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Industrial Characteristics and Employment of Older Manufacturing Workers in the Early-Twentieth-Century United States

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Chulhee Lee
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Chulhee Lee¹

Department of Economics
Seoul National University
Kwanakro 599, Kwanak-gu
Seoul, Korea
chullee@snu.ac.kr

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Abstract

This study explores how industry-specific technological, organizational, and managerial features affected the employment of older male manufacturing workers in the early-twentieth-century United States. Industrial characteristics that were favorably related to the employment of older industrial workers include: higher labor productivity, less capital- and material-intensive production, a shorter workday, lower intensity of work, greater job flexibility, and more formalized employment relationship. The technological transformations in the Industrial Era probably brought mixed consequences to the labor-market status of older workers, and the experiences of individual workers were heterogeneous.

1. Introduction

A sharp decline in the labor market activity of the elderly male population is regarded as one of the most significant labor market changes in America in the past century. In 1880, nearly four out of five men aged 65 and older were gainfully employed in the United States (Moen 1987, Costa 1998). Today, less than 20 percent participate in the labor force. Many economists have attributed the decline to the factors that influence labor supply decisions of older persons.² In particular, the implementation and expansion of social insurance programs such as the Social Security has been regarded as the major cause of the long-term decline in the labor force participation rate (LFPR, hereafter) among older men.³ In current literature on this issue, however, it is often neglected that nearly half of the decline in the economic activity of older men since 1880 happened before the Social Security Act was passed. As will be surveyed below in detail, it is not entirely clear what made the elderly male workers leave the labor force earlier than before, even prior to the rise of the welfare state.

According to contemporary accounts, the features of the workplace such as production technology, managerial practices, work organization, employment relations, and labor market conditions played more important roles in determining the timing of retirement in the past than they do today. For instance, it was widely believed that the increased speed and intensity of work forced elderly workers out of labor market either by diminishing their relative productivity or by making their employment more costly (Squier 1912, Epstein 1928, Graebner 1980). Some claimed that the decline in job flexibility, often resulting from changes in work organization and workplace management, made it difficult for elderly employees to make gradual adjustments in response to the

² Notable exceptions are studies by Hurd (1996) and Hurd and McGarry (1993) who suggested that a job's flexibility and financial aspects were important determinants of retirement decisions. Some recent studies have examined the impact of technological innovations, largely measured by computer use, on the employment of older workers. Bartel and Sicherman (1993) have shown that unexpected changes in the rate of technological changes induced workers to retire earlier. Friedberg (2003) found that technological change in a worker's environment had a negative impact on computer use, but only for workers close to retirement. Aubert, Caroli, and Roger (2006) have offered firm-level evidence that use of computer and internet tended to reduce the wage-bill share of older workers.

³ It has been suggested that the Old Age Assistance (OAA) was the main underlying force behind the sharp decline in the LFPR of older men during the 1930s (Parsons 1991). Many have attributed the decline in the LFPR of older males from the 1960s to the increase in real Social Security benefits (Boskin 1977, Parsons 1980, Hurd and Boskin 1984). Recent comparative studies have concluded that measures of work disincentives arising from old-age pension programs were strongly related to the size of labor-market activity of older males around the world (Gruber and Wise 1999, 2004). Although there is considerable disagreement in the literature as to the magnitude and direction of the effect of Social Security on labor supply (Krueger and Meyer 2002), it would be hard to deny that Social Security still remains probably the single most important explanation for the long-term decline in the LFPR of older males in the United States.

influences of aging. As technological advances made formal education and on-the-job training more crucial for improving productivity, employers increasingly hesitated to hire older workers probably because their skill sets have rapidly become obsolete and training them would pay off little. Some of the adverse impacts of industrial changes on the labor-market status of older workers could have been mediated by deteriorating health.

The purpose of this article is to study how industrial characteristics affected the employment of older manufacturing workers in the early twentieth century United States. More specifically, the article investigates how the probabilities of long-term unemployment in 1910 and retirement between 1900 and 1910 were related to the different features of the industry in which the older worker was employed, such as industry-specific labor-market conditions, size of establishment, labor productivity, input mix, hours of work, use of electric power, and employment structure. For this purpose, the Integrated Public Use Micro Samples (IPUMS) of the 1910 census and a longitudinal sample of Union Army veterans that have been linked to industry-level data compiled from the 1899 and 1909 manufacturing census reports were utilized.

This paper suggests that the incidence of long-term unemployment among older males considerably differed across industries. Industrial characteristics that were related to more favorable labor-market status of older industrial workers include: higher labor productivity, less capital- and material-intensive production, a shorter workday, lower intensity of work, greater job flexibility, and more formalized employment relationship. Based on the results, it is argued that the industrial transformations in the Industrial Era brought mixed consequences to the labor-market status of older workers, and that the labor-market experiences of individual older workers were heterogeneous.

The study may add new quantitative evidence to the literature regarding the labor-market status of older workers and the nature of retirement in the past. Relatively, there are abundant micro-level studies pertaining to long-term unemployment and retirement of older male workers in the early twentieth century US (Margo 1993, Moen 1994, Carter and Sutch 1996, Costa 1998, Lee 1998, 2002, 2005). However, this study is distinct from previous works because it examines the roles played by industrial features, together with personal characteristics. This paper may also help understand why the LFPR of older men declined prior to the Social Security era.

2. Industrial Changes and Old Labor

The United States experienced rapid maturing and deepening of industrialization from the late nineteenth to early twentieth century. This period is often referred to as the Industrial Era. As a consequence, the proportion of the labor force employed in agriculture greatly shrank during the

period. It is well documented how the change in the industrial structure affected the employment of older Americans during the period. It has been widely acknowledged in both contemporary and historical studies that self-employed jobs, farming in particular, were more favorable for the employment of older workers than wage jobs because of their greater flexibility. The self-employed can remain in the workforce until old age by adjusting their work efforts in accordance with changing health, preference, and economic need. This is similar to the condition in the early twentieth century.⁴

This reasoning led early studies on the older labor force to a conclusion that the decline of agriculture had brought a decline in the labor market involvement of older men (Durand 1948, Long 1958, Bancroft 1958). Recent quantitative evidence has confirmed that sectoral shifts that occurred between 1880 and 1940 substantially decreased the overall LFPR of older males in the United States. Lee (2002) has estimated that the decrease in the labor force employed in farming accounted for nearly a quarter of the decline in the LFPR of men aged 60 and older between 1880 and 1940. Lee (2005) has suggested that industrialization was responsible for growth of the sectors which brought about the strong pressure on old age employment.

During the period, the U.S. economy went through dramatic industrial and technological transformations, often called ‘Second Industrial Revolution,’ characterized by growth of large modern firms, emergence of new products, power sources, technologies, and changes in industrial structure (Chandler 1977, 1990). It was during this period that scientific knowledge began to be systematically applied to industrial technology, mass production methods spread, and knowledge of scientific management was adopted in workplaces. The technological changes of that era were arguably the most critical in all of modern times in terms of the magnitude of the long-run impact on productivity and human well-being—even more important than the ‘First Industrial Revolution’ or the ‘Information Technology Revolution’ in the recent decades (Gordon 2000).

