Military Service and Skill Acquisition: Evidence from a Draft Lottery

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Millions of young people worldwide are subject to military conscription. While the effects of conscription on educational attainment have been widely studied, little is known about effects on skills. To estimate military service effects on skills, we use the Danish draft lottery and skills measures from the Program for the International Assessment of Adult Competencies. While service is associated with relatively poor skills, we find positive causal effects on numeracy and literacy measured 10 years after service. Service effects are largest for men with low scores in Armed Forces Qualification Tests, who are more likely to complete vocational training after service.

I. Introduction

Conscription takes place in the majority of the world's countries, most of which are not involved in armed conflict. Military service is often extensive, ranging from a few months to several years, and is unique in that it constitutes the only remaining example in modern societies of legal forced labor outside of the criminal justice system. Conscription also occurs during an important phase of young people's lives, when they make decisions about labor market entry and higher education.[1]

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[1] Although most countries draft only men, as of 2015 nine countries also draft women. For an overview of conscription gender, ages, and length of military service worldwide, see the

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Several studies find that conscription affects postsecondary investments in human capital when enrollment in an educational institution can help potential draftees avoid the draft. In Germany, the introduction of conscription in 1995 increased the likelihood of young men completing higher education (Bauer et al. 2014). In the United States, education deferment has also provided a strong incentive for remaining in school to avoid the draft during the Vietnam War era (Card and Lemieux 2001). In contrast, after the 1997 abolition of compulsory conscription in France, the incentive to stay in education became weaker (Maurin and Xenogiani 2007). Similarly, in Turkey, the eligibility to buy an exemption from (otherwise) compulsory military service in 1999 reduced schooling attainment (Torun and Tumen 2016). Moreover, military service may also disrupt studies and impact educational attainment, as in Italy, where an exemption from the draft in some earthquake-damaged regions raised high school graduation rates (Cipollone and Rosolia 2007). Nonetheless, although these studies examine conscription and the reduced-form impact of draft eligibility, they do not focus on the effects of military service itself.[2]

While many studies have investigated the effect of military service on earnings (e.g., Angrist, Chen, and Song 2011), and earnings responses are consistent with changes in civilian labor market experience and educational attainment (Angrist and Chen 2011), they do not explicitly consider skills as a mechanism for service effects.[3] Eynde (2016) is one of the few studies investigating the role of military service on skill acquisition. Using data from World War I in colonial Punjab, he shows the effect of military enrollment on literacy, measuring literacy from population censuses and proxying military participation by war casualties according to soldiers' districts of origin. He finds that greater war casualties—and therefore greater military recruitment—are associated with increased literacy at the district level.[4]

Our paper is the first to estimate the effect of peacetime military service on skill acquisition and the first to use microdata linking service directly to skills. To estimate the effect of peacetime military service on skills, we use data from the Danish draft. In Denmark, men turning 18 years old must participate in an Armed Forces Day (AFD) military recruitment event,

Central Intelligence Agency World Factbook (https://www.cia.gov/library/publications/the-world-factbook/fields/333.html). Given the predominance of male conscription, this paper focuses only on men.

[2] Subsidies to veteran education are another more direct way of increasing educational attainment (Angrist 1993; Bound and Turner 2002; Angrist and Chen 2011).

[3] Grenet, Hart, and Roberts (2011) analyze the abolition of British military service after World War II and find no effects on earnings during a period of few civilian educational opportunities.

[4] Lee (2012) and Costa and Kahn (2009) discuss occupational mobility and the determinants of group loyalty, respectively, in the context of the American Civil War. Jha and Wilkinson (2012) discuss the determinants of ethnic cleansing by using regional variation in combat exposure in South Asia during World War II, suggesting a role for the organizational skills learned from combat.

during which they undergo a variety of tests. Men who are assessed fit for military service are randomly assigned to serve. We exploit this random assignment to credibly estimate the causal effect of peacetime military service on skills.[5]

For our analysis, we use administrative registers of the Danish population. We observe baseline (before service) measures of cognitive ability at age 18 from the military conscription board. We also use data from a large-scale skills study, the Program for the International Assessment of Adult Competencies (PIAAC). This survey includes measures of cognitive skills in three domains: numeracy, literacy, and problem-solving in technology-rich environments (OECD 2013; Rosdahl et al. 2013). For the PIAAC sample, we also have access to a subsample of persons born in 1984 and interviewed in the Organization for Economic Cooperation and Development (OECD) Program for International Student Assessment (PISA) in 2000. For this subsample, we observe scores in math and reading tests taken at age 15–16. We focus on men born between 1974 and 1990 and merge military records with their measured skills. The administrative registers allow us to observe a rich set of background variables for both these men and their parents.

We find that while peacetime military service has a negative association with skills, it has a positive causal effect on skills: men who serve because they are drafted but who otherwise would not have volunteered have higher literacy and numeracy scores. Using the subsample of data in which we can control for baseline PISA scores, we find that PIAAC numeracy and literacy gains for those forced to serve are robust to these additional controls. Allowing the service effect to vary across the Danish Armed Forces Qualification Test (AFQT) score distribution, we find that our literacy and numeracy results are driven by men with baseline AFQT scores in the middle and lowest terciles. Because our study includes men serving at different times during a 20-year period before the skills assessment, we can split the sample by time elapsed since potential service. We find that service effects on skills first become significant starting from 10 years after having served. The delay in observing significant service effects on skills suggests that service has important indirect effects on subsequent skill acquisition. We find that service increases enrollment and completion of vocational training at the expense of reduced enrollment in higher education, especially for men with mid to low AFQT scores.

Our findings have three important implications for the literature on human capital formation. First, while conscription may disrupt schooling, military service has positive effects on numeracy and literacy, effects that

[5] During the potential service period that we consider (1992–2010), the Danish military was involved in both peacekeeping and peace-enforcing operations in Afghanistan, the Balkans, and Iraq. While conscripts were not required to serve abroad, 4% of our sample volunteer to do so. Throughout the paper, we refer to this period as peacetime to distinguish it from, e.g., conscription during the Vietnam War era and to place our study alongside others in which conscription does not entail a high probability of military combat.

dominate formal schooling effects in these domains. Second, an important mechanism through which military service improves numeracy and literacy skills is through changes in educational careers, with men with mid to low AFQT scores in particular more likely to take vocational training, not higher education, because of military service. Third, that men with low AFQT scores benefit the most from service through improved literacy and numeracy suggests that raising AFQT score thresholds for service will deny these men an important learning opportunity.

The paper proceeds as follows. Section II explains the organization of military conscription in Denmark and the details of the draft lottery. Section III describes the data we use, and section IV presents our empirical approach. Section V presents our results, and section VI concludes.

II. Military Conscription in Denmark

Upon turning age 18, all men have to attend an AFD.[6] About 200 AFDs are held throughout each year, with 40–50 men assessed during 5 or 6 hours at one of the six regional military recruitment centers.[7] Men found to be fit for service are randomly assigned to military service through a lottery held at the end of the AFD.

A. Conscription Procedure

Figure 1 describes the conscription procedure for 1974–90 birth cohorts. Before attending the AFD, all prospective draftees submit a health questionnaire for use as background information for the fitness assessment. Reasons for ineligibility are serious somatic or psychiatric disorders, which need to be certified by a consulting physician at a regional public hospital (Hageman, Pinborg, and Andersen 2008). Men with medical documentation for such problems (14% of a cohort) are immediately excluded, and they do not have to attend the AFD.

The rest of the cohort attend an AFD and undergo both medical examination and psychological evaluations and complete an AFQT. This assessment forms the basis for further selection. About 30% of men attending the AFD are declared ineligible (25% of a cohort) because of low AFQT scores, high or low body mass index, or certain medical conditions (the top three are attention deficit hyperactivity disorder, musculoskeletal disorders, and asthma). Thus, 71% of those participating at an AFD (61% of each cohort) are declared fit for military service and assigned a future date at which they may be required to serve (service begins every 6 months). A deferment for completion of education before service is allowed up

[6] Since 2004, women have been invited to participate in the AFD but not in the lottery (no mandatory draft), and few women volunteered to serve during our sample period. We therefore include only men in our analysis.

[7] AFDs take place in birth order sequence within recruitment districts.

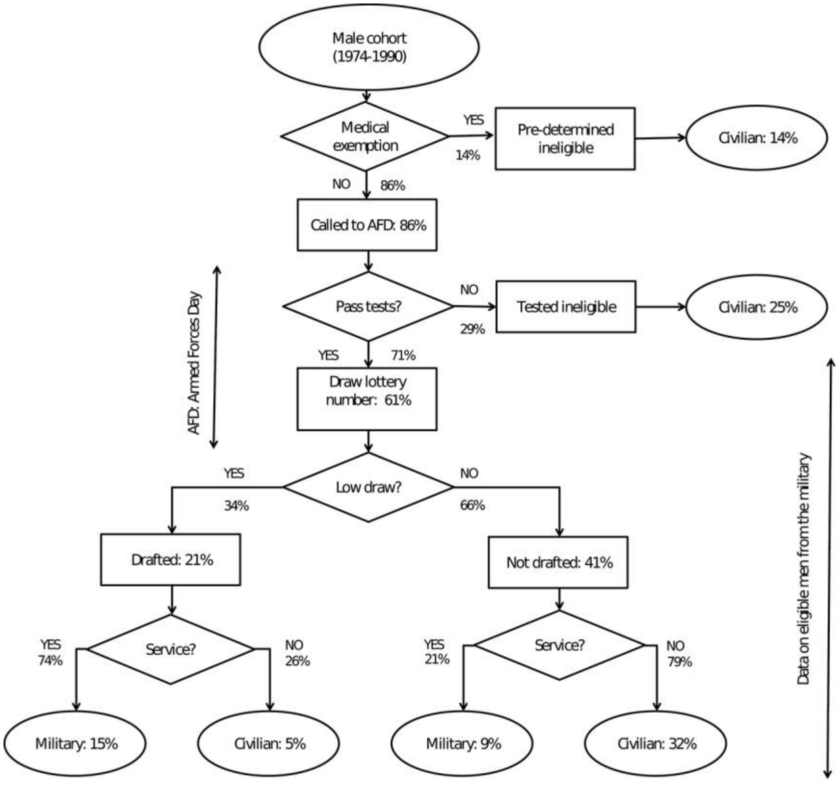

Figure 1.—Flow chart of conscription process. Numbers inside the shapes denote average percentages of our birth cohorts 1974–90. Numbers beside the arrows denote average percentages for taking each route conditional on reaching the junction. The AFD includes test taking and drawing lottery numbers. Our estimation data set contains information on all those who attended the AFD and drew a lottery number.

to age 25.[8] Finally, all fit-for-service men must draw a lottery number from a drum.

