Abandon Ship!
Evaluating Three Centuries of Quitters

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Abstract

We investigate factors related to the retention of high skilled workers from 1860 to 2020. Utilizing a rich panel dataset of nearly every U.S. naval line and engineer officer who graduated from the Naval Academy, we estimate the wage elasticity of separations across five distinct technological and institutional eras. We leverage the Navy's escalator model of promotion—where promotions and corresponding wage increases are often driven by exogenous vacancies in higher ranks—to identify the causal effect of wages on voluntary exits. We find that wage elasticities of exit are surprisingly stable over our sample, ranging between -1% and -2.5% prior to 1900 and after 1923, aligning closely with modern estimates for high-skilled workers. However, during the post-amalgamation transition of the early 1900s, this elasticity becomes slightly positive, highlighting the role of institutional churn in disrupting standard monopsonistic wage-setting. The approach allows us to recover the elasticity of labor supply for U.S. naval leaders, as well as various revealed returns to education and experiences over the last three centuries.

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1 Introduction

This paper asks a foundational question in labor economics – when do skilled professionals quit their professions? The question is of critical importance on the supply side, as young individuals accumulating human capital consider which professions to pursue. It is also very important on the demand side, as managers of skilled employees with critical and often non-replicable human capital would likely benefit from retaining their employees.

Quits can occur from extensive marginal reasons (different professions have different degrees of longevity) or intensive marginal reasons (different experiences within the job can create different incentives to leave). Young professionals launching into new careers, and managers hiring skilled professionals, would both be well advised to understand these dynamics.

In this paper we assess the answers to these questions by turning our attention to a group of highly skilled professionals —- US naval officers.

Career skilled individuals tend to work in monopsonistic organizations, where the firm has at least partial control over the wages paid to workers, and the tasks/jobs done by workers. This follows Manning (2003), where monopsony power arises from frictions that limit worker mobility. These frictions are often pronounced among high-skilled workers, whose employment relationships are characterized by match specificity, firm-specific human capital, and thin labor markets.

The US Navy is a near monopsony for global leaders, with rigid wage structures, and hierarchical task allocation. This makes the US naval officer corps an ideal group of skilled professionals to ask these questions.

Of course, in one respect US naval officers may be a poor choice for this kind of study. One might be forgiven for thinking of the US naval officer as a breed onto himself or herself, someone unmotivated by crass economic incentives, someone whose patriotic fire burns undoused by material or professional considerations.

Indeed, many professions have an aura of maintaining a kind of aristocracy, erecting barriers between a pre-chosen class of the "priesthood" and the rest of the hoi-polloi laborers. So say many military brass (Karsten 1972). But so say ER doctors, criminal trial lawyers, and university professors as well. Ours is a calling, they may aver. We are not doing it for the money, we are doing it for a higher purpose.* This idea springs from Max Weber's thoughts of science as a vocation rather than a piddly job. He labeled this *Beruf* (or calling), where work is morally binding, not just economically chosen. Recent work in medicine, for

*This brings to mind the Groucho Marx quote about how money isn't everything, but helps you avoid doing things you don't like. One who dislikes doing many things will thus find money to be very useful.

example, explicitly revisits Weber to explain why physicians often endure poor conditions yet remain attached to the profession (Nussbaum 2018). Such workers may accept lower pay or worse conditions because the work is meaningful.

Or stickiness may stem from familial duty. Historically the highly skilled followed in their father's paths, or were apprenticed at an early age. Such lock-in mechanisms can force workers to accept wage penalties to continue employment (Schleifer 2016).

In this paper, we take three centuries of naval officer career trajectories to try to assess three factors that can affect retention in the naval, or indeed any high-skilled, profession —- pay, education, and experience. These factors, typically employed in Mincerian-like analysis, can also be used to understand shifting hazards of job separation. The structure of naval operations means that wage changes and task assignments are at least quasi-exogenous for the career officer. And by tracking officer careers across vastly different periods of time, we are able also to assess the relative stability, or "temporal validity," of our findings.

Becker (1964) focuses on the accumulation of firm-specific or occupation-specific capital. High-skilled workers are often highly specialized and embedded in particular organizations. Examples include surgeons, military officers, and engineers working on niche systems. Exiting employment for such workers may be difficult, as the firm's quasi-monopsony power captures such employees.

Given these considerations, the labor market of professionals may offer some interesting features worthy of study.

First, they may produce highly inelastic supply curves. Demand shocks would leave equilibrium employment scarcely unchanged in such circumstances, damping regional and business cycle fluctuations. Second, general human capital may become indistinguishable from firm-specific human capital. Any skills accumulated in formal education or employment would remain employed by the firm, leaving any external returns from such skills unexploited. Managers of such professionals may then view such workers as a fixed commodity through their careers.

In this paper we suggest that the death of the highly-skilled mobile worker has been wildly exaggerated. To bring them back from the dead, we focus our attention on an organization with monopsonistic wage setting employing highly-skilled and career-focused workers.

Of course estimating the wage elasticity of labor supply requires exogenous changes in wages (Ashenfelter et al. 2022). Our empirical setting provides a unique identification strategy to deal with the endogeneity of salaries in the separation equation. Because the Navy often utilized an escalator model of promotion, career advancement and subsequent wage increases for lower-ranked officers frequently depended on vacancies in higher ranks. Random shocks, such as the exogenous death of higher-ranking officers, generated variation in pro-

motion timing and real wages that are uncorrelated with the specific abilities or unobserved preferences of the lower-ranked officer.

Specifically, we develop a hazard model of worker exit that follows from the work of Mortensen (1988) and Topel and Ward (1992), and employ it on the careers of naval officers. Using our data entire careers can be followed with measures of initial human capital as well as human capital accumulated over time. Further, naval pay scales were remarkably rigid and consistent, and officer exits were essentially one-sided decisions.[†] This provides us an exceptionally clean measure to gauge how alternative incentives and individual disaggregated factors of human capital directly impact worker decisions about career changes. This also allows us to impute rates of return for a sub-set of measures for general human capital and technical skill.

1.1 Findings

The findings are revealing. First, the exit elasticity with respect to wages are quite consistently negative and elastic across three centuries. Through all the tumultuous changes that the navy underwent, from being a backward littoral force in the 19th century to a more professional and global class of workers in the 20th, from continuing to use antiquated tactics to adopting cutting edge and sophisticated technologies, officers tended to respond to wage incentives with remarkable stability.

The picture that reanimates the story of the officer corps as a dynamic workforce with transferable skills and outside options is provided in figure 1. Specifically, across all periods a 1 percent rise in the real wage translates to about a 1.4 percent decrease in the likelihood of exit. The wage responsiveness among the officer corps is not only relatively stable across time periods, but also appear to be closely aligned to wage responsiveness among civilian workers.

As figure 1 clearly shows, there is one episode at the start of the 20th century where our wage elasticity estimates go a bit haywire. This gives us an informative case study of when institutional changes can disrupt otherwise consistent underlying behavior. The exception that proves the general rule in our case is the Amalgamation Act of 1899, which shifted the responsibilities of the officer corps in fundamental ways. The Act formally merged the line officers and engineer officers into a single unified line. Engineers became part of the line, theoretically eligible for command and required to engage in the leadership roles of line officers. More important, every line officer needed to master the tools of the engineer,

[†]There are episodes of officer "purges" for which we control. A number of officers resign due to "disability" or for being un-promotable. A few egregious cases of misconduct force others from the service, but the net impact of these observations on results is negligible.

something many were unable or unwilling to do.

By so dramatically changing the rules of the game, the normal mechanism of promotion wage increases to retain personnel proved ineffectual. When things are "normal" for any given era, wages keep workers in a navy job as they would in any high skilled job.

Though the responsiveness to pay increases on retention exhibits remarkable consistency that would be consistent with human behavior, other on the job factors have shifting effects on retention. The first of these is tertiary education. Given the richness of the college data from the US Naval Academy, our study has the benefit of being able to separate different types of human capital accumulation. What we find is that military or "firm specific" forms of human capital accumulated in college is a consistently strong indicator of retention in the Navy.

Human capital accumulated for more general education, however, seems to have different effects over time. During the 19th and 20th centuries, such education seemed to have a little value externally. Doing well in general interest education at the Naval Academy typically did not predict any more or less retention. This makes sense for the early days of tertiary education, when transferability of basic skills may have been far more difficult, or information on college level performance may have been more difficult to come by. Things appear to be very different today. Our study highlights a "GPA premium" that emerges over the 20th century. General education tends to have a strong pull for external employment but only in more recent decades.

Finally, we look to the effects of different experiences on professional retention. Task assignments within the Navy tend to be exogenous for any particular officer, given exigencies of naval operations and other higher level considerations (Glaser and Rahman 2023 look at job assignments in the Royal Navy, and instrument for these using geographic IVs. Results support the idea of more or less exogenous task assignments within the Royal Navy).

Like education, the value of some experiences can change over time. Some are like firm level human capital accumulated in college —- they tend to solidify work within the military. But some evolve to become valuable for occupations in other industries. These include bureaucratic office work, something that had little to no value in the early days of the Navy, but evolved into tasks that could garner a premium in other organizations. The Navy's introduction of certifications added another level of human capital accumulation which could be exploited in external work.

All told then, professional workers, even highly specialized ones , exhibit a remarkable degree of elasticity when it comes to career switching.

The rest of the paper proceeds as follows. A brief review of some literature is provided in section 2. We then provide some historical background in section 3 and a description of

the data in section 4. Section 5 presents the empirical model and section 6 discusses results and sensitivity checks.

2 Literature Review

The paper interweaves three strands of literature — labor monopsony power, personnel economics, and economic history. We discuss a small but representative set of literature from each strand.