Contemporary observers believed that elderly workers were reduced to “industrial scrap heap,” victimized by the consequences of technological changes. According to these accounts, elderly industrial workers were subject to a greater probability of job loss and forced retirement due to unfavorable work conditions, such as less flexibility and greater intensity of work (Squier 1912, Epstein 1928). A well-known anecdote is the exodus of the elderly operatives from the printing industry upon the adoption of a faster machine (Graebner 1980). It has also been suggested that

⁴ Quinn, Burkhauser, and Myers (1990) found that the majority of older self-employed workforce either reduced their work hours on the career job or became part-time workers, while wage or salary workers mainly left the labor force. In the early twentieth century United States, self-employed farmers were much less likely to retire than non-farm wage earners (Lee 2002). It has been reported that gradual retirement was a possible option for self-employed farmers because they were able to reduce the hours and intensity of their work by adjusting acreage and crop-mix or by adopting mechanization (Pedersen 1950).

industrialization brought greater disadvantages in employment associated with aging, such as more serious age discrimination and greater importance of job-specific skills that inhibited the hiring and training of older workers (Slichter 1917, Haber 1983).⁵

A case study of the American shoe industry has described how the mechanization of production diminished the flexibility of the work and the advantages of experienced workers as follows:

The machine ended worker control over their time; factory discipline involved far more than fixed hours for starting and stopping the workday and taking meals. The flow of work through the factory was tightly scheduled, and each step was a carefully regulated part of the whole production process. Workers had to be at their machine performing their tasks and no longer controlled the pace of flow of work. The fragmentation of tasks and their mechanization greatly reduced the length of time it took to train a worker.....This separation was so complete that even an experienced machine operative was unproductive if put on another machine until he had gone through the same training period as a new hand.⁶

Quantitative research in recent years regarding older labor during the industrial era provides mixed results. More optimistic results suggested that aged workers fared well economically and they voluntarily left their jobs. Costa (1998) estimated that 90 percent of the decline in the LFPR of older males between 1900 and 1930 could be attributed to secularly rising incomes. Carter and Sutch (1996) maintained that many men in early twentieth century America planned their retirement based on wealth accumulation. In support of this view, Gratton (1996) reported that earnings of elderly workers substantially increased between 1890 and 1950 both in absolute and relative values in comparison with the earnings of younger employees.

More pessimistic evidence provides that retirement in the past was more forced than it is today; and retirement decisions in the pre-Social Security era were perhaps influenced more strongly by demand-side factors. Long-term unemployment of older male workers in 1900 greatly reduced their chances of remaining in the labor force by 1910 (Lee 1998). Older men who had better occupations in terms of economic and work conditions in 1900 were less likely to retire by 1910 than were those with poorer jobs, suggesting that retirement in the past was perhaps more forced than voluntary (Lee 2005). A number of studies on Britain and France in early twentieth century also support the view that older persons in the era of industrialization, especially those in the working classes, were generally poor and that their retirement decisions were probably more strongly

⁵ There are abundant anecdotes about the doomed fate of older workers outside the manufacturing sector. Greabner (1980) has noted that between 1900 and 1930 older salesmen were pushed out of their jobs, being criticized for their inability to adopt the method of modern corporation or to adapt to a changing economic and technological environment (pp. 45-46). It is well documented that it was difficult for aged railroad operatives in transportation to continue to work because of the great hazard and increased intensity of their job (Squier 1912, 109).

⁶ Mulligan, Jr. (1981), p. 63.

determined by the absence of appropriate employment opportunities, rather than substantial assets or non-labor income (Johnson 1984, 1994, Baines and Johnson 1999, Bourdieu, Kesztenbaum, and Postel-Vinay 2011).

The current study is distinct from previous works on this issue in several respects. First, it focuses exclusively on the experiences of manufacturing workers who were perhaps most strongly influenced by the technological changes during the Industrial Era. Second, it compares measures of labor-market status of older workers across narrowly-classified industries within the manufacturing sector, which allows us to examine how the impact of industrial changes varied across men employed in different industries. Finally, it investigates how the employment of older workers was affected by industrial features related to production technologies and work environment, together with personal characteristics.

3. Data

To study how industrial characteristics affected the labor-market activity of older workers, it would be desirable to use firm-level data that contain information on both the technological and managerial characteristics and employment status of workers employed in each firm. Unfortunately, no such data are currently available for the period this study is looking into. This data limitation is circumvented by matching micro samples of population censuses (which provide information on labor-market status of individuals) with published manufacturing census reports (which offer average statistics on various technological and managerial characteristics of each industry), as will be explained below. Of course, it is not completely satisfactory to rely on industry-level analyses, ignoring differences across firms within each industry. However, if industries are classified into reasonably narrow categories, as in this study, the between-industry variations in job characteristics are likely to capture a large fraction of the overall variations.

3.1. Published Manufacturing Censuses of 1899 and 1909

Measures of industry-specific technological characteristics have been constructed from the published manufacturing census reports of 1899 and 1909. These volumes provide various average statistics for each manufacturing industry.⁷ The method of classifying industries, and the contents and definitions of statistics differ between census years. The entire manufacturing sector is classified

⁷ These statistics include the number of establishments, percentage of a particular type of ownership (e.g. shares of corporations and partnerships), number of employees by age, sex, and type of work, size of capital investments, value of products, amount of expenses on each type of input, amount of energy used by source, amount of wages paid out, and prevailing hours of work, among others.

into 350 industries in the 1899 manufacturing census report, and into 260 industries in the 1909 report.

To connect these original industry-level data sets to micro samples of population censuses, the industries in the manufacturing censuses have been reclassified according to the industry coding schemes of the 1950 population census.⁸ The 1950 census classifies industries more broadly than the published manufacturing census reports.⁹ Accordingly, multiple industries in the manufacturing censuses have been combined into a single category and classified as the same industry in the 1950 population census.¹⁰

In merging multiple manufacturing-census industries into a broader category, the sum (in the case of the total amount or number) or the weighted average (in the case of the mean or percentage) of each variable has been computed and assigned to the industrial category. In these computations, the number of wage earners employed in each industry was used as its weight, because the major purpose of this study is to examine the labor-market experiences of workers. As a consequence of this merging process, the original 260-industry dataset, compiled from the 1909 manufacturing census, was transformed into a new dataset composed of 56 more broadly classified manufacturing industries. Similarly, the original 350-industry dataset, drawn from the 1899 manufacturing census, was reshaped into a dataset containing 60 industries.

3.2. IPUMS of the 1910 Census

To study how the technological characteristics of a particular industry affected the probability of long-term unemployment of the workers employed in the industry, the industry variables drawn from the published 1909 manufacturing census have been linked to the IPUMS of the 1910 census (Ruggles and Sobek 1998). The 1910 census was the first to report information on both industry and the length of unemployment of individuals. The empirical analyses were based on a sample of 4,549 male manufacturing workers aged 45 and older. Where the industry variables were utilized, the sample was further restricted to those who were employed in the 56 manufacturing industries covered by the matched dataset.

⁸ The classification of each specific industry was determined based on the full list of industries and their codes as reported in the 1950 population census (U.S. Bureau of the Census 1950).

⁹ In the 1909 manufacturing census, for example, “clothing, horse,” “clothing, men’s buttonholes,” “clothing, men’s, including shirts,” “clothing, women’s,” and “corsets” are all separate industries, whereas the 1950 population census classifies all these industries into a single category, namely, “apparel and accessories.”

¹⁰ The methods of industry reclassifications for the 1899 and 1909 manufacturing censuses, not reported in this paper, can be obtained from the author upon request.

