hernia whose impact could be minimized by wearing a supportable such as a truss. This group is considered as the least morbid. The next morbid group was a reducible hernia, in which the contents of the protrusion could be returned to their normal location. Eighty-six percent of the patients had

either "truss effective" or "reducible" hernias. If wearing a truss did not have any effect at all, a hernia became more morbid than the previous two groups. Where there are signs of inflammation, a hernia is "inflamed." Further, when a hernia is not irreducible, it is "incarcerated." An incarcerated hernia develops into a "strangulated" hernia if the circulation is arrested (Spraycar 1995: 788-790). A patient with a single hernia is less disabled than one with double hernias, and disability increases with the size of a hernia. Group proportions under each diagnostic category are comparable with those from other populations.

Table III.3

**Hernia Severity, by Diagnostic Category
--Where an Observation Is a Patient-Exam Pair**

Diagnostic Category	Number of Cases	Percentage of Total (%)
Hernia Subtype	**5,440**	
Inguinal	4,902	90.1
More Unusual Subtypes		
Ventral	226	4.2
Umbilical	146	2.7
Femoral	52	1.0
Epigastric	1	0.0
Hiatal	2	0.0
Non-specified or Non-Classified[*]	111	2.0
Hernia Morbidity and Truss Efficacy	**4,610**	
Truss Effective	1,335	29.0
Reducible	2,609	56.6
Higher Morbidity		
Truss Not Effective	319	6.9
Inflamed	2	0.0
Incarcerated	137	3.0
Strangulated	15	0.3
Non-specified or Non-Classified	193	4.1
Hernia Location	**4,942**	
Single Hernia		
Right Hernia	2,437	49.3
Left Hernia	1,642	33.2
Double Hernias	594	12.0
Non-Specified or Non-Classified	269	5.5
Hernia Size	**4,017**	
Less than One Inch	108	2.7
One Inch to Two Inches	577	14.4
Two Inches to Three Inches	1,143	28.5
Three to Four Inches	746	18.6
Four Inches or up	800	19.9
Non-Specified or Non-Classified	643	16.0

In estimating the overall degree of disability from having a hernia or hernias, two variables may be indicative. The first candidate is a nominal dollar amount increasing with the severity of hernias. The second candidate is the ratio variable referred to as the hernia disability rating, where the denominator is the maximum severity of hernias, and the numerator is the severity of hernias observed in a patient. The nominal pension amount is unattractive to use as a hernia disability index for four reasons: First, there is a large number of missing observations in this variable (out of 6,395 patient-exam pairs, only 1,311 are non-missing). Second, the nominal amount depended on military rank. Third, the nominal amount depended on various versions of pension provisions. Fourth, the nominal amount attributed to hernias is highly correlated with the overall dollar amount of pension granted to a recruit. Since we use the overall monthly pension award as a proxy for wealth, including also the dollar award corresponding to hernias would contaminate the wealth proxy. Because of those shortcomings, we decide to switch to the ratio variable, our second candidate.[4]

The ratio variable is referred to as the disability rating. For example, hernia was considered a disability less than the 3rd grade. Based on the 1873 Consolidation Act[5], for privates, single inguinal hernia of a minor protrusion translated to a disability rating of 6/18[6], double inguinal hernia of a minor protrusion translated to 10/18, and single femoral hernia translated to 10/18. Within the same disability category, the rating unambiguously reflected a surgeon's belief about a patient's disability that is independent of military rank and pension law updates.[7]

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[4] For examples of disability dollar compensations, see Sanders 2000.

[5] For a detailed description of the history of pension laws, see Costa 1998, Appendix A.

[6] Examples are taken from the same sources given in footnote 5.

[7] Consider a private and a lieutenant, both of whom had hernia disability ratings equivalent to 0.5. A lieutenant would receive a much higher dollar amount, say $15 per month out of the $30 maximum total, while a private would receive only $4 per month out of the $8 maximum total. Regardless of a higher nominal pension received by the lieutenant, they were judged by the surgeons to be equally disabled from hernias. New laws might increase dollar

Table III.4

Hernia Severity, by Ratings
--Where an Observation Is a Patient-Exam Pair

Hernia Rating	Number of Cases	Percentage of Total (%)	Cumulative (%)
0.0000	295	5.9	5.9
0.0556	4	0.1	5.9
0.1111	286	5.7	11.6
0.1250	6	0.1	11.8
0.1429	2	0	11.8
0.1667	29	0.6	12.4
0.2000	7	0.1	12.5
0.2222	632	12.6	25.1
0.2500	88	1.8	26.8
0.2778	10	0.2	27
0.3333	607	12.1	39.1
0.3750	3	0.1	39.2
0.3889	2	0	39.2
0.4286	1	0	39.2
0.4444	917	18.2	57.5
0.5000	310	6.2	63.6
0.5556	1,017	20.2	83.9
0.5882	1	0	83.9
0.6111	3	0.1	83.9
0.6250	7	0.1	84.1
0.6316	1	0	84.1
0.6667	424	8.4	92.5
0.7500	58	1.2	93.7
0.7778	235	4.7	98.4
0.8333	12	0.2	98.6
0.8824	1	0	98.6
0.8889	17	0.3	99
0.9444	39	0.8	99.7
1.0000	12	0.2	100
Number of Observations	5,026	100	100

Table III.4 shows the distribution of surgeons' hernia ratings ranging from 0 to 1. Out of the 6,395 hernia patient-exam pairs, we have ratings information for 5,026 of them. As a chronic condition, hernia was given very high ratings. The average rating is 0.42, which is just a little

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amounts of pensions for the same disability ratings, but in the case of hernia, they barely altered the ratings themselves. It is because of the unique meaning of the hernia rating variable that we deem it an appropriate index to measure the severity of this disability.

below half disability. Over a third of the cases corresponded to at least half disability, and over a quarter of the cases corresponded to at least a quarter disability.

