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Human Capital and the Managerial Revolution in the United States

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Abstract

This paper estimates the returns to human capital accumulation during the first era of mega-firms in the United States by linking employees at General Electric—a canonical enterprise associated with the "visible hand" of managerial hierarchies—to data from the 1940 federal census. Across the hierarchy, 62 percent of employees had four or more years of a college education, a higher rate than for the country's engineers (57 percent). I find large returns to higher education through seniority in the hierarchy linked to span of control, through earnings, and through selection into management training. For identification, I instrument for years of education and college attendance using the number of land-grant colleges and historical universities proximate to an individual's birth state. The findings provide causal evidence on the human capital determinants of the managerial revolution, driven by earlier public investments supporting the expansion of the US higher education system.

Keywords: Returns to education, human capital, management practices, hierarchies

JEL Classifications: M10, M50, N62

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1 Introduction

The professionalization of management and expanding access to education were fundamental to the early development of the American economy. Managerial hierarchies enabled coordination and scale in complex business organizations (Chandler, 1977, 1994), while US leadership in the provision of education led to productivity advance through human capital accumulation (Goldin and Katz, 2008). Yet, these two changes have not been connected empirically, despite influential work on the importance of management practices (Bloom and Van Reenen, 2007; Bloom, Sadun and Van Reenen, 2010; Giorcelli, 2019) and human capital (e.g., Nelson and Phelps, 1966; Lucas, 1988; Barro, 2001; Gennaioli et al., 2013) to firm performance and economic growth.

This paper shows that human capital accumulation through access to higher education was a key factor shaping the managerial revolution in the United States during the early twentieth century. It links the economic returns to expanding access to education to the rise of professional managers as agents in the development of large-scale manufacturing enterprises. In doing so, it highlights a key channel through which public investments in higher education during the nineteenth century determined the later allocation of talent in a preeminent managerial hierarchy.

I use a new dataset linking personnel records on individuals employed at all levels of the managerial hierarchy at General Electric (GE), a pivotal R&D-based firm, to the federal census in 1940, the first to contain data on education and earnings. Using corporate *Organization Directories* I observe unique data on internal structure: the position of individuals in the hierarchy, their experience, job responsibility and department. I also observe counts of attendance at GE management training camps, which provided formal on-the-job training for employees. I use matching data from the 1940 census on an individual's age, wages, education and socioeconomic measures such as being an immigrant, owning a home and marriage status. Together these variables provide a window into the economics of management, the organization of the firm, and the demand for skills.

Focusing on a canonical firm with these extra measures means I can go beyond the wage returns to human capital typically studied in the literature. GE was a leading corporation in the first period of mega-firms (Lamoreaux, 2019) and it is frequently referenced because of its organizational significance (e.g., Rajan and Wulf, 2006; Brynjolfsson and Milgrom, 2013). Analogous to a leading high-tech firm like Apple, Microsoft or Google today, GE focused on large-scale manufacturing in the new era of electrical products and intermediate goods through science, innovation and R&D. It was the 4th largest firm in the US in 1940 by market capitalization, employing 76,314 workers that year. Its scale is critical to an understanding of why hierarchies existed and why the careers of managers directing them became so professional and technical in orientation.

I estimate the private returns to education at three levels: within the hierarchy (C-suite and senior managerial positions relative to lower level positions), which I then link to the span of control used to coordinate high-level decision-making in the firm; the wage return; and selection into management training. I estimate these returns using the cross-section of data for 1940 and for four cohorts of individuals constructed by birth years. Younger individuals, for example, may adjust their investment in years of schooling in anticipation of changing premiums (Heckman, Lochner and Todd,

2006) such that changes in the pricing of college skills by firms, or the quality of graduates, may influence the size of the average returns over time (e.g., Katz and Murphy, 1992; Autor, Levy and Murnane, 2003; Juhn, Kim and Vella, 2005). The oldest cohort of individuals in my data (with a mean age of 57 years) would have progressed through the life cycle of their careers. For these individuals the returns will be more likely to reflect permanent differences in education premiums.

Descriptive data illustrates the significance of college-educated labor. Employees in the GE hierarchy completed a mean of 14.3 years of education while 62 percent had received four or more years of a college education. By comparison, 57 percent of engineers in the 1940 census had received four or more years of college (Edelstein, 2009), 11 percent had for equivalently-aged managers officials and proprietors, and 5.0 percent had for equivalently-aged male workers. At GE's R&D lab the share with five or more years of a college education was 18 percent, signifying the growing reliance on scientists and engineers in an era where in-house research facilities diffused widely (Mowery and Rosenberg, 1991). Vocational training was also prevalent. Among those in the C-suite and in senior managerial positions, almost two-thirds had received GE management training.

When estimating the returns to education any effect can be conflated with unobserved ability returns (Card, 2001). Individuals with greater wage-earning potential and innate ability may choose to acquire more schooling, so the OLS returns to education will be biased upwards. Alternatively, since employees at GE were not randomly selected from the population, ability may not be the same by education levels across the GE hierarchy. If GE screened for workers based on education and ability, for example, the less well-educated might have higher ability than otherwise similar individuals randomly chosen from the population. In this case, if wages equal productivity, the OLS return to education could be downward biased due to the nature of recruiting practices.

To estimate a causal effect of education, I exploit the institutional expansion of the US education system to generate quasi-random variation in college years. Specifically, I instrument for years of education and college attendance using two instruments: a continuous measure of the number of land-grant colleges in the census division around an individual's birth state (the range is 3 to 8) and a binary measure for the existence of historical universities founded before 1800 in that state. Whereas college education in the traditional states, like Massachusetts, had historically been shaped by the education of elite families, land grant colleges established under the Morrill Act in 1862 and its extension to southern states in 1890, created affordable higher education and the "democratization of learning," especially in scientific and technical areas of instruction (Klein, 1930).

The instruments move in opposite directions. First-stage coefficients show that each land grant college in the census division of an individual's birth state is associated with an additional 0.3 years of education and a 4 to 6 percent increase in the probability of a college education. Being born in a traditional state with historical universities, by contrast, is associated with 0.8 to 1.1 fewer years of education and a 14 to 20 percent lower probability of college attendance. The 2SLS strategy identifies the impact of more years of education off those exposed to greater access to affordable college education outside of states with old-established elite universities. In support of the assumption that individuals attended colleges in areas local to their birth states, census data show

most unmarried white males lived at home between ages 15 and 29 (Gutmann, Pullum-Pinon and Pullum, 2002). Although the 1940 census does not identify place of higher education, personnel records for GE employees do. Most attended a college in a highly localized area around their birth state (as shown in Figure 5 and discussed in Section 4.3).

The intuition for the instruments relates to the well-known use of proximity to colleges as a source of exogenous variation in educational attainment (e.g., Card, 1993; Kane and Rouse, 1995). The research design also builds on several studies using land-grant colleges for identification. Moretti (2004) asserts that "the geographical location of land-grant colleges seems close to random" which he uses as a source of exogenous variation to identify city-level changes in the number of college graduates active in the labor market during the late twentieth century. In a study of the returns to education Ehrlich, Cook and Yin (2018) argue that "the [1862] Morrill Act was a largely exogenous policy change that exerted a pronounced effect on the growth of higher education in the United States." Although Andrews (2020) and Russell, Yu and Andrews (2021) find a link between the location of some of the land grant colleges and correlated determinants of education, in about 40 percent of cases Andrews notes, the placement of the institution was as good-as-random. Furman and MacGarvie (2007) use historical universities and the sale of land and scrip to finance land-grant colleges under the Morrill Act of 1862 as instruments in their work on the relationship between universities and the spread of industrial research in the early twentieth century.

The analysis starts by estimating the returns to education through rank in the managerial hierarchy. I use GE's 1940 *Organization Directory* to establish the level at which each individual was employed. I estimate the probability of an individual being in upper level leadership positions—the C-suite or senior managerial—relative to lower levels in 1940, conditional on years of education, potential labor force experience, socioeconomic controls and GE department fixed effects. An additional year of education increases the probability of being in the upper levels by 1.6 percent and a college education by 9 percent relative to the non-college educated. 2SLS estimates are 1.8 percent and 10 percent respectively. Models using a complete set of dummy variables for years of schooling show that advancement in the hierarchy is quite linear in its relation to education.

Results from cohort-specific OLS specifications show that positional returns in the managerial hierarchy are driven by individuals in older cohorts who had reached a more permanent position over the life cycle of a career. For these individuals, an additional year of education increases the probability of reaching the C-suite and senior managerial positions in the hierarchy by about 3.5 percent. Going to college increases the probability substantially, by over 19 percent relative to those who did not go to college. Re-estimating the returns through rank in the managerial hierarchy for this oldest cohort of individuals using a complete set of dummy variables for education indicates large positional gains to human capital through advanced years of a college education.

I link these positional returns in upper levels of the hierarchy to span of control. While job responsibility and position in the hierarchy can reflect administrative rules in promotion (Doeringer and Piore, 1985; Baker, Gibbs and Holmstrom, 1994*a*), abler managers should also be stratified in an organization according to theories of knowledge hierarchies (Garicano, 2000; Garicano and

Rossi-Hansberg, 2006). I estimate span of control as the average number of subordinates below a focal individual in three ways: at all levels below in the hierarchy; in the level immediately below; and in the level below in the same department, following the broad intuition for constructing these hierarchy-based measures in Fox (2009) and Ortín-Ángel and Salas-Fumás (2002). Span of control is then defined as the first principal component of these separate measures, which I standardize for ease of interpretation. OLS specifications show that an additional year of education is associated with an increase in span of control in upper levels of the hierarchy by 0.07 to 0.08 standard deviations whereas a college education is associated with a substantial 0.43 to 0.46 standard deviation increase. These results connect the positional returns to education to additional job responsibility in the most important levels of the hierarchy where key strategic decisions were made.

I then estimate wage regressions. Earnings should be most closely linked to productivity compared to the positional measures described above, because even individuals in upper levels of the hierarchy may exert less effort and face compensation adjustments due to contingencies in the labor contract. In these models I can use fixed effects for employment level thus identifying the returns off narrow layers in the hierarchy. I find a precisely estimated return to a year of education of around 5 to 6 percent under OLS or 9 to 10 percent under 2SLS. For comparison Feigenbaum and Tan (2020) use 1940 census data to estimate a population-based causal return to schooling of 4 percent in a sample of twins, whereas Clay, Lingwall and Stephens (2021) use changes in compulsory schooling laws to identify a causal return of 7 to 8 percent in a sample of native-born white men from the 1940 census. Modern studies find returns to a year of education of about 10 percent (Deming, 2022)

Notably, the largest returns to education in my sample are at the college-level with a college wage premium (relative to those who did not attend) of 35 percent under OLS or 64 percent in 2SLS specifications. Since the instruments have the largest effect on individuals educated in states where land grant colleges were established, but where historical universities were absent, the results suggest large wage-based gains to human capital accumulation caused by the expansion of the education system. Although the college premium declined in general from 1900 to about 1950 (Goldin and Katz, 2008) I find *larger* OLS wage-returns to education for the youngest cohorts of employees, suggesting increasing skill premiums in managerial firms at this time. Because wages in the 1940 census are top-coded (at $5,000 or about $100,000 today), which affects 15 percent of the observations, I use censored regressions and imputations based on executive compensation data from Frydman and Saks (2010) to test the robustness of the return estimates to different top-coding assumptions. Results confirm economically large college education premiums.

In the final part of the paper I estimate the causal relationship between education and selection into management training. Results indicate that the intensity of management training was increasing in years of education and particularly college attendance, suggesting an interaction between formal education and an upgrading of workplace skills. I then estimate specifications comparing the effects of education and training. Management training dominates over education in its relationship to position in the hierarchy but the reverse is true in wage regressions where the link to productivity should be clearest. This finding highlights the significance of education premiums given that the

returns to training within firms are often estimated to be much larger than the returns to additional years of schooling (e.g., Loewenstein and Spletzer, 1998).

The OLS and 2SLS estimates are robust to different approaches to modelling the regression function and to dropping major clusters of observations in the 2SLS specifications following Young (2022). Recent work has examined the extent to which 2SLS estimates based on multiple instruments can be interpreted as local average treatment effects (LATE) given the monotonicity assumption that treatment must be a consistent function of the instruments (Mogstad, Torgovitsky and Walters, 2021; Słoczyński, 2022). I test the validity of the monotonicity assumption informally by splitting the data into multiple sub-samples based on age, labor market experience as well the range of socioeconomic characteristics on individuals compiled from the 1940 census.[1] Running separate first stages on these sub-samples shows that the coefficients on the instruments always retain the same sign as the coefficients from the first-stage in the full dataset, which is indicative of monotonicity. I also show consistent estimates with interactions between the instruments and the socioeconomic characteristics of individuals as excluded instruments using 2SLS, LIML and the UJIVE estimator from Kolesár (2013).[2] Including interactions as instruments is closer in spirit to the original LATE causal specifications estimated in Angrist and Imbens (1995).

Overall, I find economically large positional, job responsibility, and wage returns to education during the managerial revolution in American manufacturing. These payoffs, in turn, can be connected to exceptional prior public-educational investment responses in the US, especially as a consequence of the diffusion of science and technology instruction through the system of land grant colleges. Since education puts "capable workers at the helm" (Goldin and Katz, 2008), the findings link together investments in human capital formation with talent stratification in the type of corporate hierarchy that became a fundamental determinant of long-run US economic growth.

Related Literature: The analysis provides micro-level quantitative evidence on the relationship between human capital accumulation and managerial hierarchies in the US, as distinct from Chandler's qualitative research. Frydman (2019) shows that top executives in US firms in the 1930s and 1940s were highly educated, especially in science and technology, and connects this human capital advantage to managerial pay. I build on this work by observing human capital at multiple layers of the corporate hierarchy, in addition to the most senior levels. I also provide links to job responsibility (position and span of control) and management training. The findings relate to new research showing the distinctiveness of management in American corporations over the long run. Notably, Bianchi and Giorcelli (2021) show how efforts to promote management training in firms during the Second World War led to persistent performance improvements in treatment firms.

In the economics of organizations, hierarchies can be coordinating devices for the allocation of talent (Geanakoplos and Milgrom, 1991; Garicano, 2000; Garicano and Rossi-Hansberg, 2006). Despite the prominence of these theories, Gibbons (2020) argues that more research is still needed

[1] This approach has been implemented in a number of empirical papers including, for example, Maestas, Mullen and Strand (2013), Dobbie, Goldin and Yang (2018), Autor et al. (2019) and Bhuller et al. (2020).

[2] For the UJIVE estimator I use the Stata code written by Raymond Han in Abdulkadiroğlu et al. (2020).

to understand "what visible hands do." Human capital and compensation data are rarely observed across multi-layered hierarchies, especially historically. The analysis contributes unique data and findings to the growing literature on micro-aspects of managerial communication and performance (e.g., Bandiera et al., 2020; Impink, Prat and Sadun, 2020) and the long-standing debate in personnel economics on how human capital impacts wage-setting and job seniority in firms (Altonji and Shakotko, 1987; Topel, 1991; Baker, Gibbs and Holmstrom, 1994*a*,*b*; Lazear and Shaw, 2007).

Finally, the findings relate to the large literature on the returns to human capital in periods of technological progress (e.g., Katz and Murphy, 1992; Juhn, Murphy and Pierce, 1993; Krueger, 1993; Autor, Levy and Murnane, 2003). To the extent that "management is a technology" (Bloom, Sadun and Van Reenen, 2016), the spread of mass production, the adoption of electricity in manufacturing plants and the emergence of R&D intensive forms of business organization during the early twentieth century would have affected the relative demand for managerial skill. The large returns to additional years of education that I find in a preeminent managerial hierarchy contributes to research highlighting the deep roots in the United States of complementarities between technology and human capital accumulation (Goldin and Katz, 1998; Katz and Margo, 2014).

2 Historical Background and Institutional Setting

This section discusses the integral role of the developing US education system as a forerunner to the managerial revolution. It provides historical background and institutional details on how public investment in education would have been a key precondition for the development of managerial expertise in the type of large R&D intensive firms that came to dominate US manufacturing.