3.3. Longitudinal Sample of Union Army Veterans

A longitudinal sample is needed for studying the probability of retirement. For this purpose, a sample of white Union Army veterans who had been linked to the 1900 and 1910 censuses, as well as military, pension, and surgeons' medical records have been matched to the industry-level datasets explained above. Considering the age distribution of individuals included in the data (the mean age of the veterans in 1900 was about 58), the Union Army sample linked to the 1900 and 1910 population censuses should be suitable for examining retirement patterns.

In using this sample, a difficulty arose. The 1900 population census did not provide information on the industry in which a given person was employed. However, occupational descriptions recorded in the census can be used for the identification of the industry that the majority of the individuals in the sample was employed in.¹¹ By exploiting this information, the three-digit 1950 industry codes for 6,699 veterans out of 8,469 men with non-missing occupational titles was determined. Of these veterans, 793 men (12 percent of the sample) were employed in a manufacturing industry. This sample was further restricted to men who were linked to the 1910 census and who were gainfully employed in 1900.

4. Industrial Differences in Long-Term Unemployment of Older Workers

The long duration of unemployment has been cited as one of the major indicatives of the fragile labor market status of older workers in the early twentieth century. Previous studies have suggested that though older workers were less likely to be unemployed than younger workers, they had greater difficulty locating new jobs once laid off (Slichter 1919, Keyssar 1986, Margo 1993).¹² Deteriorating physical strength and health, obsolete skills and knowledge, and lack of formal education as compared with their younger cohorts are some of the potential factors that may have limited employment opportunities for elderly workers. In addition, formal or informal discrimination against elderly workers made it difficult for them to find new jobs.¹³

¹¹ To take some examples, there are occupational titles such as "paper manufacturers," "works and cigar maker," "brakeman for railroad company," "hat factory," "in boot factory," and "works for boot factory," from which an industrial classification can be inferred.

¹² Unemployment around the turn of the twentieth century was predominantly involuntary for both young and old workers. According to the surveys conducted in the late nineteenth and early twentieth century, the primary cause of lost times was lay-offs, followed by sickness and accidents (Lauck and Sydenstricker 1917, Lee 2005).

¹³ Ransom and Sutch (1995) found that the days lost due to illness sharply increased with age after fifty-five among both farm and industrial workers. With regard to the roles of education and skills, Gratton (1986) has suggested that clerks in turn-of-the-century Boston were predominantly young men because younger cohorts had more education and were more likely to be native born and speak

Long-term unemployment, often defined as being unemployed for six months or longer during a given year, has also been acknowledged as a major reason for leaving the labor force in the early twentieth century. Margo (1993) reported that long-term unemployment among the elderly circa 1900 was an intermediate step toward nonparticipation. Lee (1998) found that elderly men who were unemployed six months or more in 1900 were more likely to be out of gainful employment ten years later. Lee (2005) suggested that older workers were more likely to leave their job between 1900 and 1910 if initially employed in an occupation in which the relative incidence of long-term unemployment was higher. In the light of these results, a greater probability of long-term unemployment among older workers in the early twentieth century may be regarded as indicative of a greater pressure toward leaving the labor force.

Table 1 presents the percentage of manufacturing workers in the IPUMS of the 1910 census who were unemployed for 24 weeks or more during the 1910 census year, separately for prime-age workers (aged 25 to 44) and older employees (aged 45 and older). Men aged 45 and older were classified as “older workers,” on the basis of the contemporary accounts that many industrial workers in the early twentieth century began to face various disadvantages in employment associated with aging from their mid-forties. The 1910 population census did not report the weeks of unemployment for a fraction of individuals. Hence, the full sample was used for the computation, with the assumption that the individuals who did not report the weeks of unemployment were not the long-term unemployed.¹⁴ The 56 manufacturing industries were grouped into 17 broader industrial categories for this computation.¹⁵

The absolute incidence of long-term unemployment for older workers (column 3 of Table 1) is not a completely appropriate index of disadvantages in the labor market associated with aging. It is well documented that fluctuations in demand for labor, especially those resulting from seasonality and industry-specific business cycles, were important causes of long-term unemployment for both young and old workers during the period under study. In this respect, it would be sensible to look at a relative measure of long-term unemployment of the older workers in comparison with prime-age

English well without accents. In the early twentieth century, many firms, especially large corporations, adopted a policy of not hiring anyone over some stated maximum age, the limit being 45 years or sometimes, even lower (Durand 1948, 114-116, Long 1958, 116-171).

¹⁴ According to the result related to the pattern of transition in labor-market status between 1900 and 1910, older men with no related information on the months of unemployment in 1900 were more similar to persons who did not experience unemployment than to the long-term unemployed (Lee 1998). It is thus likely that the majority of persons with no related information on the weeks of unemployment were not the long-term unemployed.

¹⁵ The incidence of long-term unemployment for each of the 56 industries, not reported in the paper, is available from the author.

workers in the same industry.¹⁶ Accordingly, the final column of Table 1 offers the ratio of the incidence of long-term unemployment among males workers aged 45 and older to that among men aged 25 to 44.

The result reported in Table 1 shows that the incidence of long-term unemployment among older manufacturing workers considerably differed across industries even within the manufacturing sector. The probability of being unemployed for 24 weeks or more in 1910 was particularly high, both absolutely and relatively, among older workers employed in the textile, lumber and wood working, printing, primary metals, and fabricated metals industries. In contrast, older workers were much less likely to experience long-term unemployment than prime-age workers in the apparel, leather, stone, clay, and glass industries.

Logistic regressions were performed to compare the probability of long-term unemployment with controlling the personal characteristics of the worker across industries. This is done to see how much of the observed industrial disparities in the incidence of long-term unemployment were attributable to the influences of industry-specific employment conditions rather than the heterogeneity of the labor force across industries. Regressions were performed for both the full sample and for the sub-sample for whom the weeks of unemployment was known. Since the results of the regressions based on the two samples were very similar, subsequent discussions will be based mainly on the results obtained from the subsample with the complete information on unemployment.

Age, race, nativity, marital status, household headship, literacy, family size, home ownership, city size, region, and occupation that have been widely employed in previous studies as determining factors of retirement decisions were included in the analysis as variables pertaining to personal characteristics.¹⁷ Variables on region and the population size of the place were added to consider differences in labor market conditions by location. The percentage of male workers aged 25 to 44 who were unemployed for 24 weeks or longer (*Young Unemployed*) was included as an indicator of industry-specific labor-market conditions. Inclusion of this variable would allow one to identify the inter-industry differences in labor-market disadvantages associated with aging, eliminating the effects of variations in seasonality and general labor market conditions. The apparel industry was chosen as the omitted category because it had the lowest relative incidence of long-term unemployment.

¹⁶ For the industrial pattern of seasonality in demand for labor, see Lauck and Sydenstricker (1917, 137-152), Kuznets (1933), Lebergott (1964, 168-172), and Engerman and Goldin (1994, 111-116).

¹⁷ Age was included in the regression, implicitly assuming a linear relationship between age and the probability of long-term unemployment. This specification approximates reasonably well the actual link between age and long-term unemployment for men aged 45 and older. The study also used alternative specifications such as dummy variable for each of five-year age intervals and polynomials of age. The estimated coefficients of other variables were not sensitive to the choice of age variable.