III.ii.   Socioeconomic Information

Occupation. Occupations are coded using the index in the 1950 Census of Population.[8] We assign occupations into the following three categories[9]:

(L) Less manually demanding: Professional, Technical and Kindred Workers

Managers, Officials and Proprietors

Clerical and Kindred

Sales Workers

(M) More manually demanding: Farmers and Farm Managers

Craftsmen, Foremen, and Kindred Workers

Operatives and Kindred Workers

Service Workers

Farm Laborers and Foremen

Laborers, Except Farm and Mine

(R) Retirees[10]

We separate the labor force in the 1900 Census File into workers that participated in less manually demanding occupations and workers that participated in more manually demanding

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[8] See U.S. Bureau of the Census 1950.

[9] There are two possibilities why a recruit who was linked to a Census failed to have an occupational record: 1) The recruit had a job but did not report it; 2) The recruit was unemployed.

[10] Following Lee (Lee, 1998), we define retirees as those whose occupation was recorded as "retired," blank, "invalid or sick or disabled," "inmate or prisoner," "landlord," or "capitalist or gentlemen." We define unemployed as those whose occupation was recorded as "unemployed or without occupation."

occupations. If hernias were physically debilitating, we would expect the retirement probability to be higher for workers in more manually demanding occupations. We exclude veterans who were already retired by 1900. This leaves us with 3,406 individuals. Out of those veterans, 1,891 men survive the data merge with the Surgeons' Certificates File. We reach the final sample of 1,796 men after the final data merge with the Pension File from which we extract the monthly pension awards.

Birth State and Residential Population Size. Original birthplaces were reported by recruits at enlistment and were stored in the Military File. Since the Civil War is an ideological war, 71% of the recruits at enlistment were native born. Furthermore, since it was easier for the native born Americans to claim pension, perhaps because it was easier for them to provide the Pension Bureau with proof of identification and evidence of service, 90% of the pensioned veterans in our sample were native born. Degree of urbanization of the 1900 residential county is of interest to us, because it approximates the residential population density.[11] Employment opportunities differ between urban and rural areas. Residents in urban areas were much more likely to participate in the labor force and engage in certain types of occupations.

Literacy, Wealth and Household Relation. Literacy measures, to a limited extent, the intellectual capacity of a veteran. A veteran who could not read or write had limited employment opportunities. We realize however, that literacy is only a very crude proxy of basic education.[12] The Census File records three indicator variables that represent the wealth holdings of a household that a veteran belonged to: whether the household had a farm versus a house, whether

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[11] A county is urban if it contains at least one city with a population of 25,000 or over. There are 165 urban counties in 1900 (See U.S. Bureau of Census).

[12] If a veteran could sign his name, he would be considered as literate.

the household owned the property or rented it, and whether there was still mortgage left to be paid. We have decided not to incorporate those indicators. Instead, we find the monthly amount of pension a veteran received from the Pension Bureau to be a more accurate wealth measure[13]. This is because the average annual pension dollars were a substantial portion of the average annual per capita national income. Pension awards, therefore, could have a significant impact on veterans' incentive to retire. Finally, veteran's marital status and head-of-household status could affect the resource allocation within the household, which could in turn affect his labor participation.

III.iii.   Reliability of Hernia Diagnoses and Sample Selection Biases

Reliability of Hernia Diagnoses. There have been speculations that examining surgeons appointed by the Pension Bureau to assess the degree of disability of pension claimants had been biased in their medical judgment. In particular, the surgeons were suspected of exaggerating the symptoms and granting higher disability ratings to veterans, therefore putting an additional strain on the already astronomical Civil War pension costs. Song (2000) tests the validity of the charges that the examining surgeons intentionally had skewed the disability severity measure of Civil War veterans. She has found a close association between the surgeons' ratings and the pension applicants' symptoms in the case of hernias. Furthermore, she has also found that this association does not change over time and among states with different political party majority votes. She concludes that the Pension Board had administered the UA pension program in a just manner and that the examining surgeons had carried out their duties accurately and fairly.

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[13] In an earlier version of the paper, we experimented with the household wealth indicators and found that none of them possesses significant explanatory power over retirement. There are two explanations for this result: Non-liquid asset holdings do not have any impact on the labor participation of UA veterans, or zero-one property dummies are not accurate wealth measures.

The finding of a close association between the hernia disability ratings and the hernia symptoms is extremely valuable for our study. Instead of sorting through numerous symptoms, we can rely on a single variable, the hernia disability ratings, to provide us with an unbiased measure of hernia severity. In the sections that follow, we will refer to the hernia disability ratings as the health indicator.

Sample Selection Biases. Three types of selection biases may exist. The first type relates to the representation of the UA men over the entire population of white males in the U.S. of similar birth and socioeconomic backgrounds. To assess the extent of the first type of bias, we would have to compare the characteristics of the UA data with surveys of other white males who were not drafted to fight the Civil War. A branch study called the "Intergenerational and Familiar Aspects of Aging (ILAS)" attempts to draw a sample of approximately 5,000 northern white males of military age from the same families, some of whom served in the UA and some of whom did not. At completion, this will be an ideal sample to serve our purpose of detecting the first type of selection bias.