We consider cohorts born between 1974 and 1990, for which the military service had an average length of about 8 months. From 2006, the length of military service was reduced to an average of 4 months (14% of our sample).

B. *Lottery Draws and Service Probability*

Regardless of the draft lottery, any man declared fit for service at the AFD can volunteer and then serve from his preassigned service date. Twice a year, the Ministry of Defense announces a lottery number threshold below which men assessed fit for service during the previous half-year are assigned to serve. Importantly, deferment has no effect on the probability of being

[8] In exceptional circumstances, service start can be delayed to age 31. See Article 25 (par. 2), Law of Military Service.

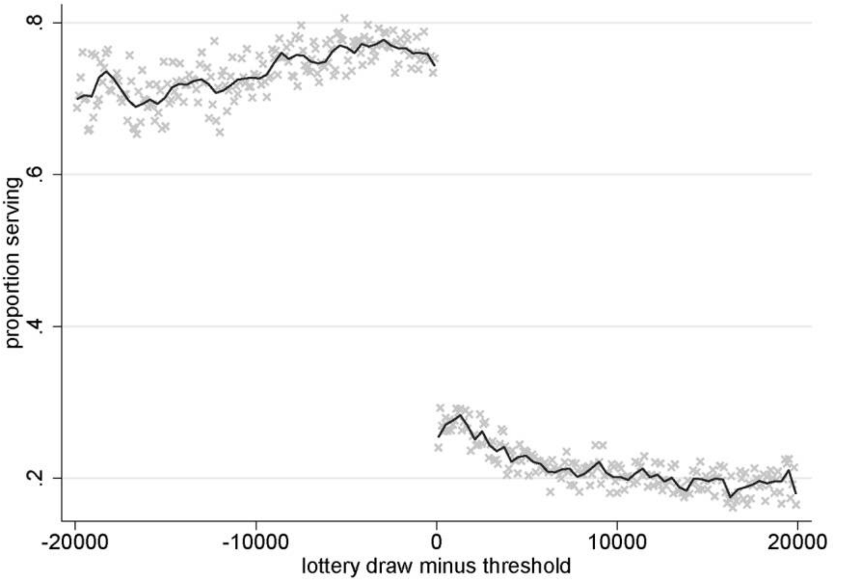

Figure 2.—Service probability by lottery draw for all fit-for-service men in birth cohorts 1974–90. X's indicate proportions serving among bins containing 100 consecutive lottery draws. The lines are kernel-weighted local polynomials estimated on the bin proportions each side of the threshold.

drafted.[9] Thresholds depend on the needs of the military and the number of volunteers by potential service dates. We refer to men drawing a lottery number below the threshold as drafted, regardless of whether they served or whether they volunteered.

A third party (TDC Holding) generates the lottery numbers, which range from 1 to 36,000. The men participating in the AFD know both the lottery thresholds for the preceding few years and the variation of the threshold.[10] Figure 2 shows the relationship between service probability and proximity to the lottery threshold. Those below the threshold (drafted) are much more likely to serve than those above the threshold. Figure 2 shows that the service probability increases around the threshold either from above or below, even though the actual threshold itself is announced only after volunteering is complete. Thus, the increase in volunteering around the threshold likely results from the desire to reduce future uncertainty among men who have drawn a low number.

Of a full male cohort, 39% are unfit for service, 37% are judged fit for service but do not serve, and 24% serve in the military. Within a cohort, 21% are

[9] In contrast to some other countries, educational deferment cannot be considered draft avoidance behavior in Denmark, because the men can postpone only the start of service: they still must serve before age 32. In our sample, 99.6% had completed their military service before turning age 25.

[10] In our data, the correlation in the threshold from one enlistment period to the next is −0.38.

TABLE 1
Draft Status, Service Status, and Complier Types

	Served = 0	Served = 1
Drafted = 0	Never-takers and compliers	Always-takers and defiers
Drafted = 1	Never-takers and defiers	Always-takers and compliers

Note.—Fit-for-service men are grouped into four different complier types, each corresponding to two combinations of draft and service status. Always-takers serve and may or may not be drafted. Never-takers do not serve and may or may not be drafted. Compliers serve if drafted and do not serve if not drafted. Defiers do not serve if drafted and serve if not drafted.

drafted, with 15% who actually serve and 5% who do not (2% are conscientious objectors,[11] 1% later suffer health problems, 0.5% have a criminal record,[12] and 0.5% are either fined or imprisoned under the draft law). Among fit-for-service men, in table 1 we distinguish several groups according to their response to draft assignment, in the terminology of Imbens and Rubin (1997): compliers, whose service status is changed by their draft assignment; always-takers, who will always serve regardless of draft assignment; never-takers, who will never serve regardless of draft assignment; and defiers, who will always do the opposite of what they are assigned to.

Table 2 shows draft and service status for fit-for-service men in our cohorts and for fit-for-service men who are also in the PIAAC survey. While we observe 14% of fit-for-service men volunteering for the military (they serve but were not drafted), we are unable to observe those who would have volunteered had they not been drafted. Assuming that no individuals are defiers, we can infer that 18% of fit-for-service men serve because they were drafted but that they otherwise would not have volunteered.[13]

For males born between 1974 and 1990 (including those not fit for service), the service rate in Denmark was 24%. For comparison, this rate ranges from 4% to 26% in the US Vietnam era (Angrist 1990) and was 40% in the Netherlands (Hubers and Webbink 2015).[14] Although we find some variation in compliance rates across the different subpopulations (not shown), the variation in Denmark is much smaller than between whites and nonwhites in the United States.

[11] Conscientious objectors are assigned to work for their local municipality in hospitals, libraries, care facilities for children or the elderly, and so on. This civil service is of a similar duration, and the rate of pay is the same as for military service.

[12] For practical purposes, criminal background checks are not run before the AFD.

[13] From cols. 1–3 of table 2, we can see that, assuming no defiers, 21.2% (38,553/181,770 × 100) of fit-for-service men are always-takers, and 25.8% (24,021/92,978 × 100) are never-takers. Therefore, 53.0% (100% − 21.2% − 25.8%) are compliers, 35.1% (66.2% of 53.0%) are compliers who do not serve, and 17.9% (33.8% of 53%) are compliers who serve. Of a full cohort, 10.9% (61% of 17.9%) of men serve because they were drafted. Alternatively, we can see from fig. 1 that 21% of fit-for-service men are always-takers, and 74% are always-takers or compliers. Therefore, 53% (74–21) of fit-for-service men are compliers. Of a full cohort, because 21% are drafted, 11% (53% of 21%) of men are compliers who serve.

[14] While rates of compliance with the draft are much higher in Denmark (74%) than in the US Vietnam era (23%), US rates are percentages of everyone with a selected date of birth and thus do not account for ineligibility (Angrist and Chen 2011). In Denmark, only those fit for service participate in the draft lottery.

TABLE 2
Observations by Draft and Service Status for Fit-for-Service and Fit-for-Service PIAAC Samples

	Fit for Service			Fit-for-Service PIAAC		
	Served = 0 (1)	Served = 1 (2)	Total (3)	Served = 0 (4)	Served = 1 (5)	Total (6)
Drafted = 0	143,217	38,553	181,770	533	116	649
	(52.1)	(14.0)	(66.2)	(55.5)	(12.1)	(67.5)
Drafted = 1	24,021	68,957	92,978	91	221	312
	(8.7)	(25.1)	(33.8)	(9.5)	(23.0)	(32.5)
Total	167,238	107,510	274,748	624	337	961
	(60.9)	(39.1)	(100.0)	(64.9)	(35.1)	(100.0)

Note.—Data are observations with cell percentages in parentheses. Columns 1–3 are men born between 1974 and 1990 who are Danish citizens, resident in Denmark on January 1 of the year they turn age 18, and fit for service with valid administrative covariates used in col 3. of table 6 (extended 2 specification). Columns 4–6 are these fit-for-service men who were also surveyed in PIAAC with valid literacy and numeracy scores.

C. Military Service Training

While assignment to military service per se is random, assignment to a particular branch of the military can reflect preferences of individuals, subject to the personnel needs of the military. For our cohorts, 82% of men serve in the army, 7% in the navy, 5% in the air force, and the remainder in civil defense and fire and rescue services.

Military training skills are generally wide and varied, not only focused on combat. The military basic training program provides conscripts with initial military skills, the common elements of which are discipline, physical training, and, for some, leadership skills. Conscripts are introduced to peace-supporting operations and civil society–supporting activities. They also acquire certain skills that will enable them to support the emergency services, for example, first aid or firefighting. The training also includes weapons handling, marksmanship, and combat activities, and it varies within both the branch (army, navy, air force) and the corps function (e.g., infantry, tanks, engineering, artillery).[15]

III. Data

We consider the population of men born between 1974 and 1990 who are Danish citizens and resident in Denmark on January 1 of the year they turn age 18. We use administrative records from the Ministry of Defense on fit-for-service men. Our data include AFQT scores, height, lottery number, the AFD half-year, and the potential starting half-year for their military service.[16] Since 1957, about 1.5 million men took the Danish AFQT,

[15] For a brief description of military service in Denmark, see https://www.forsvaret.dk/en.