The first column of Table 2 presents the result for the probability of unemployment for 24 weeks or more (denoted by P_U , hereafter). The relatively high incidence of long-term unemployment among older workers employed in several industries remained visible even if personal characteristics were controlled. In particular, the woodworking and primary metals industries stood out as having the highest P_U for older male workers. Printing and fabricated metals also showed particularly high P_U , although they missed statistical significance by small margins (p-values are, respectively 0.135 and 0.165). The other industries were statistically not different from the apparel industry, the control group.

The estimated effects of individual characteristics are summarized as follows. P_U increased with age, as previously reported by Ransom and Sutch (1986) and Margo (1993). Non-white workers were significantly less likely to be unemployed for 24 weeks or more than whites. Family size was negatively related to P_U . The effects of race and family size could reflect a lower level of reservation wages of non-whites and men with a large family arising from their greater economic needs. Dwellers in a city with 500,000 or more residents were subject to a greater risk of long-term joblessness than individuals who lived in a smaller place. P_U among older men was significantly higher in the Western region than in other regions. White collar workers were less likely to be unemployed for a prolonged period than blue collar workers.

The industrial differences in the probability of being unemployed for a shorter period (as offered by the results reported in columns 2 and 3 in Table 2) were much different from the results for long-term unemployment. The more severe labor-market disadvantages associated with aging in the four industries cited above were no longer present when short-term unemployment was concerned. The probability of unemployment for one week or longer (column 3 of Table 2) was significantly lower in the paper, printing, leather, and fabricated metals industries than those in other industries. It is notable that there was little uniformity in the effect of industry on unemployment across the three regressions. In contrast, the effects of the variables related to personal characteristics were similar across the three specifications. Perhaps, this is the case wherein the risk of losing a job in the first place and the likelihood of finding a new job when unemployed were influenced differently by industrial characteristics.

The patterns of long-term unemployment among older male workers in the industrial era may not simply be explained by inter-industry differences in technological progress, measured by productive efficiency. It is an established fact that the primary and fabricated metals and printing industries experienced major technological innovations during the late nineteenth and early twentieth century.¹⁸ However, the woodworking industry was not a forerunner in technical progress by the turn

¹⁸ In ferrous metals, mass production of steel employing the new Bessemer and open-hearth

of the twentieth century, although it was one of the symbols of the American System in the mid nineteenth century.¹⁹ Furthermore, the relative incidence of long-term unemployment among older males was not high in a number of *Chandlerian* industries such as food, chemicals (including petroleum and rubber), machinery (including electric machinery), and transportation equipment in which large modern corporations in the United States were heavily concentrated in, and which were regarded as the most capital- and technology-intensive industries of the time.²⁰ Thus, it is not sensible to relate the different labor-market status of older workers simply to variations in conventionally-defined technical progress. This calls for looking into a broader range of industrial characteristics representing work environment as well as productive efficiency, which will be discussed in the latter part of this article.

5. Industrial Characteristics related to the Employment of Older Industrial Workers

Based upon the industrial statistics reported in the 1909 manufacturing census, the variables that were likely to be related to the employment of older workers were derived. As a measure of labor productivity, the log of the value of product per production worker (*Productivity*) was employed.²¹

processes had been established. In nonferrous metals, the adoption of electrolytic refining radically transformed the copper industry (Temin 1964, Chandler 1977). In the printing industry, the introduction of the direct-line casting machine built by Ottmar Mergenthaler resulted in the replacement of the older, slower workers between 1895 and 1915 (Graebner 1980, p. 21-23).

¹⁹ Engineers in the early twentieth century believed that the technical progress of the woodworking industry was underdeveloped. For example, B. A. Parks wrote in 1921, "The woodworking industry in one of the oldest industries extant, and yet it has shown the least development and has been slowest to adopt modern principles of manufacturing of any industry of which the writer has knowledge" (Hounshell 1985, p. 126). Chandler (1977, p. 248) reiterated this belief by noting, "By the outbreak of the Civil War, nearly all the machines needed to mass produce wooden products had been perfected.....The speed and volume of throughput increased steadily but slowly.....Total output was increased more by adding men and machines than by continuing technological and organizational innovation."

²⁰ In 1917, 122 out of 200 largest industrial enterprises in the United States belonged to these industries. The primary and fabricated metals accounted for another 42 (Chandler 1990, 21). Also, meat-packing (included in the food industry in this study), tobacco, and light machinery have been listed by Chandler (1977) as examples of the industries in which mass-production was first combined with mass-distribution in response to technological changes that made the existing distribution system inadequate.

²¹ Wherever possible, this study constructed multiple measures for a particular industrial characteristic. For example, wages per production worker in addition to the value of product per production worker were considered as an index of productivity. As measures of firm size, the value of product, the number of employees, the value of capital per establishment, and the percentage of establishment with values of capitalization of one million dollars or more were considered. The discussions in the paper focus on the results that were obtained based on the measures most strongly correlated with the probability of long-term unemployment of older workers.

Three variables, namely, the size of establishment, choice of input mix, and use of electricity were selected as both indices of technology and measures of work environment. The size of establishment (*Firm Size*) was measured by the log of the value of total product. The expenditure on non-labor inputs, such as materials and fuels, as percentage of the total costs was employed as the relative importance of non-labor inputs (*Non-labor Input*). *Firm Size* might capture a wide range of technical and organizational transformations accompanied by the rise of modern large firms famously documented by Chandler (1977, 1990). Inclusion of *Non-labor Input* allows one to consider the influences of capital-using and material-using biases that were present in the technical progress in the U.S. manufacturing (Cain and Paterson 1981).

It has been believed that electrification greatly transformed the work environment, as well as the productive efficiency in the U.S. manufacturing in the early twentieth century.²² By 1909, electric drive accounted for 25 percent of total capacity for driving machinery.²³ When electricity was first used for driving machinery in the manufacturing sector in the 1880s, the major form of driving system was “electric line shaft drive” that replaced a steam engine with one or more electric motors, leaving the power distribution system unchanged. During the first two decades of the twentieth century, this rather primitive system was rapidly replaced by the “group drive” (referring to a system in which a group of machinery was operated by an electric motor), and then by the “unit drive.”

On one hand, these changes in power system greatly improved working environment and flexibility of production, which perhaps favorably affected the employment condition of older workers. Absence of the belts, pulleys, and shafts, required for overhead power transmission, led to improvements in illumination, ventilation, and cleanliness.²⁴ The group or unit drive enhanced the flexibility of production by allowing the operator to conveniently vary the speed of his or her machine. On the other hand, electrification may have increased the intensity of work. Adoption of the group or unit drive diminished time lost by making it possible to shut down only a single or a small number of machinery rather than the entire factory when a mechanical problem or need for speed change occurred. New technology and scientific management procedure, often believed to be closely related to electrification of production (Whaples 1990b), may have intensified the work as well. To take into account these potential impacts of utilizing electric power, the total horse power driven by

²² This paragraph is largely based on Devine, Jr. (1983).

²³ During the first decade of the twentieth century, 60 to 70 percent of the electric motors in manufacturing plants were powered with electricity generated by the manufacturing establishments themselves.

²⁴ Devine, Jr. (1983) states: “With unit drive, lights could be provided in places formerly occupied by belts, pulleys, and shafts. Some new buildings incorporated skylights, thus improving ventilation, as well as illumination (p. 365).

electricity per production worker (*Electricity*) was included in the analysis.