2.1 Investments in Education

The early development of the US education system created an institutional foundation for the human capital century. All states and territories had compulsory attendance legislation by 1918. During the "high school movement" between 1910 and 1940, enrollment and graduation rates increased drastically, with more than half of youths graduating by the end of this time period (Goldin and Katz, 2011). The returns to education were large. Using data on wages from the 1915 Iowa State Census Goldin and Katz (2008) estimate an additional year of high school or college to be worth 11 to 12 percent in labor market earnings. They also find large within white-collar occupational returns, especially for college years at a time of increasing demand for skilled workers and growing firm scale. Between 1900 and 1909 the ratio of while-collar employees to production workers more than doubled. At AT&T in the early twentieth century Batt (1996) writes that "external recruits were usually college-educated, and tended to be placed in positions dispersed throughout the organization."

At the higher education level the rise of colleges and universities in the United States can be connected to the establishment of the land-grant system. Under the Morrill Acts of 1862 and 1890 the sale of government land in each state provided for the establishment of educational institutions to advance the study of "agriculture and the mechanical arts." More institutions of higher education were founded in the late nineteenth century than any other era in US history, with 432 colleges and

universities being opened for instruction from 1860 to 1899. The number of private institutions—e.g., Caltech (1891), Stanford (1885), Chicago (1890)—even outnumbered those established under the land-grant system. Enrollment among 18 to 21 year-olds increased significantly—by more than five times between 1890 and 1940 (Goldin and Katz, 1999). The nature of the curriculum also shifted as the economy transitioned away from agriculture and towards large scale manufacturing enterprise. Colleges and universities reacted to this structural change by providing specialized offerings in subject areas associated with practical learning and science.

Education levels mattered because of the connection between human capital development and firm growth. Research at institutions of higher education influenced the types of projects undertaken in corporations in R&D intensive areas. Mowery and Rosenberg (1991) count 2,775 in-house corporate R&D facilities in the US in 1921 rising to 27,777 in 1940. In the pharmaceutical industry, Furman and MacGarvie (2007) detect a channel running from university research—captured by the number of Ph.D.'s granted—to the number of corporate R&D labs and employees in a county. Local agglomerations were frequently tied to university research. The Firestone Tire and Rubber Co was located close to the the University of Akron, for example, which had expertise in the study of rubber and polymers. The major chemicals company DuPont was located 15 miles away from the University of Delaware, a center of excellence in chemical engineering (Mowery et al., 2015).

Indeed, the association between corporations and science strengthened during the early twentieth century, compounding the link between science, education and management. In 1926 Charles Stine, a Ph.D. educated chemist who ran DuPont's Central Research department emphasized the importance of the distinction between basic and applied science, citing GE's central R&D lab at Schenectady (established in 1900) as a forerunner in managing innovation. Stine argued that research of a fundamental nature was necessary to the development of innovative product lines, concluding in 1929 that the new science of innovation had been "marked by excellent progress." Neoprene (1931) and Nylon (1938) followed (Hounshell et al., 1988). In-house R&D laboratories exemplified the application of frontier science to the commercialization of new technologies (Arora et al., 2021).

The decision to organize R&D as centralized or decentralized entities and the management of salaried R&D workers became subjects of business administration, but business schools were nascent in this context. Wharton, founded in 1881, had some courses in business but it was not until the late 1890s that business education became more widespread. Chicago and the University of California both established schools of commerce which we know as Booth School of Business and Haas School of Business today. NYU and Dartmouth founded separate schools in 1900, and in 1908 Harvard established its business school, graduating a thousand students annually by 1929 (Groeger, 2021). Below this layer, local vocational schools existed. In Schenectady, for example, where GE was headquartered, such schools were jointly governed by GE and the City Board of Education and offered courses in business adminstration, law and accounting. However, very few managers at the time had any formal education in business, which only became a signal of credentials from around the 1960s (Frydman, 2019). In that sense, the returns to a technical higher education would have mattered most. Philip D. Reed, CEO of GE in 1940, had graduated from the University of Wisconsin

in 1921 with an electrical engineering degree. Of the six members of the Executive Committee at GE in 1940, three had degrees in electrical engineering.

2.2 Evolving Management Practices

A technical education had advantages in an era when managerial tasks became increasingly scientific. In 1911 Frederick W. Taylor, a mechanical engineer, published *The Principles of Scientific Management*, which created a framework for incentivizing workers through standardization and the differential piece rate system. Several firms abandoned Taylorism during the interwar years as a union avoidance strategy, but 43.7 percent of manufacturing workers were still covered by such agreements in 1935 (Jacoby, 1991). Techniques of management, including Taylorism, diffused widely through publications like *Industrial Management*, which focused on shop floor practices, and *The Harvard Business Review*, which began circulation in 1922 as a general management journal. In line with a fundamental change in the task content of managerial employment, *The American Management Association* (founded in 1923) published an influential handbook in 1931 that covered leadership, team incentives, and employee-to-management communication (Guillén, 1994).

In almost every area of business administration, science began to replace intuition as a form of managerial decision-making. As Goldin and Katz (2000) note, expertise generally shifted from shop-floor craftsmen to skilled managers. Human resource management became a well-defined field by the 1920s. Elton Mayo and Fritz Roethlisberger from Harvard focused on human problems in the management of workers, conducting the famous Hawthorne studies at Western Electric in 1924 (Levitt and List, 2011). HR departments set compensation, administered aptitude tests and training programs and made provisions for health and well-being as an antidote to the blunt techniques of scientific management (Kaufman, 2008). With the rise of durable good purchases by households, companies like GE targeted consumers using sales techniques that would later contribute to the field of marketing science. In accounting and financial management, planning and budgeting improved due to advances in measurement such as the return-on-investment formula developed by Donaldson Brown at DuPont in 1914. Brown had graduated in 1902 with a degree in electrical engineering from Virginia Polytechnic Institute, a land-grant research university, beginning his career at the Sprague Electric Company, a subsidiary of GE (Flesher and Previts, 2013).

The emergence of hierarchies in large firms led to the professionalisation of management practices. Starting in the 1920s, top executives began to be compensated through incentive schemes linked to stock prices (Holden, 2005). The Hay System of job evaluation, introduced in the 1940s, assigned points to position in the hierarchy to administer compensation, building on point-based plans from a few decades earlier. Integrating employees with different job responsibilities and functional expertise into an organization became the defining characteristic of the managerial revolution. When in-house R&D produced new product lines that could be developed inside the boundaries of the firm using the multi-divisional (M-form) structure, switching from functional to divisional expertise placed even more of an emphasis on managerial abilities. M-form organizational structures were first used at General Motors and DuPont during the early 1920s. About one-fifth of the largest US corporations adopted this form by the early 1950s, including GE (Hannah, 1999).

In this context, administrative coordination superseded coordination by market mechanisms because organizations had the cognitive capacity to process information, adapt and learn (Simon, 1947; Arrow, 1974). According to Chandler (1977) "top managers, in addition to evaluating and coordinating the work of middle managers, took the place of the market in allocating resources for future production and distribution." Models of hierarchies (e.g., Lucas, 1978; Garicano, 2000; Garicano and Rossi-Hansberg, 2006) link managerial talent to productivity through the stratification of skills. Firms place individuals in the hierarchy to manage job responsibilities through span of control (Bandiera et al., 2012). Hence, hierarchies reflect organization by knowledge expertise. Since skill is heterogeneous across individuals and relative position in the hierarchy can be a key determinant of compensation patterns, this should lead to large differentials in managerial pay (Rosen, 1986). Managers at larger firms, like GE, will be of a higher quality since job responsibility increases for each level in the hierarchy by firm size. With returns to human capital, formal education should be a key determinant of position in the organization, of earnings, and span of control.

3 Data Sources

The analysis relies on two main data sources: personnel documents from GE and matching data from the 1940 federal census. This section provides descriptive evidence on variables used to measure the returns to human capital in this managerial hierarchy and how the datasets were linked together. I observe 1,893 white-collar employees at GE, 22 of whom are women. I match 1,347 (71 percent) of these individuals to the 1940 census.

3.1 Hierarchy, Department and Span of Control

As one of the largest firms in the US, GE maintained comprehensive directories of its white-collar workers. These were confidential internal publications for use by GE employees to facilitate communication between individuals in the organization. The 1940 *Organization Directory* lists 1,893 employees who worked in white-collar positions in Schenectady. I observe eight departments, as illustrated in Figure A2 (e.g., Accounting, Engineering, Sales) and the level of each individual in the hierarchy. I also observe experience at GE by tracing individuals back to the 1930 *Organization Directory*. Thus, I can control for the returns to ability through tenure at the firm.

Hierarchical levels can be identified using the physical layout of the *Organization Directory*. C-suite executives are listed on the front-pages, then within each department the indent distance associated with each name defines the next level of the hierarchy. Employees are stratified by six levels with senior executives (above vice president) at the top of the hierarchy (Level 1), followed by vice presidents (Level 2) managers (Level 3) and lower-ranked employees (Levels 4 to 6).

Figure 1A compares the shape of the hierarchy at GE in 1930 and 1940, illustrating changes over time in who was included in the organization directories. In 1930 the hierarchy takes the typical pyramidal form, but the share of lower levels individuals reported in the directories falls by 1940. Interestingly, the number of senior and middle managers included in the directory in Level 3 and 4 increases that year. Although hierarchies tend to remain stable in shape as firms optimize by choosing a span of control of greater than one at each level (Baker, Gibbs and Holmstrom,

1994*b*; Ortín-Ángel and Salas-Fumás, 2002), this change lines up with Chandler's argument that managerial layers became more important in corporations. The structure of communications within organizations should reflect the channels needed for problem solving and effective decision-making (Simon, 1947; Arrow, 1974). In that sense, the changing levels across the 1930 and 1940 directories suggest shifting priorities around employee communication flows.

Levels in the hierarchy are defined independently of wages, but also closely correspond to thresholds in these data. Subject to the caveat that wages are top-coded, as discussed further below, Figure 1B shows significant level-jumps in annual compensation. A vice president, for example, earns 77.5 percent more than a Level 6 employee. For each change in level, an employee earns 12.7 percent more on average. Compensation increases are higher for upper level managers and executives (Levels 1, 2 and 3) relative to those lower in the hierarchy (Levels 4, 5 and 6), which is consistent with a skewed distribution of pay towards higher ranks (Rosen, 1986).

Span of control measures how relationships between managers and subordinates are defined and can be approximated using the structure of the hierarchy (Fox, 2009; Ortín-Ángel and Salas-Fumás, 2002). During the 1930s and 1940s, the relationship between span of control and administrative efficiency was debated by management and organizational theorists given the rising scale and complexity of business enterprise. Graicunas (1933) suggested that span of control should account for direct subordinate relationships, direct group relationships and cross-relationships. Urwick (1956), who built on Graicunas's ideas, advocated for a "restricted span of control" of no more than five or six subordinates to promote authority and responsibility in the organization, improve managerial effectiveness and reduce stress-loads faced by senior executives.

Using information in the *Organization Directory* to construct the corporate pyramid, I measure span of control in three ways: (a) using the number of subordinates in every layer in the firm below the focal layer (b) the number of subordinates in the next layer and (c) the number of subordinates in the next layer in the same department. The first measure captures direct and cross-department subordinate relationships. The second allows for cross-department communication but only at the level immediately below. An individual in the Executive Committee, for example, would communicate with the vice president of the R&D laboratory. The third assumes that the vice president of the R&D laboratory communicates with the manager below. That measure is closest to the modern definition of span of control as the number of *direct* subordinates being supervised.

Given the censoring of directory observations in the hierarchy below Level 4 shown in Figure 1A, I estimate span of control for individuals in Levels 1 to 3. This should be the locus of decision making in the hierarchy for the allocation of the firm's resources (Bandiera et al., 2012). Illustratively, let $n_{L_{(d)}}$ be the number of individuals n in level L and department d of the hierarchy. An individual at Level 1 would then be assigned average spans of control using the following measures:

$$\overline{Span}^{a}_{\mathrm{L1}} = \frac{n_{\mathrm{L2}} + n_{\mathrm{L3}} + n_{\mathrm{L4}}}{n_{\mathrm{L1}}} \qquad \overline{Span}^{b}_{\mathrm{L1}} = \frac{n_{\mathrm{L2}}}{n_{\mathrm{L1}}} \qquad \overline{Span}^{c}_{\mathrm{L1}_{(d)}} = \frac{n_{\mathrm{L2}_{(d)}}}{n_{\mathrm{L1}_{(d)}}}$$

The first measure $Span^{a}$, includes in the calculation all subordinates across multiple levels of the

hierarchy. For upper level managers and executives this produces a mean span of control of around 13. Measures $Span^b$ and $Span^c$, use the layer of the hierarchy immediately below, producing means of around four. A true measure of span of control, at least following the arguments in Graicunas (1933), would reflect an underlying composite of all three measures. I therefore use the standardized principal component of $Span^a$, $Span^b$ and $Span^c$ as an outcome variable in the empirical analysis. The first principal component explains 61.2 percent of the sample variance.

3.2 Matching to the 1940 Census

To match individuals in the 1940 *Organization Directory* to the 1940 federal census, I first limited observations in the census to the Albany-Schenectady-Troy metro area, the location of GE's Schenectady-based activities. Due to spelling errors in the census I then used iterations of surname string similarity metrics, such as the Jaro-Winkler distance, to establish a set of possible matches. Within that set I then hand-matched to link the two datasets together.

Distinct names could be easily matched such as *W. D. Coolidge*, director of the R&D laboratory at Schenectady in the GE directory who matches with *William D. Coolidge* from Schenectady in the census with an occupation string *"Engineer Rescharch Las" [sic]*. Naturally, more common names led to multiple matches. Using a Jaro-Winkler similarity threshold of 0.9 produced a mean of 13 matches per GE employee, with many more matches for common surnames: *D. A. Smith*, an auditor at GE in the accounting department, for example, had 65 potential matches.

To establish unique matches at the hand-matching stage, I used first name and middle initial (if given) along with the occupation string. This last piece of information was particularly important because the occupation string could be checked against the job title in the 1940 *Organization Directory*, as in the case of the Coolidge example above. In another example, *R. C. Muir* a vice president at GE matches to Roy C. Muir from Schenectady with an occupation string in the census of *"Vice President" [sic]*, while J. D Lockton matches to *John D. Lockton*, also of Schenectady, with an occupation string of *"Asst Treasurer"*. As a final example, *W. L. Carson* at the general engineering laboratory at GE matches to *William L. Carson* from Colonie, Albany in the census with an occupation string *"Electrical Engineer-gen El Co" [sic]*.

I matched 71.2 percent of individuals from the 1940 directory to the 1940 census. Compared to census-to-census match rates of 25 to 30 percent (Abramitzky et al., 2021; Bailey et al., 2020) this rate is high, but my sample characteristics are amenable to matching given the restricted geographic area and the utility of the occupation string for matching. The match rate would be even higher but for the fact that the GE directory often includes individuals in affiliated companies or decentralized departments, who may not have resided in the Albany-Schenectady-Troy area. The data also include travelling sales managers who might not be at their homes at the time of enumeration. While census enumerators were asked to complete information about such individuals, it is estimated that the 1940 census still under-enumerates by about 5 percent (King and Magnuson, 1995).

An important issue for inference is whether the unmatched have characteristics that differed systematically from the matched. One test is the match rate by hierarchical level. Figure A1A shows relatively uniform match rates by level from 65 to 74 percent. Figure A1B shows 95 percent confi-

dence intervals from regressions estimating the probability of being matched, including controls for any mechanical matching by the length of an individual's surname, its commonness (defined by a count of equivalent surnames in the directory), or the number of initials in a name. An F-test fails to reject the joint null hypothesis of no difference in match rates by level in the regressions without controls (F=0.47, p=0.754) or with name diagnostic controls (F=0.48, p=0.747).

3.3 Education, Income and other Variables from the 1940 Census

The 1940 census contains important data on education. Individuals were asked the maximum full grade of school or college they had completed. If they had been educated outside the US the enumerator was instructed to enter the American school system equivalent, or otherwise the number of years of schooling they had received. Since the data are self-reported there is scope for measurement error. Goldin and Katz (2000) find a tendency among older individuals to conflate the number of years of school and the highest grade completed, thereby biasing education levels upwards.

The maximum number of college years reported in the census is top-coded at "5+" so the range of years of schooling I observe spans from zero to 17 (4 individuals in the data reported no schooling at all in the census). Figure 2A shows the distribution of education years in the data with bunching around the completion of elementary school (1 to 8 years), high school (9 to 12 years) and college (13 years or more). Figure 2B shows a monotonically declining number of years of education by age, as would be expected given the expansion of the US education system over time.