The second type of selection bias comes from the screening of potential recruits at enlistment. There were rejections based on various grounds. For example, the army did not in general take in recruits who were still in their teens or recruits who were over the age of 45. Furthermore, there are medical disqualifications for military services in the United States. People with chronic diseases such as abdomen and digestive apparatus hernia were exempted from military services in all situations (Page LI, Introduction of Baxter Report 1875). Fogel (1993) estimates that 30% of the examinees in the UA were rejected for chronic diseases. To address this type of selection bias, we need a control sample of rejectees with hernia prevalence rate prior to enlistment. Then, by assuming that the labor decision conditional on contracting hernias is the

same between our sample and the sample of rejectees, we could implement a Tobit model to correct for the truncated age-hernia distribution in our sample.

The third type of selection bias comes from extracting all the variables that are needed for our analysis from each file[14] of the UA sample and merging the resulting sub-samples to create the final data set. Many recruits were dropped during this process, because their records were not in all three UA files. We compare the variable means in the final data set with those in each of the original UA file to detect whether the means have changed significantly after every merge. We conclude that the final data set we use for our analysis represents a random sample of the original UA files. We include all the recruits who survive the data merge into our regressions, even though some of their records are incomplete, by creating dummy variables for missing values.

IV. Econometric Specification and Results

IV.i. Modeling Labor Force Outcomes

Given that a recruit was in the labor force in 1900, define the probabilities of two outcomes as:

$$p_r = \text{Prob}(Y = 1 \mid L \text{ or } M) = \text{Prob}(\text{retirement in } 1910 \mid L \text{ or } M)$$
$$1 - p_r = \text{Prob}(Y = 0 \mid L \text{ or } M) = \text{Prob}(\text{Remained in Labor Force in } 1910 \mid L \text{ or } M) \qquad (3)$$

We assume that recruit i's probability of each outcome can be approximated as a logistic function of hernia status in 1900, hernia status in 1910, and other unobserved factors, $\mathring{a}_i$,

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[14] That is, the Military File, the 1900 Census File, the 1910 Census File, and the Surgeons' Certificates File.

controlling for k-dimensional demographic characteristics in 1900, x_{ki}. Omit the recruit index i to simplify notation. The SAS procedure "PROC LOGISTIC" fits the logistic model

$$\text{logit}(p_r) = \log(\frac{p_r}{1-p_r}) = á_1 + â' x \tag{4}$$

Equation (4) can be re-formulized as

$$p_r = \frac{e^{á_1 + â' x}}{1 + e^{á_1 + â' x}} \tag{5}$$

The slope of the logistic regression with respect to any explanatory variable x_k is

$$\frac{\partial p_r}{\partial x_k} = p_r(1-p_r)â_k \tag{6}$$

Regression coefficients are estimated using the Maximum Likelihood Method. We refer to Equations (4) through (6) as the "**retirement regression**."

IV.ii.   Hernia Prevalence, Hernia Persistence, and Occupational Trend

Hernia Prevalence. We assume that there was no incidence of hernias before the enlistment time, because hernias were amongst the official military disqualification. Recruits contracted hernias either during the Civil War between 1861 and 1865, or after the War. Military pension for UA recruits started in 1862. Several important pension laws were passed since then until 1912. Both the qualification criterion and the amount of compensation were getting more generous over time. Table IV.1 shows that the first major inflow of recruits who claimed pension and got examined for conditions occurred within a decade and a half after the 1873 Act. By 1886, 44% of the veterans in the Surgeons' Certificates had already been examined. There was

another major inflow of new pension claimants within three years after the 1890 Act.[15] By 1893, 92% of the recruits who would eventually have been examined already went through their first round of examinations.

Table IV.1

Years of First Exams and Years When Hernia First Found

Exam Year	Number of Recruits Being Examined the First Time	% Recruits Eventually Being Examined --Cumulative % in ()	Number of Recruits First Diagnosed with Hernias	% Recruits Eventually Diagnosed with Hernias --Cumulative % in ()
1861-1862	5	0.1	1	0
1863-1870	36	0.3	0	0
1871-1873	324	3.3	44	2.0
1874-1886	4,021	40.3 (44.0)	407	19.2 (21.2)
1887	364	3.6	45	2.1
1888	400	4.0	57	2.7
1889	421	4.2	48	2.3
1890	566	5.7 (61.5)	108	5.1 (33.4)
1891	2,205	22.1	376	17.7
1892	709	7.1	184	8.6
1893	137	1.4 (92.1)	53	2.5 (62.2)
1894-1900	521	5.2 (97.3)	372	17.4 (79.6)
1901-1906	235	2.4	261	12.3
1907-1911	13	0.1	39	1.6
1912-1929	19	0.2	133	6.1
Total	9,976	100	2,128	100

Note: The Consolidation Act of 1873 established various grades of disabilities. The 1890 Act marked the beginning of a universal disability and old-age pension program under which the veteran's disability did not need to be related to military service. Legislation after 1912 consisted mainly of automatic increases in pension ratings for age and service. For a detailed description of the history of pension laws, see Costa 1998, Appendix A.

