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The Adoption of Job Rotation: Testing the Theories

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Abstract

This paper tests three possible explanations for why firms adopt job rotation: employee learning (rotation makes employees more versatile), employer learning (through rotation, employers learn more about individual workers' strengths), and employee motivation (rotation mitigates boredom). Whereas previous studies have examined either establishment characteristics or a single firm's personnel records, this study merges information from a detailed survey of Danish private sector firms with linked employer-employee panel data, allowing firm characteristics, work force characteristics, and firms' human resource management practices to be included as explanatory variables. The results reject the employee motivation hypothesis, but support the employee learning and, especially, the employer learning hypotheses. Firms allocating more resources to training were more likely to rotate workers; rotation schemes were more common in less hierarchical firms and in firms with shorter average employee tenure; and both firm growth rates and firms' use of nation-wide recruitment were positively associated with rotation schemes.

KEYWORDS: job rotation

THE ADOPTION OF JOB ROTATION: TESTING THE THEORIES

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This paper tests three possible explanations for why firms adopt job rotation: employee learning (rotation makes employees more versatile), employer learning (through rotation, employers learn more about individual workers' strengths), and employee motivation (rotation mitigates boredom). Whereas previous studies have examined either establishment characteristics or a single firm's personnel records, this study merges information from a detailed survey of Danish private sector firms with linked employer-employee panel data, allowing firm characteristics, work force characteristics, and firms' human resource management practices to be included as explanatory variables. The results reject the employee motivation hypothesis, but support the employee learning and, especially, the employer learning hypotheses. Firms allocating more resources to training were more likely to rotate workers; rotation schemes were more common in less hierarchical firms and in firms with shorter average employee tenure; and both firm growth rates and firms' use of nation-wide recruitment were positively associated with rotation schemes.

Why is it that some firms introduce job rotation and others do not? A growing amount of research is using representative surveys of establishments to answer this question (Osterman 1994, 2000; Gittleman,

Horrigan, and Joyce 1998; OECD 1999). Because their unit of analysis is the establishment, these papers usually provide little evidence about the effect of *employee* characteristics on the probability of adoption. They focus on establishment characteristics instead. Analyses of job rotation based on individual data are more unusual because they often require access to personnel records, which firms are rarely willing to grant. Moreover, those studies that are based on personnel records typically are

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Computer programs used to generate the results presented in the paper, as well as copies of the questionnaire, are available from the first author. Because the data were linked with the matched employer-employee data within Statistics Denmark, they cannot be released. Readers interested specifically in the questionnaire can contact the first author at tor@asd.dk.

able to examine only one firm at a time (Campion, Cheraskin, and Stevens 1994; Kusunoki and Numagami 1998), which raises the issue of whether their results are representative. We think that a satisfactory test of the theories should combine a representative sample of establishments with data on employee characteristics. To build such a database, we have merged a representative survey of Danish firms with the employer-employee linked panel constructed by Statistics Denmark, which provides data on each employee at the sampled firms. The resulting database is richer than most surveys of establishments and provides more representative evidence than do single-firm case studies.

We concentrate on three theories of job rotation. The employee learning theory claims that employees who rotate accumulate more human capital than other employees because they are exposed to a wider range of experiences. The employer learning theory is that the firm itself learns more about its own employees if it can observe how they perform at different jobs. Finally, the employee motivation theory is that job rotation motivates employees who would otherwise grow bored with endless repetition of the same tasks. These theories deliver different predictions regarding the types of employees who are more likely to rotate and the types of firms that are more likely to adopt job rotation.

Theories and Empirical Implications

The *employee learning* argument contends that job rotation is an effective way to develop employees' abilities. For example, inter-functional job rotation helps prepare junior employees to become top managers. As employees move up to broader jobs, they need to gain deeper understanding of more aspects of business, and job rotation helps them do so. At lower hierarchical levels, intra-functional rotation can be very useful for allocative efficiency reasons: firms benefit from being able to re-allocate employees across different tasks because this enables them to meet production requirements. But re-allocation is too costly unless

employees have already gained experience in different jobs.

The *employer learning theory* also argues that job rotation improves job assignments, but in a different way. The idea is that job rotation provides the employer with information about the employee's abilities. Specifically, it enables the firm to identify which part of an employee's performance is due to the employee's general abilities, which part to job-specific factors unrelated to the employee (for example, the job might be particularly difficult and performance low for that reason), and which part to the employee's job-specific abilities. This information can be used to improve promotion decisions. Ortega (2001) showed that the relative benefits of job rotation are greater when the firm knows less about its employees' abilities, and when the firm is engaging in activities for which the returns are *a priori* more uncertain.

The *employee motivation* argument is that job rotation helps make work more interesting. This argument was mentioned in the late 1970s literature on the so-called "plateaued" employees—employees with limited promotion prospects (see Ference, Stoner, and Warren 1977)—and it was also analyzed by Cosgel and Miceli (1999).

Finally, we should note that the literature highlights some *human resource practices*—such as work teams, quality circles, Total Quality Management, and performance pay—as complementary to job rotation. These practices should therefore affect the decision to adopt job rotation (see Osterman 1994; Pil and MacDuffie 1996; and Gittleman, Horrigan, and Joyce 1998).¹

¹In principle, these practices can complement job rotation in two different ways. One possibility is that, independently of the reasons that lead a firm to introduce rotation (learning or motivation), these practices reduce the costs of adoption. For example, it is easier to implement job rotation when employees are already used to working in teams or to interacting with other employees through quality circles. Another possibility is that these practices are complementary with rotation only insofar as they serve the same purpose as job rotation (learning or motivation).

Table 1. Determinants of Adoption of Job Rotation Predicted by Three Theories.