[16] Military service status is not recorded for all members of earlier cohorts. Albæk et al. (2017) digitize records for the 1964 birth cohort from one recruitment district and use general employment records to infer whether the person has worked for the military.

a cognitive test called the Børg Prien Prøve, developed for Danish Armed Forces recruitment.[17] The test comprises 78 items, with an even balance of logical (matrices), verbal (analogies), numerical (series), and spatial (geometry) reasoning. Tests are time limited, items are not multiple choice, and the total test score is the sum of correct items, together measuring fluid intelligence rather than acquired knowledge.[18]

We combine administrative records from the Ministry of Defense with data from PIAAC. The Danish PIAAC survey is a representative sample of people aged 16–65 years interviewed between September 2011 and April 2012. The OECD developed the PIAAC survey to measure key cognitive and workplace skills that individuals need for job advancement and societal participation. The survey includes an assessment of cognitive skills in three domains: numeracy, literacy, and problem-solving in technology-rich environments (hereafter, problem-solving).[19] Literacy is broadly understood as individuals' ability to understand, evaluate, use, and engage with written texts to participate in society, achieve their goals, and develop their knowledge and potential. Numeracy is broadly defined as individuals' ability to access, use, interpret, and communicate mathematical information and ideas in order to engage in and manage the mathematical demands of a range of situations in adult life. Problem-solving is defined as individuals' ability to use digital technology and communication tools and networks to acquire and evaluate information, communicate with others, and perform practical tasks.[20] Mean numeracy, literacy and problem-solving scores for Denmark are close to the OECD mean: slightly below average for literacy and above average for numeracy (fig. A.1, available online; OECD 2013).

In addition to the representative sampling of individuals aged 16–65 years, a core sampling common to PIAAC countries, Denmark oversampled three groups: immigrants, individuals aged 55–65, and PISA 2000 respondents. For international comparability, all OECD statistics use the

[17] See Teasdale (2009) for psychometric properties of the Børg Prien Prøve and a review of its applications. Mortensen, Reinisch, and Teasdale (1989) show that the Børg Prien Prøve is correlated 0.82 with the Wechsler Adult Intelligence Scale.

[18] Men with AFQT scores below a certain percentile are deemed unfit for service, but otherwise scores are not used in assignment. The educational background of potential recruits is known to the assessors, and AFQT scores that appear inconsistent with educational attainment may be re-evaluated at another AFD. For recent cohorts, Bingley, Lundborg, and Lyk-Jensen (2020) validate AFQT scores with scores obtained in mandatory tests taken at the end of compulsory school (ninth grade) and show that AFQT scores are a good measure of intelligence, not undermined by strategic test taking. Given the requirements of the military, our sample of men is somewhat positively selected in terms of academic performance.

[19] These three skill domains are described in more detail in OECD (2013).

[20] Problem-solving was not measured among (1) respondents with no computer experience according to information from the questionnaire, (2) persons with computer experience who (in the interview situation) opted out of the computer-based assessment and were therefore directed to the paper-based assessment, and (3) persons who started the computer-based assessment but did not pass the computer exam and were therefore directed to the paper-based assessment. Categories 2 and 3 included a very clear majority of persons who did not answer the computer-based test.

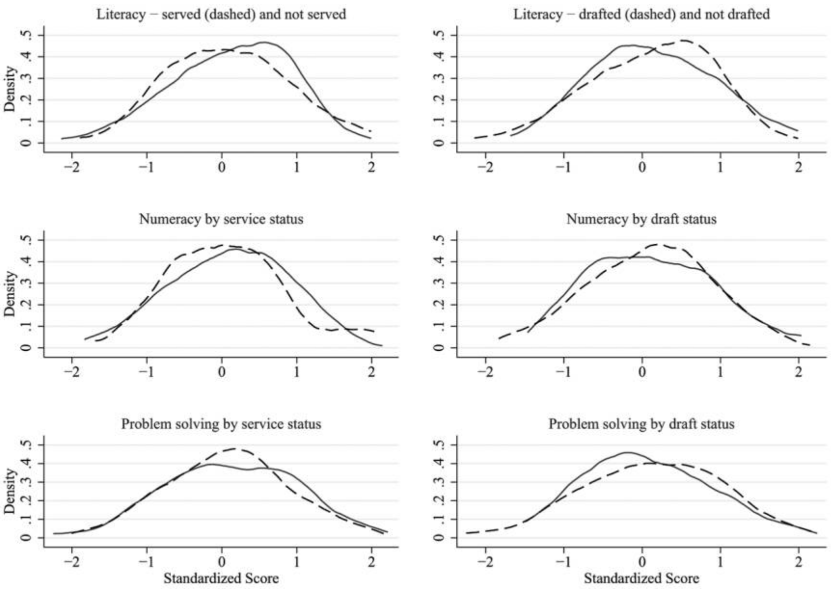

Figure 3.—Standardized PIAAC skill score densities by service status (*left*) and by draft status (*right*). The sample is men born between 1974 and 1990 who are fit for service and surveyed in PIAAC with valid administrative covariates and valid literacy, numeracy, or problem-solving scores. *Left*, dashed lines indicate served = 1, and solid lines indicate served = 0. *Right*, dashed lines indicate drafted = 1, and solid lines indicate drafted = 0.

core country-representative sample and two of the oversampled groups: immigrants and individuals aged 55–65. In PIAAC 2011–12, Denmark was the only country that oversampled participants in PISA. For our study, the PISA 2000 group is particularly useful, because we observe service status for the 1984 birth cohort.[21] In our analyses, we pool all PIAAC observations for men born between 1974 and 1990—those in the core sample and those in the PISA 2000 oversampled group. In the remainder of the paper, we call this pooled sample the PIAAC sample.

Figure 3 presents distributions of standardized skill measures for our sample. In the left panels, the densities are split by service status. Densities for those who served (dashed lines) are somewhat to the left of densities for those who did not serve (solid lines). In contrast, the right panels, split by draft status, show that those who were drafted (dashed lines) have densities somewhat to the right of densities for those who were not drafted (solid lines). While no obvious pattern emerges in the contrasts of distributions within each panel, and while the magnitude of the contrasts appears very similar, the differences between the left and right panels is

[21] Rosdahl (2014) describes this special subsample in the Danish PIAAC survey. The respondents are interviewed as 15–16-year-olds.

TABLE 3
Summary Statistics: Population, PIAAC, and Fit-for-Service Samples

	Population (1)	Fit for Service (2)	PIAAC (3)	PIAAC + Fit for Service (4)
Household income at age 15 (US$1,000)	28.7696	29.3397	29.2620	29.5712
	(14.4098)	(14.4892)	(14.6827)	(15.8171)
Mother with college education	.2305	.2524	.2785	.2882
	(.4211)	(.4344)	(.4484)	(.4532)
Father with college education	.2354	.2576	.2866	.3070
	(.4243)	(.4373)	(.4523)	(.4615)
Mother with high school education	.4348	.4444	.4424	.4370
	(.4957)	(.4969)	(.4968)	(.4963)
Father with high school education	.5007	.5045	.4878	.4807
	(.5000)	(.5000)	(.5000)	(.4999)
Standardized AFQT score		−.0000		.1741
		(1.0000)		(.9885)
Height (cm)		180.4769		180.4964
		(6.5852)		(6.3473)
Draft status = 1		.3384		.3247
Service status = 1		.3913		.3507
Literacy			.0072	.0841
			(.9147)	(.8369)
Numeracy			.0035	.0953
			(.9098)	(.8416)
Individuals			1,476	961
Problem-solving			.0130	.0629
			(.8956)	(.8520)
Individuals	446,530	274,748	1,430	944

Note.—Data are means with standard deviations in parentheses. The population covers men born between 1974 and 1990 who are Danish citizens and resident in Denmark on January 1 of the year they turn age 18. Column 2 describes members of this population with a valid lottery number, service status, height, AFQT score, and potential service date. Column 3 describes men in the first population surveyed in PIAAC who also have valid literacy and numeracy scores. This PIAAC sample pools regular PIAAC observations with those that are oversampled for PISA-PIAAC. Column 4 describes men from the first population who are both fit for service and surveyed in PIAAC. Disposable household income at age 15 is equivalized according to the formula (sum of income in the household plus transfers minus taxes)/(1 × first adult + 0.7 × second adult + 0.5 × number of children) and deflated to 2018 prices by the consumer price index and converted to US$1,000 at the following exchange rate: 1 Danish kroner = US$0.147. AFQT score, height, and draft status are observed on the AFD. AFQT scores are standardized for the fit-for-service sample. Service status is observed in 1994–2010. Mother's and father's schooling are observed on January 1 of the year the son turns age 15. Literacy, numeracy, and problem-solving are standardized PIAAC proficiency values from each skill domain, standardized for the male population born between 1974 and 1990. Reported means pool all of the 10 plausible values from each domain. Standard deviations of proficiency values are adjusted for the imputation variance of the plausible values (see Khorramdel et al. 2020).

striking: those who served have skills slightly lower in the overall distribution than those who did not serve, while those who were drafted have skills slightly higher in the overall skills distribution than those who were not drafted.