We have included about 80% of the final hernia patients when 1900 is chosen as the base year to study the labor force transition in the next decade. According to the last column of Table IV.1, about a third of the recruits who would eventually contract hernias already found out by

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[15] This is because at the early stage of the development of the UA pension program, a recruit had to prove that the condition under his claim was war-related. However, after the 1890 Act, this constraint was relaxed, so that a veteran could be entitled to pension with any disability, although a war-related one received a higher rating that was transformed into a higher dollar amount.

1890 that they had hernias. Between 1890 and 1900, an additional forty-four percent of the eventual hernia patients would have claimed pension under this disability. It is not clear whether the large hernia discovery rate between 1890 and 1900 was due to the herding of applicants taking advantage of the 1890 Act, or it was due to the fact that the risk of hernias rose as veterans started to reach seniority.[16] An important aspect for our study is that we have captured most of the hernia patients in our sample.

Hernia Persistence. We argue that both past (1900) and contemporaneous (1910) health status contribute to labor participation decisions. Table IV.2 presents the ordinary least squares (OLS) regression of hernia ratings in 1910 on a constant term and on hernia ratings in 1900.

Table IV.2

**OLS Regression of 1910 Hernia Ratings on 1900 Hernia Ratings
--369 Recruits with Non-Missing Hernia Ratings in both 1900 and 1910**

	Coefficient Estimates	t-Statistics
Intercept	0.1772***	7.81
1900 Hernia Ratings	0.6132***	11.69
Dependent Variable (1910 Hernia Ratings) Mean = 0.43		
Independent Variable (1900 Hernia Ratings) Mean = 0.39		
Adjusted R^2 = 0.2686		
Note: The symbol "***" indicates statistical significance at the 1% level.		

If past health status perfectly predicts present health status, we would observe the adjusted-R square to be very close to one, and the slope coefficient to be also very close to one that is highly statistically significant. Table IV.2 shows that past health only partially predicts present health by explaining 27 percent of the variation in present health. The intercept is 0.18,

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[16] An average recruit in the Surgeons' Certificates data would be 65 by 1900, and 75 by 1910.

or about 45 percent of past hernia ratings (0.1772/0.39). The coefficient estimate is 0.61, which means that on average, 61 percent of ratings in 1900 would contribute to our inference of ratings in 1910. Since the 1910 ratings contain new heath information that is not captured by the 1900 ratings, we will use both of them to measure health.

Trends in Occupational Choices between 1900 and 1910. Table IV.3 displays the occupational transition between 1900 and 1910 for those veterans who were in the labor force in 1900.[17]

Table IV.3

Occupational Transition between 1900 and 1910
--Veterans Who Were in the Labor Force in 1900

1900 Category	1910 Category		
	Less Manually Demanding	More Manually Demanding	Retired
718 Veterans in Less Manually Demanding	54.74%	22.42%	22.84%
2,688 veterans in More Manually Demanding	5.25%	70.16%	24.59%

3,406 veterans were linked to both the 1900 and the 1910 Census Files. The 1900 more manually demanding category has a much higher occupational persistence in that seventy percent stayed in the same category ten years later. In comparison, only about half of the veterans who

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[17] Some of those veterans who were either retired or unemployed in 1900 could have returned to labor force in 1910. Lee detected persistence in the long-term unemployment among older males (Lee 1998). He found that for those men aged 50 or older in 1900, being unemployed in 1900 greatly increased the chances of retirement within the next ten years. Out of the nonoccupational responses in the 1900 Census File, only very few were "unemployed." In contrast, more than a quarter of them were "unemployed" in the 1910 Census. The percentage of unemployment in 1900 is very likely to be understated, because the meaning of "unemployed" may not have been clear to many people in 1900, whereas within a decade's time, people got more used to the concept as they reported to the Census takers. In our sample, we have excluded recruits who were not in the labor force in the 1900 Census File, as well as those who were unemployed in the 1910 Census File.

engaged in less manually demanding occupations in 1900 remained in the same category. A fair proportion of veterans retired from their 1900 occupations in 1910. The percentage is slightly higher amongst more manually demanding occupations in 1900.[18] Very few veterans in the more manually demanding category switched to the less manually demanding category. In contrast, occupational changes occurred four times as frequently for those in the less manually demanding category.

IV.iii.   Logistic Regression (LOGIT) Results

Table IV.4 gives the variable definitions in the LOGIT procedure. We divide hernia ratings into groups according to heaps in the ratings distribution (See Table III.4). The variable H1ST00 is the interaction between having hernias in 1900 (HERNIA00) and hernia ratings in 1900.[19] Other hernia rating dummies are similarly defined. In order to base our analysis on the most amount of information, we create dummy variables for missing observations so that even though a record did not contain all the health and demographic information, we could still include that record in the regressions. For example, HMISS00 is the interaction between HERNIA00 and the dummy variable indicating whether the rating was missing for a hernia patient.[20] Likewise, MISBRYR equals to one if the birth year is unknown, and zero if it is unknown.

Table IV.5 lists the variable means for the entire sample and respectively for the two groups of recruits: those engaged in less versus more manually demanding work in 1900.

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[18] Costa found that with the inclusion of retirement as a professional category, it was men within the most physically demanding occupational categories, i.e., those of laborers and farmers, who were most likely to retire (Costa 1998: Table 5.8 on page 90). She used an earlier version of the 1900 and 1910 Census data, which did not contain as many recruits as the current version.

[19] For those who do not have hernias, H1ST00 is zero.

[20] For those who do not have hernias, HMISS00 is zero.