2.1 Labor monopsony power

Our paper contributes to the burgeoning literature on monopsony power in the labor market. Robinson (1933) first documented that geographical isolation, workers' idiosyncratic preferences, and information frictions can lead to market failures and an upward-sloping labor supply curve to the firm[cite: 670]. Manning (2003a) further developed this idea and demonstrated that firms can be monopsonists despite the existence of many competitors[cite: 672].

Recognizing the obstacles of directly estimating the labor supply elasticity, a growing strand of literature adopts a worker separation-based approach to estimate the labor supply elasticity from the wage elasticity of separations[cite: 720]. This approach has been applied to grocery retailers (Ransom and Oaxaca 2010), schoolteachers (Ransom and Sims 2010), and broad occupational groups (Bassier, Dube, and Naidu 2021)[cite: 728, 729]. More recently, researchers have applied this framework to high-skilled, thin labor markets, such as university faculty, finding exploitation rates of around 7%[cite: 661, 737].

2.2 Personnel economics

We also build on the historical personnel economics literature. Topel and Ward (1992) analyzed mobility decisions based on the maximization of the net present value of lifetime wealth for young men[cite: 195, 197]. This work along with Bartel Borjas (1981) was among the first to structurally link turnover hazards to wage dynamics. Subsequent work using this approach in other contexts include Light (1995), Neal (1999) and Adda et al. (2022).

What is interesting about this literature is that it focuses study on young men in the immediate post-bellum world of the latter 20th century. Yet what of men prior to the Second World War, or men and women during the 1990s up until the present?

Within the military context, Glaser and Rahman (2011) explored human capital accumulation on US Naval officer career earnings during the late 19th century [cite: 19], while Glaser

and Rahman (2023) examined how pay, promotions, and peers influenced retention in the British Royal Navy between 1878 and 1905[cite: 21]. We extend this literature by utilizing expanded measures of human capital—including undergraduate coursework, post-graduate training, and cumulative at-sea experience—over a much longer time frame[cite: 29, 37].

2.3 Labor Mobility in Economic History

The literature on gauging labor mobility for earlier periods is much thinner, surely in part due to data limitations. Carter and Savoca (1990) perhaps provides the closest example of a Topel and Ward styled analysis for the 19th century. They find that early industrial labor markets exhibited high baseline exit hazards and frequent job switching.

Jacoby (1984, 1985) documents labor markets in the early 20th century, finding that firms can reduce quit rates with seniority wages and promotion ladders. Labor markets in the American South has been studied by Alston and Higgs (1982, 1984), Wright (1986) and Naidu (2008). And Claudia Goldin has numerous works on the early labor market dynamicsm and mobility of women. We bring something new to the literature by introducing modern hazard/elasticity methods to historical labor markets and linking them to modern labor markets.

3 Background

3.1 Early days

The Navy of the post-bellum era was one that faced technological uncertainty and personnel policy sclerosis. Our finding stable wage elasticities in the face of an organization so different from today's Navy is telling.

The U.S. Navy faced immediate stagnation and difficulties in its post-bellum period. Buhl (1978) describes technological uncertainties to have stabilized only by 1890.[‡] Vlahos (1989) labels 1865–1885 for the U.S. Navy a period of "post-war parochialism," and 1885-1888 as a time of "ferment before transformation." The new battleship strategic philosophy, developed and championed by England, defined the American technological paradigm only after 1890 (McBride 1990). Before that the Navy was motley mix of ships with different hull constructions, different propulsion mechanics, and incompatible strengths and objectives.

By most accounts then, the navy was transformed into industrialized workplaces only

[‡] "However linear and inexorable the technological progress of the period appears in hindsight, to the contemporaries everywhere, experts and amateurs alike, things were a terrible jumble — a confused jigsaw puzzle of many unknown pieces, being fitted together quite unsystematically." (Buhl 1978)

by the final decade of the 19th century. Navies historically have served as laboratories and vanguards of technological progress (O'Brien 2001) — here we can observe internal labor effects during a period of such transition. Technological advances implemented after 1890 changed nearly every aspect of naval operations, and these changes coincided with economy-wide technological advances in steel manufacturing, chemicals and electricity during the second industrial revolution (Mokyr 1990). The corps of officers had very different experiences in working with these technologies.

Personnel was also structured very different then. Prior to the early 1900s the overall officer corps were comprised of two fairly distinct groups — regular line-officers and engineering officers. Each group had different background skills, and performed different operations aboard vessels or on shore duty. Each group also had opportunities for task-specific naval or engineering training. Secretary of the Navy Gideon Welles argued back in 1864 that all Naval Academy students should study engineering (McBride 2000). Much like England, it would take America a few more decades to provide all new officers with more highly technical educations. Indeed the process evolved over time and involved everything from executive orders, to acts of Congress and even rulings by the United States Supreme Court (Glaser and Rahman 2011).

As discussed in Blank and Stigler (1957) and more extensively in Edelstein (2009), a great demand arose during the second industrial revolution for engineering-based skilled labor to manage and facilitate production using new technologies. While college educated metallurgical and chemical engineers were needed in their respective growing industries, other sectors of the economy needed workers with technological understanding in the applied sciences. The technically educated also participated in various processes of innovation and patenting (Usselman 1999), and even went into areas of business management and the bureaucracy of industrial organizations, particularly before the rise of explicit business degrees in the 20th century (Calvert 1967).

3.2 The Twentieth Century

Undersecretary of the Navy Theodore Roosevelt wanted all officers to become engineers "whether they wanted to or not." The result was the Amalgamation Act which incited many erstwhile officers to abandon their naval pursuits.

The Amalgamation Act of 1899 formally merged the engineer corps into the line and aimed to rationalize promotion flows, but contemporaries noted that even after three years "a three years' test is not long enough" to evaluate its success (Proceedings 1902).

Subsequent evidence suggests a prolonged period of institutional adjustment: although

the Naval Academy quickly unified training, tensions over professional identity and command persisted through at least 1916. The later reintroduction of engineering specialization during World War I further indicates that full integration was neither immediate nor complete. The restricted line officer concept of "engineering duty only" (EDO) was revived in 1916 when the Engineer Corps officers proved inadequately prepared for the expanded shipbuilding programs of World War I (Snyder, Philip W., RADM USN, (February 1979) "Bring Back the Corps", Proceedings of the United States Naval Institute).

Although the Personnel Act of 1899 formally unified the line and engineer corps, the integration of career paths and professional identities was protracted. As McBride (2000) emphasizes, the Navy faced persistent tension between technological specialization and command authority, while the broader institutional literature (Sprout and Sprout 1939; Albion 1980) suggests that organizational adaptation proceeded incrementally into the World War I era. More focused work (Latimer) shows that conflicts over engineering identity and operational integration persisted through at least 1916, implying a multi-decade adjustment process. Functional integration was fully achieven only after WWI (Sprout and Sprout 1939).

Institutional sluggishness in the face of changing demands for new skills have many examples in history (Goldin and Katz 2008). The tensions arising between engineers and managers in the railroad industry (Chandler 1977), between physicians and administrative specialists in hospitals (Starr 1982) and between programmers and managers in IT (Bresnahan et al. 2002) all stem from technological changes moving ahead of institutional changes.

The 1920s and 1930s saw large changes to naval operations. The Personnel Act of 1916 attempted to devise a more modern and flexible personnel system, addressing longstanding problems with promotion bottlenecks and rigid career structures.

At the same time the fulfilment of Roosevelt's wish at the turn of century meant officers decades later had exposure to an ever-widening range of technical and mechanical tasks. The 20th century officer had different opportunities to develop skills as liaisons to steel foundries, ship building yards, supply-chain managers, electrical and lighthouse inspectors, lawyers, engineers and bureaucrats. Their training also enabled some of them to develop skills in the art of diplomacy and negotiation, mathematics, chemistry, electricity, telecommunications and numerous other fundamental tools useful in private industry. Certain military jobs undoubtedly enhanced general human capital, and made certain personnel attractive candidates for jobs in other rapidly expanding private sectors. This is supported by words from the U.S. Navy Chief of the Bureau of Construction and Repair in 1913, who blamed the loss of human capital principally on the private sector's preference for the technically proficient (McBride 2000).[§]

[§]This is also supported by our cursory examination of U.S. census records for those few ex-officers we

3.3 The Twenty-first Century and Beyond...

Today we might expect much more labor fluidity between military and civilian workforces. Skills and experiences in military service has been shown to produce opportunities for private-sector work in many different contexts (Angrist 1990, Loughran (2008), Angrist and Chen (2011)). And working today in the most powerful and technologically advanced armada in the world must open up tremendous prospects elsewhere.

This remains an open question. Our approach here can test the "temporal validity" of the effects of military experiences on private employment. Despite all the advances that elevated the US Navy to be the strongest navy ever, officers today continue to work under rigid pay structures, doing jobs typically not of their own choosing. Our empirical approach can thus be employed for this contemporaneous period as well.

4 Data

Data is compiled from a combination of publicly available and proprietary data sources. For historic data We have digitized officer career records from documentation housed in the National Archives and in the historical archives of the United States Naval Academy library. Published annually, the *U.S. Navy Register* contain data on the job assignments, rank and duty station of every officer and engineer for every year of their career, and also the deployment status of the ships on which they served. Wage tables which outline how rank, station and job assignment affect annual pay for personnel are also available in the *U.S. Navy Register*. These data also enable the construction of measures for year-specific and cumulative human capital. Wage profiles for US naval officers are displayed in Figure 2. We gather more recent data from the Navy Standard Integrated Personnel System (NSIPS).

Data also exist for each officer's time at the United States Naval Academy, the college before service for all officers in this data. Student records before WWII are kept in annual Naval Academy register volumes. Student records starting from the Class of 1988 are available through the electronic Midshipman Information System. These include specific measures of academic and military performance, including overall rankingsw within class, useful as standardized measures of general academic and more "firm-specific" abilities.