In addition, several indirect measures of hours, intensity, and flexibility of work were employed in the study. First, the percentage of workers employed in an establishment in which the prevailing hours of work was 60 and over (*Hours 60 and Over*) was considered. Lengthy work was perhaps a major factor that prohibited older workers from continuing to work. A study of micro-census linked to city-level statistics has suggested that older workers had a higher labor force participation rate when the work week fell (Whaples 1990a).

Second, the percentage of female workers (*Female*) was considered as a proxy variable of the requirement for physical strength and other types of human capital. Goldin (1990, 81) has reported that the manufacturing industries circa 1900 were heavily segregated along the gender lines and that many of the male-intensive industries required substantial amounts of strength or more trainings. Thus, industries with a larger fraction of female employees could have been more favorable for the employment of older male workers. This conjecture seems to be consistent with the fact that *Female* was positively correlated with some indexes of lower work requirements and higher flexibility.²⁵ If female workers were inferior to male workers in the early-twentieth-century manufacturing industries, a higher proportion of women in an industry might indicate a tighter labor market condition that led employers to turn to less-preferred job candidates. However, this conjecture was not supported well by the patterns of correlation between industry variables.²⁶

Third, the number of superintendents and managers per 100 production worker (*Manager*) was included as a proxy variable of work organization and managerial practices. Until the early twentieth century, the overall operation of work-floor in manufacturing units, including decisions on employment, wage, and work-organization, was largely controlled by foremen (Jacoby 1985). According to a Marxist account, companies hired more managers and superintendents in an effort to curb the power of the so-called “craft control” during the late nineteenth and early twentieth century (Lazonick 1990). Thus, *Manager* could have been related to the development of more formal management of workplaces. Indeed, *Manager* was positively correlated with some measures of the

²⁵ These correlations have been computed using the industry-level data (including 260 industries) compiled from the 1909 manufacturing census. The percentage of female workers was negatively correlated with wages per worker [correlation coefficient, (denoted ρ , hereafter) = -0.571, p-value (p) < 0.0001], the capital-labor ratio (ρ = -0.241, p < 0.0001), the value of product per worker (ρ = -0.209, p = 0.0007), and the percentage of workers employed in an establishment in which the prevailing hours of work was 72 and over (ρ = -0.0625, p = 0.3129). On the other hand, it was positively correlated with the percentage of child workers (ρ = 0.640, p < 0.0001).

²⁶ The percentage of female workers was weakly but positively correlated with the long-term unemployment rate of younger workers (p-value = 0.2567), and uncorrelated with the percentage of older workers, another type of marginal workers (p-value = 0.5755).

stability of employment relationship.²⁷ It is likely that the formalization of workplace management began in more advanced and productive industries. If this was the case, *Manager* should be positively correlated with measures of technological and managerial development. Indeed, this was the case. It was positively and statistically significantly correlated with capital-labor ratio, electric power use per worker, percentage of expenditure on non-labor inputs, and the value of product per worker.²⁸

Finally, the number of clerks per 100 production workers (*Clerk*) as a measure of production technology and demand for white-collar workers was considered. It has been widely acknowledged that technology and skilled labor are complementary in production. Since white collar workers employed in manufacturing in the early twentieth century were largely skilled workers, a higher proportion of clerks could be regarded as an index of technological progress. In fact, *Clerk* was positively correlated with measures of higher productivity and more advanced production technology.²⁹ Clerks in the early nineteenth century were recruited mostly from a pool of younger and more educated persons. Thus, compared to production workers and older workers who, on the average were less educated, a larger value of *Clerk* might indicate lower demand for older workers as well.

Table 3 presents the sample means of these industry variables computed for each industry group. The selected measures of work environment were markedly different across industries, even within the group of sectors in which the extent of technical progress was arguably comparable. For example, the chemicals/petroleum/rubber and primary metals industries were among the leading sectors with technical and organizational innovations in that era (Chandler 1977). This reputation was reflected in the result that shows these two industrial groups at or near the top of the orders of *Firm Size* and *Productivity* with relatively similar values. However, there were substantial differences between the two industries in terms of *Electricity*, *Hours 60 and Over*, *Female*, *Manager*, and *Clerk*. These suggest that technical improvements and organizational innovations in the manufacturing industries, though introduced for the same purpose of improving productivity, considerably differed across industries in terms of their features and their influences on the work environment of older

²⁷ The number of managers per production worker was negatively correlated with the long-term unemployment rate of older workers ($\rho = -0.329$, $p = 0.0333$) and the long-term unemployment rate of younger workers ($\rho = -0.226$, $p = 0.1307$). On the other hand, this index was positively correlated to the percentage of workers aged 45 and older.

²⁸ The results for the long-term unemployment rate and for the share of older workers are obtained by analyzing the industry-level data set (including 56 industries) matched to the 1910 population census, because information on the age composition of employees and unemployment can be drawn only from the population census.

²⁹ It was positively correlated with the capital-labor ratio ($\rho = 0.285$, $p < .0001$), electric power use per worker ($\rho = 0.128$, $p = 0.0389$), the percentage of expenditure on non-labor inputs ($\rho = 0.226$, $p = 0.0002$), and the average wages ($\rho = 0.134$, $p = 0.0301$). These correlations have been computed using the industry-level data (including 260 industries) collected from the 1909 manufacturing census.

workers.

6. Industrial Characteristics and Employment of Older Workers: Regression Results

6.1. Regression Analyses for Long-Term Unemployment

Logistic regressions were conducted to examine how the variables pertaining to industrial characteristics introduced in the preceding section influenced the probability of long-term unemployment (P_U). The same variables on personal characteristics employed in the previous regressions reported in Table 2 were included in addition to the industry variables. The results are reported in Table 4. The regression results for individual variables were remarkably similar to those reported in Table 2, and thus omitted from the table.

A few variables pertaining to technological and managerial features exerted significant effect on P_U . *Young Unemployed* was positively related to P_U . *Productivity* was negatively associated with P_U . On the other hand, *Non-labor Input* was positively related to P_U , whereas, *Firm Size* and *Electricity* had no significant effect. This suggests that although more efficient production itself was innocuous for elderly workers, more capital- or material-intensive production technology tended to hurt their labor-market status.

As iterated above, measures of length, intensity, and flexibility of work turned out to be significant predictors of long-term unemployment of older workers. *Hours 60 and Over* was positively associated with P_U , and *Female* had a negative effect on P_U . *Clerk* also had a strong positive effect on P_U . Lastly, more formal employment relationship was perhaps beneficial for older workers, as indicated by the strong positive effect of *Manager* on P_U .

In addition to this baseline regression, similar regressions were performed in which the probabilities of being unemployed for 16 weeks or more, and one week or more were used as dependent variables (columns 2 and 3 of Table 4). A comparison of these results reveals that industry variables had stronger effect on long-term unemployment than on unemployment for a shorter period. In contrast, occupational differences in the probability of unemployment were smaller for lengthier joblessness than for short-term unemployment. This implies that inter-industry differences in technological and managerial characteristics largely affected the degree of difficulty of finding a new job when unemployed rather than the risk of losing one's job.³⁰

³⁰ Similar regressions were conducted separately for the sub-samples, namely, relatively older (ages 55 and older) and middle-age (ages 45 to 54) manufacturing workers. The results of the two regressions, not reported in the paper, are generally similar. However, the effects of industry variables on P_U were somewhat larger in magnitude and more significant for older workers than for middle-aged persons. In particular, the effects of *Non-labor Input* and *Clerk* were much stronger for older

The regression results were generally consistent with the inter-industry differences in the labor-market status of older workers. The particularly higher incidence of long-term unemployment in several industries (Table 2) is explained reasonably well by the results reported in Tables 3 and 4. For example, in case of the primary metals industry, the particularly high value of *Hours 60 and Over* and low value of *Female* were perhaps the major reasons that produced the highest incidence of long-term unemployment.³¹ Similarly, the very low values of *Productivity* and *Female*, as well as the relatively high value of *Hours 60 and Over* might at least partially explain the high rate of long-term unemployment among older males employed in the woodworking and lumber industry. A regression result, not reported in the paper, offers that the inter-industry differences in long-term unemployment (presented in Table 2) were no longer present if the variables related to industry-specific technology and work environment were controlled. This indicates that different industrial characteristics captured by the variables considered in this analysis could explain a large fraction of the differences in labor-market status of older males across industries.