Comparing the first column with the second one, we see that the hernia prevalence rates are similar. However, veterans who were in the more manually demanding occupations had slightly worse ratings conditioning on having hernias, in that there are more cases with ratings between 0.555 and 1, especially in 1910. The cohort composition and the regional composition are slightly different between the two groups. There are also fewer urban dwellers in the more manually demanding occupations, perhaps due to a high proportion of farmers or farm laborers in this group.

The effect of hernias on labor force transitions of veterans between 1900 and 1910 is summarized in IV.6. Hernias had a weak influence on retirement. In the first specification where only the zero-one indicators of past and contemporary hernia prevalence are considered, having hernias in 1900 marginally increase the odds of retirement in 1910 by 10%. In the second specification where categorical dummies representing hernia ratings in 1900 and 1910 enter the regression, only two groups of hernia patients' were influenced. Namely, relative to those with median ratings (between 0.25 and 0.5), patients having ratings of the least severe degree (between 0.1111 and 0.1667) in 1900 or in 1910 were more likely to retire and less likely to stay in the labor force by 1910. The result in the first specification (regression 1) is not so surprising, if we consult the statistics in Table III.3. From Table III.3, we see that more than 90% patients had the usual inguinal hernias, more than 85% of the veterans had less morbid hernias (29.0% truss effective and 56.6% reducible), more than 80% had single hernia, and less than 40% had hernias of size three inches or up. Because the majority of the patients had hernias that were most likely not considered debilitating, although they were probably very discomforting, we do not observe a strong reaction in the labor participation. The result in the second specification (regression 2) is somewhat surprising. One possibility could be that veterans learned to cope with hernias when the condition reached a certain degree of severity. The least sever hernias were

likely to be the most discomforting ones, perhaps because patients were in the adjustment process to having them.

Table IV.4

Variable Definitions in the Proportional Logistic Regressions

(0) RETIRED	Dummy=1 if retired in 1910 (but in the labor force in 1900)
(1) HERNIA00	Dummy=1 if hernias by 1900
(2) H0TH00	Dummy=1 if 1900 hernia patients with zero rating
(3) H1ST00	Dummy=1 if 1900 hernia patients rated between 0.1111 and 0.1667
(4) H2ND00	Dummy=1 if 1900 hernia patients rated 0.2222
(5) H3RD00	Dummy=1 if 1900 hernia patients rated between 0.25 and 0.5
(6) H4TH00	Dummy=1 if 1900 hernia patients rated between 0.555 and 0.625
(7) H5TH00	Dummy=1 if 1900 hernia patients rated between 0.6667 and 1
(8) HMISS00	Dummy=1 if 1900 hernia patients ratings missing
(9) HERNIA10	Dummy=1 if no hernias by 1910
(10) H0TH10	Dummy=1 if 1910 hernia patients with zero rating
(11) H1ST10	Dummy=1 if 1910 hernia patients rated between 0.1111 and 0.1667
(12) H2ND10	Dummy=1 if 1910 hernia patients rated 0.2222
(13) H3RD10	Dummy=1 if 1910 hernia patients rated between 0.25 and 0.5
(14) H4TH10	Dummy=1 if 1910 hernia patients rated between 0.555 and 0.625
(15) H5TH10	Dummy=1 if 1910 hernia patients rated between 0.6667 and 1
(16) HMISS10	Dummy=1 if 1910 hernia patients ratings missing
(17) CO1234	Dummy=1 if born between 1812 and 1834
(18) CO3539	Dummy=1 if born between 1835 and 1839
(19) CO4044	Dummy=1 if born between 1840 and 1844
(20) CO4551	Dummy=1 if born between 1845 and 1851
(21) MISBRYR	Dummy=1 if birth year missing
(22) HHREL_0	Dummy=1 if 1900 head of household
(23) MISREL_0	Dummy=1 if 1900 household relationship missing
(24) HHNUM_0	1900 number of residents in the household
(25) MARRY00	Dummy=1 if 1900 married
(26) NATBPL_0	Dummy=1 if native born
(27) YRED_0	Dummy=1 if reads
(28) MISRED_0	Dummy=1 if literacy unknown
(29) NERSTA_0	Dummy=1 if 1900 residence northeast region
(30) SRSTA_0	Dummy=1 if 1900 residence south region
(31) WRSTA_0	Dummy=1 if 1900 residence west region
(32) MWRSTA_0	Dummy=1 if 1900 residence mid-west region
(33) MISSTA_0	Dummy=1 if 1900 residence unknown
(34) UBCTY_0	Dummy=1 if 1900 residence urban county
(35) RULAMT	Monthly Pension Award Granted in the Year Closest to, but before 1910
(36) LESS_0	Dummy=1 if 1900 occupation was less manually demanding