For both historic and contemporary datasets we have further information regarding voluntary or involuntary retirement and sick leave. For the historic navy we also track whether an officer applied for or received a pension due to dis-ability or infirmity. These serve as

can match with near-certainty after they leave the service. Self-reported professions include such skilled jobs as banker, "capitalist" (presumably this meant he was an independent businessman), lawyer, moulder, consulting and civil or mechanical engineers.

important checks to our results, as we wish to focus on voluntary departures from naval service.

5 Econometric Model

The labor literature contains a number of theoretical and empirical studies which highlight the job switching process, including a useful and extensive meta-discussion in Gibbons and Waldman (1999). That being said, the empirical model we use follows from the work of Mortensen (1988) and most importantly Topel and Ward (1992).[¶] In general, this model best connects job switching decisions to the key factors highlighted in the model of section 2: the distributions of external and internal job offers, human capital acquired over time, internal wages and job tenure.

5.1 Topel and Ward job separations

The empirical model begins with the primal assumption that naval officers base mobility decisions on the maximization of the net present value of lifetime wealth. Wage offers from private-sector firms ($\bar{w}$) generate from a known distribution and vary as careers progress due to the nature of work experience. Let x represent experiences accumulated by the officer. The distribution of external private-sector offers depends of this observable experience and is defined by

$$Prob(\bar{w} < z; x) = G(z; x) \ . \tag{1}$$

If $G_{x}(\cdot) < 0$ then wage offers increase with the accumulation of experience. The *occurrence* of new job offers from the private-sector for officers follow a Poisson distribution with parameter π.

Internal wage changes for individual personnel occur through one of three basic mechanisms. First, promotions, though infrequent, allow for the largest jumps in wages. A deterministic mechanism for promotions does not exist on record, with only anecdotal discussions that relate it to seniority, merit and availability of openings. Promotions were also likely related to the type and amount of fleet experience. Glaser and Rahman (2011) highlight the factors that most affected American officer promotions during the latter 19th century, noting especially how the U.S. Navy was plagued with an overall dearth of promotions during the 1870s and 80s. In this study we analyze, among other things, the effects of wage changes on

[¶]Additional work from Bernhardt (1995) and McCue (1996) on promotions proved especially helpful for developing ideas.

job exits for navies of different eras — as highlighted earlier, promotion was the key factor affecting wages no matter the time period.

Without a promotion, officers faced smaller year-to-year changes in wages based on their job assignments serving on ships at sea, in international embassies/consulates, at domestic shore stations (bureaucratic or technical), or awaiting further orders without a current assignment. These wage changes often depended as well on one's rank.

Finally, officers and engineers could receive smaller wage increases if they stagnated *within* the same rank. For much of naval history this happened for pentennial intervals (after 5, 10, 15 or 20 years in the same rank).These within-rank interval wage changes were well known to all officers.

The distribution of internal *navy* wage offers (job assignments), w^n, depends on current wages, w, experience, and the overall number of years in the Navy (years since commissioning), t. We further control for wage increases due to promotion stagnation through the variable s. Hence the distribution of internal offers is defined by:

$$Prob(w^n < y; w, s, x, t) = F(y; w, s, x, t) \ . \tag{2}$$

As Mortensen (1988) details, a higher current wage increases the entire distribution of internal offers such that stochastically $F_{w}(\cdot) < 0$. If internal wage growth is non-increasing (concave) with tenure, then stochastically $F_{t}(\cdot) \geq 0$. The automatic pay raises due to officers who stagnatewithin rank implies that $F_{s}(\cdot) < 0$. The probability of an internal wage change is also assumed to be Poisson.

Assuming a discrete choice between extending his career in the Navy or separating, the offer distributions given by (1) and (2) jointly capture the characteristics of the current career outcome of the officer, given his set of alternatives. With both sides of the labor market defined, the value function, $v(w, s, x, t)$, represents the expected present discounted value of lifetime wealth for officers paid a wage of w at the t'th year of his career. Given a private-sector offer w^p, and human capital transferability of $0 < \delta < 1$, a job switch occurs when $v(w, s, x, t) < v(\bar{w}, s, \delta x, 0)$. That is, an exit from the Navy occurs when the outside job (with experience set at $t = 0$ and retained human capital at δx) has greater expected value than the current naval job. On the margin, a reservation wage exists, $r(w, s, x, t)$, such that $v(r(w, s, x, t), s, \delta x, 0) = v(w, s, x, t)$. Any private sector offer $\bar{w}$ exceeding the reservation wage leads to a job separation from the Navy.[‖]

Topel and Ward (1992) define the hazard as the product of the probability of receiving a

[‖]Not observed of course are any non-pecuniary benefits earned from promotions. With such benefits any wage increase stemming from promotions should bump up the reservation wage even more, such that $r_{w}(\cdot) > r_{s}(\cdot)$. We do not analyze this additional prediction here.

new offer, π, and the probability that the new wage exceeds the reservation wage. In other words, the hazard at time t is

$$h(w,s,t,x) \;=\; \pi Prob(\bar{w} > r(w,s,t,x)) \;=\; \pi\left[1 - G(r(w,s,t,x))\right] \;. \tag{3}$$

For comparative statics and empirical predictions, assume that $r(\cdot)$ is differentiable, and let $g(z;x) = G_{z}(z;x)$ define the density of wage offers. A change in the current wage affects the hazard by

$$h_{w}(w,s,t,x) = \; -\pi g(r;x) r_{w}(w,s,t,x) \;. \tag{4}$$

A larger current Navy wage increases the net present value of the current job and bumps-up the reservation wage. This implies that $h_{w}(w,s,t,x) < 0$.

Secondly, the effect of service time on the hazard appears as

$$h_{t}(w,s,t,x) = \; -\pi g(r;x) r_{t}(w,s,t,x) \;. \tag{5}$$

Given the assumption of concave wage-profiles over time from on-the-job general training, then $r_{t} < 0$ for $t > 0$. All else equal, switching jobs becomes optimal over time as private sector jobs offer larger growth in expected wages due to greater experience. Indeed officers may choose to accept a wage cut with the separation simply because the potential for wage growth on the new job over time leads to higher lifetime wealth (see Bernhardt 1995). This indicates a result in which $h_{t}(w,s,t,x) > 0$. Related to both of these prior results, since both navies guaranteed wage increases for certain within-rank intervals (due to lack of promotion), s should have a positive effect on the reservation wage, $r_{s}(w,s,t,x) > 0$. Therefore we expect that $h_{s}(w,s,t,x) < 0$ for each point in time one receives a wage increase without a promotion.

Finally, the effect of human capital experience on the hazard is given by

$$h_{x}(w,s,t,x) \;=\; -\pi g(r;x) r_{x}(w,s,t,x) \;=\; -\pi G_{x}(r;x) \;. \tag{6}$$

We allow for the possibility that different types of jobs (technical, bureaucratic, ship service and command) all may have different effects on the hazard. Presumably $G_{x} > 0$ for experience with more firm-specific human capital, and $G_{x}(\cdot) \leq 0$ for more generally transferable forms of human capital. If general human capital has a linear effect on the mean of log wage offers, and the reservation wage follows from an officer's current wage, then (4) and (6) can be combined to impute the rate of return to a year of experience. Holding other variables constant, the fraction $\frac{-h_{x}}{h_{w}}$ represents the annual growth in wage offers from experience.**

**For discussion purposes later in the paper, the estimates for $h_{w}(\cdot)$ and $h_{x}(\cdot)$ are the partial derivatives

5.2 Estimation

We estimate (3) by semi-parametric likelihood estimation. The likelihood function, which follows from Meyer (1990), is defined by the conditional probability at time t that an officer separates during year $t+1$ of his career. During the latter 19th century (and unlike today), navies did *not* have a defined mechanism to force officers from service until they were of a certain age or physically unable to perform. In most cases, separation decisions were one-sided.[††] Assuming covariates remain constant on the intervals between time periods t and $t+1$, the specification of the log-likelihood function used to estimate the model for N officers follows as:

$$log\ L(\gamma,\beta) \ = \ \sum_{i=1}^{N}[\phi_i log\,[1-exp\,\{-exp\,[\mathbf{x}_i(T_i)'\beta_x+\gamma(T_i)]\}] \ - \ \sum_{t=1}^{T_i-\phi_i} exp\,[\mathbf{x}_i(t)'\beta_x+\gamma(t)]] \ . \tag{7}$$

This log-likelihood is a discrete time model with incompletely observed continuous hazards for censored ($\phi_i = 0$) and uncensored ($\phi_i = 1$) careers. Our estimates track careers from the beginning of year 6 until the beginning of year 36[‡‡]. Step-function intervals define the experience spline for years $[6,10),[11,15),...,[31,35)$. The job tenure spline generates from estimates of γ. Control variables at time period t are defined by the vector $\mathbf{x}(t)$ and include: the officer's wage, cumulative experience at sea or in command, a dummy variable to designate stagnation within rank, a dummy variable capturing status as an engineer, cumulative experience in various types of technical and bureaucratic jobs, controls for physical constitution, and year fixed effects. Alternative specifications include controls for unobserved individual-specific heterogeneity.

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of (7) with respect to internal wages, w, and years of general (technical) experience, x. See Topel and Ward (1992) for more detail on this method of imputation.

[††]Results are not sensitive to exclusion of the handful of cases that apparently were not one-sided. Forced retirements are controlled for in all specifications.

[‡‡]By Congressional stipulations at the time, officers could not continue working beyond sixty-two years of age or with forty years of service. Due to the limited number of observations remaining in the data beyond the thirty-fifth year and the impending forced retirements for this handful, we limit the career time-frame to thirty-five years.

We choose five year intervals for tractability and for presentation, but the results presented throughout the paper are not sensitive to the choice of 5 year intervals.

These include the cumulative years that an officer is designated for sick leave and a dummy variable indicating sick leave status in a specific year.