6.2. Regression Analyses for Retirement

Employing a similar regression model presented in equation 5 (replacing P_U with P_R , denoting the probability of leaving the labor market between 1900 and 1910), and using a sample of 316 Union Army veterans who were active manufacturing workers in 1900, the study investigated how industrial characteristics affected retirement decisions. Some minor modifications have been made to consider some differences in data. The log value of Union Army pensions was added to consider the previous results that stated that Union Army pensions greatly increased the probability of retirement of veterans (Costa 1998, Lee 1998, 2005). Since the amount of Union Army pensions was determined based on health status, age, and military experiences, this variable might capture the effects of both non-labor incomes and health. For industry variables, the average of the 1899 and 1909 values were used, wherever possible, to have a closer measure of work environment that the veterans were exposed to during the entire decade under study. For *Hours 60 and Over*, *Manager*, and *Clerks*, which were not available from the 1899 manufacturing census, the 1909 values were used.³² Separate regressions were conducted for men aged 55 and older to consider the fact that not

men than younger workers. This indicates that technical changes should have severely hurt the labor-market prospect of older workers than that of younger ones. On the other hand, P_U of a younger worker was strongly influenced by personal characteristics such as age, race, and family size more than that of an older worker.

³¹ *Hours 60 and Over* was 28.312, as compared to 0.466 in the apparel industry (the control group), the second highest of all industries following the paper industry (33.744). *Female* was 2.953 as compared to 60.134 in the apparel industry, the fourth from the bottom.

³² It is unlikely that hours of work in manufacturing industries changed much between 1899 and

many males under age 55 left the labor market for good in the early twentieth century.³³ The results are reported in Table 5.

In spite of some serious limitations arising from the small and selected sample used for the analysis, the regression results are at least suggestive. The estimated coefficients for *Hours 60 and Over*, *Female*, and *Manager* were all significant, and their signs were the same as those estimated from the regression for long-term unemployment. The parameters for *Non-labor Input* and *Clerk* had the same signs, too, although they were statistically insignificant. On the other hand, unlike the results for long-term unemployment, P_R was related positively to *Firm Size*, and negatively to *Electricity*.

As noted above, the present results are neither representative nor reliable. Moreover, it is difficult to determine whether differences between the two regressions are attributed to employing different measures of labor-market status of older men or to utilizing different samples. Nevertheless, if accepted as real, this result strengthens the argument that length, intensity, and flexibility of work were powerful determinants of labor-market status of older workers. This also suggests that the rise of large corporations had brought about adverse consequences for the employment of elderly workers. The negative relationship between P_R and *Electricity* could be explained by the improvements in the working environment allowed by electrification of the workplace (Devine, Jr. 1983).

7. Conclusions and Implications

This study has explored how industry-specific technological, organizational, and managerial characteristics affected the labor-market status of older male manufacturing workers in the early twentieth century United States. For this purpose, industry-level data have been compiled from the 1899 and 1909 manufacturing censuses and linked to the IPUMS of the 1910 census and a longitudinal sample of Union Army veterans.

The incidence of long-term unemployment among older workers relative to that of prime-age workers, an index of labor-market status of the elderly, was particularly higher in the primary metals, woodworking, printing, and fabricated metals industries than in other sectors. The incidence is true when the personal characteristics of the workers employed in these industries were held constant. Differences in the extent of conventionally defined technical progress did not explain well

1909 during which nine hours per day was the standard in many industries (Whaples 1990b).

³³ Other minor changes were as follows: The dummy variable for race was eliminated because the sample is composed of white veterans. Taking into account the small sample size and its geographic concentration in the Northeast and Mid West, the dummy variables pertaining to the city size, region, and occupation were reconstructed in ways to represent broader categories of individuals.

the industrial differences in the employment status of elderly workers.

The regression results suggested that industrial characteristics that were favorably related to the labor-market status of older industrial workers were: higher labor productivity, less capital- or material-intensive production technology, shorter workday, lower intensity of work, greater job flexibility, and more formalized employment relationship. These industrial characteristics accounted for the observed inter-industry differences in the incidence of long-term unemployment.

The U.S. manufacturing industries experienced tremendous transformations in production technology, work-organization, and managerial practices in the late nineteenth and early twentieth century. Table 6 offers a snapshot of these changes from 1889 to 1929 by providing selected average statistics of the whole manufacturing sector, many of which were considered in this study. It is apparent from the result that firms rapidly grew in size, labor productivity soared, and production became more heavily dependent on materials and energy especially on electric power. It has been well documented that the prevailing hours of work decreased during the period, especially after 1909, although the prevalence of shorter workdays probably came with strengthened intensity of work (Whaples 1990b). In addition, the number of managers per worker and the number of clerks per worker appear to have been increasing.³⁴ The proportion of female workers in manufacturing remained stable over the period under investigation in spite of the gradual rise in the LFPR of females.

The results of the study suggest that the transformations in the U.S. industry had probably brought about both favorable and adverse consequences to the labor-market status of older manufacturing workers. On one hand, technical progress and organizational modifications may have improved their employment prospect by improving labor productivity, diminishing hours of work, and formalizing employment relations. On the other hand, some types of technical innovations that led to a more capital- and material-intensive production may have forced older workers out of their jobs by augmenting the requirements for physical strength, mental agility, and ability to acquire new skills. Given that the pace and features of technical change differed across industries, and possibly across firms within the same industry, the experiences of individual older workers were presumably highly heterogeneous. In some industries, a few elderly workers probably fell to the state of 'industrial scrap heap,' as claimed by some contemporary critics. However, such a pessimistic view of older workers cannot be generalized for the entire manufacturing industries.

³⁴ The data this observation was based on were gathered from 1909 and 1919 only. In the 1899 and 1929 manufacturing censuses, the number of managers and clerks are reported in a combined category, making it difficult to calculate their numbers separately.

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Table 1
Incidence of Long-term Unemployment by Industry in 1910

Industry	Age 25-44		Age 45 and Older		(5) (4)/(2)
	(1) Number	(2) Long-term Unemployed	(3) Number	(4) Long-term Unemployed	
(20) Food	1023	1.08	490	1.63	1.51
(21) Tobacco	231	1.30	131	1.53	1.18
(22) Textile	756	1.72	383	3.66	2.13
(23) Apparel	523	4.59	200	2.50	0.54
(24) Lumber/Woodworking	1479	1.56	630	3.49	2.24
(25) Furniture	271	2.58	119	2.52	0.98
(26) Paper	181	1.10	70	1.43	1.30
(27) Printing	1218	2.79	504	3.97	1.42
(28-30) Chemical/Petroleum/ Rubber	364	1.37	152	1.32	0.96
(31) Leather	479	3.76	260	2.69	0.72
(32) Stone/ Clay/ Glass	685	3.21	268	1.87	0.58
(33) Primary Metals	1325	5.36	438	8.22	1.53
(34) Fabricated Metals	807	2.60	321	4.36	1.68
(35-36) Machinery	824	2.79	391	2.30	0.82
(37) Transportation Equipments	773	4.27	297	4.04	0.95
(38) Instruments	56	3.57	32	3.13	0.88
(39) Miscellaneous/Unclassified	263	1.90	146	3.42	1.80
(20-39) All Industries	10,941	2.82	4666	3.44	1.22

Source: IPUMS of the 1910 Census.