Table IV.5

Variable Means in the Proportional Logistic Regressions

	370 Veterans in 1900 Less Manually Demanding Professions (Dummies in %)	1442 Veterans in 1900 More Manually Demanding Professions (Dummies in %)	Overall (Both More and Less Manually Demanding Professions in 1900) (Dummies in %)
	Column 1	**Column 2**	**Column 3**
(0) RETIRED	24.32	25.39	25.17
(1) HERNIA00	13.51	14.24	14.09
(2) H0TH00	0	0.28	0.22
(3) H1ST00	0.81	0.98	0.95
(4) H2ND00	1.89	1.75	1.78
(5) H3RD00	4.59	4.00	4.12
(6) H4TH00	1.62	2.24	2.12
(7) H5TH00	0.81	1.05	1.00
(8) HMISS00	3.78	3.93	3.90
(9) HERNIA10	19.19	18.72	18.82
(10) H0TH10	1.08	0.07	0.28
(11) H1ST10	0	0.63	0.50
(12) H2ND10	0.81	0.98	0.95
(13) H3RD10	1.62	1.47	1.50
(14) H4TH10	0.81	1.96	1.73
(15) H5TH10	0.54	0.91	0.84
(16) HMISS10	14.32	12.69	13.03
(17) CO1234	5.41	9.05	8.30
(18) CO3539	15.68	20.62	19.60
(19) CO4044	50.81	46.21	47.16
(20) CO4551	22.16	20.69	20.99
(21) MISBRYR	5.95	3.44	3.95
(22) HHREL_0	91.08	94.46	93.76
(23) MISREL_0	2.70	1.26	1.56
(24) HHNUM_0	3.02	3.28	3.23
(25) MARRY00	88.11	89.20	88.98
(26) NATBPL_0	90.27	87.66	88.20
(27) YRED_0	96.49	94.46	94.88
(28) MISRED_0	3.24	1.54	1.89
(29) NERSTA_0	30.27	40.60	38.47
(30) SRSTA_0	2.70	3.72	3.51
(31) WRSTA_0	5.14	3.02	3.45
(32) MWRSTA_0	59.46	51.47	53.12
(33) MISSTA_0	2.43	1.19	1.45
(34) UBCTY_0	32.43	21.32	2.36
(35) RULAMT	14.92	14.70	14.75

Table IV.6

Marginal Probabilities in the Proportional Logistic Regressions ($\partial E(p)/\partial x_k$) --Effect of Hernias Evaluated at the Mean of the Explanatory Variables

(Column 1)	Retirement Regression 1 (N = 1,796) $\partial E(p_r)/\partial x_k$ (Column 2)	Retirement Regression 2 (N = 1,796) $\partial E(p_{ml})/\partial x_k$ (Column 3)
(0) INTERCEPT	-0.2106**	-0.2270**
(1) HERNIA00	0.0970*	
(2) H0TH00		Note (3)
(3) H1ST00		0.2816**
(4) H2ND00		-0.0106
(5) H4TH00		0.0110
(6) H5TH00		-0.0313
(7) HMISS00		-0.0004
(8) HERNIA10	-0.0755	
(9) H0TH10		0.1879
(10) H1ST10		-0.3573*
(11) H2ND10		0.0486
(12) H4TH10		-0.0640
(13) H5TH10		-0.0129
(14) HMISS10		0.0140
(15) CO3539	-0.0945***	-0.0951***
(16) CO4044	-0.1629***	-0.1648***
(17) CO4551	-0.2763***	-0.2795***
(18) MISBRYR	-0.1634***	-0.1655***
(19) HHREL_0	-0.0796*	-0.0752
(20) MISREL_0	0.0690	0.0751
(21) HHNUM_0	-0.0135***	-0.0132***
(22) MARRY00	0.0121	0.0050
(23) NATBPL_0	0.0014	0.0011
(24) YRED_0	0.0812	0.0941
(25) MISRED_0	-0.0260	-0.0629
(26) SRSTA_0	-0.0686	-0.0637
(27) WRSTA_0	0.2401***	0.2393***
(28) MWRSTA_0	0.1115***	0.1127***
(29) MISSTA_0	-0.0077	0.0444
(30) UBCTY_0	-0.0325	-0.0322
(31) RULAMT	0.0089***	0.0092***
(32) LESS_0	-0.0154	-0.0210
-2 Log L (p-Value)	0.0001	0.0001

Notes:

1) The omitted hernias categories are H3RD00 and H3RD10. The omitted demographic categories are born between 1812 and 1834, and residence in the Northeast Region in 1900.

2) The symbol "***" indicates a statistical significance of 1%, the symbol "**" indicates a statistical significance of 5%, and the symbol "*" indicates a statistical significance of 10%.

3) The number of observations with a value of one in the dummy variable H0TH00 is so small that including this dummy variable in the logistic procedure would cause a convergence problem in the maximum likelihood estimation.

Table IV.6 also presents the effect of other demographic variables on labor force transitions of veterans between 1900 and 1910. We conclude that age is a highly significant factor in the labor force participation of the Civil War veterans. Relative to the oldest veterans, those born in later cohorts are much less likely to retire. Monthly pension award is another significant determinant on retirement decision. An increase of $1 per month in the pension award increases the retirement probability by almost one percentage point. There are strong regional effects on labor force decisions for veterans engaging in more manually demanding jobs in 1900. Relative to those residing in the Northeast Region, veterans from the West and the Midwest regions are more likely to retire. Finally, we did not find any difference in the propensity to retire between veterans in the less versus those in the more manually demanding occupations.

V. CONCLUSIONS AND FUTURE WORK

One of the most challenging aspects in empirical studies on health and labor supply is the construction of an accurate measure of health status. Promising candidates for this measure include life expectancy (Riley 1991), mortality rate (Waaler 1984; Costa and Steckel 1997), calorie intake (Fogel 1993; Haines et al. 2000), height and Body Mass Index (BMI) (Costa 1998; Costa 1997; Costa 1993; Fogel 1993; Waaler 1984), and composite indicators of infectious diseases or chronic disabilities (Costa 2000a; Costa 2000b). As noted by Costa (1994), "[t]he difficulty in using life expectancy as a health measure is that life expectancies can be high and health poor if advances in medical technology have led to an increased burden from chronic conditions." This difficulty applies to the mortality measure as well, because mortality can be viewed as the flip side of life expectancy. Calorie intake, height and BMI are measures of past and current nutritional status and thus reflect all demands made upon the body, including those

of disease, labor, and even climate (Costa 1994). Yet those are indirect measures of disabilities and they do not always have strong predictions on the prevalence of each condition. Zero-one disease indicators are interpreted as probabilities of contracting diseases. However, they do not contain information on the severity of each disease.