Specifications of the likelihood with unobserved heterogeneity also follow from Meyer (1990) with gamma distributed heterogeneity. That is

6 Summary of Findings

6.1 The Historic Navy: 1860–1940

Table 1 presents our first set of results of estimated hazard rates. Here we employ the full set of historical data spanning from the dawn of civil war until the dawn of global war" 1860–1940. These eighty years saws the US Navy undergo a series of technological and institutional convulsions. In an uneven process it transformed from a backward and middling littoral force into the fiercest armada the world had ever seen.

Yet throughout the tumult certain underlying features of naval personnel remained steady. Key among these is the responsiveness of personnel to internal wages. In table 1 we see that the elasticity is roughly 1% for the whole historic sample, which is precisely the elasticity found in Topel and Ward (1992) for young men in the 1950s and 60s. Our first claim is thus a potentially contentious one. Those of us belonging to *homo economicus* may wear civilian OR military garb. We all respond to economic incentives, irrespective of professional commitment.

With this backdrop of wage incentives, we can gauge the inherent external value of various skills and experiences in naval service in various periods of time. We first look to different abilities as measured by performance on different types of courses at the United States Naval Academy. To capture potential nonlinearities, we produce indicator variables for whether the officer had performed in the top or bottom third of his class for engineering-oriented, navy-specific, general and non-cognitive courses. We find no discernible "GPA premia" during this time period. More specifically, general and engineering course grades do not appear to motivate exits. This is a big difference compared with the modern analysis, as we will see shortly.

On the other hand, poor navy-specific performance at the Academy is a strong predictor of exit. This likely captures poor performance or "fit" in military service. Those with strong non-cognitive skills tend to remain in service, perhaps due to the need of soft skills in leadership roles, whatever the technological environment.

In specification 2 we add cumulative experience measures. Here and in subsequent specifications we divide episodes of naval service into four warfare communities (aero, subs, carri-

$$log\ L(\gamma,\beta,\sigma^2)\ =\ \sum_{i=1}^{n} log\left[\left[1+\sigma^2\sum_{t=0}^{T_i-\phi_i} exp\left[\mathbf{x}_i(T_i)'\beta+\tilde{\gamma}(T_i)\right]\right]^{-\sigma^{-2}} - \phi_i\left[1+\sigma^2\sum_{t=0}^{T_i} exp\left[\mathbf{x}_i(t)'\beta+\tilde{\gamma}(t)\right]\right]^{-\sigma^{-2}}\right].$$

Positive estimates indicate a *ceteris paribus* higher likelihood of exit. Negative estimates indicate a *ceteris paribus* lower likelihood of exit

ers, and all other vessels) and four shore responsibilities (leadership roles, learning/teaching at external universities, teaching/service at USNA, and other shore office duties). These categories allow for easy comparisons across sub-time periods.

Results on cumulative naval experiences tend to remain consistent across different periods, including right up to today. Service for specific warfare communities tend not to have any long-run benefits for external use. On the other hand experience in outside universities, and/or service at the Naval Academy, tend to raise retention. This is also true of the modern corps. This is a striking finding. Graduate education and teaching assignments typically come with obligated service, raising the tenure of servicemen. Serving at the Academy, the Alma Mater for the vast majority of these officers, helps them develop leadership and communication capital. This raised the internal returns to staying, conceivably beyond whatever gains external employment offered.

Shore office work tends to lower retention. This is also true of the modern corps. It suggests positive revealed returns to office experience. Such roles would produce highly transferable skills for civilian jobs in management, administration, logistics or policy.

Note that here we cannot entirely rule out selection into service billets based on qualities we do not observe. In general however the exigencies of naval operations held the greatest importance in filling billets. Furthermore we control for a range of quality measures.

The results above may belie some heterogeneous effects across time. Tables 2 through 5 redo the analysis for various sub-periods — the Bellum and Post-Bellum Navy (1860–1887), the Steel Navy Transition (1888–1900), the Progressive/World War I Navy (1901–1923), and the Interwar Treaty Navy (1924-1940).

Table 2 shows the results for the Bellum and Post-Bellum Navy (1860–1887). During this time the naval corps had fairly high exit elasticities — a 1% rise in wages results in a roughly 2.5% lower likelihood of exit. This certainly counters the idea of an entrenched "naval aristocracy" unmotivated by considerations of income (Karsten 1972).

Here we see that not falling behind navy-specific content was very important in those days! But doing well in other kinds of classes didn't matter.

Also during this period engineers made up their own corps. They were technically proficient and under-appreciated in the Navy (McBride 2000). However they tended to remain in the service, likely because their skills in the Navy were in great demand and relatively short supply.

Also, during these early years, office experience had no revealed return to outside employment. And taking on leadership roles leads to greater retention during this time.

Table 3 shows the results for the Steel Navy Transition period (1888–1900). During this period the Navy started modernizing its fleet, but the exit elasticity remains high.

Table 4 shows the results for the Progressive/World War I Navy (1901–1923). The Amalgamation Act of 1899 (put into practice a couple of years after) transformed the corps. Officers had to be skilled in engineering concepts and techniques. Erstwhile engineers on the other had to learn the leadership skills of the line officer. The result? Engineers were no longer as sticky to naval service. More strikingly, higher wages no longer predict lower job separation. The promotion associated with the biggest wage gains likely entailed more technical skills that many officers did not possess or did not wish to employ.

Other estimates from Table 4 are notable. The "early adopters" of warfare both above and below the water's surface (aero, sub, carriers) tended to stick it out in naval service. This may serve as a good lesson for transforming organizations. Those engaged with the cutting edge of technological developments will tend to remain in service. Perhaps this is because the value of learning such techniques are clear in the Navy, while their applicability outside the military during the early days are far murkier.

Table 5 shows the results for the Interwar Treaty Navy (1924-1940). This is a navy that starts to look like our current force, with technological and personnel developments echoing those of the 21st century. Wage elasticities go back to being fairly high.

Here we see that for the first time, shore office experience has a revealed return from outside employment. Is this evidence of the rise of the modern office? It is unclear, but it interesting that, as we see, returns to office work remain positive for the modern corps.

There are some other interesting findings. Leadership roles once again leads to greater retention. Further, starting in 1930, officers could become certified in various tasks, which we categorize as engineering, general or firm-specific. Getting certified in general human capital tasks appear to have a revealed return.

6.2 The Contemporary Navy: 1988–2018

One important benefit of analyzing the same institution over time is that we can assess the stability, or "temporal validity," of our estimates. With this in mind we now hurtle decades into the future to analyze the Navy of the 1990s and 2000s. Table 6 shows hazard estimates for the full modern sample of 1988–2018. Tables 7 and 8 provide sub-sample estimates.

As should be clear from these tables, the modern brigade is moderately elastic when it comes to wages influencing exit decisions. But this is not exactly a new feature. These measures are quite comparable to historic estimates. And just like most of the history that we have uncovered, this suggests that work experiences which show positive effects on exits continue to reveal positive external value.

Take college education. Now there appears to be a GPA premium — pulling yourself

out from the bottom third in academic classes boosts your revealed return. Doing well in military specific courses still produces a pull towards continued service. The implication is that those who perform better in academic relative to military coursework gain valuable skills in external markets.

There is also some remarkable consistency on the effects of exit from various job experiences. Leadership, university and USNA experiences continue to pull officers towards longer service. Office work on the other hand continues to earn a premium in external employment.

The Academy introduced academic majors in the mid-1970s, with the first class graduating with distinct majors in 1976. The Academy lumped (and continues to lump) all majors into one of three "groups" — engineering (Group I), math or sciences (Group II), and humanities or social sciences (Group III). The final specification includes indicators for Group II or Group III majors. Here we see a revealed return from enrolling in non-engineering majors. This shows us something interesting. If you are already in an engineering oriented organization, having other kinds of skills can be valuable to you (if not your current employer!).

In this final specification we also include indicator variables for minority-race and female officers. As has been documented elsewhere, female officers in general are more likely to exit naval service, while minority-rate officers in general are less likely to exit naval service.

7 Application 1: Parameterizing Monopsony Models

We rely on the standard monopsony framework to map our estimated wage elasticities of separation to the firm-level elasticity of labor supply. Here we simply lay out some of the basic ideas to demonstrate how this mapping works.

7.1 The Static Model of Monopsony

Consider a monopsonist firm (in our case, the Navy) that optimally chooses the level of employment N to minimize total labor costs given a revenue-maximizing (or service-maximizing) level of production[cite: 770]. The cost minimization problem can be written as:

$$min\{w(N)N\}, s.t. Y(N) = \overline{Y}$$

The first African-American graduate of the Academy was Wesley A. Brown in 1949. The first women graduating from the Academy matriculated in 1980.

Females and minorities are also slightly less responsive to wage incentives than white males (results not reported).

with the first-order condition:

$$w(N) + w'(N)N = Y'(N)$$

[cite: 772, 773].

Rearranging this condition yields the rate of exploitation, E, which represents the proportional gap between the marginal revenue product (MRP) and the wage:

$$E = \frac{MRP - w}{w} = \frac{1}{\epsilon_{Nw}}$$

[cite: 777, 778].

This formulation illustrates that a non-zero E implies a discrepancy between the wage and the MRP, that is, the power of the firm to set the wage below the MRP[cite: 782].

7.2 The Dynamic Model of Monopsony

To motivate our empirical separation-based approach, we assume a dynamic model where workers leave the firm over time at a rate $s(w_t)$, and recruits arrive at a rate $R(w_t)$[cite: 788]. The firm size in the next period is:

$$N_{t+1} = [1 - s(w_t)]N_t + R(w_t)$$

[cite: 790].

In a steady state, the number of recruits balances the number of separations, yielding the long-run labor supply function:

$$N(w) = \frac{R(w)}{s(w)}$$

[cite: 792, 793].