Earnings are recorded in the 1940 census as the amount of money, wages or salary earned over the prior year. This variable is also top-coded with enumerators instructed to write "5,000+" for any individual reporting earnings in excess of $5,000. Earnings captures wage-work and excludes "business profits" or "fees from income." Goldfield (1958) concludes that the data should be reasonably accurate for wage-workers. Response rates were high with only some degree of salary-underreporting. Figure 3A shows plots of the wage series by age using an OLS regression and a Tobit specification to adjust for top-coding. Both series reflect the life-cycle profile in earnings.

Separately, the census records if an individual received above $50 from sources other than wage-work, including interest or dividends. In that regard, GE employees could participate in stock ownership, savings and investment plans (Moriguchi, 2005). About 34 percent of individuals reported receiving $\geq$ $50 in such income, rising to 64 percent for those in upper levels (Levels 1 to 3).

The census also records the number of weeks an individual worked in 1939, and it provides a snapshot of their hours worked during the week of March 24-30, 1940. Most individuals in the data (88.4 percent) worked 52 weeks of the year. Figure 3B shows hours by age peaked around the mid-30s, with attenuation towards the end of a career. When estimating the wage returns to education I use weekly wages defined as annual earnings divided by the number of weeks worked.

Two issues are of note when using the 1940 wage data. First, reluctance to reveal income may induce selection bias for higher-level workers given privacy norms around salary (Cullen and Perez-Truglia, 2018). Of the 1,347 individuals traced to the census, I observe wage information on 73.7 percent. Figure A3 shows 95 percent confidence intervals from a regression estimating the probability of wage data being observed by level and formal tests reject any statistically significant

differences between the coefficients (F=1.04, p=0.387). While the point estimate is lower than the baseline (Level 6) for top executives in Level 1, consistent with heightened disclosure reservations for those who earned more, it is higher than the baseline for those in Level 2 occupations.

Second, while top-coding is a generic problem in administrative data, it is more pronounced in my setting with 15 percent of individuals reporting a top-coded salary. Accordingly, I estimate the returns including and excluding top-coded values. I also use Tobit regression specifications with an upper-censoring limit, and impute values for top-coded observations in the hierarchy based on detailed executive compensation data from Frydman and Saks (2010).

Specifically, the Frydman and Saks data document compensation for top executives active in US corporations from 1936 to 1991. I calculate median compensation (remuneration plus bonus) for the 1939 cross section of 214 executives active in 67 firms to line up with the salary data in the 1940 census reflecting earnings in the year prior. I then assign top-coded values in my dataset the median value of $65,922. To get a sense of magnitudes, three top GE executives are included in the Frydman and Saks data starting in 1942: Clark H. Minor who earned $67,000 in annual salary plus bonuses, and Gerard Swope and Owen D. Young both of whom earned $66,000. GE's CEO, Philip D. Reed, earned $128,000 in 1945, the first year he is included in the data. In the empirical analysis I also provide results using the 25th percentile value of $42,000 instead. This imputation approach will provide an upper bound on the returns to education given that imputed values will reflect compensation for the highest paid executives in US corporations at this time.

I use further variables collected from the 1940 census as socioeconomic status and family background controls. I observe marital status and number of children (which may have constrained additional years of education), home ownership (as a proxy for intergenerational social status) and being an immigrant (as a control for potential wage differentials or other forms of discrimination). 7 percent of individuals were foreign-born; most were from the United Kingdom or Germany.

Finally, the data sources identify gender: 22 women were employed in Levels 4, 5 and 6 of the hierarchy, consistent with barriers to advancement in the workplace (Goldin, 2021). Star scientist Katharine B. Blodgett, for example, was awarded a Ph.D. in physics from Cambridge University in 1926, was 42 years of age in 1940, worked in GE's R&D laboratory as an expert in surface chemistry, and earned $3,502 in annual salary. Because women were not employed in upper levels of the hierarchy and the return to schooling tends to be greater for women than for men, I exclude these observations from the empirical analysis. Controlling for age, women had completed 1.6 fewer years of education than men; they earned 38 percent less at the same levels.

3.4 Management Training

Knowledge acquired through management training provides another channel through which human capital accumulation can affect position in the managerial hierarchy, job responsibility or earnings. Yet it is rare to observe systematic data on training at the firm-level (e.g., Bartel, 1995; Hoffman and Burks, 2017). I exploit unique data through GE's operation of a training center on Lake Ontario—called Association Island—about 160 miles north west of Schenectady where managers and other employees from across all its US plants would be sent for vocational training, team-building and

networking over 2 to 3 day events. Tents/cabins were used for housing; a fleet of boats transported participants to the island; and even a plane delivered mail daily from Schenectady.

Employees received both general and specific training. In the context of Acemoglu and Pischke (1998) general training made sense because turnover was low, and GE could capture the surplus on the human capital accumulation of its employees. Each GE department had its own training camp, with "Camp General" bringing together employees from across the organization. At these events, typically held in the summer, presentations were given by company leaders on research, engineering, manufacturing, marketing and administration. Employees learned how to "more adequately understand and discharge their responsibilities to customers, to stockholders, and to each other" and they developed skills "for the development of principles, products and methods." Training by camps started around 1910 and lasted until 1956, when the center was closed to save costs.

I collected data on the incidence of management training using attendance lists at Camp General matched to individuals in the 1940 *Organization Directory*. Between 1927 and 1939 GE held 9 camps. Around 13 percent had been to one of these prestigious camps with 7 percent attending more than once. Because attendance was not randomly-assigned—more capable employees were more likely to receive vocational training as their careers advanced—these data cannot be used to identify the causal effects of training. Rather, I estimate both selection into training through years of education, and I approximate the average return to training relative to the return to education while controlling for tenure at GE, general labor market experience, personal background characteristics and position in the hierarchy.

3.5 Descriptive Statistics

Table 1 provides descriptive evidence on the main variables with separate summary statistics for upper and lower levels of the managerial hierarchy. By age, I observe careers at a snapshot in time with individuals being in their early 40s on average. Those who had reached upper levels of the hierarchy (12 percent of all individuals in the dataset) were closer to 50 years of age. There are no significant differences across the hierarchy in the share of immigrants or the rate of marriage, though senior managers and executives had slightly more children and were more likely to own a home. Though data on home values from the census is sparse, this was generally an affluent group with the average value of a home for someone in the upper levels being $21,595, almost five-times higher than the average of $4,473 for the Albany-Schenectady-Troy metro area.

Education levels were high compared to national averages with a mean of around 14 years of schooling. Moreover, human capital accumulation through formal education was deeply embedded into the hierarchy, with no significant differences across upper and lower levels in the number of years of education individuals had received. Few had no schooling at all. 70 percent had received some form of a college education with 11 percent having five or more years of college, compared to 1.5 percent of equivalently aged males in the Albany-Schenectady-Troy metro area.

On average individuals worked 51 weeks of the year and completed a 40 hour work-week. Wage compensation was naturally higher in upper compared to lower levels, and those in upper levels were also more likely to earn non-wage income (64 versus 30 percent). Tenure at the firm was often long.

45 percent of the individuals in the data can be traced to the 1930 *Organization Directory* while 72 percent of upper level executives and managers had at least a decade of experience at GE. The span of control measures reflect the breadth of job responsibility in upper levels of the hierarchy. Management training was widespread in upper levels of the hierarchy with 62 percent of individuals attending a GE training camp at least once.

4 Empirics and Identification

I follow the general Mincer (1974) approach to estimating the returns to human capital with an extended set of outcome measures. Mincer modelled investments in education by agents seeking to maximize the present value of lifetime earnings, and I use this framework to capture the economic return to an additional year of education in the managerial hierarchy more broadly. Specifically, I run regressions at the individual-level,

$$\mathbf{y}_{i(d)} = \beta_1 \mathbf{E}_{i(d)} + \beta_2 \mathbf{E}^2_{i(d)} + \beta_3 \mathbf{E}^{GE}_{i(d)} + \gamma \mathbf{Education}_{i(d)} + \delta \mathbf{X}_{i(d)} + \eta \mathbf{D}_d + \epsilon, \tag{1}$$

where $\mathbf{y}_{i(d)}$ is one of the outcomes for individual i in department d: an indicator for upper levels of the hierarchy, span of control, the log of weekly wages, and the incidence of management training.

Potential labor market experience $\mathbf{E}_{i(d)}$ enters as its square and is defined as (age – years of education – 7) to approximate labor market activity since leaving full-time education. I also measure *actual* experience at GE, $\mathbf{E}^{GE}_{i(d)}$, using an indicator for individuals who could be traced to the 1930 *Organization Directory*. The background variables $\mathbf{X}_{i(d)}$ are from the census while $\mathbf{D}_d$ denotes department fixed effects. The key parameter, γ, measures the private return to education.

There are at least three main issues associated with estimating this type of specification: measuring education, changing cohort effects, and causal identification of the private return.

4.1 Measuring Education

I use the number of years of education reported in the census and I also run specifications using an indicator variable coded 1 for college attendance and 0 otherwise. Additionally, I estimate the following version of equation 1 with a full set of dummy variables for 9 to 17 years of education relative to a non-school/elementary school baseline. This provides a check on functional form and tests for differential returns by level of education.

$$\mathbf{y}_{i(d)} = \beta_1 \mathbf{E}_{i(d)} + \beta_2 \mathbf{E}^2_{i(d)} + \beta_3 \mathbf{E}^{GE}_{i(d)} + \theta_I \mathbf{Education}^{(9-17)}_{i(d)} + \delta \mathbf{X}_{i(d)} + \eta \mathbf{D}_d + \epsilon. \tag{2}$$

In both specifications any positive association between unobserved ability and educational attainment will lead to an upward bias in OLS estimates of the returns to education. This problem is addressed through 2SLS estimates of equation 1 as described in Section 4.3. These estimates will also be robust to classical measurement error in measuring years of education.

Because years of education is self-reported in the 1940 census, however, the measurement error may be non-classical. Goldin (1998) notes how older adults tended to overstate their years of schooling at a time when the rest of the population was experiencing substantial gains in schooling

years. Feigenbaum and Tan (2020) adopt a "milestone approach" to address this issue in their study of the returns to schooling based on the 1940 census, assuming that respondents recall reaching education milestones rather than the precise number of years. Here, the results using an indicator for college attendance as a milestone should be most robust to any measurement error biases.

4.2 Cohort Effects

Cohort effects will be important if expectations of the returns to education change substantially over time thereby affecting the decision to invest in additional schooling (Heckman, Lochner and Todd, 2006). While Goldin and Katz (2008) find a pronounced general drop in the college education premium between 1915 and 1950 as the supply of college graduates outstripped demand, we do not know how the premium may have varied over time in a corporate setting. I construct four cohorts by birth quartile: those born 1857-1889, 1890-1899, 1900-1907 and 1908-1921. I then estimate both equation 1 and 2 to recover the returns to education by cohort.

4.3 Endogenous Education: Land Grant Colleges and Historical Universities

I estimate equation 1 using 2SLS with two instruments: the number of land grant colleges in the census division of an individual's birth state—allowing for localized movement across state borders to access education—and an indicator for historical universities in an individual's birth state.[3]

Historical universities act as an exogenous determinant of tradition in the provision of high-cost elite education, while the land-grant instrument exploits a policy change leading to lower access costs. The political advocacy group, the *Farmers' Alliance* noted the democratizing effect of the land grant system: "The son of a rich man can go to Harvard, Yale, Columbia, or Princeton, and pay the $150 to $200 per year demanded by these institutions for tuition... but the boy from the poor man's home cannot do this... the free state university is his only hope" (Gelber, 2011). Because states could have both land-grant colleges *and* traditional universities, individuals born in non-traditional states where land grant colleges were opened should be most responsive to the treatment. That subgroup of individuals accounts for 38 percent of the sample.

In terms of further institutional details, the 1862 Morrill Act sought to "promote the liberal and practical education of the industrial classes." States were granted public land in proportion to their size, which could be sold to raise financing for the new colleges. The 1890 Morrill Act extended provisions to the southern states. Nevins (1962) notes the significance of the 1862 Act as the state of Illinois, for example, would have "waited many years" for the University of Illinois to be established, whereas "without the act the state of California might have been long delayed in developing its university to the point where, with eight different campuses, it is one of the wonders of the educational world." Prior to the Act, 21 state universities and colleges existed. More than 70 land-grant colleges and universities were founded as a consequence of the 1862 and 1890 legislation. Every state had at least one land grant college; some had as many as three.[4]

[3] Given the demographics of individuals in the dataset, I exclude historically black colleges and tribal colleges established under the land grant system.

[4] Initial enrollments were high though financial inducements through room-and-board subsidies and scholarships were also offered at some of the colleges to maintain student numbers. For a later period—1931—Goldin and Katz (1999)

Figure 4 maps individuals by their birth state as well as the instruments: the land grant colleges by census division and states with historical universities. The largest share of individuals (38.7 percent) were born in GE's headquarter state of New York, which has one land grant college—Cornell University—inside the state and three in its census division. 12.6 percent were born in states where land grant colleges were established under the 1890 Morrill Act. Both instruments are set to zero for immigrants, and I test for robustness by dropping these individuals altogether.

The instruments rely on the localization of higher-education relative to a birth state. Two pieces of evidence support this assumption. First, the median home-leaving age for white males between 1880 and 1940 was 22 to 24 years of age with 65 percent of unmarried white males living at home between ages 15 and 29, rising to about 85 percent by 1940 (Gutmann, Pullum-Pinon and Pullum, 2002). Second, although the 1940 census does not detail specific colleges attended, these data are available from personnel files at GE for a subset of employees. Herman C. Verwoert from the Central Engineering Department at GE, for example, was born in the state of California and attended UC Berkeley. Figure 5 plots the birth state against the home state for each individual showing a close correspondence between the two variables. 57 percent had attended a college in their birth state; 60 percent had attended a college in the census division of their birth state.

Finally, the land grant instrument is a relevant predictor of educational attainment for GE employees. *The United States Office of Education* noted in its 1930 survey of the land grant colleges:

> The directors of the research laboratories of the General Electric Co., the Westinghouse Electric & Manufacturing Co., the General Motors organization and the American Telephone and Telegraph Co. hold degrees from land-grant engineering colleges [as do]... the presidents of the General Electric Co.... and many others of the leading manufacturing and public utility industries.

5 Results

In this section I present the main results for the outcome measures—position in the hierarchy linked to span of control, and earnings. I then estimate selection into management training as a function of education, before estimating the returns to management training relative to the returns to eduction.

5.1 Positional Returns in the Managerial Hierarchy

5.1.1 OLS, 2SLS, LIML and UJIVE Estimates

Table 2 Panel A reports linear probability estimates of equation 1 where the dependent variable is an indicator for individuals in upper levels of the hierarchy relative to those lower down. I provide estimates of the positional return to an additional year of education (columns 1 to 4) and to a college education relative to a non-college education (columns 5 to 8). I use specifications with Mincer-type experience controls, experience at GE, department fixed effects and background controls from the census. Panel B of Table 2 reports 2SLS estimates with the same covariates and fixed effects.

find a one standard deviation reduction in tuition costs and fees at public universities is associated with about a 9 percent increase in enrollments.

Column 1 Panel A shows that an additional year of education is associated with a 1.9 percent increase in the probability of being in the upper level of the hierarchy whereas column 2 implies a 1.7 percent increase in the probability when controlling for experience at GE. Column 3 adds department fixed effects and column 4 further adds background controls. The estimates are highly stable across these specifications. Columns 5 to 8 show the college-level binary estimates of the positional return are also stable with large magnitudes. Being college-educated increases the probability of being in the upper levels by 9 to 11 percent relative to the non-college educated.

Panel B shows 2SLS results. In the first-stage each land grant college in the census division of an individual's birth state is associated with an additional 0.26 to 0.32 years of education (columns 1 to 4) and a 4 to 6 percent increase in the probability of a college education (columns 5 to 8), whereas being born in a traditional state with historical universities is associated with 0.8 to 1.1 fewer years of education and a 14 to 22 percent lower probability of college attendance. Over-identification tests fail to reject the null hypothesis that the estimates are the same across these instruments, and the Montiel-Pflueger F-statistics suggest relevance of the instruments for identification.