TABLE 4
Summary Statistics by Draft and Service Status for Fit-for-Service PIAAC Sample

	Served			Drafted		
	Yes (1)	No (2)	Difference (3)	Yes (4)	No (5)	Difference (6)
Household income at age 15 (US$1,000)	29.5457	29.5849	.0392	28.7333	29.9739	1.2406
	(12.2585)	(17.4490)	(.9664)	(12.7649)	(17.0861)	(.9859)
Mother with college education	.2315	.3189	.0875**	.2436	.3097	.0661*
	(.4224)	(.4664)	(.0296)	(.4299)	(.4627)	(.0304)
Father with college education	.2938	.3141	.0203	.3077	.3066	−.0011
	(.4562)	(.4645)	(.0310)	(.4623)	(.4614)	(.0318)
Mother with high school education	.4570	.4263	−.0307	.4423	.4345	−.0078
	(.4989)	(.4949)	(.0336)	(.4975)	(.4961)	(.0342)
Father with high school education	.4748	.4840	.0092	.4744	.4838	.0095
	(.5001)	(.5001)	(.0338)	(.5001)	(.5001)	(.0345)
Standardized AFQT score	.1971	.1617	−.0354	.1159	.2020	.0861
	(1.068)	(.9790)	(.0674)	(1.194)	(.9728)	(.0692)
Height (cm)	180.7478	180.3606	−.3872	180.5192	180.4854	−.0339
	(6.5191)	(6.2536)	(.4345)	(6.4867)	(6.2842)	(.4424)
Draft status = 1	.6558	.1458	−.51***			
Service status = 1				.7083	.1787	−.52***
Literacy	.0331	.1117	.0786	.0924	.0801	−.0123
	(.8368)	(.8363)	(.0566)	(.8443)	(.8339)	(.0579)
Numeracy	.0506	.1195	.0688	.1195	.0837	−.0358
	(.8444)	(.8398)	(.0570)	(.8463)	(.8398)	(.0582)
Individuals	337	624	961	312	649	961
Problem-solving	−.0282	.1118	.1400*	.0383	.0747	.0364
	(.8548)	(.8472)	(.0582)	(.8599)	(.8486)	(.0595)
Individuals	330	614	944	307	637	944

Note.—Data are means with standard deviations in parentheses. The sample is men born between 1974 and 1990 who are fit for service and surveyed in PIAAC with valid administrative covariates and valid literacy, numeracy, or problem-solving scores. Variable definitions are the same as in table 3. Statistics are calculated by service status, draft status, and their differences. Standard deviations of proficiency values are adjusted for the imputation variance of the plausible values (see Khorramdel et al. 2020).
* $p < .10$.
** $p < .05$.
*** $p < .01$.

For several reasons, our sample may be unrepresentative of the population of men born between 1974 and 1990, because we consider only men who are fit for service (whereas PIAAC is representative of men in 2011) and because we oversample PISA 2000 respondents.[22] For

[22] PIAAC provides sample weights and replication weights so that analyses of the respondent sample can be made representative of the 2011 population. We do not use PIAAC sampling or replication weights in our analysis, as our inference does not need to be 2011 representative.

TABLE 5
Randomization Balance Check for Draft Assignment

	Basic (1)	Extended 1 (2)	Extended 2 (3)
Standardized AFQT score	−.0269	−.0260	−.0232
	(.0162)	(.0165)	(.0169)
Standardized AFQT score^2	.0187	.0180	.0184
	(.0122)	(.0124)	(.0124)
Height (cm)		−.0472	−.0375
		(.0954)	(.0952)
Height^2		.0001	.0001
		(.0003)	(.0003)
Number of brothers		.0101	.0080
		(.0234)	(.0237)
Number of sisters		.0474	.0445
		(.0246)	(.0248)
Number of half-siblings		.0024	.0028
		(.0186)	(.0187)
Mother married		.0145	.0144
		(.0363)	(.0368)
Living in urban area		−.0101	−.0070
		(.0334)	(.0338)
Living in rural area		−.0771	−.0762
		(.0422)	(.0425)
Birth weight lowest quartile			−.0805*
			(.0392)
Birth weight top quartile			−.0085
			(.0369)
Mother with college education			−.0732
			(.0433)
Father with college education			.0226
			(.0458)
Mother with high school education			−.0350
			(.0370)
Father with high school education			−.0144
			(.0398)
Household income at age 15 (US$1,000)			−.0003
			(.0010)
F-statistic	1.9344	1.2316	1.1631
F-statistic p-value	.1451	.2663	.2887
Partial R^2	.0041	.0132	.0211
Observations	961	961	961

Note.—The sample is men born between 1974 and 1990 who are fit for service and surveyed in PIAAC with valid administrative covariates and valid literacy and numeracy scores. The columns contain coefficients from different OLS regressions. The dependent variable is an indicator taking a value of 1 if the lottery draw was below the threshold and the individual was drafted and 0 otherwise. Brothers, sisters, and half-siblings are counts that are top coded at 2, 2, and 3. Urban (rural) indicates living in a municipality with the highest (lowest) third population density. Birth weight is measured by the midwife. These regressions also control for birth half-year and birth month. Standard errors are in parentheses.
* $p < .10$.

comparison with the general population, table 3 presents descriptive statistics for our fit-for-service sample and men born between 1974 and 1990. Within our fit-for-service sample, differences by service status are small, as shown in table 4.

Table 4 presents descriptive statistics for our PIAAC fit-for-service sample by draft status and service status. Demographic characteristics are generally very similar for the two splits of the data, with a few notable exceptions: men who did not serve or were not drafted have a higher proportion of mothers with a college degree, AFQT scores are highest for men who served or were not drafted, and literacy and numeracy are highest among men who did not serve. Nevertheless, none of these pairwise differences are statistically significant.

As the tests from the AFD take place before the lottery, we can use them together with other preassignment variables to assess whether the lottery randomization is balanced. Table 5 shows coefficients explaining draft assignment by the lottery from three separate ordinary least squares (OLS) regressions. We also control for half-year of birth and month of birth because the draft lottery threshold changes each 6 months. As expected, conditional on these controls, covariates do not predict assignment status, confirming that the lottery is a balanced random assignment.

IV. Method

To measure the effect of military service on subsequent skills, s = {literacy, numeracy, problem-solving}, we estimate the following equation:

$$y_{is} = \pi_{0s} + \pi_{1s} Military_i + \pi_{2s} X_i + v_{is},$$

where y_{is} is the skill s of individual i, *Military* is an indicator of participating in military service, and X is a set of control variables. However, an OLS estimate of π_{1s} would be biased by individual service decisions (either volunteering to serve or not serving if drafted), thereby making military service status endogenous. To deal with this endogeneity problem, we exploit the draft lottery and instrument *Military* according to the following equation:

$$Military_i = \delta_0 + \delta_1 Lottery_i + \delta_2 X_i + \eta_i,$$

where $Lottery_i$ is an indicator variable for drawing a lottery number below the threshold and thus being assigned to military service. Our instrumental variable (IV) estimator provides a local average treatment effect (LATE), which reflects the effect of military service among the group of compliers—in our case, men who would serve if randomly assigned to do so but who would otherwise not have volunteered. The effect on draft compliers is of particular interest for measuring the effect of forced service.

V. Results

We begin our analyses by estimating relationships among draft status, service status, and skills, and we do so by pooling all individuals for whom we observe an extended set of covariates and a skill measure. We run robustness checks testing sensitivity of estimates to the exclusion of observations close to the draft lottery threshold and to the choice of instrument set. To examine two potentially important sources of heterogeneity, we split the sample by (baseline) AFQT scores and group the sample by time elapsed between military service and skills measurement. To investigate mechanisms for service effects on skills, we consider effects on subsequent education and training, and we examine the characteristics of individuals changing behavior because of the draft in a compliers analysis. In two extensions, we also control for baseline PISA test scores for the subsample in which we observe them, and we consider alternative soft skills (e.g., conscientiousness or trust) that the PIAAC survey also measures.

Table 6 presents regression coefficients for the relationships among draft status, service status, and skills. In panel A, we show coefficients for an indicator for service in separate OLS regressions that explain different skills. Estimates are very stable across specifications, showing that those serving have significantly lower skills than those who do not.

In panel B, we present our causal analysis and show reduced-form, or intention-to-treat (ITT), estimates of the effect of draft status on skills. Those who are drafted have better literacy and numeracy than those who are not drafted. OLS and reduced form estimates have opposite signs due to the selection into service, because the dependent variables in the two regressions differ for men who are drafted but do not serve and for men who serve without being drafted.

To estimate the LATE of serving, we need to relate the ITT estimate to the fraction of compliers—the sample proportion who will serve if drafted but not serve if not drafted. First-stage estimates of the effect of draft status on military service appear in panel C. Being drafted increases the probability of service by 55 percentage points, and *F*-statistics show that draft status is very important for explaining service status (Stock, Wright, and Yogo 2002).

Panel D shows IV estimates of the effect of service on skills. Military service improves literacy and numeracy but has no significant effect on problem-solving. Estimates are very stable across specifications, becoming slightly more precise as more covariates are included. IV estimates are of similar magnitude to OLS estimates but are of opposite sign. Military service increases numeracy and literacy by 7%–10% of a standard deviation.[23]

[23] To put the magnitude of these effects into perspective, we can see from other covariates in the regressions that a 1 standard deviation increase in AFQT scores is associated with 46%, 50%, and 47% of a standard deviation increase in literacy, numeracy, and problem-solving skills, respectively. Having a mother with a college degree rather than a high school diploma is associated with 14%, 10%, and 0% increases in these respective skills. Having a father with a college degree rather than a high school diploma is associated with 24%, 18%, and 14% increases in these respective skills.

A. Robustness

While estimates of service effects on skills, instrumenting with draft status, are stable across specifications, it might be the case that men drawing lottery numbers close to the draft threshold behave differently—figure 2 shows that men just above the threshold are more likely to serve—and this differential behavior might bias our estimates. To look for bias, we perform two robustness checks: excluding men close to the draft threshold and adding polynomials of lottery draws as excluded instruments.