Writing this in terms of elasticities, the wage elasticity of labor supply (ϵ_{Nw}) is the difference between the wage elasticity of recruits (ϵ_{Rw}) and the wage elasticity of separations (ϵ_{sw})[cite: 800]. Following Manning (2003a), we assume that in a steady-state equilibrium, one firm's recruits from other firms by offering higher wages should be another firm's quits[cite: 802]. Thus, the wage elasticity of recruits equals the negative of the wage elasticity of separations, yielding:

$$\epsilon_{Nw} = \epsilon_{Rw} - \epsilon_{sw} = -2\epsilon_{sw}$$

[cite: 804]. Therefore, estimating the wage elasticity of separations alone suffices to recover the wage elasticity of labor supply[cite: 731].

The labor supply of such professionals is fairly and consistently elastic. This means personnel can rise or fall with exogenous demand shocks, complicating objectives for consistency of personnel or retention of critical skills.

8 Application 2: Revealed returns to education

The analysis above offers a unique opportunity for us to impute the returns to various kinds of human capital accumulation. Take college education. All officers in our data are graduates of the United States Naval Academy. By incorporating such education in hazard models, we can assess the value of various college courses over various periods of time for external employment. What we find is that while poor performance in naval-specific subjects can raise exit rates, performance in more general subjects had no meaningful impact on exits prior to WWII. This changes dramatically after the war — for more modern times we observe a distinct "GPA premium" for academic courses, and a "GPA penalty" for more navy- or military-specific courses.

How valuable were external opportunities for naval personnel precisely? With our broad specifications that include extensive control variables, these hazard regressions provide lower-bound baseline estimates for the wage-gain from various forms of experiences. As noted in Topel and Ward (1992), the ratio of marginal effects on the hazard, $\frac{h_x(\cdot)}{h_w(\cdot)}$, provides an estimated rate of return to experience. Indeed, within rigid bureaucracies we cannot look to internal earnings to measure such rates of return, as these are distorted. Measuring rates of exit for accumulated experiences are the *only* way to measures rates of human capital return in these cases. Furthermore, given our rich array of college performance, we can also calculate rates of return from different college-course performances.

We report these revealed returns in table 10. The top portion of the table report positive returns to education. As should be immediately apparent, external returns to any college education are essentially non-existent historically. Conceivably firm-specific education should by definition never garner a positive external return, and this appears true here. Returns to college performance emerge positively only for the modern era.

9 Application 3: Revealed returns to experience

We can use the same approach to analyze returns to experiences in naval service. We augment our hazard models with cumulative experiences over a range of different tasks.

In summary, transferable job skills (general experience) increase job switching through an exit, while other types of human capital support the extension of naval careers. This is consistent with outside firms perceiving (and paying for) general skills in high-tech and management sectors of the economy, presumably with a higher distribution of wage offers.

Specifically, bureaucratic office work emerges as a potentially valuable to outside employers starting in the 1930s and continuing into the present era. And as the navy began to offer certifications in the late 1920s for specialized trainings, those trainings more oriented towards general abilities had greater external value. What we see here is that broad education and trainings began to become more commodifiable over time.

10 Tables

Table 1: Exponential Survival Model: 1860–1940

	(1)	(2)
Ln Real Wages	-1.016***	-0.995***
	(0.251)	(0.260)
Engineering coursework, top third	-0.035	-0.034
	(0.050)	(0.050)
Engineering coursework, bottom third	-0.005	-0.013
	(0.041)	(0.041)
Navy-specific coursework, top third	-0.053	-0.048
	(0.044)	(0.044)
Navy-specific coursework, bottom third	0.183***	0.180***
	(0.043)	(0.043)
General coursework, top third	0.043	0.042
	(0.052)	(0.052)
General coursework, bottom third	0.084	0.090
	(0.078)	(0.078)
Non-cognitive coursework, top third	-0.082**	-0.078**
	(0.036)	(0.035)
Non-cognitive coursework, bottom third	0.036	0.031
	(0.041)	(0.041)
Eligible for Retirement	1.713***	1.726***
	(0.430)	(0.430)
Engineer	0.166*	0.161
	(0.098)	(0.102)
Construction Corps	0.080	0.017
	(0.115)	(0.125)
Sick leave, cumulative	0.415***	0.412***
	(0.079)	(0.077)
Aero experience, cumulative		-0.036
		(0.027)
Submarine experience, cumulative		-0.011
		(0.020)
Carrier experience, cumulative		0.015
		(0.042)
Other ship experience, cumulative		0.004
		(0.024)
Leadership experience, cumulative		-0.003
		(0.016)
University experience, cumulative		-0.056**
		(0.024)
USNA experience, cumulative		-0.034**
		(0.016)
Office experience, cumulative		0.034***
		(0.012)
Year and spline effects	Yes	Yes
Observations	135630	135630
Log Likelihood	-7614.143	-7598.548

Log-hazard coefficients; negative coefficients imply a lower likelihood of exit

Table 2: Exponential Survival Model: 1860–1887

	(1)	(2)
Ln Real Wages	-2.623***	-2.497***
	(0.267)	(0.268)
Engineering coursework, top third	-0.027	-0.036
	(0.119)	(0.119)
Engineering coursework, bottom third	-0.056	-0.038
	(0.121)	(0.119)
Navy-specific coursework, top third	-0.063	-0.073
	(0.125)	(0.124)
Navy-specific coursework, bottom third	0.377***	0.353***
	(0.123)	(0.122)
General coursework, top third	-0.002	-0.018
	(0.129)	(0.132)
General coursework, bottom third	0.029	0.013
	(0.105)	(0.106)
Non-cognitive coursework, top third	0.059	0.034
	(0.133)	(0.138)
Non-cognitive coursework, bottom third	-0.025	-0.067
	(0.114)	(0.119)
Eligible for Retirement	-0.046	0.293
	(0.904)	(0.824)
Engineer	-0.417**	-0.421**
	(0.170)	(0.169)
Construction Corps	0.907*	0.878**
	(0.515)	(0.427)
Ship experience, cumulative	-0.116***	-0.193***
	(0.039)	(0.041)
Sick leave, cumulative	0.582***	0.524***
	(0.060)	(0.058)
Leadership experience, cumulative		-0.620**
		(0.258)
University experience, cumulative		-12.361***
		(0.812)
USNA experience, cumulative		-0.548**
		(0.223)
Office experience, cumulative		-0.726***
		(0.208)
Year and spline effects	Yes	Yes
Observations	13426	13426
Log Likelihood	-933.309	-922.373

Log-hazard coefficients; negative coefficients imply a lower likelihood of exit

Table 3: Exponential Survival Model: 1888–1900

	(1)	(2)
Ln Real Wages	-1.763***	-2.586***
	(0.526)	(0.904)
Engineering coursework, top third	0.104	0.045
	(0.215)	(0.215)
Engineering coursework, bottom third	0.083	0.016
	(0.168)	(0.184)
Navy-specific coursework, top third	-0.296	-0.245
	(0.240)	(0.237)
Navy-specific coursework, bottom third	0.170	0.151
	(0.204)	(0.201)
General coursework, top third	-0.024	-0.088
	(0.281)	(0.271)
General coursework, bottom third	-0.017	-0.080
	(0.360)	(0.296)
Non-cognitive coursework, top third	-0.296	-0.218
	(0.209)	(0.195)
Non-cognitive coursework, bottom third	0.194	0.138
	(0.209)	(0.179)
Eligible for Retirement	-0.874	3.156***
	(1.033)	(1.128)
Engineer	-0.084	-0.033
	(0.353)	(0.361)
Construction Corps	1.042*	1.674***
	(0.562)	(0.623)
Ship experience, cumulative	-0.059*	-0.040
	(0.031)	(0.044)
Sick leave, cumulative	0.726***	0.668***
	(0.133)	(0.141)
Leadership experience, cumulative		0.083
		(0.075)
University experience, cumulative		-11.747***
		(0.981)
USNA experience, cumulative		-0.318***
		(0.059)
Office experience, cumulative		-0.123*
		(0.068)
Year and spline effects	No	Yes
Observations	8493	8493
Log Likelihood	-337.470	-315.615

Log-hazard coefficients; negative coefficients imply a lower likelihood of exit

Table 4: Exponential Survival Model: 1901–1923

	(1)	(2)
Ln Real Wages	0.286***	0.402*
	(0.092)	(0.211)
Engineering coursework, top third	-0.006	-0.032
	(0.093)	(0.092)
Engineering coursework, bottom third	-0.006	-0.016
	(0.075)	(0.075)
Navy-specific coursework, top third	0.045	0.045
	(0.074)	(0.075)
Navy-specific coursework, bottom third	0.201***	0.208***
	(0.068)	(0.067)
General coursework, top third	0.056	0.064
	(0.091)	(0.093)
General coursework, bottom third	0.036	0.002
	(0.084)	(0.074)
Non-cognitive coursework, top third	-0.035	-0.006
	(0.071)	(0.071)
Non-cognitive coursework, bottom third	-0.021	-0.024
	(0.061)	(0.061)
Eligible for Retirement	0.291	0.296
	(0.827)	(0.821)
Engineer	0.169	0.165
	(0.122)	(0.127)
Construction Corps	0.118	-0.119
	(0.177)	(0.195)
Ship experience, cumulative	0.002	-0.012
	(0.010)	(0.012)
Sick leave, cumulative	-0.018	-0.041
	(0.160)	(0.156)
Aero experience, cumulative		-0.238
		(0.151)
Submarine experience, cumulative		-0.103**
		(0.045)
Carrier experience, cumulative		-11.812***
		(0.429)
Other ship experience, cumulative		-0.078
		(0.082)
Leadership experience, cumulative		0.030
		(0.021)
University experience, cumulative		-0.155***
		(0.058)
USNA experience, cumulative		-0.223***
		(0.061)
Office experience, cumulative		-0.019
		(0.016)
Year and spline effects	Yes	Yes
Observations	36741	36741
Log Likelihood	-2036.098	-1941.916