For these estimates to represent the LATE requires the effect of the instruments on years of education or college attendance should be constant across individuals. As an informal test of the monotonicity assumption, Table A1 reports estimates of the first-stage coefficients for sub-samples of the data based on the specifications in columns 4 (for years of education) and column 8 (for college attendance) of Panel B Table 2. If monotonicity holds, the sign of the first-stage coefficients on the instruments cannot become positive (negative) in any sub-sample if it was negative (positive) in the full sample. For each sub-sample split by median age, labor market experience, or binary measures of socioeconomic characteristics, the coefficients retain the same sign as the coefficients in the full sample. Also, the sub-sample coefficients are almost always statistically significant from zero and of a similar economic magnitude to the full sample first-stage coefficients.

In columns 1 to 4 the 2SLS estimate of an extra year of education on position in the hierarchy is to raise the probability of being in the upper levels by 1.8 to 2.4 percent whereas in columns 5 to 8 a college education increases the probability by 10 to 14 percent relative to the non-college educated, with confidence intervals that include zero in the most demanding specifications in columns 4 and 8. The 2SLS point estimates for years of education are between 13 and 31 percent larger than the corresponding OLS estimates, or between 12 and 34 percent larger for the college attendance indicator. Under a LATE interpretation these results are consistent with higher returns to schooling for a complier group experiencing more years of education due to the land grant system.

Table A2 reports robustness checks on the OLS and 2SLS results for years of education (Panel A) and college attendance (Panel B). All specifications use a complete set of experience controls, department fixed effects and background controls. Using a probit specification (column 1) produces a positional return in the hierarchy to an additional year of education of 1.2 percent, compared to 1.6 percent in the linear probability model. The corresponding return to a college education is 7.4 percent compared to 10 percent in the linear probability case. Following Murphy and Welch (1990) column 2 uses a quartic term in years of labor market experience for estimation and the results are

similar. Column 3 uses years of age instead of years of labor market experience, confirming the general tendency noted by Card (1999) that the age-returns will be lower than the experience-returns. Column 4 shows that the results are robust to dropping immigrants (7 percent of observations). Dropping outliers leads to lower returns in column 5, but this specification identifies off only 31 individuals in upper levels of the hierarchy compared to 148 in the regressions in Table 2.

Turning to the 2SLS robustness checks in columns 6 to 9, Young (2022) finds that instrumental variable estimates can be highly sensitive to dropping a few clusters of observations. I cannot drop the largest cluster of individuals born in the state of New York as this would reduce sample size in upper levels of the hierarchy, but when excluding individuals born in Pennsylvania and Massachusetts—the two largest birth state clusters outside of New York—columns 6 and 7 reveal larger positional returns in the managerial hierarchy compared to the estimates in Table 2. In these regressions the Montiel-Pflueger F-statistics indicate even stronger first stages. An additional year of education leads to a 2.2 percent increase in the probability of being in the upper level of the hierarchy whereas a college education increases the probability by around 13 percent.

While the results from Table A1 are consistent with the assumption of monotonicity, as an additional check I follow the suggestion in Słoczyński (2022) and use interactions between the instruments and covariates to estimate specifications closer to the original LATE estimation framework in Angrist and Imbens (1995). In column 8 of Table A2 I replicate the specifications in Table 2 column 4 (for years of education) and column 8 (for college attendance) but add interactions between both instruments and labor market experience as well as the background socioeconomic characteristics from the census (being married, a homeowner and number of children). The point estimates on years of education and college attendance are slightly larger and more precisely estimated than the 2SLS estimates in Table 2 (2.4 percent versus 1.6 percent and 13 percent versus 10 percent respectively) with a cost that the instruments are somewhat weaker with a more saturated specification.[5]

Under weak instruments the 2SLS estimates will be biased towards OLS. Column 9 therefore re-estimates the same models using LIML and column 10 implements the UJIVE estimator of Kolesár (2013), which is the most consistent estimator in this context. In column 9 the coefficients on years of education and college attendance are identical—or close—to the 2SLS estimates in column 8.[6] The UJIVE estimates are also similarly-sized, implying a 2.4 percent increase in the probability of being in the upper level of the hierarchy per additional year of education or a 14 percent increase for college attendance. These effects are 33 and 26 percent larger than the corresponding OLS positional returns from Table 2, suggesting economically sizeable LATE estimates.

5.1.2 Estimates by Year of Education and by Cohort

The estimates so far assume a linear return to education. Figure 6A tests this assumption by plotting OLS point estimates and 95 confidence intervals from equation 2 of the positional return by year.

[5] The Montiel-Pflueger F-statistic in both specifications is 14 to 15 but the 10 percent worst case bias threshold under 2SLS is 18 to 19.

[6] The Montiel-Pflueger F-statistics now clear the LIML 5 percent (14.7) and 10 percent (12.2) worst case bias thresholds respectively, because the threshold values decline faster (compared to 2SLS) as the number of instruments increases (Olea and Pflueger, 2013).

The baseline is 0 to 8 years of education (i.e. no education or elementary school) and the specification includes experience controls, an indicator for tenure at GE, socioeconomic background controls and GE department fixed effects. The return to education in the hierarchy increases reasonably uniformly by year with large effects in the college-year ranges. For an individual with 17 or more years of education, for example, the probability of being in the upper hierarchy increases by 14 percent.

The rate of return to education may also vary by individuals in a given birth group. Figures 6B-C show the OLS positional returns to education estimated for each cohort, where the oldest cohorts would be expected to have reached a relatively permanent position in the managerial hierarchy. Of those in the upper level of the hierarchy 49 percent were in the oldest cohort falling to 28, 18 and 5 percent in the remaining cohorts respectively. The figures show most of the estimated positional return to education is being driven by educational differences among older individuals. For those in the oldest cohort an additional year of education increases the probability of being in the upper levels by 3.5 percent whereas a college education increases the probability by 19 percent relative to the non-college educated. For the second cohort of individuals, the effects are 1.8 percent and 8 percent respectively, and indistinguishable from zero in the third and fourth cohorts.

Re-estimating equation 2 using observations for only the oldest cohort highlights the magnitude of the positional returns to education for individuals who were at the most advanced stage in the life cycle of their careers. The impact of a college-education stands out. Figure 6D shows that the probability of being in the upper levels of the hierarchy increases by 41 percent for an individual with 17 or more years of education relative to an individual with 0 to 8 years. These results are consistent with strong positional returns to human capital in the structure of the managerial hierarchy.

5.1.3 Span of Control

If education influences the capacity for decision making in organizations, these positional returns should be reflected in the relationship between education and span of control. Recall from Section 3.1 that span of control is the standardized principal component of the three measures of span of control—the number of overall subordinates, those in the next layer below, and those in the next layer below in the same department. While span of control is related to position in the hierarchy given the pyramidal structure of the organization, it provides additional information about the breadth of job responsibility across functional areas and within departments. Given censoring in the structure of the firm shown in the *Organization Directory* (see Figure 1), the estimates apply to the key top managers and executives in upper layers of the hierarchy (Levels 1 to 3).

Table 3 shows OLS estimates. An additional year of education is associated with an increase in span of control by 0.07 to 0.08 standard deviations, which is a large effect across the range of years of education in the data. The coefficients are precisely estimated and stable across specifications with experience controls (columns 1 and 2) and background controls (column 3). Similarly, the relationship is consistently estimated in columns 4 to 6. A college education is associated with a higher span of control by 0.43 to 0.46 standard deviations. Overall, these results suggest a strong relationship between human capital accumulation through educational attainment and greater breadth in job responsibility in the managerial hierarchy.

5.2 Wage Returns to Education

5.2.1 OLS, 2SLS, LIML and UJIVE Estimates

The estimates using earnings as an outcome measure reflect the labor market returns to education. I follow the same approach as the results for position in the hierarchy by reporting OLS, 2SLS, LIML and UJIVE estimates. I discuss additional results in Section 5.2.3 which adjust for salary top-coding in the 1940 census. The dependent variable is the log of weekly wages and the sample is all individuals who disclosed compensation to the census enumerators.

The OLS estimates in Panel A of Table 4 imply a return to a year of education of about 5 to 6 percent in the basic Mincer earnings model (column 1), when controlling for experience at GE (column 2), when adding department fixed effects (column 3) and when using background controls from the census (column 4). In the basic model in column 1 the R^2 is 0.36 so the model is explaining slightly more of the variation in earnings than the typical 20 to 35 percent noted by Card (1999) in modern studies using equivalent regressions. When adding fixed effects for hierarchical level in column 5 the estimate of the returns remains robust. Across columns 6 to 9 the wage-return to college years is substantial at between 30 and 34 log points or between 35 and 41 percent based on the exact percentage change ($\Delta\text{wages} = \exp(\hat{\gamma}) - 1$). The within-hierarchy-level estimate of the return to a college education relative to the non-college educated is 35 percent in column 10.

In the 2SLS regressions in Panel B of Table 4 the return to a year of education is 9 to 10 percent, whereas the return to a college education relative to a non-college education is 62 to 72 percent. The instrumented returns are therefore 50 to 68 percent larger than the corresponding OLS returns for years of education and 55 to 67 percent larger in the case of the college indicator. The assumption underlying the 2SLS estimates is that investment in land-grant colleges, especially outside of the traditional states, would have induced exogenous reductions in the cost of accessing higher education. These results imply the widening of college attendance yielded important earnings gains in the labor market. Both instruments perform well under the diagnostic test for weak instruments. The Montiel-Pflueger F-statistics exceed the 10 percent critical values in all specifications, exceeding the 5 percent critical value in the most demanding specifications with granular fixed effects (columns 4, 5, 9 and 10). Overall, the 2SLS results suggest that human capital accumulation through educational attainment led to sizeable wage-differentials in the corporate labor market.

Robustness checks in Table A3 show that OLS returns to both a year of education (Panel A) and to a college education (Panel B) are quite stable in columns 1 to 4 with various modifications to the regression specifications. The 2SLS estimates imply causal effects of education on wages of around 8 to 9 percent for a year of education or 65 to 69 percent for college attendance when dropping large clusters of observations of individuals born in Massachusetts and Pennsylvania in columns 5 and 6. Columns 7 and 8 produce similar 2SLS return estimates when using interactions between experience and socioeconomic characteristics as excluded instruments in the first stage. While the instruments are comparatively weaker in these specifications, the Montiel-Pflueger F-statistic exceeds the 10 percent critical value using the LIML estimator in column 8. In column 9 the UJIVE estimator leads to quite close point estimates, suggesting that an additional year of

education caused labor market earnings to be 9.4 percent higher for an additional year of education, or earnings to be 72 percent higher for the college educated.

5.2.2 Estimates by Year of Education and by Cohort

Figure 7 plots OLS point estimates and 95 percent confidence intervals of the returns to education from equation 2. The impact of a college education on wage differentials is striking with a wage-return of around 49 percent over the baseline of 0-8 years of education for an individual with 16 years of education or 60 percent over the baseline for an individual with 17 years or more of education. That latter return is 2.8 times the return to education for an individual with 13 or 14 years of education. These results are consistent with substantial economic returns to human capital investment, especially in a context where the workforce was highly educated (see Table 1).

Figures 7B-C indicate that the returns to education are concentrated in the *younger* cohorts, contrary to the older-cohort effects estimated for the returns to education as a function of seniority in the hierarchy identified earlier in the analysis (see Figures 6B-C). For the youngest two cohorts (Cohorts 3 and 4) the OLS return to a year of education is around 9 percent based on these point estimates, while the return to a college education is between 42 and 46 percent.

Coefficients on the indicators for years of education on these cohorts in Figure 7D illustrate visually pronounced wage-returns. In these cohorts 16 years of education is associated with 124 percent higher wages compared to the baseline, whereas 17 or more years of education is associated with a 148 percent premium. For the population as a whole, we know education premiums declined over time during the early twentieth century, driven by the large increase in the supply of educated workers (Goldin and Katz, 2008). These results show relatively higher wage-returns to younger, better-educated, workers in a managerial hierarchy, perhaps because of the economic value of specialized capabilities in science and technology areas tied to their educational knowledge.

5.2.3 Testing for Robustness to Top-Coding

I now turn to the top-coding of wages in the 1940 census at annual incomes exceeding $5,000. Recall that I observe individuals throughout the managerial hierarchy, not just at the top where compensation levels would be highest. Censoring may lead to biased estimates of the returns to education, however, under the type of convex pay structure predicted in tournament models of top executive compensation (Rosen, 1986). Table 5 presents results from three approaches: dropping top-coded observations; using Tobit (censored) regressions; and replacing top-coded values with median executive compensation data from Frydman and Saks (2010), as described in Section 3.3.

In Panel A dropping the top-coded observations means estimating the returns to education for individuals in the data below senior executive positions, which is the main component of the dataset. The returns to a year of education range from 4.9 to 5.5 percent compared to 5.3 to 6.2 percent when the top-coded observations are included in Table 4. Hence, the results are similar in terms of magnitudes. Likewise, the returns to a college education relative to a non-college education are in the range of 33 to 36 percent, compared to 35 to 41 percent in Table 4. Results from the Tobit regressions in Panel B show a return to a year of education in the range of 6.2 to 7.3 percent, and to

a college education of 41 to 49 percent, again close to the main OLS results.

In Panel C imputing top-coded compensation values using the median value for top executive pay in the US at this time ($65,922 annual, expressed as weekly wages in the regressions) shows larger estimated returns to a year of education of 15.1 to 16.7 percent, and to a college education of 116 to 138 percent. These estimates represent an upper limit on the returns due to the assumption that each individual in the GE hierarchy with top-coded earnings in the 1940 census would have earned at the median level for all US executives. Re-estimating these specifications by replacing top-coded values with the 25th percentile ($42,000 annual, expressed as weekly wages in the regressions) instead of the median leads to estimated returns to a year of education of 13.4 to 14.8 percent and to a college education of 99 to 117 percent. Based on the results in Panels A and B the baseline return estimates in Table 4 Panel A are not overly sensitive to top-coding, perhaps because within-firm inequality in executive pay was quite low during this era (Frydman, 2019). The results in Panel C imply the baseline estimates will reflect lower bounded returns.

5.3 Linking Education to Management Training

To complete the analysis I now examine the relationship between selection into management training and education before estimating the joint impact of education and management training on position in the hierarchy and wages. The outcome variable is a count of attendance at management training camps, as described in Section 3.4, using the inverse hyperbolic sine transformation.

5.3.1 OLS, 2SLS, LIML and UJIVE Estimates

Table 6 Panel A reports results from OLS specifications as a test of whether human capital accumulation could be amplified by education through its impact on selection into management training. A year of education is associated with a 5 percent increase in the intensity of management training (columns 1 to 4) or a 3 percent increase with fixed effects for hierarchical level (column 5). A college education is associated with a 25 to 33 percent increase relative to the non-college educated (columns 5 to 9), falling to 13 percent in the within-hierarchy specification in column 10.

Table 6 Panel B estimates causal effects using the same 2SLS approach as in Table 2. The 2SLS coefficients on years of education and college attendance are consistently larger than the OLS coefficients in Panel A, which accords with all the results presented so far showing large effects of treatment for individuals exposed to more education through the land grant colleges. A causal interpretation of these estimates would rule out the confounding effect that higher ability workers choose to acquire more education and therefore were selected-in to management training.

Both the estimates in Panel A and Panel B of Table 6 are robust in Table A4 based on specifications with a full set of fixed effects. Using a negative binomial count data specification rather than the inverse hyperbolic sine transformation leads to even larger estimates of the impact of years of education and college attendance on the intensity of management training (column 1). The results are robust to different implementations of the experience controls (columns 2 and 3) and to dropping immigrants (column 4). Dropping outliers leads to somewhat smaller estimated effects: a 2 percent increase in the intensity of management for an additional year of education or a 12 percent increase

for the college educated relative to the non-college educated.

Robustness checks on the 2SLS results in columns 6 to 10 reveal slightly larger returns to education when dropping clusters of individuals born in Pennsylvania and Massachusetts (columns 6 and 7). Using interactions between covariates and the instruments leads to weaker first stages in columns 8 and 9, but overall in these specifications—as well as in column 10 which implements the UJIVE estimator—the impact of education on selection into management training is substantively large. A year of education is associated with around a 7 percent increase in the intensity of management training, whereas a college education is associated with a 51 to 54 percent increase.

