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# Establishment size and task-specific wages: evidence from historical contract data

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## Abstract

This study examines whether task-specific jobs are rewarded differently across establishments of different sizes and whether these rewards vary across distinct technologies. We found that the aggregate premium estimates on the impact of size on wages conceal significant differences between tasks and technologies and that these differences reflect unobserved individual heterogeneity. The role of self-selection of more productive workers into larger establishments is particularly substantial in the case of abstract tasks.

Jel classification: J31

Keywords: Establishment size; wages; job tasks; technology; contract data

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## 1. Introduction

Moore's (1911) seminal study on the impact of firm size on wages indicates that the condition of the laborer improves in numerous ways as the size of the establishment increases. Since Moore's research, the firm-size wage effect has been detected in a number of countries with differing labor market institutions. As Oi and Idson (1999, p. 2207) conclude, this phenomenon has not changed a century later. According to their study, "a worker who holds a job in a large firm is paid a higher wage, receives more generous fringe benefits, gets more training, and is provided with a cleaner, safer, and generally more pleasant work environment." The wage differential between small and large establishments appears to be substantial and pervasive.<sup>1</sup>

The present study explores the firm size-wage relation using data from a period that predates the era of Moore's original study. Accordingly, the paper has both value and interest. The novelty of the study, however, builds on two general aspects. First, we connect the analysis to the contemporary debate regarding the polarizing impacts of technological changes on wages. The polarization theory categorizes jobs as routine or non-routine tasks and argues that technological advances lead to an increase in the demand for jobs, with non-routine tasks at the expense of jobs with routine tasks.<sup>2</sup> We follow this line of thought and ask whether similar argumentation applies to establishment size; i.e., are tasks at both ends of the wage distribution better rewarded in large firms than in small firms? Second, we investigate whether the impact of establishment size on task-specific wages is technology specific. Contract data from the maritime industry spanning the period 1860-1914 provide an ideal case for our purposes because the industry uses two distinct technologies: vessels that are powered by either sail or steam.

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<sup>1</sup> Barth and Dale-Olsen (2011) provide a brief account of recent literature. Of the most recent contributions, see also Cereira and Guimaraes (2012).

<sup>2</sup> The theory is also termed the routinization hypothesis (Autor, Levy and Murnane, 2003). Non-routine tasks are either abstract jobs (such as managerial jobs) at the top end of the wage distribution or manual jobs (such as services) at the bottom end of the wage distribution. Routine tasks (such as office jobs) are concentrated in the middle of the wage distribution.

## 2. Data and results

The data used in this study are compiled from the seamen's house recruitment records.<sup>3</sup> We utilize contract documents that were collected from six major port towns in Sweden and that span from the 1860s to the early 1910s. The sample consists of 49,550 labor contracts of 28,515 different individuals employed on 1,752 different vessels. Individual-level information includes the name, the date and place of birth, age, marital status, salary, occupation on board, and the date of hire. The name, tonnage, type, and likely destination of the vessel on which each sailor worked are also documented. The data comprise one of the earliest examples of matched employer-employee information.

We focus on five occupations that are labeled into the following three groups: high-skilled/high-wage mates and engineers engaging in abstract tasks, intermediate skilled/middle-wage able-bodied seamen performing routine tasks, and unskilled/low-wage ordinary seamen and engine room operatives fulfilling manual tasks. The duties of mates included managerial and supervisory tasks, responsibility for the cargo, keeping the logbook, navigational measurements and commanding the round-the-clock watches. Engineers were the key laborers on steam vessels. Their tasks included tending the machinery, ensuring that it was operating properly and undertaking repairs. Able-bodied seamen occupied routine tasks, such as handling the ropes to achieve the desired positions of the masts, spars and sails on sailing vessels. Ordinary seamen were sailors with limited amounts of experience who performed manual tasks. The engine room operatives consisted of the trimmers who carried the coal from the storage areas to the boiler areas and the firemen who shoveled coal into the boilers to generate steam.<sup>4</sup>

Simple descriptions from the data show that larger vessels pay higher wages (Data Appendix). In this study, we measure establishment size by the gross capacity of the vessel instead of the number of employees per vessel because the contract data do not provide an exact identifier for

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<sup>3</sup> The data were compiled by the Swedish National Archives in the late 1990s and published as a CD-Rom under the title "Arkion". For further information, see <http://www.arkion.ra.se/>.