Log-hazard coefficients; negative coefficients imply a lower likelihood of exit

Table 5: Exponential Survival Model: 1924–1940

	(1)	(2)	(3)	(4)
Ln Real Wages	-2.257***	-1.881***	-3.053***	-3.220***
	(0.570)	(0.405)	(0.780)	(0.787)
Engineering coursework, top third	-0.035	0.011	-0.098	-0.094
	(0.070)	(0.071)	(0.101)	(0.101)
Engineering coursework, bottom third	0.007	0.007	0.025	0.021
	(0.060)	(0.084)	(0.081)	(0.081)
Navy-specific coursework, top third	-0.042	-0.167	0.013	0.006
	(0.065)	(0.133)	(0.072)	(0.074)
Navy-specific coursework, bottom third	0.086	-0.121	0.199**	0.203**
	(0.064)	(0.080)	(0.081)	(0.081)
General coursework, top third	0.026	0.259**	-0.042	-0.042
	(0.076)	(0.119)	(0.097)	(0.094)
General coursework, bottom third	0.231*	0.221**	0.125	0.103
	(0.132)	(0.095)	(0.176)	(0.170)
Non-cognitive coursework, top third	-0.139***	-0.165*	-0.114	-0.121*
	(0.050)	(0.088)	(0.070)	(0.070)
Non-cognitive coursework, bottom third	0.027	0.012	0.039	0.027
	(0.056)	(0.074)	(0.078)	(0.079)
Eligible for Retirement	3.478***	1.448***	4.157***	4.257***
	(0.669)	(0.406)	(0.864)	(0.893)
Engineer	0.384**	0.449	0.565**	0.572**
	(0.162)	(0.314)	(0.249)	(0.267)
Construction Corps	-0.348*	0.075	-0.543**	-0.568
	(0.183)	(0.264)	(0.229)	(1.002)
Aero experience, cumulative	-0.017	-0.055	-0.009	-0.002
	(0.024)	(0.073)	(0.021)	(0.022)
Submarine experience, cumulative	-0.011	-0.045	-0.023	-0.023
	(0.018)	(0.056)	(0.016)	(0.016)
Carrier experience, cumulative	-0.012	-0.386	-0.000	0.001
	(0.041)	(0.298)	(0.040)	(0.040)
Other ship experience, cumulative	-0.016	-0.035	-0.023	-0.019
	(0.022)	(0.063)	(0.025)	(0.025)
Leadership experience, cumulative	-0.060***	-0.073	-0.057***	-0.055***
	(0.017)	(0.060)	(0.017)	(0.017)
University experience, cumulative	-0.071***	-0.026	-0.067**	-0.067***
	(0.023)	(0.063)	(0.026)	(0.026)
USNA experience, cumulative	-0.042***	-0.085*	-0.034**	-0.036**
	(0.015)	(0.051)	(0.015)	(0.015)
Office experience, cumulative	0.020	-0.019	0.036**	0.039**
	(0.016)	(0.033)	(0.016)	(0.016)
Sick leave, cumulative	0.356	0.388	-0.032	0.026
	(0.406)	(0.356)	(0.175)	(0.178)
Engineering human capital				-0.069
				(0.064)
General human capital				0.197***
				(0.061)
Firm-specific human capital				-0.124*
				(0.068)
Year and spline effects	Yes	Yes	Yes	Yes
Observations	76970	22533	54437	53283
Log Likelihood	-4057.085	-1778.905	-2009.216	-1945.042

Log-hazard coefficients; negative coefficients imply a lower likelihood of exit

Table 6: Exponential Survival Model: 1988–2018

Ln Real Wages	-1.488***	-1.486***	-1.486***
	(0.015)	(0.015)	(0.015)
Navy-specific coursework, top third	-0.181***	-0.154***	-0.149***
	(0.039)	(0.039)	(0.039)
Navy-specific coursework, bottom third	0.099***	0.059	0.053
	(0.037)	(0.038)	(0.038)
General coursework, top third	0.036	0.021	-0.018
	(0.038)	(0.038)	(0.039)
General coursework, bottom third	-0.130***	-0.128***	-0.077*
	(0.038)	(0.039)	(0.040)
Ship experience, cumulative	0.002***	0.001	0.001
	(0.001)	(0.001)	(0.001)
Aero experience, cumulative	-0.002***	0.001	0.001
	(0.000)	(0.000)	(0.000)
Submarine experience, cumulative	-0.001	0.000	-0.000
	(0.001)	(0.001)	(0.001)
Carrier experience, cumulative	-0.001	-0.002	-0.001
	(0.001)	(0.001)	(0.001)
Leadership experience, cumulative	-0.004***	-0.004***	-0.004***
	(0.001)	(0.001)	(0.001)
University experience, cumulative	-0.007***	-0.007***	-0.007***
	(0.001)	(0.001)	(0.001)
USNA experience, cumulative	-0.010***	-0.012***	-0.012***
	(0.001)	(0.001)	(0.001)
Office experience, cumulative	0.006***	0.005***	0.005***
	(0.001)	(0.001)	(0.001)
Training experience, cumulative	0.001	0.001*	0.001*
	(0.001)	(0.001)	(0.001)
Patrol experience, cumulative	-0.000	-0.001	-0.001
	(0.001)	(0.001)	(0.001)
Reserve experience, cumulative	-0.004***	-0.005***	-0.005***
	(0.001)	(0.001)	(0.001)
Female			0.297***
			(0.042)
Minority			-0.142***
			(0.039)
Math/Science major			0.096**
			(0.038)
Hum/Soc Science major			0.205***
			(0.037)
Year and spline effects		Yes	Yes	Yes
Service selection included		No	Yes	Yes
SAT scores included		No	No	Yes
Observations		255387	255387	255387
Log Likelihood		-6021.796	-5918.528	-5866.127

Exponentiated coefficients; Standard errors in parentheses

Table 7: Exponential Survival Model: 1988–2004

Ln Real Wages	-1.192***	-1.191***	-1.187***
	(0.044)	(0.045)	(0.045)
Navy-specific coursework, top third	-0.230**	-0.204*	-0.186*
	(0.105)	(0.106)	(0.107)
Navy-specific coursework, bottom third	0.038	0.034	0.023
	(0.104)	(0.106)	(0.107)
General coursework, top third	0.168	0.172	0.184*
	(0.104)	(0.106)	(0.108)
General coursework, bottom third	-0.063	-0.031	-0.016
	(0.106)	(0.109)	(0.112)
Ship experience, cumulative	-0.006***	-0.007***	-0.005**
	(0.002)	(0.003)	(0.003)
Aero experience, cumulative	-0.016***	-0.016***	-0.016***
	(0.002)	(0.003)	(0.003)
Submarine experience, cumulative	0.005	0.008*	0.008*
	(0.004)	(0.004)	(0.004)
Carrier experience, cumulative	0.009	0.007	0.008
	(0.007)	(0.007)	(0.007)
Leadership experience, cumulative	-0.031***	-0.034***	-0.033***
	(0.004)	(0.004)	(0.004)
University experience, cumulative	-0.018***	-0.016***	-0.016***
	(0.005)	(0.005)	(0.005)
USNA experience, cumulative	0.028***	0.029***	0.029***
	(0.004)	(0.005)	(0.005)
Office experience, cumulative	0.034***	0.036***	0.036***
	(0.003)	(0.003)	(0.003)
Training experience, cumulative	0.016***	0.019***	0.019***
	(0.003)	(0.004)	(0.004)
Patrol experience, cumulative	0.005	0.005	0.005
	(0.003)	(0.003)	(0.003)
Reserve experience, cumulative	-0.035***	-0.043***	-0.041***
	(0.007)	(0.008)	(0.008)
Female			0.341***
			(0.110)
Minority			0.002
			(0.105)
Math/Science major			0.096
			(0.108)
Hum/Soc Science major			0.278***
			(0.102)
Year and spline effects		Yes	Yes	Yes
Service selection included		No	Yes	Yes
SAT scores included		No	No	Yes
Observations		71835	71835	71835
Log Likelihood		-1101.831	-1073.367	-1064.362

Exponentiated coefficients; Standard errors in parentheses

Table 8: Exponential Survival Model: 2001–2018

Ln Real Wages	-1.486***	-1.484***	-1.484***
	(0.015)	(0.015)	(0.015)
Navy-specific coursework, top third	-0.185***	-0.156***	-0.150***
	(0.039)	(0.039)	(0.039)
Navy-specific coursework, bottom third	0.101***	0.060	0.054
	(0.038)	(0.038)	(0.038)
General coursework, top third	0.034	0.020	-0.019
	(0.038)	(0.039)	(0.040)
General coursework, bottom third	-0.134***	-0.132***	-0.080**
	(0.038)	(0.039)	(0.040)
Ship experience, cumulative	0.002***	0.001	0.001
	(0.001)	(0.001)	(0.001)
Aero experience, cumulative	-0.002***	0.001	0.001
	(0.000)	(0.000)	(0.001)
Submarine experience, cumulative	-0.001	-0.000	-0.000
	(0.001)	(0.001)	(0.001)
Carrier experience, cumulative	-0.001	-0.002	-0.001
	(0.001)	(0.001)	(0.001)
Leadership experience, cumulative	-0.004***	-0.004***	-0.004***
	(0.001)	(0.001)	(0.001)
University experience, cumulative	-0.007***	-0.007***	-0.007***
	(0.001)	(0.001)	(0.001)
USNA experience, cumulative	-0.010***	-0.012***	-0.012***
	(0.001)	(0.001)	(0.001)
Office experience, cumulative	0.006***	0.005***	0.005***
	(0.001)	(0.001)	(0.001)
Training experience, cumulative	0.001	0.001*	0.001*
	(0.001)	(0.001)	(0.001)
Patrol experience, cumulative	-0.000	-0.001	-0.001
	(0.001)	(0.001)	(0.001)
Reserve experience, cumulative	-0.004***	-0.005***	-0.005***
	(0.001)	(0.001)	(0.001)
Female			0.304***
			(0.042)
Minority			-0.145***
			(0.039)
Math/Science major			0.099***
			(0.038)
Hum/Soc Science major			0.210***
			(0.037)
Year and spline effects		Yes	Yes	Yes
Service selection included		No	Yes	Yes
SAT scores included		No	No	Yes
Observations		217705	217705	217705
Log Likelihood		-5967.183	-5859.449	-5805.581