5.3.2 Estimates by Year of Education and by Cohort

Figure 8A plots OLS point estimates and 95 percent confidence intervals on the year dummies from equation 2 showing an approximately linear relationship between years of education and the intensity of management training over most of the range of values, with higher returns at extended years of college attendance. 16 years of education, for example, is associated with a 43 percent increase in the intensity of management training and 17 or more years with a 71 percent increase, both estimates being relative to a baseline of no years of education or just elementary school.

Figure 8B-C show the OLS estimates split by birth cohort which reveals strong career dynamics in management training over the life cycle. Most of the estimated effect is being driven by the oldest two cohorts where position in the hierarchy as a function of age would have increased potential exposure to management training. For these cohorts 24 and 17 percent of individuals had attended at least one management training camp compared to 7 and 1 percent in the youngest cohorts respectively. Figure 8D re-estimates the coefficients on the year indicators for the oldest cohort, which highlights the magnitude of the returns to a higher education in the upper tail of the distribution. 16 years of education is now associated with a 48 percent increase in the intensity of management training while 17 or more years is associated with a 219 percent increase.

5.3.3 The Joint Effect of Education and Training

As a final exercise, Table 7 estimates the returns to management training when also controlling for the returns to education using position in the hierarchy (upper versus lower levels) and wages as outcome measures. Training programs might boost human capital through skill acquisition in ways that more directly impact productivity than education. A one unit increase in the intensity of management training is associated with a 16 percent increase in the probability of being in the upper levels of the hierarchy (column 1) and with a wage return of 3.5 percent in column 4 or 10.4 percent in column 7 when adjusting for censoring in the earnings distribution. Moreover, when controlling for years of education or college attendance, the relationship between management training and position in the hierarchy remains robust (columns 2 and 3) with the coefficients on the education variables becoming smaller in size and statistically insignificant from zero.

In the wage regressions, however, the relationship between education and earnings is robust to controlling for management training, while the coefficients on training now become smaller in size and sometimes statistically insignificant. This is notable given that training tends to be asso-

ciated with much higher wage-returns (e.g., Loewenstein and Spletzer, 1998). To the extent that wage returns (in theory) should provide the closest mapping to productivity, these findings provide suggestive evidence of a strong role for formal education as a direct determinant of earnings. Controlling for management training, the return to a year of education is 5.3 percent (column 5) to 6.0 percent (column 8) and the return to a college education is 34 percent (column 6) to 39 percent (column 9), both being close to the baseline estimates of the returns to education in Table 4.

6 Conclusion

The growing scale of business organizations and the expansion of education opportunities through the human capital century were two defining characteristics of early US economic development (Chandler, 1977, 1994; Goldin and Katz, 2008). Complex coordination problems associated with supervising market activity necessitated organization by managerial hierarchies. While there is a general consensus about the importance of skilled managers to corporate development and long-run economic growth (Bloom and Van Reenen, 2007; Bloom, Sadun and Van Reenen, 2010; Giorcelli, 2019), nothing systematic is known about the acquisition of these skills at the micro-level during the managerial revolution, how "visible hands" were organized as knowledge hierarchies, or the link between human capital accumulation and management practices.

This paper has provided new data and empirical evidence in all these areas through the lens of a canonical mega-firm associated with the visible hand of managerial hierarchies. Using unique personnel records detailing the micro-structure of GE, the results show a clear ordering of senior managers and executives and lower ranking employees by their education levels. I find large returns to higher education through position in the hierarchy linked to span of control, strong wage-based returns, and evidence to suggest education acted as a key selection mechanism into management training. If firms faced learning costs and communication challenges as production expanded, it would have made sense to organize management as a knowledge hierarchy to exploit specialization by vertical layer (Garicano, 2000; Garicano and Rossi-Hansberg, 2006).

Instrumenting for years of education and college attendance using the presence of land grant colleges and historical universities local to an individual's birth area supports a causal interpretation of these results. Through the identification strategy, the findings also illustrate how the development of managerial hierarchies depended on historical public investments in education in the United States in the nineteenth century, which gave rise to a national system of secondary education and land-grant colleges. Based on the findings in this paper, access to educational opportunities created a pathway to long-run economic growth through the human capital accumulation and careers of professional managers who coordinated the allocation of resources in large firms. US leadership in education was, therefore, foundational to the managerial revolution in manufacturing.

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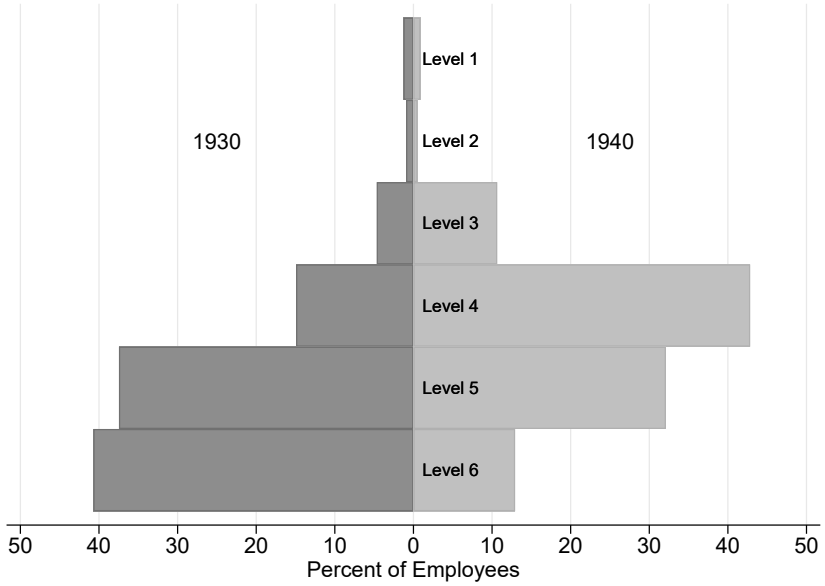
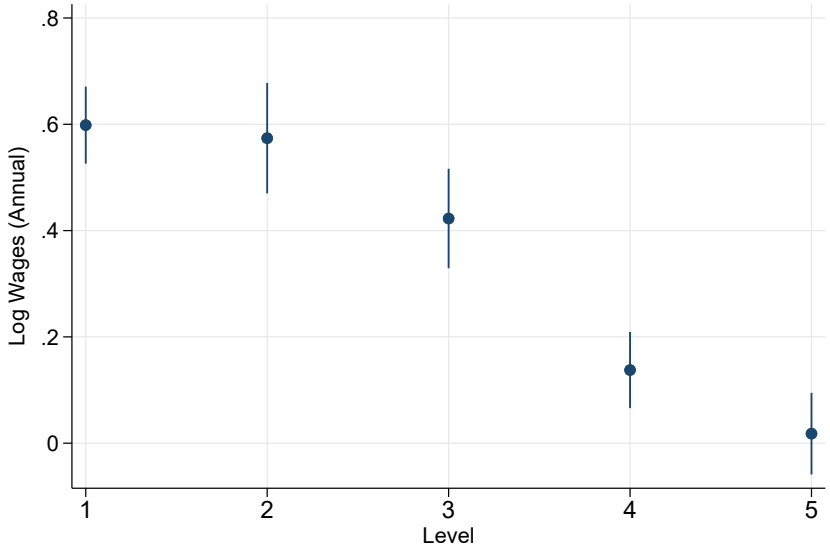
FIGURE 1: THE MANAGERIAL HIERARCHY AND COMPENSATION



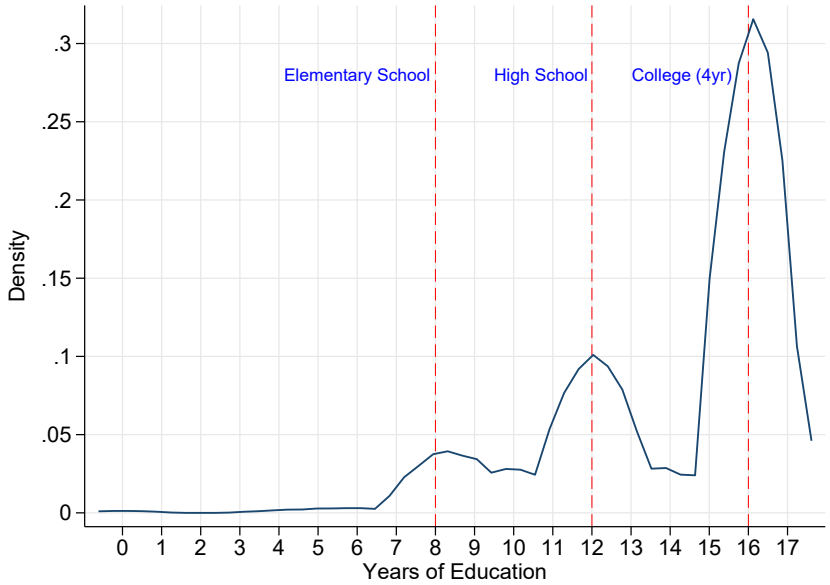
A: THE HIERARCHY 1930 AND 1940



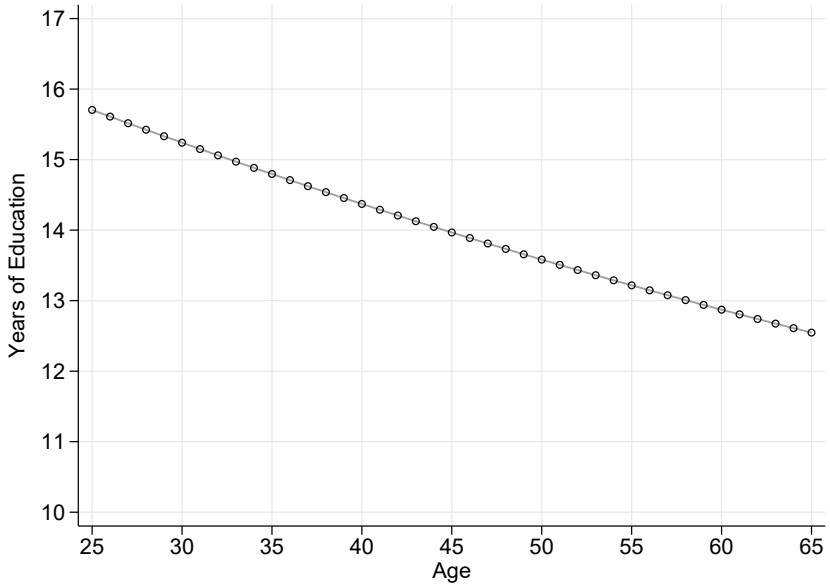
B: WAGES IN THE HIERARCHY 1940

Notes: Figure 1A shows hierarchical levels with Levels 1, 2 and 3 being upper level positions and Levels 4, 5 and 6 being lower level positions. Figure 1B plots point estimates and 95 percent confidence intervals from an OLS regression of annual wages on indicators for levels in the hierarchy controlling for weeks and hours worked. The baseline is Level 6.

FIGURE 2: THE DISTRIBUTION OF EDUCATION



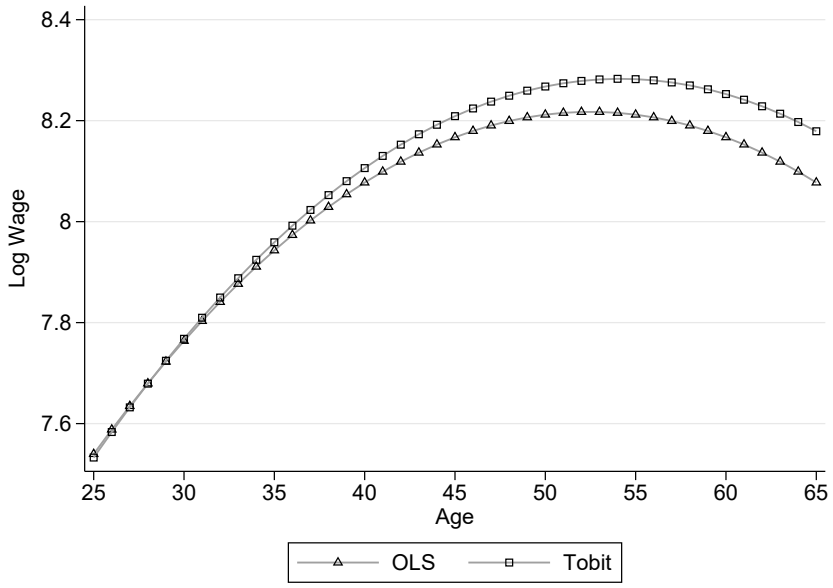
A: KERNEL DENSITY OF EDUCATION



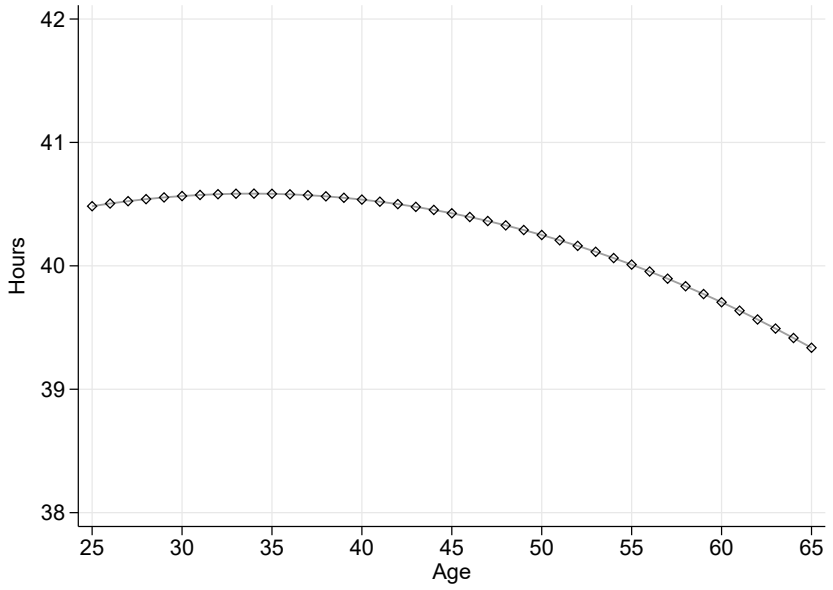
B: YEARS OF EDUCATION BY AGE

Notes: Figure 3A shows the distribution of education by years for individuals in the dataset. Figure 3B plots point estimates from a regression of years of education on a quadratic in age controlling for women and immigrants.

FIGURE 3: ANNUAL COMPENSATION AND HOURS WORKED OVER THE LIFE CYCLE



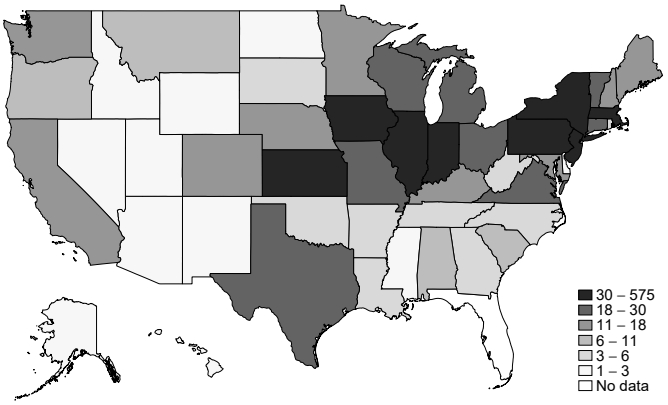
A: WAGE PROFILE



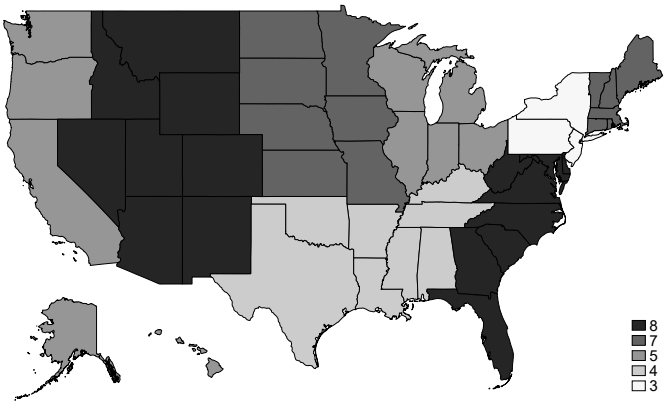
B: HOURS WORKED

Notes: Figure 4A plots point estimates from regressions of annual wages from the 1940 census on a quadratic in age controlling for women, immigrants and hours and weeks worked. Tobit estimates adjust for top-coding of census wages at $5,000. Figure 4B plots point estimates from regressions of hours worked on a quadratic in age controlling for women, immigrants and weeks worked.