<sup>4</sup> See, e.g., Chin et al. (2006) for more details on job tasks in the maritime industry.

vessels. For abstract tasks, the average wages rise steadily with the establishment size, from 57.9 kronas in the first quarter to 77.6 kronas in the fourth quarter, indicating an increase of 34 percent. For routine tasks, the pattern is moderate, and wages increase by 13 percent. For manual tasks, the size-wage profile is, in effect, flat with a small decline in the third quarter. The numbers also show that both the average age and the share of married mariners decrease with the vessel size. The age-vessel size profile is rather even, whereas the share of married mariners declines from 30 percent in the smallest vessels to 18 percent in the largest vessels. The relationship between technology and vessel size, in turn, is U-shaped. Steam-operated vessels are common amongst the largest vessels (30 percent of the total) and the smallest vessels (20 percent of the total).

Table 1 focuses on the average impact of establishment size on wages. The purpose of the analysis is to examine whether our measure of establishment size produces results that are comparable to earlier studies that quantify establishment size by the number of employees. The basic findings are indeed similar. The benchmark OLS estimate (column 1) without controls, excluding time dummies, implies a substantial but typical premium: a doubling of vessel size is related to an increase in wages of 6.7 percent. Controlling for workers' characteristics (age, age squared, marital status and home port) shrinks the estimate to 5.8 percent (column 2). The inclusion of a vessel's observable characteristics (the type of sail ship, steamship) halves the remaining effect to 3.4 percent (column 3). The estimate decreases further to 1.8 percent when the specifics of the labor contracts (destination, duration) are added into the model (column 4). The magnitudes are well in line with earlier findings and imply that observable heterogeneity is important and substantial: individual and vessel heterogeneity account altogether for approximately 50 percent of the premium. The role of contract characteristics is also important, accounting for approximately 25 percent.

Table 2 reports the estimates by job task and technology. The results suggest that only abstract tasks receive considerable premiums, with the OLS estimates measured at approximately 7 percent for both technologies. These preliminary findings are intuitively appealing. The tasks of mates may be more demanding in larger vessels than in small vessels, and thus the workers on these vessels are more highly compensated. Alternatively, premiums may reflect profit sharing related to the higher productivity of larger vessels. The estimates are smaller for routine and manual tasks and differ across technology: for vessels powered by sail, the premiums are 2-3 percent, whereas for those powered by steam, the premiums are effectively zero. Observed

technology differences may be caused by various factors. For example, monitoring costs or efficiency wage considerations may be more size-related for sail-operated vessels than for steam-operated vessels.

One obvious explanation for wage premiums, namely the selection of workers into differently sized vessels, is examined in this study using individual fixed effects (FE).<sup>5</sup> In particular, the results of Table 3 ease our assessment of the possible sources of size premiums for abstract tasks; that is, the premiums vanish when we account for unobserved individual heterogeneity. This finding applies to both technologies and suggests that larger vessels attract more productive individuals. The FE results for other task groups are alike, with the estimates statistically insignificant in all cases. Thus, our findings challenge the general view on the universal nature of employer-size wage premiums.

### 3. Conclusions

The study examines whether task-specific jobs are rewarded differently across establishments of different sizes and whether these rewards vary across distinct technologies. Our findings were as follows: (i) the capacity measure of establishment size produces results that are comparable to studies that quantify establishment size by the number of employees, (ii) aggregate OLS estimates conceal significant differences between tasks and technologies on the impact of establishment size on wages, (iii) differences in task- and technology-specific wage premiums reflect unobserved individual heterogeneity, and (iv) the role of self-selection of more productive workers toward larger vessels is particularly substantial in the case of abstract tasks.