In a first set of robustness checks in table A.12 (tables A.1–A.13 are available online), we run regressions using the same specifications in columns 3, 6, and 9 of table 6, excluding men with lottery draws that are in the closest 5%, 10%, and 20% to the draft threshold. First-stage estimates are stable, IV estimates of service effects on literacy are similar to those from the full sample, and IV estimates are somewhat smaller for numeracy than for the full sample; however, the estimates do not differ significantly between samples.

In a second set of robustness checks, we allow the excluded instrument to work differently according to the distance of the lottery draw from either side of the draft threshold. Specifically, in table A.13, using the same specifications as in columns 3, 6, and 9 of table 6 as excluded instruments together with draft status, we use polynomials of the difference between lottery draw and draft threshold for each side of the threshold. The IV estimates of service effects on skills are very stable across instrument sets. Moreover, while the F-statistic on excluded instruments falls as we use more instruments, the instruments are always relevant.

Taken together—that estimates do not significantly differ when excluding observations close to the lottery draft threshold and that estimates are stable when using polynomials of lottery draws as additional excluded instruments—these points suggest that our estimates are not biased by the service behavior close to the lottery threshold displayed in figure 2. For the remainder of the paper, we continue to use all lottery draws and to use draft status as our only excluded instrument.

B. Heterogeneity

To investigate possible heterogeneous effects of service, we split the sample into AFQT score terciles and group the sample by time elapsed between conscription and service. While we control for baseline AFQT scores in all specifications, the effects on skills may differ by baseline ability.

Table 7 presents IV estimates of the relationship between service status and skills split by AFQT score tercile. Estimates show that military service effects on literacy gains are driven entirely by men in the lowest tercile of AFQT scores, with an increase of 16% of a standard deviation. Numeracy gains are driven by men in the middle and lowest terciles, with increases of 24% and 22% of a standard deviation, respectively. Effects on problem-solving

TABLE 6
Draft Status, Military Service Status, and Skills

	Literacy			Numeracy			Problem-Solving		
	Basic Controls (1)	Extended Controls 1 (2)	Extended Controls 2 (3)	Basic Controls (4)	Extended Controls 1 (5)	Extended Controls 2 (6)	Basic Controls (7)	Extended Controls 1 (8)	Extended Controls 2 (9)
	A. OLS Regressions: Outcome Skills								
Service status = 1	−.0981***	−.0960**	−.0719***	−.0944***	−.0954***	−.0778***	−.147***	−.148***	−.139***
	(.0196)	(.0178)	(.0180)	(.0187)	(.0166)	(.0166)	(.0202)	(.0178)	(.0179)
Adjusted R^2	.314	.324	.353	.341	.346	.363	.287	.300	.308
	B. Reduced-Form Regressions: Outcome Skills								
Draft status = 1	.0406*	.0455**	.0554***	.0488***	.0489***	.0566***	.00588	.00950	.0165
	(.0218)	(.0192)	(.0198)	(.0185)	(.0156)	(.0173)	(.0216)	(.0187)	(.0174)
Adjusted R^2	.312	.322	.353	.339	.345	.363	.281	.295	.304

	C. First-Stage Regressions: Outcome Service Status = 1								
Draft status = 1	.550***	.550***	.549***	.550***	.550***	.549***	.550***	.550***	.549***
	(.0304)	(.0307)	(.0307)	(.0304)	(.0307)	(.0307)	(.0304)	(.0307)	(.0307)
Adjusted R^2	.294	.296	.303	.294	.296	.303	.294	.296	.303
F-statistic on excluded instruments	317	310	307	317	310	307	321	314	312
Mean of dependent variable	.351	.351	.351	.351	.351	.351	.351	.351	.351
	D. Second-Stage IV Regressions: Outcome Skills								
Service status = 1	.0738*	.0826**	.101***	.0888***	.0889***	.103***	.0106	.0171	.0298
	(.0397)	(.0344)	(.0368)	(.0338)	(.0290)	(.0318)	(.0396)	(.0337)	(.0315)
Mean of dependent variable	.0841	.0841	.0841	.0953	.0953	.0953	.0629	.0629	.0629
Individuals	961	961	961	961	961	961	944	944	944

Note.—The sample is men born between 1974 and 1990 who are fit for service and surveyed in PIAAC with valid administrative covariates and valid literacy, numeracy, or problem-solving scores. Each cell contains the coefficient of interest from different regressions. The dependent variables in panels A, B, and D are standardized PIAAC proficiency values from each skill domain. Reported point estimates are means of estimates from regressions for each of the 10 plausible values from each domain. Standard errors in panels A, B, and D are adjusted for the imputation variance of the plausible values (Khorramdel et al. 2020). IV standard errors in panel D are further bootstrapped to account for generated regressors from the first stage. Columns differ according to the set of other explanatory variables included and which skills measure is considered. Columns 1, 4, and 7 use a basic specification including half-year of birth dummies, month of birth dummies, and a quadratic function of AFQT scores. Columns 2, 5, and 8 use an extended specification that also includes a quadratic function of height and controls for family composition (number of brothers, sisters, and half-siblings), mother marital status, household income at age 15, and dummies for urban or rural residence at age 15. Columns 3, 6, and 9 additionally include dummies for birth weight and mother and father levels of schooling. Standard errors are in parentheses. tF standard error adjustment is unnecessary, given our large F-statistics on excluded instruments (Lee et al. 2021).

* $p < .10$.
** $p < .05$.
*** $p < .01$.

TABLE 7

Military Service Status and Skills by AFQT Score

	AFQT Score Tercile								
	Literacy			Numeracy			Problem-Solving		
	Low (1)	Middle (2)	High (3)	Low (4)	Middle (5)	High (6)	Low (7)	Middle (8)	High (9)
Service status = 1	.156***	.0665	.0361	.235***	.218***	−.0216	−.0208	.0438	−.00309
	(.0595)	(.0770)	(.0537)	(.0520)	(.0806)	(.0539)	(.0621)	(.0846)	(.0613)
	[.0676]	[.0973]	[.0610]	[.0591]	[.1019]	[.0612]	[.0705]	[.1069]	[.0696]
F-statistic on excluded instruments	124	46	119	124	46	119	129	53	112
Mean of dependent variable	−.510	.124	.636	−.516	.145	.655	−.512	.108	.582
Individuals	320	320	321	320	320	321	311	317	316

Note.—The sample is men born between 1974 and 1990 who are fit for service and surveyed in PIAAC with valid administrative covariates and valid literacy, numeracy, or problem-solving scores. Each cell contains the coefficient of interest from different IV regressions. Point estimates are means of estimates from regressions for each of the 10 plausible values from each proficiency domain. Standard errors are adjusted for the imputation variance of the plausible values (Khorramdel et al. 2020) and are further bootstrapped to account for generated regressors from the first stage. The columns contain different dependent variable skill measures split by AFQT score terciles: low (cols. 1, 4, 7), medium (cols. 2, 5, 8), and high (cols. 3, 6, and 9). All columns include the extended specification as in cols. 3, 6, and 9 of table 6. Table A.10 presents associated OLS, reduced-form, and first-stage estimates. Standard errors are in parentheses. *tF* standard error adjustments are in square brackets (Lee et al. 2021)).

*** $p < .01$.

are insignificant across the AFQT score distribution. Thus, for men in the lowest tercile of AFQT scores, military service offsets 30% and 45% of their below-average numeracy and literacy skills, respectively.[24]

One important feature of our data is that while skills are measured in 2011, service can take place between 1992 and 2010. Thus, cohorts differ in the time elapsed since potential service date, with the first cohort measured 19 years after they may have served. This feature of the data allows us to estimate service effects on skills by time since potential service. Figure 4 shows how the effect of military service changes according to the time elapsed between potential service and PIAAC survey. While military service has a modest negative effect on skills measured 6 years after service, the effect becomes significantly positive from 9 years after service, especially for literacy and numeracy.[25]

While skills increase on average between ages 16 and 30, probably as a result of education and labor market experience, estimates presented in figure 4 control for birth cohorts with dummies and intercepts in order to identify the effect of service on skills by time elapsed since potential service. Nevertheless, because PIAAC skills are measured in 2011 and date of potential service corresponds so closely with date of the AFD following the eighteenth birthday, separating time since service from cohort trends is difficult. Furthermore, confidence intervals are tightest for the sample window centered 7–11 years after service, reflecting oversampling of the 1984 birth cohort, who were surveyed in PISA 2000. To relax these sampling restrictions, in section V.C we explore potential explanatory mechanisms by looking at educational outcomes measured over a range of calendar years and ages for all fit-for-service men born between 1974 and 1990.

While the nature of military service changed little during the 19-year period, the reduction in service length from 8 months to 4 months in 2006 affected 14% of the sample, all of whom have skills measured within 5 years of the potential service date. These more recent birth cohorts all have shorter service durations, which we include at the beginning of the estimation window in figure 4 (centered at 10 years elapsed since potential service date), possibly explaining the insignificant service effects shortly after the potential service date.[26]

[24] Bingley, Lundborg, and Lyk-Jensen (2020) find insignificantly positive effects of service on earnings for men with lowest-quartile AFQT scores, in contrast to significantly negative effects on earnings for men with AFQT scores above the median. This earnings gradient by AFQT scores is consistent with the skills gradient by AFQT scores that we find.

[25] Because date of potential service may be deferred for education and may be endogenous, we also estimated the effects of service on skills by time elapsed between AFD and the PIAAC survey (not shown). We find almost identical patterns but with time elapsed shifting by about a year, reflecting the typical delay between assessment and service. The similarity in effects by different ways of measuring time elapsed suggests that educational deferment does not bias service effects by time elapsed until skills are measured.