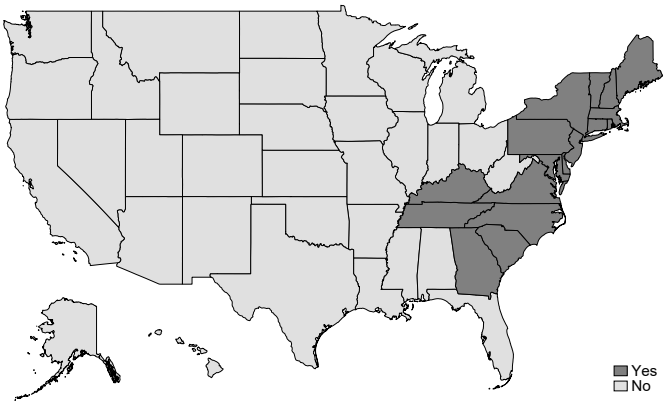
FIGURE 4: BIRTH STATES, LAND GRANT COLLEGES AND HISTORICAL UNIVERSITIES



A: INDIVIDUALS BY BIRTH STATES



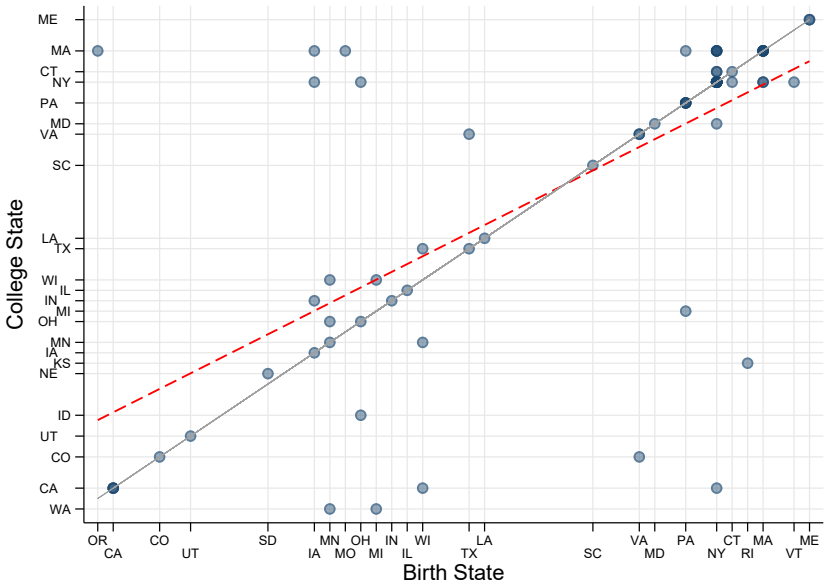
B: LAND GRANT COLLEGES



C: HISTORICAL UNIVERSITIES

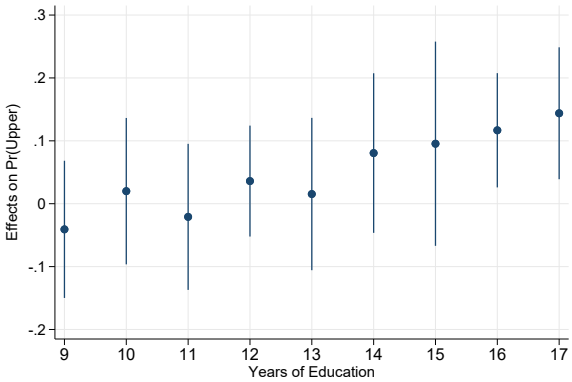
Notes: Figure A shows the geography of birth places for individuals in the dataset, Figure B the number of land grant colleges in each census division (excluding historically black colleges and tribal colleges) and Figure C whether a state has historical universities defined as those founded before 1800.

FIGURE 5: THE RELATIONSHIP BETWEEN BIRTH STATES AND COLLEGE STATES

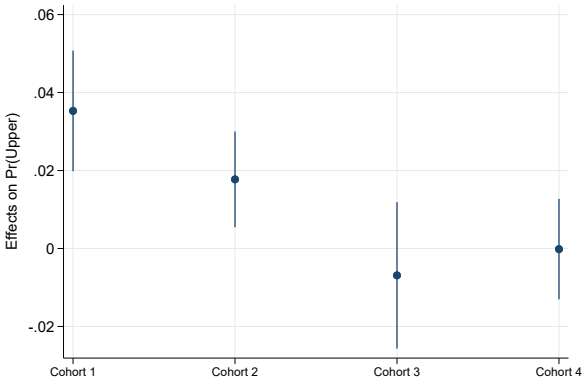


Notes: This figure shows the relationship between birth states and college states. The solid line is a 45 degree line and the dashed line is the line of best fit. The states are organized on each axis to reflect their geographic proximity to each other. Shading reflects the concentration of observations.

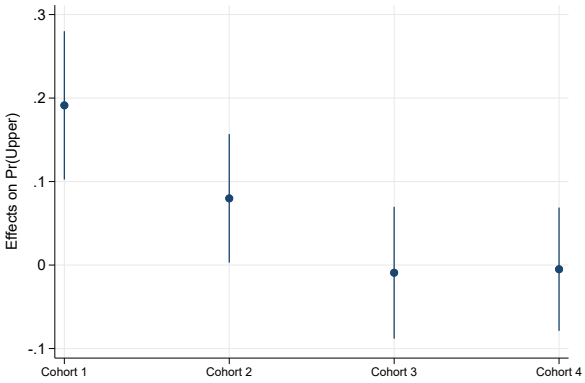
FIGURE 6: POSITION IN THE HIERARCHY BY YEARS OF EDUCATION, COLLEGE ATTENDANCE AND BY BIRTH COHORT



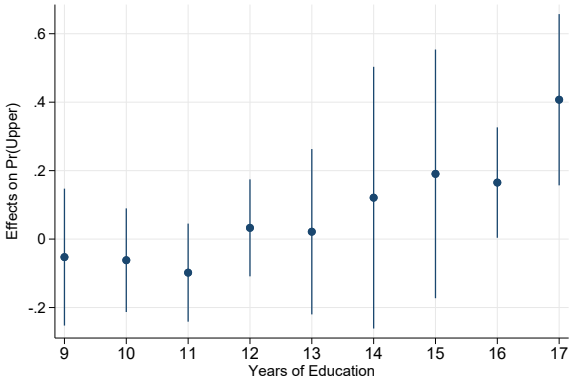
A: EDUCATION INDICATORS



B: COHORTS: YEARS OF EDUCATION



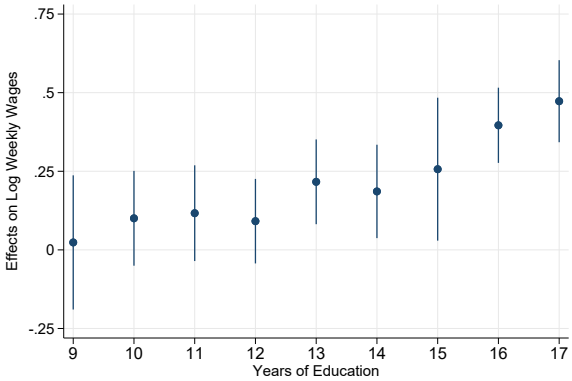
C: COHORTS: COLLEGE ATTENDANCE



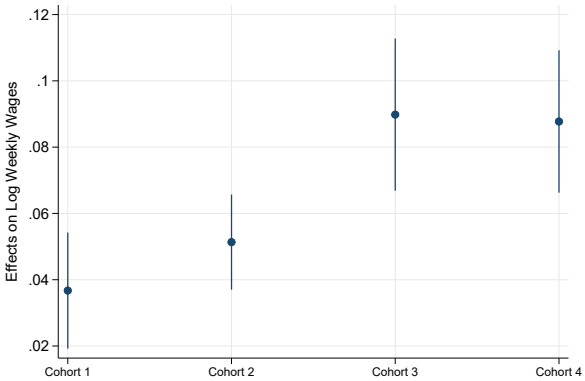
D: COHORT 1: EDUCATION INDICATORS

Notes: Figure A plots point estimates and 95 percent confidence intervals from the most demanding specifications of equation 1 where the dependent variable is coded 1 for upper levels of the hierarchy and 0 for lower levels. The baseline is 0-8 years of education. Figures B and C plot estimates and 95 percent confidence intervals for each cohort where cohort 1 is the oldest cohort and cohort 4 is the youngest. Figure B plots the return to a year of education whereas Figure C plots the return to college attendance relative to non-attendance. Figure D plots cohort-specific estimates, which can be compared to the estimates for all individuals in Figure A.

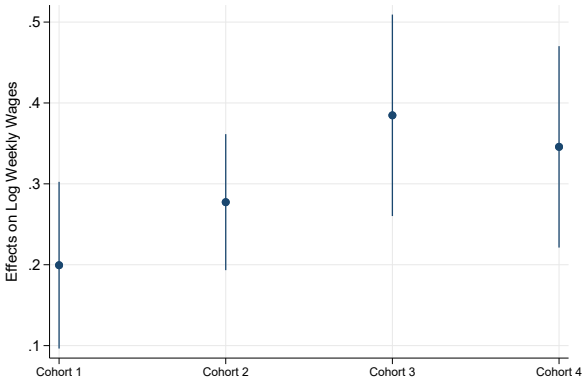
FIGURE 7: COMPENSATION BY YEARS OF EDUCATION, COLLEGE ATTENDANCE AND BY BIRTH COHORT



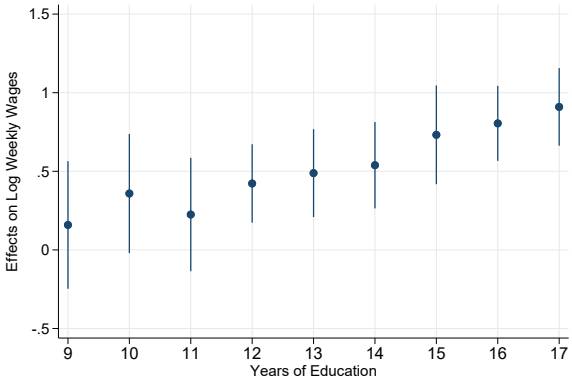
A: EDUCATION INDICATORS



B: COHORTS: YEARS OF EDUCATION



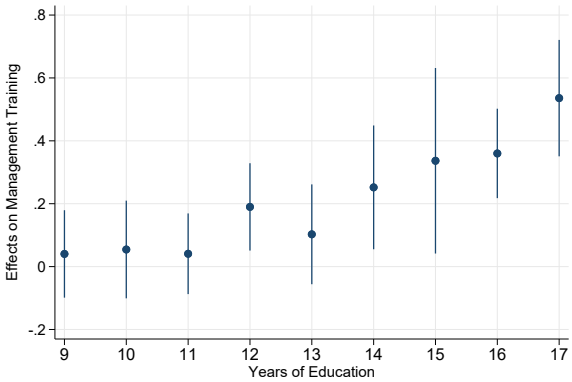
C: COHORTS: COLLEGE ATTENDANCE



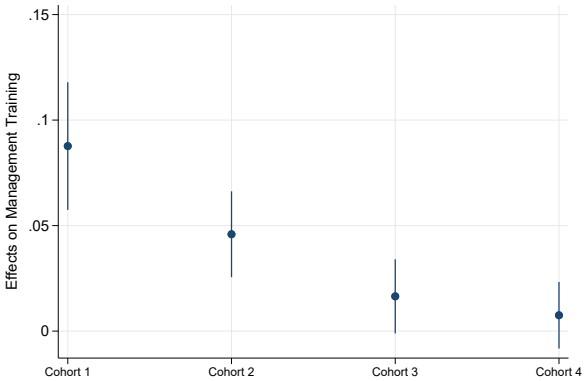
D: COHORTS 3 AND 4: EDUCATION INDICATORS

Notes: Figure A plots point estimates and 95 percent confidence intervals from the most demanding specifications of equation 1 where the dependent variable is the log of weekly wages. The baseline is 0-8 years of education. Figures B and C plot estimates and 95 percent confidence intervals for each cohort where cohort 1 is the oldest cohort and cohort 4 is the youngest. Figure B plots the return to a year of education whereas Figure C plots the return to college attendance relative to non-attendance. Figure D plots cohort-specific estimates, which can be compared to the estimates for all individuals in Figure A.

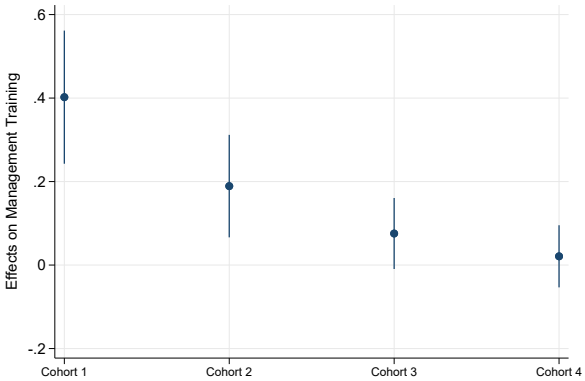
FIGURE 8: MANAGEMENT TRAINING BY YEARS OF EDUCATION, COLLEGE ATTENDANCE AND BY BIRTH COHORT



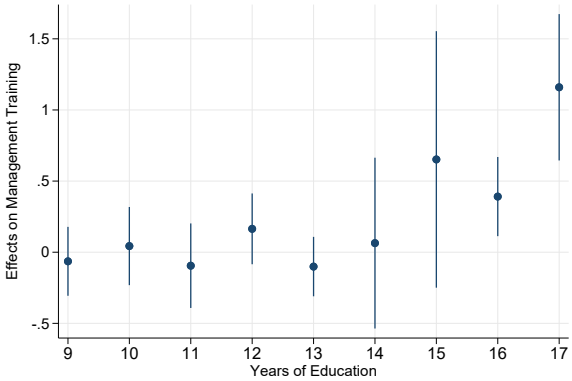
A: EDUCATION INDICATORS



B: COHORTS: YEARS OF EDUCATION



C: COHORTS: COLLEGE ATTENDANCE



D: COHORT 1: EDUCATION INDICATORS

Notes: Figure A plots point estimates and 95 percent confidence intervals from the most demanding specifications of equation 1 where the dependent variable is the inverse hyperbolic sine transformation of the count of attendance at management training camps. The baseline is 0-8 years of education. Figures B and C plot estimates and 95 percent confidence intervals for each cohort where cohort 1 is the oldest cohort and cohort 4 is the youngest. Figure B plots the return to a year of education whereas Figure C plots the return to college attendance relative to non-attendance. Figure D plots cohort-specific estimates, which can be compared to the estimates for all individuals in Figure A.

TABLE 1: DESCRIPTIVE STATISTICS

	All	Upper Hierarchy	Lower Hierarchy	*t*-test
Personal Characteristics:				
Age	42.2	49.7	41.2	9.12
Married	64%	65%	63%	0.51
Children (#)	1.06	1.22	1.04	1.90
Immigrant	7%	7%	7%	-0.12
Homeowner	63%	71%	62%	2.33
Managerial Hierarchy:				
Upper (senior managers and executives)	12%	-	-	-
Span of Control (overall)	-	13.4	-	-
Span of Control (next level)	-	4.47	-	-
Span of Control (next level same department)	-	4.21	-	-
Education:				
Highest Grade:				
No Schooling	0.2%	1%	0.2%	1.19
Elementary School	1%	1%	1%	-0.43
Middle School	11%	12%	11%	0.36
High School	18%	14%	18%	-1.45
College	70%	73%	69%	0.92
College (4+ years)	62%	66%	62%	0.87
Years of Education	14.3	14.3	14.2	0.31
Compensation:				
Weeks Worked	51.4	51.6	51.4	0.59
Hours Worked	40.3	40.2	40.4	-0.44
Annual Wage	$3,251	$4,374	$3,112	11.79
Weekly Wage	$63	$84	$60	11.76
Non-wage Income	34%	64%	30%	8.52
Training and Experience:				
Management Training	13%	62%	6%	29.02
Management Training (#)	0.33	2.04	0.09	29.14
Employed by GE in 1930	45%	72%	41%	9.19

Notes: This table reports descriptive statistics on the man variables. Upper levels of the hierarchy are Levels 1, 2 and 3 in the organizational structure whereas lower levels are Levels 4, 5 and 6. Span of control is described in Section 3.1 for individuals in upper levels of the hierarchy as the average number of subordinates in all levels below in the hierarchy, in the next level below, and in the next level below in the same department. *t*-tests for each variable are under the null that the difference in the mean between upper and lower levels of the hierarchy is zero.