Note: Two-digit Standard Industrial Classification code is given in parentheses.

Table 2
 Logistic Regressions: Industrial Differences in the Probability of Long-Term Unemployment in 1910
 Male Manufacturing Workers Aged 45 and Older

	Mean	(1)		(2)		(3)	
		Unemployed for 24 weeks or longer		Unemployed for 16 weeks or longer		Unemployed for one week or longer	
		$\partial P/\partial x$	P-value	$\partial P/\partial x$	P-value	$\partial P/\partial x$	P-value
Age	53.524	0.0018	<.0001	0.0016	0.0028	0.0020	0.0321
Nonwhite	0.049	-0.0969	0.0158	-0.0812	0.0039	-0.0578	0.0893
Foreign	0.438	0.0033	0.6515	0.0062	0.4977	0.0015	0.9054
Married	0.804	-0.0026	0.7867	-0.0177	0.1430	-0.0213	0.2935
Head of household	0.819	0.0091	0.3757	0.0114	0.3735	-0.0073	0.7398
Illiterate	0.075	0.0081	0.5048	0.0277	0.0450	0.0442	0.0631
Family size	4.206	-0.0026	0.0915	-0.0032	0.0983	0.0039	0.1862
Residence Owned	0.407	-0.0074	0.2985	-0.0061	0.4935	-0.0256	0.0692
City size							
Under 2,500	0.219	NI	NI	NI	NI	NI	NI
2,500-49,999	0.305	-0.0032	0.7643	-0.0205	0.1042	-0.0101	0.6087
50,000-499,999	0.243	0.0158	0.1287	-0.0028	0.8179	-0.0211	0.3077
500,000 and over	0.233	0.0323	0.0032	0.0290	0.0291	0.0411	0.0571
Region							
Northeast	0.509	NI	NI	NI	NI	NI	NI
Midwest	0.312	-0.0082	0.3063	-0.0098	0.3284	-0.0233	0.1438
South	0.126	0.0104	0.3766	0.0061	0.6918	-0.0213	0.3819
West	0.053	0.0290	0.0296	0.0384	0.0265	0.0678	0.0215
Occupation							
White collar I	0.059	-0.0311	0.1327	-0.0501	0.0869	-0.2108	<.0001
White collar II	0.052	-0.0452	0.0551	-0.0639	0.0510	-0.2628	<.0001
Craftsmen	0.310	NI	NI	NI	NI	NI	NI
Operatives	0.344	0.0006	0.9377	0.0267	0.0121	0.0519	0.0019
Service	0.027	-0.0099	0.6412	0.0053	0.8373	-0.0567	0.2475
Manual labor	0.208	0.0087	0.3421	0.0390	0.0009	0.0770	<.0001
Young Unemployed	2.709	0.0040	0.2558	0.0064	0.1440	0.0137	0.0575
Industry Dummy							
Food	0.098	0.0110	0.6733	-0.0574	0.0551	-0.0694	0.1016
Tobacco	0.026	0.0022	0.9486	-0.0281	0.4180	0.0408	0.4840
Textile	0.084	0.0282	0.2300	-0.0061	0.7851	-0.0435	0.2599
Apparel	0.040	NI	NI	NI	NI	NI	NI
Lumber/Woodworking	0.091	0.0491	0.0374	0.0121	0.6557	-0.0037	0.8448
Furniture	0.028	0.0088	0.7714	-0.0368	0.2740	-0.0617	0.2006
Paper	0.017	0.0001	0.9997	-0.0942	0.1519	-0.0125	0.0659
Printing	0.109	0.0320	0.1350	-0.0019	0.9118	-0.0668	0.0707
Chemical/Petroleum	0.032	0.0001	0.9964	-0.0616	0.1395	-0.0451	0.3533
Leather	0.059	0.0097	0.6867	-0.0450	0.0781	-0.0667	0.0819
Stone/Clay/Glass	0.060	0.0030	0.9076	-0.0223	0.3639	-0.0021	0.8866
Primary Metal	0.104	0.0500	0.0128	0.0133	0.5237	-0.0093	0.7417
Fabricated Metal	0.058	0.0336	0.1645	-0.0106	0.6769	-0.0542	0.2000
Machinery	0.088	0.0121	0.6066	-0.0178	0.4518	-0.0798	0.0410
Transportation Equipment	0.069	0.0223	0.3095	0.0050	0.8339	-0.0202	0.5417
Instrument	0.007	0.0148	0.7354	-0.0533	0.4175	0.0592	0.4773
Miscellaneous	0.032	0.0244	0.3690	-0.0293	0.3608	-0.0628	0.1907
Number of observations		3769		3769		3769	
-2 Log L without covariates		1317.876		1892.056		3888.758	
-2 Log L with covariates:		1205.159		1749.981		3663.520	
Likelihood Ratio		112.717(p< 0.0001)		142.075(p<0.0001)		225.237(p<0.0001)	

Source: IPUMS of the 1910 census linked to the published 1909 manufacturing census.

Note: The dependent variable for each regression is one if the person was unemployed for 24 weeks or longer during the year prior to the enumeration of the 1910 census, and zero, otherwise. The mean of the dependent variable is 0.042 for (1), 0.069 for (2), and 0.211 for (3). The sample was limited to individuals for whom the number of weeks unemployed was reported. Statistically significant variables are given in bold numbers.

Table 3
Sample Means of Industrial Characteristics by Industry Group

Industry	N	Firm Size	Productivity	Non-labor Input	Electricity	Hours 60 and Over	Female	Manager	Clerk
(20) Food	485	11.654	9.039	92.141	0.975	22.390	11.214	3.036	13.385
(21) Tobacco	131	10.103	7.747	81.049	0.067	0.419	48.218	1.300	4.966
(22) Textile	361	12.618	7.530	77.765	0.514	8.566	43.728	0.770	1.984
(23) Apparel	200	11.233	7.734	78.671	0.124	0.466	60.148	1.085	8.041
(24) Lumber/Woodworking	435	10.207	7.396	69.760	0.201	10.451	2.818	1.681	3.072
(25) Furniture	119	11.047	7.549	71.923	0.393	0.196	4.330	1.765	6.237
(26) Paper	70	12.415	8.002	81.938	1.479	33.744	18.731	1.605	4.893
(27) Printing	504	9.995	7.874	72.941	0.880	0.269	22.399	3.005	20.619
(28-30) Chemical/Petroleum/Rubber	151	12.365	8.666	90.432	1.176	15.061	10.687	2.665	13.730
(31) Leather	260	12.057	7.973	82.040	0.311	0.155	25.120	1.509	6.385
(32) Stone/ Clay/Glass	268	10.408	7.278	58.623	1.011	11.473	2.420	1.965	3.985
(33) Primary Metals	438	13.534	8.188	81.374	2.287	28.312	2.953	1.478	6.573
(34) Fabricated Metals	265	11.643	8.092	79.424	0.672	13.361	7.036	1.986	10.056
(35-36) Machinery	391	11.642	7.767	73.135	1.136	0.799	5.324	2.159	10.337
(37) Transportation Equipments	297	11.528	7.528	65.581	0.725	5.798	0.542	1.645	5.297
(38) Instruments	28	12.229	7.258	61.792	0.279	0.970	45.034	1.021	4.428
(39) Miscellaneous/Unclassified	146	11.067	7.729	75.124	0.327	4.578	24.689	1.565	8.297
(20-39) All Industries	4549	11.470	7.908	76.648	0.835	9.942	16.041	1.932	8.700

Source: IPUMS of the 1910 census linked to industry-level data compiled from the published report of the 1909 manufacturing census.