[26] In table A.3, we allow for differential service effects after 2006 to account for shorter potential service length. While first-stage estimates for the outcome service after 2006 (panel C2) show that our instruments are still relevant, the *F*-statistics on excluded instruments are much lower than for service overall. IV estimates of service interactions with

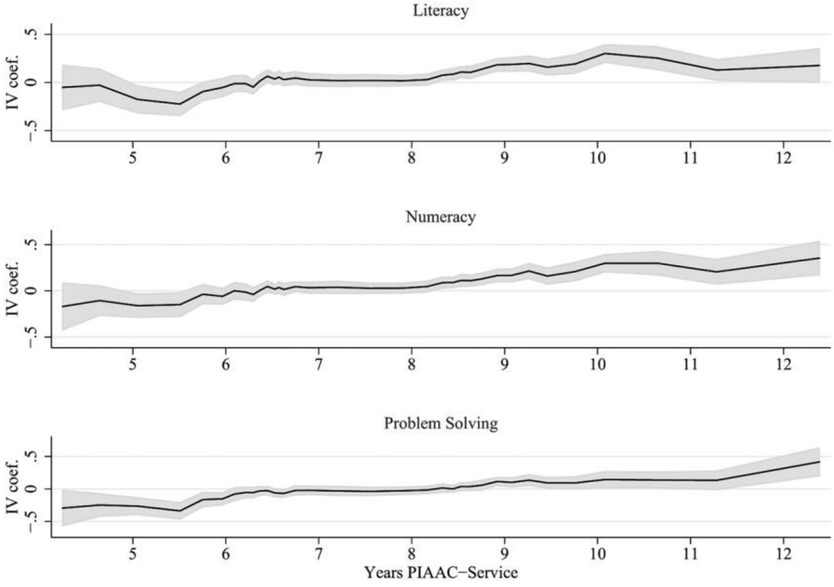

Figure 4.—IV estimates of effect of military service on skills by time elapsed since potential service. The lines in the figures connect point estimates based on subsamples of observations in an 8-year rolling window centered on the time elapsed stated on the horizontal axis. The sample and specifications are as in table 6 (cols. 3, 6, 9), here run separately for each 8-year window. Point estimates are means of estimates from regressions for each of the 10 plausible values from each domain. Shaded areas indicate 95% confidence intervals adjusted for the imputation variance of the plausible values (Khorramdel et al. 2020) and bootstrapped to account for generated regressors from the first stage.

Alternatively, the delayed service effects we observe might not be due to service itself but rather result from associated changes in education and career paths after having served, changes that only exhibit themselves long after service. In section V.C, we investigate the extent to which the effects of service on skills operate through changes in education and training.

C. *Mechanisms*

One potential mechanism for the delayed effects of military service may be via changes in subsequent type of education and career choices, which are caused by the experience of serving.[27] In this section, we show the effects of service on enrollment and completion of different types of education

post-2006 dummies are insignificant. These IV estimates on interactions are insignificant even without making a 0.05 *tF* adjustment (Lee et al. 2021). The average effect of service remains significant and of slightly smaller size than the estimates from table 6, but the differences in the average estimate between specifications are insignificant.

[27] Another potential mechanism for delayed military service effects on skills may be via disruption to education and delayed graduation. Bingley, Lundborg, and Lyk-Jensen (2020) show for the 1976–83 cohorts of Danish men that military service reduces educational attainment up to age 30.

(vocational training and higher education). To further investigate the timing of effects, we show how service effects on education and training vary by age. We also analyze how AFQT score gradients in skills effects correspond with differences in the completion of vocational training and higher education by AFQT scores. Finally, we conduct a compliers analysis of means and time trends in characteristics of those responding to draft assignment.

To investigate the mechanisms for military service effects, we expand our data set to include all fit-for-service men in birth cohorts 1974–90, as described in column 2 of table 3. After men serve in the military, typically at age 20, their education careers take either vocational or academic routes. Table 8 presents IV estimates of the effect of military service on subsequent choices among the four most popular broad educational routes: vocational training and academic education, split into short-, medium-, and long-cycle higher education.[28]

Panel A of table 8 shows enrollment, and panel B shows completion. While military service increases the probability of both enrollment and completion of vocational training, it reduces those probabilities for higher education. About half of men enroll in vocational training, and military service increases this probability by 2 percentage points (4% at the mean), whereas about 40% of men enroll in medium-cycle higher education, and military service decreases this probability by 4 percentage points (10% at the mean). While completion effects show a similar pattern, the proportions are somewhat smaller. We can infer service effects on dropping out of each route by the difference between completion and enrollment estimates: differences that are significant only for medium-cycle higher education, where service decreases the probability of dropping out by 1 percentage point (16% at the mean). To understand the effects of service on vocational training, we drill down to estimate separate effects on the most popular vocational programs (see table A.4), finding a great deal of heterogeneity between programs in terms of enrollment, dropout, and completion effects. For example, we find that service effects on electrician training cause 2% fewer men to enroll in training (38% at the mean) but increases completion by 22% at the mean.

Table 9 presents estimates of service effects on the probability of completing vocational training or higher education by AFQT score. As expected, the majority of men in the lowest tercile of AFQT scores complete vocational training, whereas the majority of men in the highest tercile complete higher education. Table 9 clearly shows that the effects in panel B of table 8

[28] Short-cycle higher education programs last 18–30 months, are taught in academies of professional higher education (erhvervsakademier), and combine theory with practical experience in fields such as laboratory technician and design professional. Medium-cycle higher education programs last 3–4 years, are taught in university colleges (professionshøjskoler), and are professionally oriented in fields such as social work and marketing. Long-cycle higher education programs last 3–6 years, are taught in universities, and span the humanities, engineering, law, natural sciences, social sciences, and health sciences.

TABLE 8
Higher Education and Vocational Training Enrollment and Completion

	Vocational Training (1)	Higher Education: Short Cycle (2)	Higher Education: Medium Cycle (3)	Higher Education: Long Cycle (4)
	A. Ever Enrolled			
Service status = 1	.0204***	−.0183***	−.0383***	−.0131***
	(.00377)	(.00264)	(.00368)	(.00308)
Mean of dependent variable	.524	.111	.412	.213
	B. Ever Completed			
Service status = 1	.0184***	−.0144***	−.0281***	−.0110***
	(.00377)	(.00249)	(.00362)	(.00296)
Mean of dependent variable	.456	.0977	.350	.183

Note.—The population covers men born between 1974 and 1990 who are Danish citizens and resident in Denmark on January 1 of the year they turn age 18 and are fit for service, as described in col. 2 of table 3. Each cell contains the coefficient of interest from different IV regressions. The dependent variable is a binary indicator taking a value of 1 if an individual is observed enrolled (panel A) or having completed (panel B) an education or vocational training during the years 1994–2018 and 0 otherwise. The set of covariates is the same as the extended 2 specification in col. 3 of table 6. For all regressions, the *F*-statistic on excluded instruments is 82,525 and the number of observations is 274,613. It is possible to enroll and complete more than one education during the period. Short-, medium-, and long-cycle higher educations are defined in n. 29. Standard errors are in parentheses.
*** $p < .01$.

are driven by men in the middle and lowest terciles of AFQT scores. Indeed, for the highest tercile, service does not significantly change the probability of higher education completion. While service increases completion of vocational training across the AFQT score distribution, twice as many men from the lowest tercile of AFQT scores complete vocational training compared with men from the highest tercile. These results are consistent with military service encouraging men with mid to low AFQT scores to take vocational training rather than higher education, and differential completion estimates suggest that these were better matches. AFQT score gradients in service effects for numeracy and literacy skills correspond with these service effects improving vocational and higher education matches more for men with mid to low AFQT scores.

Taken together, the education results from tables 8 and 9 show that military service causes a shift away from higher education and into vocational training and that these effects are driven by men in the middle and lowest terciles of AFQT scores. Training in numeracy and literacy skills differs between and within vocational and higher educations, and these differences could contribute to the effects of service on skills that we find in table 6. Because individuals with different abilities select into different educational careers, the effects of service on these paths might contribute to explaining the AFQT score gradients in skills effects that are evident in table 7. Military service may act as a career counselor by matching the

TABLE 9
Higher Education and Vocational Training Completion by AFQT Score Tercile

		Higher Education		
	Vocational Training (1)	Short Cycle (2)	Medium Cycle (3)	Long Cycle (4)
	A. Lowest-Tercile AFQT Score			
Service status = 1	.0161**	−.0165***	−.0339***	−.0140***
	(.00702)	(.00390)	(.00538)	(.00334)
F-statistic on excluded instruments	24,960	24,960	24,960	24,960
Mean of dependent variable	.601	.0714	.166	.0542
Observations	91,346	91,346	91,346	91,346
	B. Middle-Tercile AFQT Score			
Service status = 1	.0257***	−.0207***	−.0403***	−.0202***
	(.00669)	(.00462)	(.00652)	(.00507)
F-statistic on excluded instruments	27,511	27,511	27,511	27,511
Mean of dependent variable	.482	.114	.351	.161
Observations	91,565	91,565	91,565	91,565
	C. Highest-Tercile AFQT Score			
Service status = 1	.0134**	−.00484	−.00685	.000143
	(.00585)	(.00435)	(.00669)	(.00626)
F-statistic on excluded instruments	30,197	30,197	30,197	30,197
Mean of dependent variable	.287	.107	.533	.334
Observations	91,702	91,702	91,702	91,702

Note.—The population covers men born between 1974 and 1990 who are Danish citizens and resident in Denmark on January 1 of the year they turn age 18 and are fit for service, as described in col. 2 of table 3. Each cell contains the coefficient of interest from different IV regressions. The dependent variable is a binary indicator taking a value of 1 if an individual is observed having completed an education or vocational training during the years 1994–2018 and 0 otherwise. The set of covariates is the same as the extended 2 specification of col. 3 in table 6. The panels present estimates based on terciles of the AFQT score distribution. Short-, medium-, and long-cycle higher educations are defined in n. 29. Standard errors are in parentheses.
** $p < .05$.
*** $p < .01$.

aptitude of the recruits to type of education. While military service does not include any training directly related to our skills outcomes, it includes both theoretical and practical elements with supervision and mentoring. These elements are also present in vocational training, possibly explaining why men with low AFQT scores are more likely to choose vocational training after their military service (i.e., a better match for their preferences).