TABLE 2: RETURNS TO EDUCATION: POSITION IN THE HIERARCHY

	1	2	3	4	5	6	7	8
	Panel A: OLS							
Years of Education	0.019***	0.017***	0.016***	0.016***				
	(0.004)	(0.004)	(0.004)	(0.004)				
College					0.107***	0.092***	0.090***	0.089***
					(0.023)	(0.023)	(0.023)	(0.023)
R^2	0.069	0.077	0.087	0.089	0.067	0.075	0.086	0.087
	Panel B: 2SLS							
Years of Education	0.024**	0.021**	0.021**	0.018				
	(0.010)	(0.011)	(0.010)	(0.011)				
College					0.141**	0.123**	0.121**	0.100
					(0.060)	(0.061)	(0.060)	(0.061)
First Stage Coefficients:								
Land Grant College	0.296***	0.265***	0.260***	0.320***	0.049***	0.044***	0.044***	0.057***
	(0.054)	(0.053)	(0.052)	(0.063)	(0.010)	(0.010)	(0.010)	(0.013)
University <1800	-1.065***	-1.079***	-1.090***	-0.791***	-0.194***	-0.197***	-0.198***	-0.135***
	(0.284)	(0.290)	(0.283)	(0.187)	(0.056)	(0.057)	(0.057)	(0.035)
Montiel-Pflueger F	22.0	19.5	20.0	29.6	17.3	15.2	15.3	23.0
p-value (Hansen J)	0.906	0.696	0.495	0.346	0.982	0.755	0.543	0.336
Observations	1,293	1,293	1,293	1,293	1,293	1,293	1,293	1,293
Mean of Dep. Var.	0.114	0.114	0.114	0.114	0.114	0.114	0.114	0.114
Experience Controls	Y	Y	Y	Y	Y	Y	Y	Y
GE Experience Control	N	Y	Y	Y	Y	Y	Y	Y
Department FE	N	N	Y	Y	N	N	Y	Y
Background Controls	N	N	N	Y	N	N	N	Y

Notes: This table reports results from linear probability models where the dependent variable is an indicator coded 1 for upper levels of the hierarchy (Levels 1, 2 and 3) and 0 for lower levels (Levels 4, 5 and 6). "Years of Education" is a continuous measure from the 1940 census and "College" is an indicator for 13 or more years of education. The instruments in the 2SLS specifications are the number of land grant colleges in the census division of an individual's birth state and an indicator for whether historical universities founded before 1800 are present in that state. Robust standard errors in parentheses. In the 2SLS specifications the standard errors are clustered by birth state. *p<0.1, **p<0.05, ***p<0.01.

TABLE 3: THE RELATIONSHIP BETWEEN SPAN OF CONTROL AND EDUCATION

	1	2	3	4	5	6
Years of Education	0.068**	0.069***	0.078**			
	(0.027)	(0.027)	(0.034)			
College				0.430***	0.439***	0.460**
				(0.162)	(0.163)	(0.209)
R^2	0.067	0.068	0.083	0.064	0.065	0.076
Observations	148	148	148	148	148	148
Mean of Dep. Var.	0.0331	0.0331	0.0331	0.0331	0.0331	0.0331
Experience Controls	Y	Y	Y	Y	Y	Y
GE Experience Control	N	Y	Y	N	Y	Y
Background Controls	N	N	Y	N	N	Y

Notes: This table reports results from models where the dependent variable is the standardized principal component of span of control described in Section 3.1. The sample is all individuals in upper levels of the hierarchy (Levels 1, 2 and 3). "Years of Education" is a continuous measure from the 1940 census and "College" is an indicator for 13 or more years of education. Robust standard errors in parentheses. *p<0.1, **p<0.05, ***p<0.01.

TABLE 4: RETURNS TO EDUCATION: COMPENSATION

	1	2	3	4	5	6	7	8	9	10
					Panel A: OLS					
Years of Education	0.062***	0.061***	0.060***	0.056***	0.053***					
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)					
College						0.344***	0.340***	0.335***	0.309***	0.298***
						(0.027)	(0.028)	(0.028)	(0.027)	(0.028)
R^2	0.367	0.367	0.386	0.406	0.430	0.353	0.353	0.376	0.395	0.423
					Panel B: 2SLS					
Years of Education	0.093***	0.095***	0.096***	0.086***	0.089***					
	(0.011)	(0.013)	(0.012)	(0.011)	(0.011)					
College						0.532***	0.535***	0.540***	0.480***	0.497***
						(0.050)	(0.059)	(0.051)	(0.057)	(0.054)
First Stage Coefficients:										
Land Grant College	0.306***	0.268***	0.264***	0.332***	0.316***	0.051***	0.045***	0.044***	0.061***	0.058***
	(0.059)	(0.058)	(0.057)	(0.057)	(0.055)	(0.011)	(0.011)	(0.011)	(0.012)	(0.012)
University <1800	-1.163***	-1.186***	-1.186***	-0.818***	-0.769***	-0.217***	-0.221***	-0.220***	-0.138***	-0.132***
	(0.285)	(0.292)	(0.285)	(0.174)	(0.169)	(0.056)	(0.059)	(0.059)	(0.034)	(0.032)
Montiel-Pflueger F	23.3	20.4	20.8	40.0	38.9	18.5	16.5	16.1	29.4	30.3
p-value (Hansen J)	0.999	0.849	0.944	0.323	0.389	0.666	0.601	0.781	0.315	0.415
Observations	956	956	956	956	956	956	956	956	956	956
Mean of Dep. Var.	4.065	4.065	4.065	4.065	4.065	4.065	4.065	4.065	4.065	4.065
Experience Controls	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
GE Experience Control	N	Y	Y	Y	Y	Y	Y	Y	Y	Y
Department FE	N	N	Y	Y	Y	N	N	Y	Y	Y
Background Controls	N	N	N	Y	Y	N	N	N	Y	Y
Hierarchical Level FE	N	N	N	N	Y	N	N	N	N	Y

Notes: This table reports results from models where the dependent variable is the log of weekly wages. "Years of Education" is a continuous measure from the 1940 census and "College" is an indicator for 13 or more years of education. The instruments in the 2SLS specifications are the number of land grant colleges in the census division of an individual's birth state and an indicator for whether historical universities founded before 1800 are present in that state. Robust standard errors in parentheses. In the 2SLS specifications the standard errors are clustered by birth state. *p<0.1, **p<0.05, ***p<0.01.

TABLE 5: RETURNS TO EDUCATION: COMPENSATION (TOP-CODING)

	1	2	3	4	5	6	7	8	9	10
	Panel A: Dropping Top-Coded Observations									
Years of Education	0.054***	0.055***	0.054***	0.049***	0.050***					
	(0.006)	(0.006)	(0.006)	(0.005)	(0.006)					
College						0.302***	0.303***	0.305***	0.276***	0.284***
						(0.028)	(0.029)	(0.029)	(0.028)	(0.029)
R^2	0.296	0.297	0.309	0.330	0.335	0.291	0.291	0.305	0.327	0.332
Mean of Dep. Var.	3.977	3.977	3.977	3.977	3.977	3.977	3.977	3.977	3.977	3.977
Observations	814	814	814	814	814	814	814	814	814	814
	Panel B: Tobit									
Years of Education	0.073***	0.072***	0.071***	0.066***	0.062***					
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)					
College						0.401***	0.393***	0.387***	0.360***	0.341***
						(0.031)	(0.032)	(0.032)	(0.032)	(0.032)
Mean of Dep. Var.	4.065	4.065	4.065	4.065	4.065	4.065	4.065	4.065	4.065	4.065
Right-Censored Obs.	142	142	142	142	142	142	142	142	142	142
Observations	956	956	956	956	956	956	956	956	956	956
	Panel C: Imputing Top-Coded Observations									
Years of Education	0.167**	0.161***	0.152***	0.151***						
	(0.034)	(0.033)	(0.028)	(0.029)						
College						0.867***	0.824***	0.789***	0.770***	
						(0.164)	(0.157)	(0.120)	(0.124)	
R^2	0.265	0.268	0.315	0.319		0.238	0.243	0.295	0.298	
Mean of Dep. Var.	4.448	4.448	4.448	4.448		4.448	4.448	4.448	4.448	
Observations	956	956	956	956		956	956	956	956	
Experience Controls	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
GE Experience Control	N	Y	Y	Y	Y	Y	Y	Y	Y	Y
Department FE	N	N	Y	Y	Y	N	N	Y	Y	Y
Background Controls	N	N	N	Y	Y	N	N	N	Y	Y
Hierarchical Level FE	N	N	N	N	Y	N	N	N	N	Y

Notes: This table reports results from models where the dependent variable is the log of weekly wages. "Years of Education" is a continuous measure from the 1940 census and "College" is an indicator for 13 or more years of education. In Panel C top coded observations are replaced with the median value of (weekly) executive pay for all US executives active at the same time as described in Section 3.3. In Panel C standard errors are bootstrapped with 1000 replications and clustered by hierarchical level. *p<0.1, **p<0.05, ***p<0.01.

TABLE 6: SELECTION INTO MANAGEMENT TRAINING

	1	2	3	4	5	6	7	8	9	10
					Panel A: OLS					
Years of Education	0.058***	0.050***	0.047***	0.048***	0.030***					
	(0.007)	(0.007)	(0.007)	(0.007)	(0.005)					
College						0.284***	0.239***	0.226***	0.226***	0.124***
						(0.038)	(0.037)	(0.037)	(0.038)	(0.029)
R^2	0.128	0.148	0.174	0.179	0.496	0.108	0.132	0.160	0.163	0.488
					Panel B: 2SLS					
Years of Education	0.074***	0.065***	0.066***	0.061***	0.044***					
	(0.018)	(0.017)	(0.017)	(0.016)	(0.017)					
College						0.427***	0.376***	0.380***	0.346***	0.248**
						(0.119)	(0.110)	(0.112)	(0.098)	(0.101)
First Stage Coefficients:										
Land Grant College	0.296***	0.265***	0.260***	0.320***	0.309***	0.049***	0.044***	0.044***	0.057***	0.055***
	(0.054)	(0.053)	(0.052)	(0.063)	(0.060)	(0.010)	(0.010)	(0.010)	(0.013)	(0.012)
University <1800	-1.065***	-1.079***	-1.090***	-0.791***	-0.760***	-0.194***	-0.197***	-0.198***	-0.135***	-0.130***
	(0.284)	(0.290)	(0.283)	(0.187)	(0.177)	(0.056)	(0.057)	(0.057)	(0.035)	(0.032)
Montiel-Pflueger F	22.0	19.5	20.0	29.6	30.7	17.3	15.2	15.3	23.0	24.5
p-value (Hansen J)	0.975	0.641	0.400	0.120	0.313	0.905	0.761	0.506	0.123	0.315
Observations	1,293	1,293	1,293	1,293	1,293	1,293	1,293	1,293	1,293	1,293
Mean of Dep. Var.	0.186	0.186	0.186	0.186	0.186	0.186	0.186	0.186	0.186	0.186
Experience Controls	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
GE Experience Control	N	Y	Y	Y	Y	Y	Y	Y	Y	Y
Department FE	N	N	Y	Y	Y	N	N	Y	Y	Y
Background Controls	N	N	N	Y	Y	N	N	N	Y	Y
Hierarchical Level FE	N	N	N	N	Y	N	N	N	N	Y

Notes: This table reports results from models where the dependent variable is the inverse hyperbolic sine transformation of the count of attendance at management training camps. "Years of Education" is a continuous measure from the 1940 census and "College" is an indicator for 13 or more years of education. The instruments in the 2SLS specifications are the number of land grant colleges in the census division of an individual's birth state and an indicator for whether historical universities founded before 1800 are present in that state. Robust standard errors in parentheses. In the 2SLS specifications the standard errors are clustered by birth state. *p<0.1, **p<0.05, ***p<0.01.

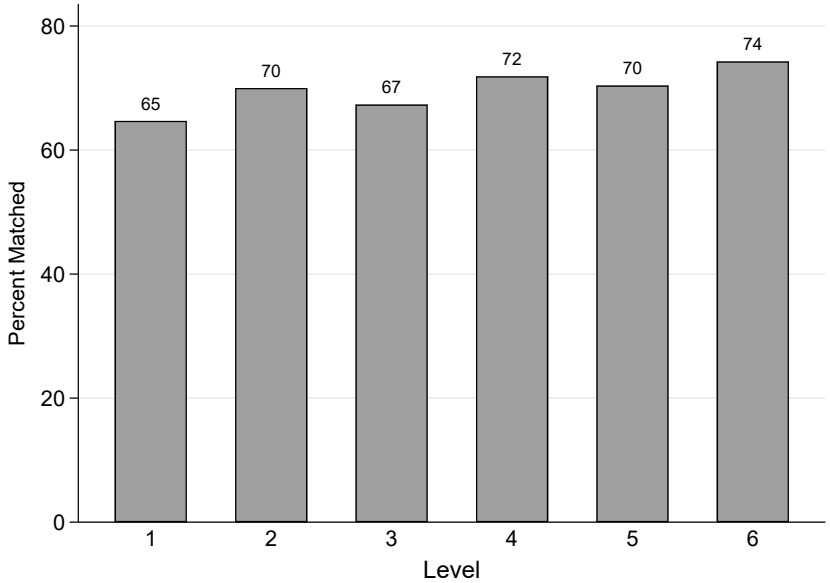
TABLE 7: RETURNS TO EDUCATION AND MANAGEMENT TRAINING

	1	2	3	4	5	6	7	8	9
	Upper			Wages			Wages (Tobit)		
Training	0.161***	0.160***	0.159***	0.035***	0.009	0.018	0.104***	0.070*	0.079**
	(0.010)	(0.010)	(0.010)	(0.013)	(0.013)	(0.013)	(0.037)	(0.036)	(0.036)
Years of Education		0.001			0.053***			0.060***	
		(0.004)			(0.005)			(0.006)	
College			0.021			0.294***			0.329***
			(0.019)			(0.028)			(0.031)
R^2	0.364	0.364	0.364	0.345	0.431	0.424			
Observations	1,293	1,293	1,293	956	956	956	956	956	956
Mean of Dep. Var.	0.114	0.114	0.114	4.065	4.065	4.065	4.065	4.065	4.065
Experience Controls	Y	Y	Y	Y	Y	Y	Y	Y	Y
GE Experience Control	Y	Y	Y	Y	Y	Y	Y	Y	Y
Department FE	Y	Y	Y	Y	Y	Y	Y	Y	Y
Background Controls	Y	Y	Y	Y	Y	Y	Y	Y	Y
Hierarchical Level FE	N	N	N	Y	Y	Y	Y	Y	Y

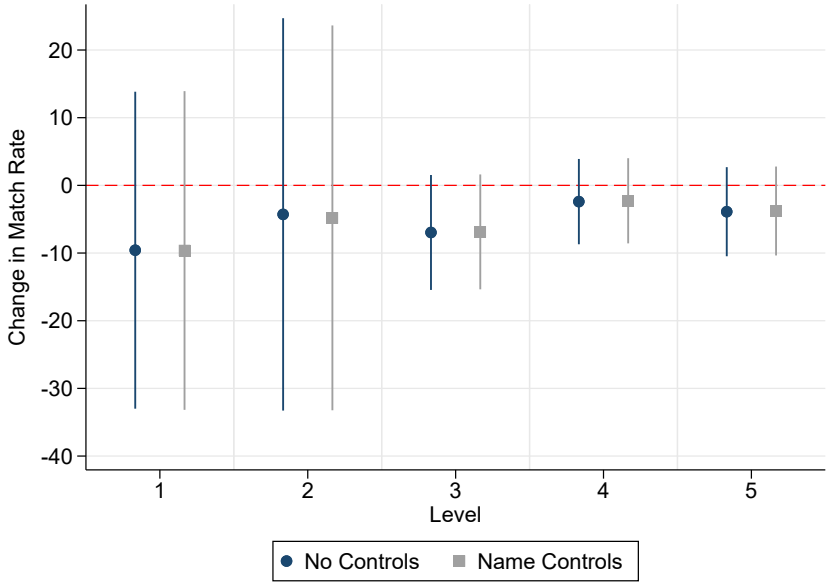
Notes: This table reports results from models where the dependent variables are an indicator for being in the upper levels of the hierarchy or the log of weekly wages in OLS (columns 4 to 6) or Tobit (columns 7 to 9) specifications. "Years of Education" is a continuous measure from the 1940 census and "College" is an indicator for 13 or more years of education. "Training" is a count of attendance at management training camps. *p<0.1, **p<0.05, ***p<0.01.