Exponentiated coefficients; Standard errors in parentheses

Table 9: Exponential Survival Model with GPA: 1988–2018

Ln Real Wages	-1.482***	-1.480***	-1.480***
	(0.015)	(0.015)	(0.015)
Final Semester Cumulative Academic QPR	0.205***	0.170***	0.077
	(0.043)	(0.046)	(0.050)
Final Semester Cumulative Military QPR	-0.427***	-0.323***	-0.297***
	(0.061)	(0.062)	(0.063)
Ship experience, cumulative	0.002***	0.001*	0.001*
	(0.001)	(0.001)	(0.001)
Aero experience, cumulative	-0.002***	0.001	0.001
	(0.000)	(0.000)	(0.000)
Submarine experience, cumulative	-0.001	0.000	-0.000
	(0.001)	(0.001)	(0.001)
Carrier experience, cumulative	-0.001	-0.001	-0.001
	(0.001)	(0.001)	(0.001)
Leadership experience, cumulative	-0.004***	-0.004***	-0.004***
	(0.001)	(0.001)	(0.001)
University experience, cumulative	-0.008***	-0.007***	-0.007***
	(0.001)	(0.001)	(0.001)
USNA experience, cumulative	-0.010***	-0.012***	-0.012***
	(0.001)	(0.001)	(0.001)
Office experience, cumulative	0.006***	0.005***	0.005***
	(0.001)	(0.001)	(0.001)
Training experience, cumulative	0.001	0.001	0.001*
	(0.001)	(0.001)	(0.001)
Patrol experience, cumulative	-0.000	-0.001	-0.001
	(0.001)	(0.001)	(0.001)
Reserve experience, cumulative	-0.004***	-0.005***	-0.005***
	(0.001)	(0.001)	(0.001)
Female			0.308***
			(0.042)
Minority			-0.151***
			(0.039)
Math/Science major			0.089**
			(0.038)
Hum/Soc Science major			0.200***
			(0.037)
Year and spline effects	Yes	Yes	Yes
Service selection included	No	Yes	Yes
SAT scores included	No	No	Yes
Observations	256116	256116	256116
Log Likelihood	-6070.320	-5970.554	-5917.081

Exponentiated coefficients; Standard errors in parentheses

Table 10: Revealed Returns to Human Capital, $-\frac{h_x}{h_w}$

	1860–1900	1901–1940	1988–2018
Panel A: Education			
general education			
rate of return	-	-	0.068**
(p-value)			(0.043)
firm-specific education			
rate of return	-	-	-
(p-value)			
Panel B: Experience			
shore office experience			
rate of return	-	0.008	0.0035***
(p-value)		(0.122)	(0.000)
engineering			
rate of return	-	0.114**	n/a
(p-value)		(0.038)	
general training			
rate of return	n/a	0.112***	n/a
(p-value)		(0.000)	
navy-specific training			
rate of return	n/a	-	n/a
(p-value)			

Use of coefficients from regressions not necessarily reported.
One-sided significance indicated as *** if $p \leq 0.01$, ** if $p \leq 0.05$ and * if $p \leq 0.10$.

11 Figures

Figure 1: Wage Exit Elasticities across Three Centuries

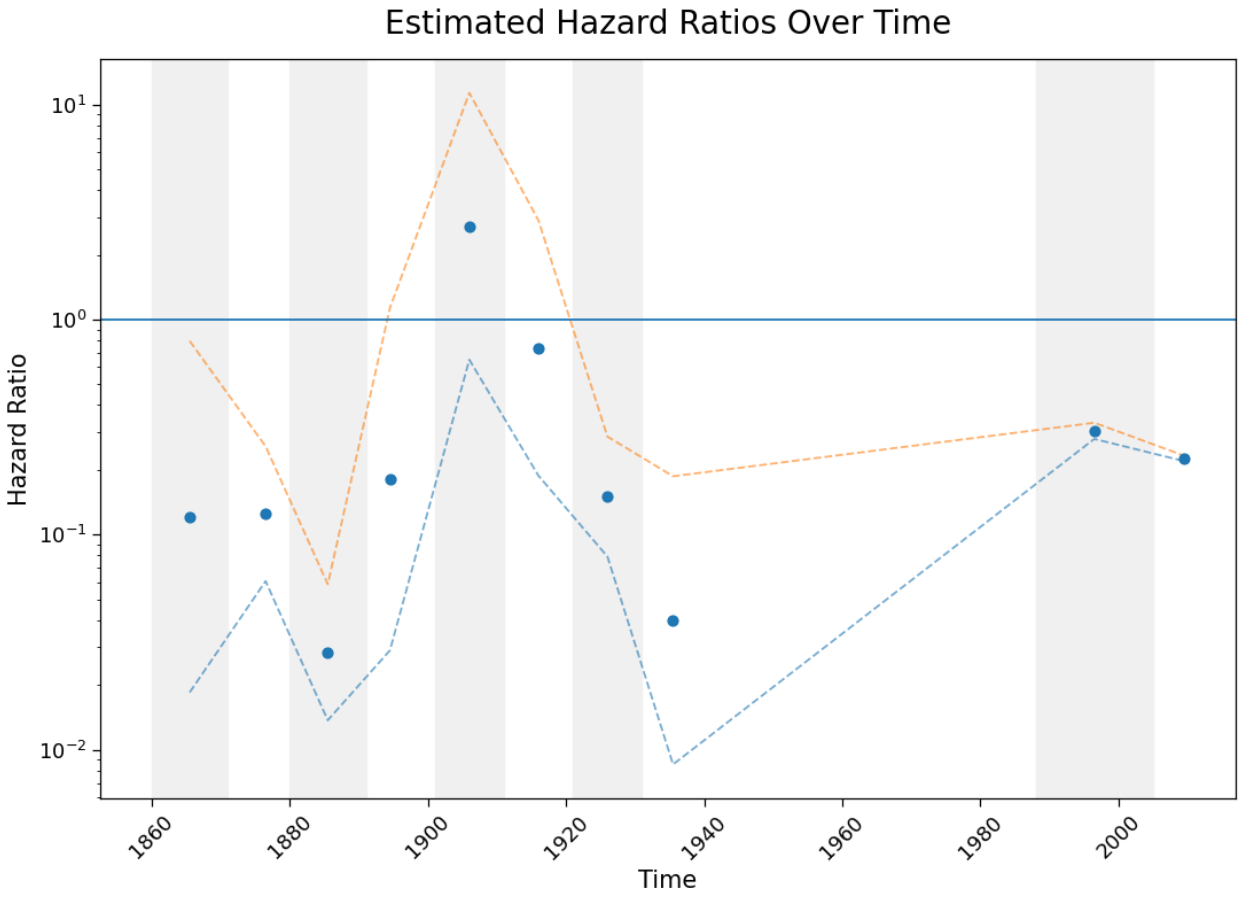
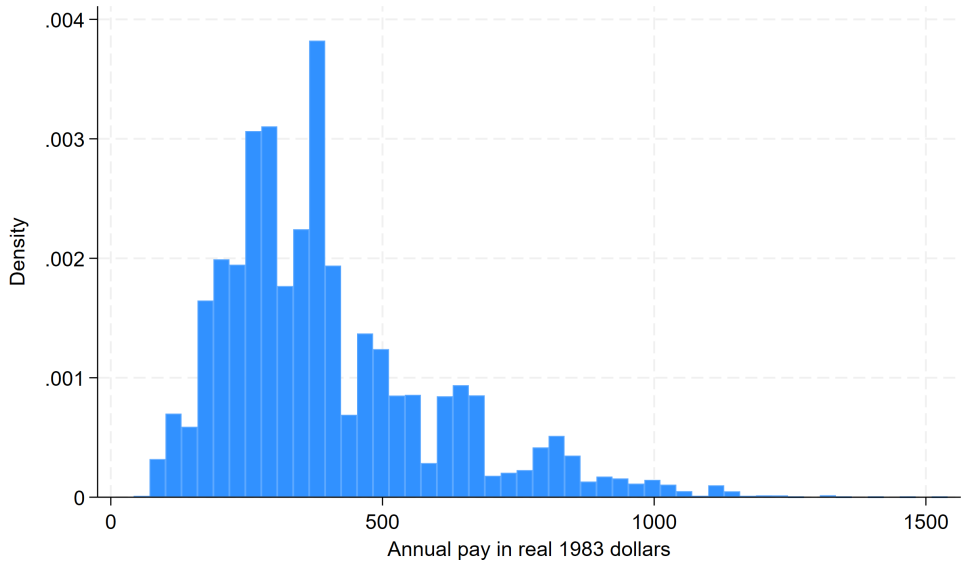