Having established that military service effects on skills are consistent with an educational career mechanism, we still need to determine why these effects take so many years to manifest. Part of the difference between estimates of the short-run and the long-run effects on education and training could be due to induced delays in graduation. Figure 5 presents estimates of service effects on completion of vocational training and higher education by age. Effects on vocational training completion are significantly positive at age 22 and again from age 27. Those completing their

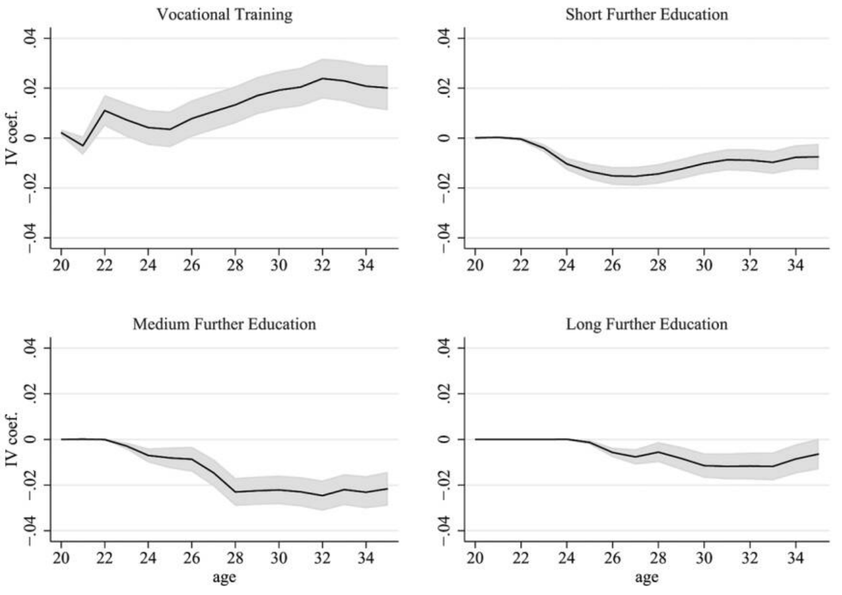

Figure 5.—IV estimates of effect of military service on completion of education and vocational training by age. The lines in the figures connect point estimates, and the shaded areas represent 95% confidence intervals for the coefficients of interest from different regressions. The dependent variable is a binary indicator taking a value of 1 if an individual is observed having completed an education or vocational training during the years 1994–2018 and 0 otherwise. The sample and specifications are as in table 8, here run separately for ages 20–35.

vocational training at age 22 would likely have interrupted their vocational training to serve, and service increases the probability of completion on returning to the civilian labor market. Increased completion from age 27 likely applies to those encouraged to start a vocational training after having served in the military and taking several years to complete. Service effects on reducing completion of short-, medium-, and long-cycle higher education first become significant at ages 23, 24, and 26, respectively. That vocational training completion effects first appear in the late twenties is consistent with a long lag in numeracy and literacy skills effects becoming significant after service.

A complementary way of understanding the mechanisms underlying the effects of service on skills is to describe the characteristics of individuals who are driving our IV results through a compliers analysis, in which we describe always-takers, compliers, and never-takers (see Imbens and Angrist 1994). Differences between OLS and IV estimates are due to selection, and describing differences in characteristics between complier groups helps explain this selection process. The idea is to describe the characteristics of those who are affected by the draft. Assuming that there are no defiers, we know that individuals who are drafted but do not serve are never-takers and that individuals who are not drafted but serve are always-takers. However, among men who do not serve when not drafted,

TABLE 10
COMPLIERS ANALYSIS: MEANS OF RESIDUALIZED CHARACTERISTICS BY COMPLIER TYPE

	Always-Takers (1)	Selection In (2)	Compliers Serving (3)	Compliers Not Serving (4)	Selection Out (5)	Never-Takers (6)
Standardized AFQT score	−.0142	−.0177	.0035	.0053	−.0116	−.0063
	(.0044)	(.0076)	(.0044)	(.004)	(.0093)	(.0057)
Household income at age 15 (US$1,000)	−.0051	−.0068	.0017	.0007	.0015	.0021
	(.0005)	(.001)	(.0006)	(.0005)	(.0012)	(.0007)
Mother with education lower than high school	.0101	.0052	.0049	−.0127	.0183	.0056
	(.0022)	(.0039)	(.0022)	(.002)	(.0044)	(.0027)
Mother with college education	−.023	−.0201	−.0028	.0107	−.0044	.0063
	(.002)	(.0033)	(.002)	(.002)	(.0044)	(.0026)
Father with education lower than high school	.0102	.0092	.001	−.011	.0168	.0058
	(.0018)	(.0033)	(.0021)	(.0019)	(.0044)	(.0027)
Father with college education	−.0207	−.0153	−.0053	.0093	−.0012	.008
	(.0019)	(.0036)	(.0022)	(.002)	(.0046)	(.0027)

Note.—Data are residualized weighted means of selected covariates used in the main analysis based on the population of men born between 1974 and 1990 who are Danish citizens and resident in Denmark on January 1 of the year they turn age 18 and are fit for service, as described in col. 2 of table 3. Covariates are first regressed on a set of half-year of birth dummies and month of birth dummies. We calculate weighted means of residuals from these regressions according to the formulas in Imbens and Rubin (1997), adapted to our context as described in app. B (apps. A–C are available online). IV estimates the difference between compliers serving (those who serve because of the draft but otherwise would not have served) and compliers not serving (those who do not serve because they were not drafted but otherwise would have served). OLS estimates include always-takers (together with serving compliers) and never-takers (together with compliers not serving) in the difference. The contrast between OLS and IV estimates is due to selection. Selection in (to service) is calculated as follows: col. 2 = col. 1 − col. 3. Selection out (of service) is calculated as follows: col. 5 = col. 6 − col. 4. Standard deviations based on 100 bootstrap replications are in parentheses.

we cannot distinguish between complier and never-taker individuals. Similarly, among men who serve when drafted, we cannot distinguish compliers from always-taker individuals. Nevertheless, we can describe the characteristics of compliers by calculating weighted averages of different groups. In table 10, we perform a compliers analysis on selected covariates one by one after conditioning on half-year of birth and month of birth.

By comparing columns 1, 3, 4, and 6 of table 10, we see that compliers have higher (residualized) AFQT scores. Otherwise, no characteristics show distinctive contrasts between compliers and noncompliers. That only modest differences exist between men driving our IV estimates and others who are fit for service enhances the generalizability of our findings.

The large differences between OLS and IV estimates in table 6 are due to selection effects, and we can explain this selection by extending our compliers analysis. Following Imbens and Rubin (1997), we describe the (residualized) characteristics of those selecting into service (the difference between always-takers and compliers who serve) and those selecting out of service (the difference between never-takers and compliers who do not serve). From column 2 of table 10, we can see that men selecting into service have lower (residualized) mean household income at age 15 and are less likely to have college-educated parents. These selection effects by family background characteristics are consistent with the OLS-IV contrasts of table 6, suggesting lower numeracy and literacy scores among sons selecting into service.

Thus far, our compliers analysis has pooled all cohorts 1974–90 and described residualized mean characteristics. In table A.5, we describe cohort trends in complier characteristics. While most trends are significant, no obvious differential trends appear between compliers and other fit-for-service men. Extending the complier trend analysis and estimating complier trend differences to look at selection trends, we find almost no covariates to be significant. The stability of the selection process over time supports the inference we draw from all years pooled in the main analysis.

D. Extensions

In two extensions to the analysis of mean effects, we consider additional baseline controls and alternative outcomes to the numeracy, literacy, and problem-solving skills thus far examined.

1. Controlling for PISA Test Scores

A unique feature of the Danish PIAAC study is the additional inclusion of those born in 1984 who took part in PISA 2000. This oversampling allows us to control for PISA scores in math and reading for a subsample of our PIAAC data. The domains tested in PISA math and PIAAC numeracy are different, as are the domains for PISA reading and PIAAC literacy. Nevertheless, the scores are highly correlated, therefore making ideal baseline controls for broad skills, in addition to controlling for baseline ability by using AFQT scores.

PISA 2000 surveyed 4,235 individuals born in 1984, 1,881 of whom also participated in PIAAC. From PISA, we observe 1,071 male Danish citizens who were resident in Denmark the year they turn age 18 and have valid reading and math scores. Of these 1,071, 517 were surveyed again in PIAAC, with valid numeracy and literacy scores; 691 were assessed as fit for service with valid military records, and 344 were both fit for service and surveyed again in PIAAC. Table A.8 presents descriptive statistics for the different subsamples leading to our PISA-PIAAC subsample of fit-for-service men. Demographic characteristics are very similar between samples. Compared with the cohort representative PISA sample, standardized PISA scores are 5% higher among those fit for service, 13%

higher for men also surveyed in PIAAC, and 14%–15% higher for men meeting both criteria. AFQT scores are standardized for all fit-for-service men: those in PISA are 4% above the mean, and men who are also in PIAAC are 16% above the mean. PIAAC scores are standardized for all men in our birth cohorts. Those also in PISA are 8%–9% above the mean, and men who are also fit for service and in PISA are 12%–13% above the mean. Thus, in terms of test scores, our PISA-PIAAC sample is clearly positively selected from the general population but only marginally more selected than our PIAAC sample without further PISA selection.