This paper is a first step in an endeavor to construct a much more sophisticated chronic disability index from comprehensive medical records and to use this index to better forecast the labor supply of older men. We narrow the scope of this first step by focusing only on hernias, a chronic disability which could be extremely debilitating in its later development. We fully capture the severity of hernias by quantifying descriptions in all symptoms: subtype, location, size, and morbidity. We choose to use the hernia rating variable for our analysis. This variable is a fraction with the denominator being the maximum scale assigned to the most severe hernias, and the numerator being the scale assigned to a particular hernia patient. A previous study (Song 2000) shows that hernia ratings embed correctly hernia severity under each symptom. Alternatively, we could directly incorporate all symptoms in the labor participation regressions. The inconvenience with this alternative is that the regressions become very cumbersome, because each symptom enters the regressions via a set of categorical dummies, and the number of right hand side variables can easily explode as we deal with multiple symptoms.

Controlling for demographic characteristics, we find only weak evidence of the influence of hernias on the labor force decision of the Civil War veterans. Age was a highly significant factor in the labor force participation of older veterans. Younger cohorts were much less likely to retire by 1910. Consistent with the literature (See, for example, Blau and Gilleskie 1997; Coile and Gruber 2000b), we find monthly pension award to be a significant predictor for retirement. Every dollar increase in the monthly pension raises the odds of retirement by almost 1%. There existed strong regional effects on retirement for veterans the West and the Midwest regions, relative to those residing in the Northeast Region. There is no evidence on any difference in the

propensity to retire between veterans in the less versus those in the more manually demanding occupations.

Based on a more accurate hernia severity measurement, these findings suggest that the presence of a groin hernia does not influence labor force decisions as much as age, wealth, and regional factors do. There are two possible explanations for this result. First, it could be that what modern medical practice believes to be "debilitating", as in the case of hernias, may only be in fact "discomforting." As a result, retirement was not so much influenced by this condition. Second, it could be that older veterans in our sample endured hernias as long as hernias did not pose a mortal threat. In this case, contracting hernias and the worsening of hernias would not cause a reduction in earnings from exiting the labor force, but it would induce a reduction in welfare from the disutility of coping with the pain and possibly from rising medical costs.

Since the UA Surgeons' Certificates File is a rich source for many other chronic disabilities, the next step in the building of a composite health index would be to extend our methodology to those disabilities. For example, there are several dimensions to investigating the cardio-vascular condition. We could rely on symptoms such as the pulse, timing and type of heart murmurs, non-murmur heart valve descriptions, and incidences of enlarged heart, oedema, cyanosis, and dyspnoea. We could test whether the fractional heart rating is a good representative of all the cardio-vascular symptoms by regressing the heart rating on the symptoms. If similar to the case of hernias, the rating correctly reflect the severity under all symptoms, we could select the rating variable as the severity measure for the cardio-vascular condition. Otherwise, the transcribed categorical dummies in all the symptoms have to be considered altogether as severity measures. Once we have anchored on precise measures for each individual condition, we could borrow the framework summarized in Mullahy (2000) to map disability attributes into health status. Only then can we gain a thorough understanding of the role of health in economic behavior.

BIBLIOGRAPHY

Abramson J, Gofin J, Hopp C, Makler A, and Epstein L. 1978. "The Epidemiology of Inguinal Hernia: A Survey in Western Jerusalem. *J Epidemiol Comm Health*. 32 (1): 59-67.

Bassini E. 1889. *New Operative Method for the Radical Cure of Inguinal Hernias [Italian]*. Padua, Italy.

Baxter J. 1875. *Statistics, Medical and Anthropological: Provost Marshall General's Bureau, Records of the Examinations for Military Service in the Armies of the United States during the Late War of the Rebellion of over a Million Recruits, Drafted Men, Substitutes, and Enrolled Men*. Washington: Government Printing Office.

Blau D. and Gilleskie D. 1997. "Retiree Health Insurance and the Labor Force Behavior of Older Men in the 1990s." NBER Working Paper #5948.

Bound J, Schoenbaum M, Stinebrickner T, and Waidmann T. 1998. "The Dynamic Effects of Health on the Labor Force Transitions of Older Workers." NBER Working Paper #6777.

Bull W. 1890. "On the Radical Cure of Hernia, with the Results of One Hundred and Thirty-four Operations." *Trans Am Surg Assn*. 8: 99-117.

Center for Population Economics. 1998. *Public Use Tape on the Aging of Veterans of the Union Army*. Chicago: University of Chicago.

Chan S. and Stevens A. 1999. "Job Loss and Retirement Behavior of Older Men." NBER Working Paper #6920.

Coile C. and Gruber J. 2000a. "Social Security and Retirement." NBER Working Paper #7830.

Coile C. and Gruber J. 2000b. "Social Security Incentives for Retirement." NBER Working Paper #7651.

Coley W., Keen W., and DaCosta J (ed). 1910. *Surgery, Its Principles and Practice*. Philadelphia: WB Saunders.