Figure 2: **Wage Distributions**

(a) 1860–1940



(b) 1988-2018

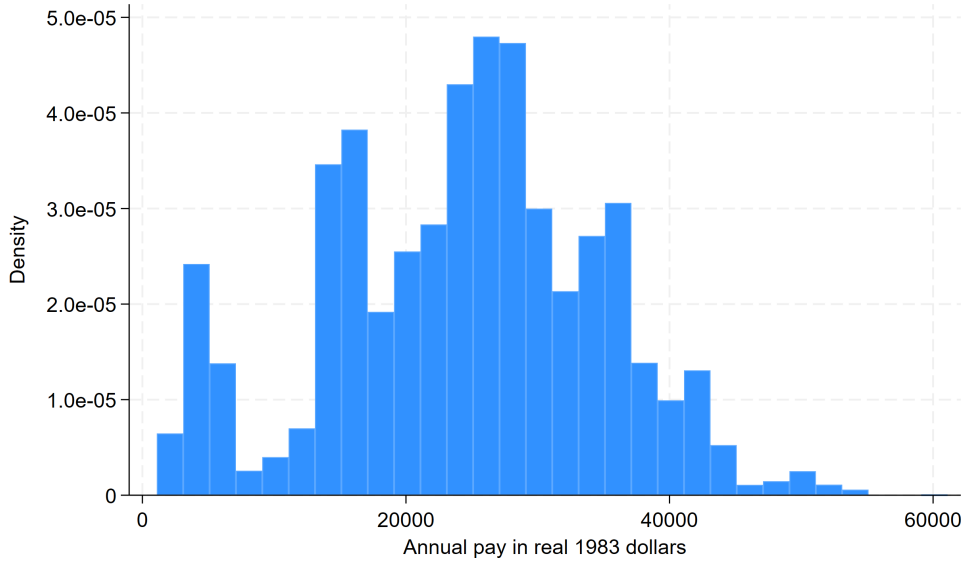
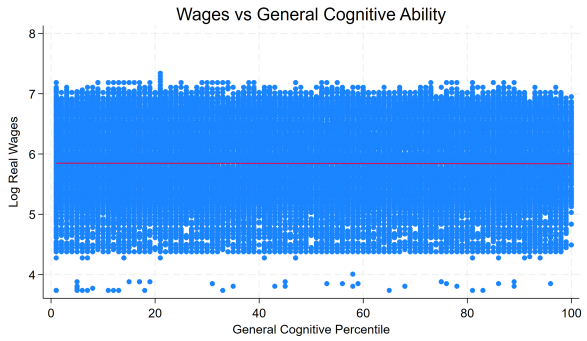
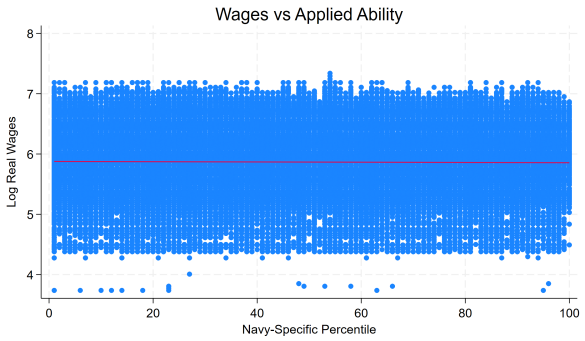


Figure 3: **Ability and Wages**

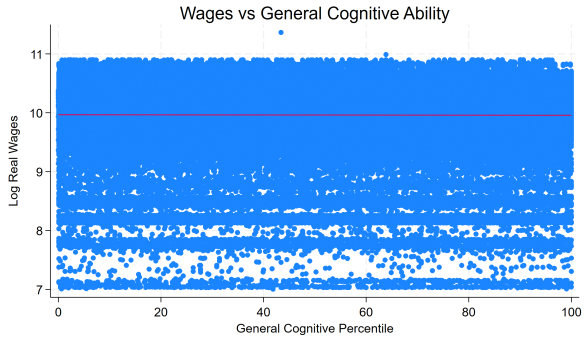
(a) 19th and 20th centuries: General cognitive ability



(b) 19th and 20th centuries: Naval cognitive ability



(c) 21st century: General cognitive ability



(d) 21st century: Naval cognitive ability

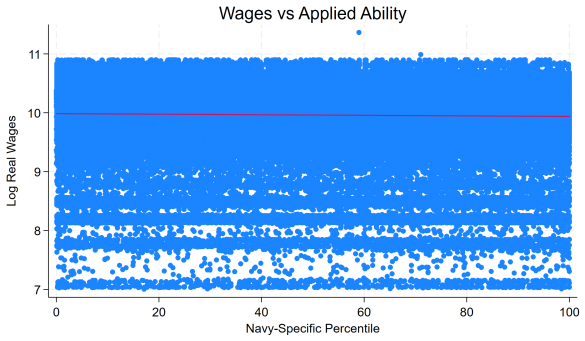


Figure 4: **Exit Distribution, 1860–1900**

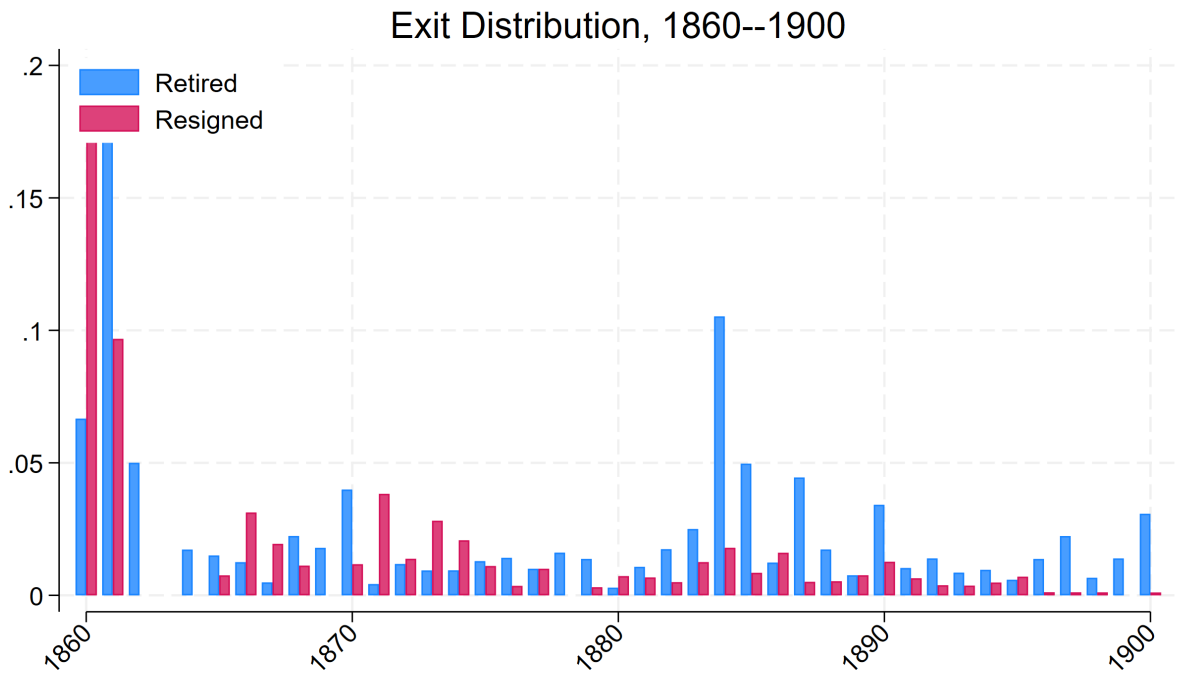


Figure 5: **Exit Distribution, 1901–1940**

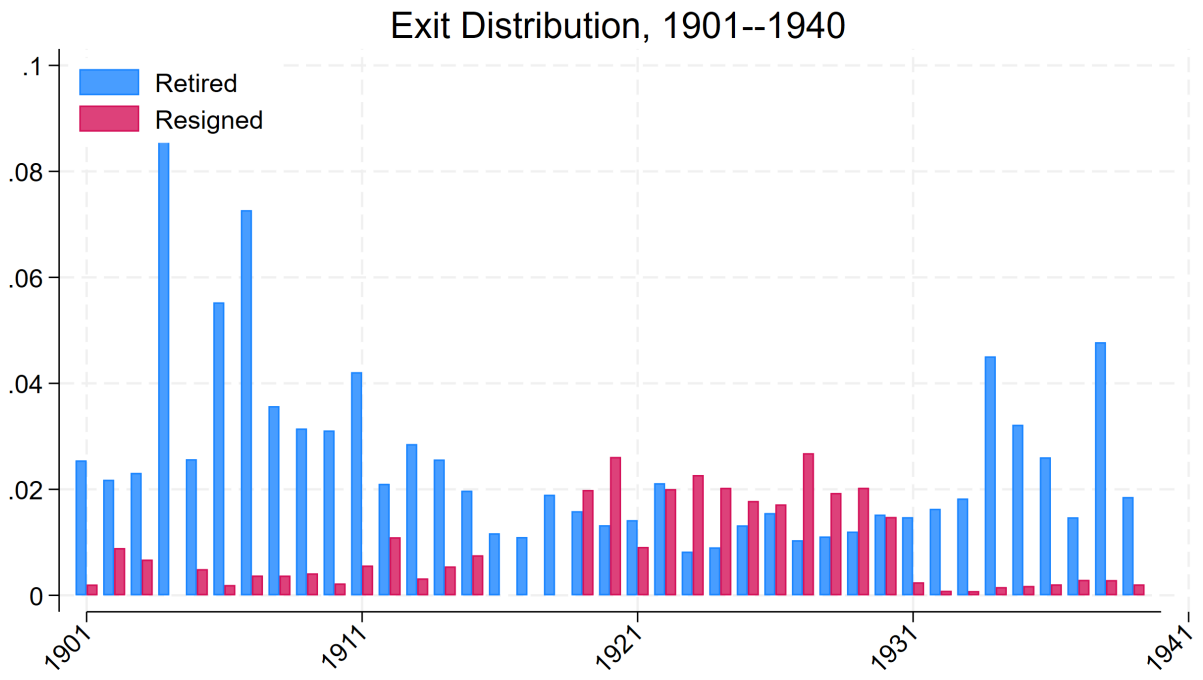


Figure 6: **Exit Distribution, Contemporary**