Because controlling for PISA scores reduces the sample size, checking whether the draft remains balanced on observed characteristics for this restricted sample is important. Using three specifications, as in table A.1, but now including PISA math and reading scores as covariates, table A.2 presents randomization balance tests for the PISA-PIAAC sample. While the PISA scores are unrelated to draft status, the quadratic term on the AFQT score now becomes significant. Nevertheless, *F*-statistics show that both extended specifications are overall balanced on observed characteristics.

TABLE 11
Military Service Status and Skills: Results for Fit-for-Service–PISA–PIAAC Sample

	Second-Stage IV Regressions: Outcome Skills					
	Literacy			Numeracy		
	Basic Controls (1)	Extended Controls 1 (2)	Extended Controls 2 (3)	Basic Controls (4)	Extended Controls 1 (5)	Extended Controls 2 (6)
Service status = 1	.0558***	.0626***	.0406*	.0902***	.111***	.0894***
	(.0213)	(.0216)	(.0217)	(.0242)	(.0212)	(.0209)
	[.0242]	[.0245]	[.0247]	[.0275]	[.0241]	[.0237]
Mean of dependent variable	.0850	.0850	.0850	.0762	.0762	.0762
Individuals	344	344	344	344	344	344

Note.—The sample includes men born in 1984 and surveyed in PISA 2000 with valid math and reading scores and who are Danish citizens and resident in Denmark on January 1 of the year they turn age 18. Furthermore, they must have a valid lottery number, service status, height, AFQT score, and potential service date. Additionally, they must be surveyed in PIAAC and have valid literacy and numeracy scores. Each cell contains the coefficient of interest from a different regression. The dependent variable is standardized PIAAC skills. Columns differ according to the set of other explanatory variables included and which skills measure is considered. Columns 1 and 4 use a basic specification including half-year of birth dummies, month of birth dummies, and quadratic function of AFQT and PISA standardized scores. Columns 2 and 5 use an extended specification that also includes quadratic function of height, controls for family composition (number of brothers, sisters, and half-siblings), mother marital status, household income at age 15, and dummies for urban or rural residence at age 15. Columns 3 and 6 additionally include dummies for birth weight and mother and father level of schooling. Standard errors are in parentheses. See table A.9 for associated OLS, reduced-form, and first-stage estimates. In the IV regression, we use all PIAAC and PISA plausible values of skill measures and baseline scores. IV standard errors are bootstrapped to account for generated regressors from the first stage. The 0.01 *tF* standard error adjustments are in square brackets (Lee et al. 2021).
* $p < .10$.
*** $p < .01$.

Table 11 presents IV regression coefficients for the relationships between service status and skills, similar to those presented in panel D of table 6 but additionally controlling for PISA math and reading in all specifications. Associated OLS, reduced-form, and first-stage estimates are presented in table A.9. We do not consider effects on problem-solving skills, because there is no related test conducted in PISA. OLS coefficients on service are negative and significant, and controlling for PISA scores somewhat reduces the absolute value of the coefficients for literacy and reduces them a great deal for numeracy. Reduced-form effects are similar regardless of PISA controls. IV estimates in table 11 are positive and significant. Literacy estimates are smaller when we include PISA controls, whereas numeracy estimates remain similar.[29]

Given that PISA scores are unrelated to draft assignment and the draft randomization is balanced for the subsample of men in both PISA and PIAAC, the draft lottery instrument remains valid when controlling for both PISA reading and math scores when we estimate the effects of service on PIAAC numeracy and literacy. Even after controlling for PISA scores, we find that while service is negatively associated with PIAAC skills, it still has a positive effect on PIAAC numeracy and literacy skills, thereby supporting our main analysis.

2. Soft Skills

We use PIAAC because it contains validated and internationally comparable measures of skills pertaining to numeracy, literacy, and problem-solving. Moreover, PIAAC contains measures of soft skills, such as openness, conscientiousness, and trust. These measures can put our skills findings in a broader context and thus help explain the mechanisms by which service affects our three hard skills measures. We select questions to construct soft skills potentially affected by military service—volunteer work, trust, and learning strategies that enable us to construct measures of the personality traits openness and conscientiousness.[30] Table 12 presents regression coefficients for the relationship between service status and soft skills.

Although OLS point estimates show positive associations between service and volunteer work and between service and conscientiousness, all associations between service and soft skills are insignificant. While IV point estimates of the effect of service on volunteer work, openness, and conscientiousness are positive, the point estimate of the effect on trust is negative, and all service effects on soft skills are insignificant. IV estimates of the

[29] When comparing table 6 with table 11, we have restricted the sample and changed the specification to include PISA math and reading baseline controls. In table A.6, we present estimates using the PISA-PIAAC sample but excluding math and reading controls, i.e., using the same specification as in table 6 but using the same sample as in table A.6. While effects on literacy become insignificant, effects on numeracy remain large and significant without PISA controls.

[30] These questions on soft skills are documented in OECD (2010, 103–6). Our full set of survey questions appears in app. C.

TABLE 12

Effect of Military Service on Selected Soft Skills from PIAAC Survey

	Volunteer Work			Learning Strategies: Openness			Learning Strategies: Conscientiousness			Trust		
	Basic Controls (1)	Extended Controls 1 (2)	Extended Controls 2 (3)	Basic Controls (4)	Extended Controls 1 (5)	Extended Controls 2 (6)	Basic Controls (7)	Extended Controls 1 (8)	Extended Controls 2 (9)	Basic Controls (10)	Extended Controls 1 (11)	Extended Controls 2 (12)
	A. OLS Regressions: Outcome Soft Skill											
Service status = 1	.0384	.0357	.0395	−.0574*	−.0562*	−.0510	.0212	.0196	.0232	−.00894	−.0103	.00422
	(.0340)	(.0342)	(.0342)	(.0330)	(.0330)	(.0332)	(.0330)	(.0333)	(.0335)	(.0300)	(.0300)	(.0299)
	B. Second-Stage IV Regressions: Outcome Soft Skills											
Service status = 1	.0154	.00840	.0148	.0179	.0173	.0226	.0699	.0662	.0613	−.0130	−.0139	−.00460
	(.0642)	(.0641)	(.0643)	(.0617)	(.0613)	(.0616)	(.0622)	(.0620)	(.0622)	(.0564)	(.0562)	(.0557)
F-statistic on excluded instruments	317	310	307	317	310	307	317	310	307	317	310	307
Mean of dependent variable	.475	.475	.475	.632	.632	.632	.629	.629	.629	.267	.267	.267
Individuals	961	961	961	961	961	961	961	961	961	961	961	961

Note.—The sample is men born between 1974 and 1990 who are fit for service and surveyed in PIAAC with valid administrative covariates and valid literacy, numeracy, or problem-solving scores. Each cell contains the coefficient of interest from a different regression. We construct binary dependent variables from ordered survey responses to questions about each soft skills domain. The dependent variable is a dummy for doing volunteer work (cols. 1–3), learning strategies related to openness (cols. 4–6), learning strategies related to conscientiousness (cols. 7–9), and trusting other people (cols. 10–12). See app. C for details about construction of the dependent variables. Columns differ according to the set of other explanatory variables included and which soft skills measure is considered. Columns 1, 4, 7, and 10 use a basic specification including half-year of birth dummies, month of birth dummies, and quadratic function of standardized AFQT. Columns 2, 5, 8, and 11 use an extended specification that also includes quadratic function of height, controls for family composition (number of brothers, sisters, and half-siblings), mother marital status, household income at age 15, and dummies for urban or rural residence at age 15. Columns 3, 6, 9, and 12 additionally include birth weight dummies and mother and father levels of schooling. Standard errors are in parentheses.

* $p < .10$.

relationship between service status and soft skills split by AFQT score tercile are largely insignificant and show no obvious patterns (see table A.11). Interestingly, the only significant effect is on conscientiousness for middle-tercile AFQT scores: the same tercile with the largest and most significant service effect on increasing vocational training completion in table 9.

VI. Conclusions

Military conscription is widespread, with many young people around the world performing months of service. While the effects of service on a variety of outcomes have been studied, little is known about what skills conscripts learn from service. We use the Danish draft lottery in combination with skills data from the PIAAC to estimate precisely what conscripts learn from service. Although military service is associated with reduced skills, we find a positive causal effect on skills—numeracy and literacy—measured 10 or more years after service for men forced to serve who otherwise would not have served. The positive service effect on literacy is largest for men with low AFQT scores, and the positive effect on numeracy is largest for men with mid to low AFQT scores.

Military service generally involves physical training, discipline, and learning to support both the emergency services and civil society in general, with no explicit numeracy and literacy training, and Danish service is unremarkable in these respects. In Denmark, military service typically takes place after high school at age 20 on average, similar to the age in many countries, but lasts on average only 4–8 months, a relatively short period. These features of military service—and the delay in observing significant service effects on skills—suggests that service has important indirect effects on subsequent skill acquisition. We find that service increases enrollment and completion of vocational training at the expense of enrollment in higher education, especially for men with mid to low AFQT scores.

Numeracy and literacy in Denmark are close to the OECD mean. While extrapolating from our findings to other countries is not advisable, our results show nothing clearly distinctive about Danish military service that may be driving our results. Indeed, the combination of random assignment to service with highly validated skills measures is what makes our study unique.

Much of the service effects literature has focused on educational attainment through schooling disruption or draft avoidance behavior. While ours is one of the few to look directly at skill acquisition effects, it is the first to do so for peacetime service and the first to do so by using microdata. That these numeracy and literacy skills are important for job advancement and societal participation speaks to the broader impact of military service, an impact that has not previously been quantified and that clearly deserves more attention. Our finding that literacy and numeracy gains are driven by men with low AFQT scores suggests that this group will lose out as recruitment standards are raised or conscription is abolished.

That the reintroduction of conscription is being debated in several countries, such as France, adds heightened importance to our findings.

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