APPENDIX

FIGURE A1: MATCHING TO THE CENSUS



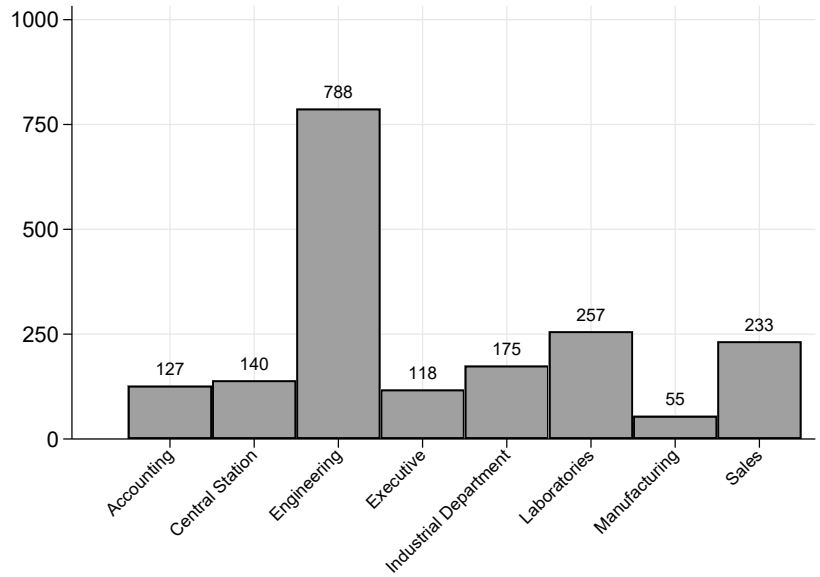
A: MATCH RATES BY LEVEL



B: RELATIVE CHANGES IN MATCH RATES

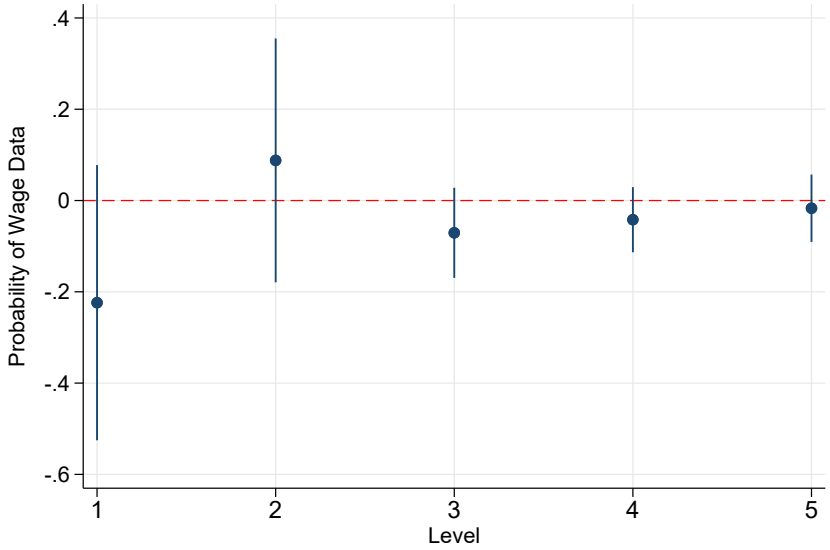
Notes: Figure 2A shows the match rate between individuals in GE's *Organization Directory* and the 1940 census. Figure 2B plots point estimates and 95 percent confidence intervals from a linear probability regression of an indicator for being matched on indicators for levels in the hierarchy, both unconditionally and controlling for the length of an individual's surname, its commonness (defined by a count of equivalent surnames in the directory), or the number of initials in a name. The baseline is Level 6.

FIGURE A2: CORPORATE DEPARTMENTS



Notes: This figure shows the number of individuals in the dataset by corporate department. The Central Station included a variety of cross-functional activities.

FIGURE A3: MATCH RATE OF OBSERVATIONS WITH COMPENSATION DATA



Notes: This figure plots point estimates and 95 percent confidence intervals from a linear probability regression of an indicator for being matched with compensation data available from the census on indicators for levels in the hierarchy. The baseline is Level 6.

TABLE A1: ASSESSING THE MONOTONICITY ASSUMPTION

	1	2	3	4
	Years of Education		College	
A. Age	> Median	≤ Median	> Median	≤ Median
Land Grant College	0.492***	0.125*	0.079***	0.032**
	(0.056)	(0.067)	(0.012)	(0.014)
University <1800	-0.779**	-0.597***	-0.124**	-0.116***
	(0.306)	(0.163)	(0.049)	(0.033)
Observations	631	662	631	662
B. Labor Market Experience	> Median	≤ Median	> Median	≤ Median
Land Grant College	0.489***	0.136*	0.080***	0.032**
	(0.061)	(0.070)	(0.013)	(0.014)
University <1800	-1.109***	-0.596***	-0.179***	-0.109***
	(0.328)	(0.163)	(0.055)	(0.031)
Observations	631	662	631	662
C. Children	> Median	≤ Median	> Median	≤ Median
Land Grant College	0.324***	0.314***	0.059***	0.056***
	(0.078)	(0.061)	(0.012)	(0.014)
University <1800	-0.731**	-0.786***	-0.118***	-0.138***
	(0.279)	(0.199)	(0.042)	(0.037)
Observations	417	876	417	876
D. Marital Status	Married	Not Married	Married	Not Married
Land Grant College	0.327***	0.180	0.055***	0.066***
	(0.065)	(0.119)	(0.012)	(0.018)
University <1800	-0.754***	-1.074***	-0.127***	-0.190***
	(0.195)	(0.372)	(0.034)	(0.049)
Observations	1161	132	1161	132
E. Home	Owner	Renter	Owner	Renter
Land Grant College	0.320***	0.327***	0.057***	0.058***
	(0.065)	(0.073)	(0.012)	(0.017)
University <1800	-0.758***	-0.855***	-0.135***	-0.140***
	(0.216)	(0.201)	(0.037)	(0.042)
Observations	813	480	813	480

Notes: Following the specifications in columns 4 and 8 of Table 2 Panel B, this table reports first-stage coefficients for sub-samples of data by age, labor market experience, number of children, marital status and home ownership. "Years of Education" is a continuous measure from the 1940 census and "College" is an indicator for 13 or more years of education. The instruments are the number of land grant colleges in the census division of an individual's birth state and an indicator for whether historical universities founded before 1800 are present in that state. Standard errors are clustered by birth state. *p<0.1, **p<0.05, ***p<0.01.

Table A2: Robustness Checks: Position in the Hierarchy

	1	2	3	4	5	6	7	8	9	10
	Panel A: Years of Education									
Years of Education	0.012***	0.016***	0.009**	0.016***	0.007***	0.022**	0.022**	0.024**	0.024**	0.024**
	(0.004)	(0.004)	(0.004)	(0.005)	(0.002)	(0.009)	(0.010)	(0.011)	(0.012)	(0.012)
R^2		0.093	0.092	0.084	0.063					
Observations	1,293	1,293	1,293	1,186	1,174	1,212	1,144	1,293	1,293	
Mean of Dep. Var.		0.114	0.114	0.116	0.0264	0.113	0.111	0.114	0.114	
First Stage Coefficients:										
Land Grant College						0.353***	0.327***			
						(0.049)	(0.052)			
University <1800						-0.882***	-0.949***			
						(0.171)	(0.189)			
Montiel-Pflueger F						62.1	60.1	14.8	14.8	
p-value (Hansen J)						0.318	0.330	0.263	0.266	
	Panel B: College									
College	0.074***	0.089***	0.057***	0.092***	0.035***	0.120**	0.125**	0.133**	0.137**	0.136*
	(0.021)	(0.023)	(0.020)	(0.025)	(0.012)	(0.053)	(0.058)	(0.063)	(0.069)	(0.071)
R^2		0.087	0.092	0.084	0.061					
Observations	1,293	1,293	1,293	1,186	1,173	1,212	1,144	1,293	1,293	1,293
Mean of Dep. Var.		0.114	0.114	0.116	0.0256	0.113	0.111	0.114	0.114	0.114
First Stage Coefficients:										
Land Grant College						0.063***	0.056***			
						(0.010)	(0.009)			
University <1800						-0.152***	-0.174***			
						(0.030)	(0.030)			
Montiel-Pflueger F						53.1	62.8	14.1	14.1	
p-value (Hansen J)						0.307	0.343	0.220	0.221	
Experience Controls	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
GE Experience Control	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Department FE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Background Controls	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Robustness Check	Probit	Quartic Experience (OLS)	Age Instead of Experience (OLS)	Dropping Immigrants (OLS)	Dropping Outliers (OLS)	Drop 1 Cluster (PA) (2SLS)	Drop 2 Clusters (PA, MA) (2SLS)	Interactions as Instruments (2SLS)	Interactions as Instruments (LIML)	Interactions as Instruments (UJIVE)

Notes: This table reports robustness checks on the results in Table 2. Outliers are defined using Cook's Distance. The dependent variable is an indicator coded 1 for upper levels of the hierarchy (Levels 1, 2 and 3) and 0 for lower levels (Levels 4, 5 and 6). "Years of Education" is a continuous measure from the 1940 census and "College" is an indicator for 13 or more years of education. The instruments in columns 6 and 7 are the number of land grant colleges in the census division of an individual's birth state and an indicator for whether historical universities founded before 1800 are present in that state. In columns 8 and 9 these instruments are interacted with socioeconomic variables from the 1940 census. Robust standard errors in parentheses. In the 2SLS and LIML specifications the standard errors are clustered by birth state. UJIVE is the version in Kolesár (2013). *p<0.1, **p<0.05, ***p<0.01.

Table A3: Robustness Checks: Compensation

	1	2	3	4	5	6	7	8	9
	Panel A: Years of Education								
Years of Education	0.055***	0.044***	0.053***	0.051***	0.091***	0.093***	0.086***	0.088***	0.094***
	(0.005)	(0.004)	(0.005)	(0.004)	(0.008)	(0.009)	(0.012)	(0.013)	(0.012)
R^2	0.446	0.452	0.439	0.584					
Observations	956	956	883	917	899	851	956	956	956
Mean of Dep. Var.	4.065	4.065	4.064	4.092	4.060	4.057	4.065	4.065	4.065
First Stage Coefficients:									
Land Grant College					0.342***	0.338***			
					(0.045)	(0.054)			
University <1800					-0.841***	-0.866***			
					(0.162)	(0.183)			
Montiel-Pflueger F					66.1	58.9	11.5	11.5	
p-value (Hansen J)					0.402	0.638	0.493	0.490	
	Panel B: College								
College	0.301***	0.256***	0.297***	0.250***	0.501***	0.525***	0.516***	0.528***	0.543***
	(0.028)	(0.026)	(0.029)	(0.023)	(0.047)	(0.046)	(0.051)	(0.052)	(0.072)
R^2	0.434	0.444	0.434	0.565					
Observations	956	956	883	921	899	851	956	956	956
Mean of Dep. Var.	4.065	4.065	4.064	4.094	4.060	4.057	4.065	4.065	4.065
First Stage Coefficients:									
Land Grant College					0.063***	0.057***			
					(0.009)	(0.010)			
University <1800					-0.146***	-0.163***			
					(0.030)	(0.031)			
Montiel-Pflueger F					57.4	56.9	12.2	12.2	
p-value (Hansen J)					0.422	0.881	0.771	0.769	
Experience Controls	Y	Y	Y	Y	Y	Y	Y	Y	Y
GE Experience Control	Y	Y	Y	Y	Y	Y	Y	Y	Y
Department FE	Y	Y	Y	Y	Y	Y	Y	Y	Y
Background Controls	Y	Y	Y	Y	Y	Y	Y	Y	Y
Hierarchical Level FE	Y	Y	Y	Y	Y	Y	Y	Y	Y
Robustness Check	Quartic Experience (OLS)	Age Instead of Experience (OLS)	Dropping Immigrants (OLS)	Dropping Outliers (OLS)	Drop 1 Cluster (PA) (2SLS)	Drop 2 Clusters (PA, MA) (2SLS)	Interactions as Instruments (2SLS)	Interactions as Instruments (LIML)	Interactions as Instruments (UJIVE)

Notes: This table reports robustness checks on the results in Table 4. Outliers are defined using Cook's Distance. The dependent variable is the log of weekly wages. "Years of Education" is a continuous measure from the 1940 census and "College" is an indicator for 13 or more years of education. The instruments in columns 5 and 6 are the number of land grant colleges in the census division of an individual's birth state and an indicator for whether historical universities founded before 1800 are present in that state. In columns 7 and 8 these instruments are interacted with socioeconomic variables from the 1940 census. Robust standard errors in parentheses. In the 2SLS and LIML specifications the standard errors are clustered by birth state. UJIVE is the version in Kolesár (2013). *p<0.1, **p<0.05, ***p<0.01.

Table A4: Robustness Checks: Management Training

	1	2	3	4	5	6	7	8	9	10
	Panel A: Years of Education									
Years of Education	0.106***	0.049***	0.034***	0.048***	0.021***	0.062***	0.066***	0.070***	0.072***	0.071***
	(0.022)	(0.007)	(0.006)	(0.007)	(0.004)	(0.016)	(0.018)	(0.018)	(0.020)	(0.022)
R^2		0.187	0.184	0.177	0.118					
Observations	1,293	1,293	1,293	1,186	1,212	1,212	1,144	1,293	1,293	1,293
Mean of Dep. Var.		0.186	0.186	0.190	0.0766	0.186	0.183	0.186	0.186	0.186
First Stage Coefficients:										
Land Grant College						0.353***	0.327***			
						(0.049)	(0.052)			
University <1800						-0.882***	-0.949***			
						(0.171)	(0.189)			
Montiel-Pflueger F						66.1	58.9	14.8	14.8	
p-value (Hansen J)						0.123	0.187	0.282	0.289	
	Panel B: College									
College	0.379***	0.227***	0.171***	0.236***	0.114***	0.347***	0.380***	0.412***	0.434***	0.425***
	(0.087)	(0.038)	(0.032)	(0.040)	(0.021)	(0.096)	(0.108)	(0.112)	(0.127)	(0.131)
R^2		0.164	0.175	0.166	0.113					
Observations	1,293	1,293	1,293	1,186	1,214	1,212	1,144	1,293	1,293	1,293
Mean of Dep. Var.		0.186	0.186	0.190	0.0769	0.186	0.183	0.186	0.186	0.186
First Stage Coefficients:										
Land Grant College						0.063***	0.056***			
						(0.010)	(0.009)			
University <1800						-0.152***	-0.174***			
						(0.030)	(0.030)			
Montiel-Pflueger F						57.4	56.9	14.1	14.1	
p-value (Hansen J)						0.125	0.207	0.192	0.203	
Experience Controls	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
GE Experience Control	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Department FE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Background Controls	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Robustness Check	Neg. Bin.	Quartic Experience (OLS)	Age Instead of Experience (OLS)	Dropping Immigrants (OLS)	Dropping Outliers (OLS)	Drop 1 Cluster (PA) (2SLS)	Drop 2 Clusters (PA, MA) (2SLS)	Interactions as Instruments (2SLS)	Interactions as Instruments (LIML)	Interactions as Instruments (UJIVE)

Notes: This table reports robustness checks on the results in Table 6. Outliers are defined using Cook's Distance. The dependent variable is the inverse hyperbolic sine transformation of the count of attendance at management training camps, except in column 1 where it is the count. "Years of Education" is a continuous measure from the 1940 census and "College" is an indicator for 13 or more years of education. The instruments in columns 6 and 7 are the number of land grant colleges in the census division of an individual's birth state and an indicator for whether historical universities founded before 1800 are present in that state. In columns 8 and 9 these instruments are interacted with socioeconomic variables from the 1940 census. Robust standard errors in parentheses. In the 2SLS and LIML specifications the standard errors are clustered by birth state. UJIVE is the version in Kolesár (2013). *p<0.1, **p<0.05, ***p<0.01.