Note: See text for definition of variable. N denotes the number of men aged 45 and older included in the IPUMS of the 1910 census who were employed in the given manufacturing industry.

Table 4
 Logistic Regressions: Industrial Characteristics and the Probability of Long-Term Unemployment
 Male Manufacturing Workers Aged 45 and Older

	Mean	(1) Unemployed for 24 weeks or longer		(2) Unemployed for 16 weeks or longer		(3) Unemployed for one week or longer	
		$\partial P/\partial x$	P-value	$\partial P/\partial x$	P-value	$\partial P/\partial x$	P-value
Industry Variables							
Young Unemployed	2.709	0.0062	0.0239	00113	0.0004	0.0177	0.0005
Firm Size	11.516	-0.0012	0.7517	-0.0043	0.4949	-0.0117	0.2285
Productivity	7.900	-0.0831	0.0036	-0.0670	0.0418	0.0011	0.9745
Non-labor Input	76.515	0.0033	0.0175	0.0017	0.2835	-0.0025	0.2717
Electricity	0.850	-0.0096	0.4232	-0.0037	0.7509	-0.0161	0.3604
Hours 60 and Over	9.886	0.0010	0.0470	0.0008	0.2132	0.0027	0.0015
Female	15.891	-0.0013	0.0008	-0.0009	0.0354	0.0003	0.6753
Manager	1.898	-0.0310	0.0049	-0.0388	0.0048	-0.0395	0.0215
Clerks	8.559	0.0054	0.0007	0.0054	0.0041	0.0033	0.2001
Number of observations		3769		3769		3769	
-2 Log L w/o covariates		1317.876		1892.056		3888.758	
-2 Log L with covariates:		1206.352		1755.332		3666.221	
Likelihood Ratio		111.5239 (p= 0.0002)		136.725 (p<0.0001)		222.5366 (p<0.0001)	

Source: IPUMS of the 1910 census linked to the published 1909 manufacturing census.

Note: All the independent variables pertaining to personal characteristics (reported in Table 2) were included in the regressions, but omitted from the current table. The dependent variable for each regression is one if the person was unemployed for 24 weeks or longer during the year prior to the enumeration of the 1910 census, and zero, otherwise. The sample was limited to individuals for whom the number of weeks unemployed is reported. Statistically significant variables are given in bold numbers.

Table 5
 Logistic Regressions: Industrial Characteristics and the Probability of Retirement between 1900 and 1910
 Union Army Veterans Aged 45 and Older

	(1) All veterans			(2) Older veterans (ages 55 and older)		
	Mean	$\partial P/\partial x$	P-value	Mean	$\partial P/\partial x$	P-value
Individual Variables						
Age	57.996	0.0229	<0.0001	60.191	0.0276	0.0006
Foreign	0.225	-0.0937	0.3674	0.222	-0.1680	0.0755
Married	0.877	-0.1812	0.0881	0.852	-0.1268	0.2072
Head of household	0.899	0.1246	0.5465	0.887	0.0590	0.9867
Illiterate	0.019	0.0730	0.8755	0.017	0.0821	0.7369
Family size	3.547	0.0338	0.0397	3.309	0.0358	0.2143
Residence Owned	0.525	-0.1116	0.2218	0.548	0.0096	0.8884
Reside in urban areas	0.329	-0.0307	0.6542	0.309	-0.0183	0.6827
Region						
Northeast	0.500	NI	NI	0.491	NI	NI
Midwest/ South/West	0.500	0.0060	0.9942	0.509	0.0010	0.8138
Occupation						
Unskilled	0.316	NI	NI	0.274	NI	NI
Skilled	0.573	-0.0436	0.2542	0.609	-0.0821	0.2227
White collar	0.111	-0.0203	0.8796	0.117	-0.0524	0.5595
Log of UA pension	1.735	0.0664	0.0412	1.762	0.0410	0.2059
Industry Variables						
Firm Size	11.544	0.0600	0.0672	11.547	0.0736	0.0882
Productivity	7.984	-0.1276	0.3803	7.969	-0.1049	0.5749
Non-labor Input	78.846	0.0035	0.7972	78.544	0.0035	0.7469
Electricity	0.402	-0.1237	0.4421	0.403	-0.4154	0.0368
Hours 60 and Over	10.077	0.0024	0.3887	10.261	0.0081	0.0376
Female	15.077	-0.0078	0.0014	15.637	-0.0094	0.0023
Manager	2.068	-0.0395	0.4242	2.064	-0.1437	0.0563
Clerk	9.410	0.0011	0.7633	9.209	0.0173	0.2269
Number of observations	316			230		
-2 Log L w/o covariates	405.873			305.075		
-2 Log L with covariates:	351.060			266.913		
Likelihood Ratio	54.8129 (p < 0.0001)			38.1620 (p = 0.0085)		

Source: Longitudinal sample of Union Army veterans linked to 1900 and 1910 censuses, and published 1899 and 1909 manufacturing censuses.

Note: The dependent variable for each regression is one if the person was not gainfully employed when the 1910 census was enumerated, and zero, otherwise. The sample is limited to individuals for who were gainfully employed in 1900. The average of the 1899 and 1909 values were used for the following industry variables: *Productivity*, *Non-labor Input*, *Electricity*, and *Female*; the values for 1909 were used for the following industry variables: *Hours 60 and Over*, *Manager*, and *Clerk*. Statistically significant variables are given in bold numbers.

Table 6
Changes in Selected Average Characteristics of Manufacturing Industries, 1889-1929

Industrial Characteristics	1889	1899	1909	1919	1929
(1) Value of capital per establishment (dollar)	18,359	19,165	68,636	153,228	
(2) Value of product per establishment(dollar)	26,370	25,386	76,993	215,157	333,879
(3) Value of product per worker (dollar)	1,989	2,450	3,125	6,862	7,969
(4) Expenses on materials / Wages	2.26	3.16	3.54	3.55	3.32
(5) Power per 100 workers (horse power)	140	218	288	333	491
(6) Share of Electric power (percent)		4.8	25.4	55.0	82.3
(7) Share of Female workers (percent)	19.5	20.0	20.6	20.1	21.0
(8) Managers per 100 worker			2.0	3.1	
(9) Clerks per 100 worker			8.7	11.4	
(10) Managers & clerks per 100 worker		7.5	10.7	14.5	15.4

Source: Calculated from published manufacturing censuses of 1889, 1899, 1909, 1919, and 1929, except for (5) and (6) that were drawn from Carter et al. (2006), Table Dd848-853.

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