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<sup>5</sup> The identification of the premium estimates is based on individuals with labor contracts for vessels of different size.

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Table 1 Vessel size and wages, OLS estimates

	(1)	(2)	(3)	(4)
<b>Log size</b>	0.067*** (0.003)	0.058*** (0.003)	0.034*** (0.003)	0.018*** (0.004)
<b>Worker characteristics</b>	-	yes	yes	yes
<b>Vessel characteristics</b>	-	-	yes	yes
<b>Contract characteristics</b>	-	-	-	yes
<b>R2</b>	0.051	0.476	0.502	0.504
<b>No of Obs.</b>	49 550	49 550	49 550	49 550

Standard errors are corrected for clustering at the individual level. Test for the equality of the impact of firm size on wages across specifications:  $\chi^2(3) = 11,58$  ( $p < 0.009$ )

Table 2 Vessel size and wages by job task and technology, OLS estimates

	(1)	(2)	(3)	(4)	(5)	(6)
	Abstract tasks		Routine tasks		Manual tasks	
	Sail	Steam	Sail	Steam	Sail	Steam
<b>Log size</b>	0.074*** (0.008)	0.069*** (0.012)	0.030*** (0.007)	-0.009 (0.010)	0.020*** (0.007)	-0.009 (0.006)
<b>Controls</b>	yes	yes	yes	yes	yes	yes
<b>R2</b>	0.201	0.254	0.090	0.360	0.185	0.379
<b>No of Obs.</b>	7 441	1 912	7 474	1 538	16 831	4 446

Standard errors are corrected for clustering at the individual level. Controls include all workers, vessels and contract characteristics. Test for the equality of the impact of firm size on wages across groups:  $\chi^2(5) = 157,53$  ( $p < 0.000$ )

Table 3 Vessel size and wages by job task and technology, FE estimates

	(1)	(2)	(3)	(4)	(5)	(6)
	Abstract tasks		Routine tasks		Manual tasks	
	Sail	Steam	Sail	Steam	Sail	Steam
<b>Log size</b>	0.001 (0.009)	0.022 (0.018)	-0.006 (0.010)	0.034 (0.028)	0.0016 (0.008)	0.014 (0.010)
<b>Controls</b>	yes	yes	yes	yes	yes	yes
<b>Fixed effects</b>	yes	yes	yes	yes	yes	yes
<b>R2(within)</b>	0.188	0.387	0.070	0.233	0.534	0.311
<b>No of Obs.</b>	7 441	1 912	7 474	1 538	16 831	4 446
<b>No of Groups</b>	3 861	1 185	4 852	1 245	11 655	3 712



## Data Appendix

The characteristics of labor contracts by vessel capacity, grouped into four quarters

<b>Vessel capacity</b>	<b>1. Qrt (91 tons)</b>	<b>2. Qrt (257 tons)</b>	<b>3. Qrt (374 tons)</b>	<b>4. Qrt (766 tons)</b>
<b>Abstract tasks</b>				
- wage	57.9 (27.5)	63.6 (20.7)	64.7 (22.7)	77.6 (34.3)
- share, %	6.46	6.05	5.75	4.85
<b>Routine tasks</b>				
- wage	41.1 (8.71)	43.7 (8.17)	45.3 (9.30)	46.3 (9.85)
- share, %	3.30	5.87	6.34	7.17
<b>Manual tasks</b>				
- wage	29.7 (12.5)	28.0 (10.1)	27.0 (9.50)	30.0 (12.1)
- share, %	11.1	13.3	14.0	15.2
<b>Average age</b>				
- years	27.96 (12.3)	26.38 (9.61)	26.19 (9.43)	26.17 (9.26)
<b>Duration</b>				
- months	5.77 (4.12)	8.11 (6.92)	9.91 (8.09)	11.60 (9.65)
<b>Steam vessels</b>				
- %-share	20.8	15.4	9.4	31.7
<b>Married</b>				
- %-share	30.6	20.3	19.8	18.4

Standard deviations are in brackets.