Cooper A. 1804. *The Anatomy and Surgical Treatment of Inguinal and Congenital Hernia*. London: T Cox.

Cooper A. 1807. *The Anatomy and Surgical Treatment of Crural and Umbilical Hernia, Part II*. London: Longman, Hurst, Rees, and E. Cox.

Costa D. 2000a. "Understanding Mid-life and Older Age Mortality Declines: Evidence from Union Army Veterans." Unpublished Manuscripts. MIT and NBER.

Costa D. 2000b. "Long-term Declines in Disability among Older Men: Medical Care, Public Health, and Occupational Change." NBER Working Paper #7605.

Costa D. 1998. *The Evolution of Retirement: An American Economic History 1880-1990.* Chicago & London: University of Chicago Press.

Costa D. and Steckel R. 1997. "Long-term Trends in Health, Welfare, and Economic Growth in the United States." In *Health and Welfare during Industrialization,* ed. Richard H. Steckel and Roderick Floud. Chicago: University of Chicago Press.

Costa D. 1994. "Health and Labor Force Participation of Older Men, 1990-1991." NBER Working Paper #4929.

Costa D. 1993. "Height, Weight, Wartime Stress, and Older Age Mortality: Evidence from the Union Army Records." *Explorations in Economics History.* 30: 424-449.

Cutler D. and Madrian B. "Labor Market Responses to Rising Health Insurance Costs: Evidence on Hours Worked." NBER Working Paper #5525.

Dwyer D. and Mitchell O. 1998. "Health Problems as Determinants of Retirement: Are Self-Rated Measures Endogenous?" NBER Working Paper #6503.

Fogel R. 1993. "New Sources and New Techniques for the Study of Secular Trends in Nutritional Status, Health, Mortality, and the Process of Aging." *Historical Methods.* 26 (1): 5-43.

Gustman A. and Steinmeier T. 2000. "Retirement Outcomes in the Health and Retirement Study." NBER Working Paper #7588.

Haines M., Craig L., and Weiss M. 2000. "Development, Health, Nutrition, and Mortality: The Case of the 'Antebellum Puzzle' in the United States." NBER Historical Paper #130.

Halsted W. 1889. "The Radical Cure of Hernia." *Johns Hopkins Bulletin.* 1: 12-13.

Hesselbach F. 1806. *Anatomic-Surgical Treatise on the Origin of Inguinal Ruptures [German].* Wurzburg: Baumgartner.

Hesselbach F. 1814. *Latest Anatomic-Pathologic Investigations Concerning the Origin and Progress of Inguinal and Femoral Ruptures [German].* Wurzburg: Staheliano.

Iason A. 1941. "The Incidence of Hernia in Man." *Hernia.* Philadelphia: Blakiston.

Lee C. "Long-term Unemployment and Retirement in Early Twentieth Century America." *Journal of Economics History.* 58 (3): 844-856.

Lichenstein I. 1987. "Herniorrhaphy. A Personal Experience with 6321 Cases." *Am J Surg.* 153 (6): 553-559.

McVay C. 1948. "Inguinal and Femoral Hernioplasty: Anatomic Repair." *Arch Surg.* 57: 524-530.

Mitchell O. and Phillips J. 2000. "Retirement Responses to Early Social Security Benefit Reductions." NBER Working Paper #7963.

Mullahy J. 2000. "Live Long, Live Well: Quantifying the Health of Heterogeneous Populations." NBER Working Paper #7895.

Ponka J. 1980. *Hernias of the Abdominal Wall*. Philadelphia: WB Sanders.

Riley J.C. 1991. "Working Health Time: A Comparison of Preindustrial, Industrial, and Postindustrial Experience in Life and Health." *Explorations in Economic History*. 28: 169-191.

Rubenstein R, Beck S, and Lohr K. 1983. *Conceptualization and Measurements of Physiologic Health for Adults.* Santa Monica: Rand.

Rutkow I. 1998. "A Selective History of Groin Hernia Surgery in the Early 19th Century." *Surg Clin North Am.* 78 (6): 921-940.

Sanders, Matthew. 2000. "History of the Civil War Pension Laws." *Data User's Manual Version M-5 Appendix XII*.

Scarpa A. 1809. *Hernia, Anatomic-Surgical Notes [Italian]*. Milano: dalla Reale Stamperia.

Scarpa A. 1821. *Perineal Hernias [Italian]*. Pavia: Pietro Bizzoni.

Shearburn E, and Myers R. 1969. "Shouldice Repair for Inguinal Hernia." *Surgery*. 66 (2): 450-459.

Song C. 2000. "Justice or Politics: New Evidence on Surgeons' Performance during the United States Civil War Pension Process." Unpublished Manuscript. Center for Population Economics. University of Chicago.

Song C. 1999. "Obtaining Years of Birth and Cleaning Exam Ages in the Union Army Military and Surgeons' Certificates Data Sets." Unpublished Manuscript. Center for Population Economics. University of Chicago.

Spraycar, Marjory (ed). 1995. *Stedman's Medical Dictionary, 26th Edition.* Baltimore, MD: Williams & Wilkins.

U.S. Bureau of Census. *Historical Statistics of the United States, Colonial Times to 1970, Part 1.*

Waaler H.T. 1984. "Height, Weight, and Mortality. The Norwegian Experience." *Acta Medica Scandinavica [Suppl.]* 679: 1-56.

Welsh D, and Alexander M. 1993. "The Shouldice Repair." *Surg Clin North Am.* 73 (3): 451-469.