Variable	Predicted Effects		
	Employee Learning	Employer Learning	Employee Motivation
<i>Firm Characteristics:</i>			
Number of Job Levels	+	+	-
Firm Age	0	-	0
Firm's Growth Rate	0	+	0
Firm Size	+	+	+
<i>Work Force Characteristics:</i>			
Average Tenure in the Firm	-	-	+
Average Tenure in the Industry	-	0	0
Heterogeneity of the Work Force	+	+	0
<i>Other HRM Practices:</i>			
Internal or Local Recruitment	0	-	0
Training Costs Relative to Industry	+	0	0

Existing Evidence

In the past decade, several authors have provided evidence on the adoption of job rotation practices (Osterman 1994, 2000; Bailey 1994; Pil and MacDuffie 1996; Gittleman, Horrigan, and Joyce 1998; Jenkins and Florida 1999; Nordflex 1999; Eriksson 2000). Considerably fewer studies have been able to test the theories. In fact, previous papers analyzing the decision to introduce job rotation have not spoken to the question of why rotation is useful, largely because it is difficult to do so without data on employee characteristics.

There are, however, two exceptions. Campion, Cheraskin, and Stevens (1994) studied job rotation inside the finance department of a large U.S. pharmaceutical company. They found that tenure had a negative effect on the rate of job rotation. In addition, they showed that employees viewed increased knowledge as the main benefit of rotation. Kusunoki and Numagami (1998) studied interfunctional rotation of engineers in a large Japanese company and found no statistically significant effect of tenure on rotation. However, both studies found that employees who had been involved in job rotation programs were more likely to be promoted in the future, which seems to be consistent with the

learning theories. Since the two articles were based on case studies, it is difficult to tell whether their findings are representative of job rotation practices throughout the economy. In addition, we shall argue that it is important to have data on many firms in order to test the theories of adoption.

Hypothesized Relationships

We now briefly describe the hypothesized relationships between job rotation and three sets of relevant variables. (See Table 1 for a summary.)

Job rotation and firm characteristics. The hierarchical structure of the firm is important because it affects promotion prospects. Firms with more hierarchical levels rely more heavily on promotions than firms with fewer levels. Hence, the former are less likely to have plateaued employees and, from a motivation perspective, they should use less rotation than the latter. By contrast, from a learning perspective, firms with more levels have a greater need to train and select the right employees and should therefore use more rotation (Ouchi 1981). The *age of the firm* and the firm's *employment growth rate* should also be important according to the employer learning theory, since expanding firms are in a situation similar to that of young firms when it

comes to learning about new employees in new jobs: both types of firms need to learn which tasks different employees are best at.

Job rotation and work force characteristics. Employees' average *tenure* in the firm and in the industry are key to testing the theories. According to the employee learning argument, rotation is more likely when employees have more need to be trained. Therefore employees with more tenure in the firm, as well as those with previous work experience in similar firms (firms belonging to the same industry, for example), should be less likely than other employees to rotate. The employer learning theory, too, predicts that employees with more tenure in the firm will be less likely to rotate (the firm does not need to learn about them), but, controlling for firm tenure, it predicts that previous work experience in the same industry will be irrelevant. According to the employee motivation theory, employees with more tenure are more likely to have motivational problems than those with less tenure. The implication is that tenure should have a positive effect on rotation. Previous experience in similar firms should, in principle, have no effect on motivation.

Finally, the *heterogeneity* of personnel should also play an important role, from the employee and employer learning perspectives. A firm with a more diverse work force is more likely to benefit from obtaining information about its employees (see Lazear 1998:473–74) and may also have greater training needs. Rotation should be useful for both purposes.

Job rotation and other HRM practices. The recruitment and training decisions of the firm should be related to the adoption of job rotation, according to the learning hypotheses. The employer learning hypothesis predicts that job rotation will be more common in firms recruiting outside the firm itself, because in those cases the firm has less information about the employees being recruited. For the same reason, rotation should be more likely in firms that recruit at a national level than

in firms recruiting at a local level: at a local level, the firm is more likely to have trustworthy references about the new employees. Training should be an important variable according to the employee learning hypothesis, which predicts a positive relationship between training and job rotation. To the extent that high training expenses reflect high training needs, plants where the levels of on-the-job training are high should use more job rotation.

Controls

Other work practices, such as self-managed teams, TQM, quality circles, and performance-related pay systems, have been shown to be complementary with job rotation (see Osterman 1994, 2000). We therefore expect these practices to have a positive effect on the adoption of job rotation. We also expect the level of compensation paid by the firm relative to the levels of compensation paid by other firms in the market to influence job rotation. The presence of *unions* and *firm size* are important controls, too. Unions occasionally resist more flexible work practices but, at times, have also facilitated changes toward increased employee involvement. Firm size may also have a positive or negative effect: on the one hand, in order to operate a *stable* job rotation scheme, firms must be above a certain size; but on the other hand, multi-tasking and flexibility seem to be less valuable in larger establishments or firms (see Lazear 1998:445–46, 473–74). Finally, it is important to take into account the job levels at which job rotation is being adopted: the purpose and the types of job rotation might differ at different levels of the hierarchy.

Testing the Theories

Methods and Data

The data used in this paper refer to Denmark. The institutional setting for the adoption of job rotation schemes and other new work organizations is the so-called Danish model for co-operation in the labor

market, whereby the trade unions and employers' federations agree to take responsibility not only for wage bargaining and wage setting, but also for regulatory issues such as normal working hours, labor protection, and the work environment. The role of the government is mainly to "pay the bill," that is, to pay unemployment benefits and provide training to workers who have lost their jobs. Thus, an important difference between the Danish model and the models in other Nordic countries is that the former relies much less on tripartite cooperation. Moreover, since the late 1980s bargaining and cooperation have become more decentralized and increasingly occur at the level of the firm. About 80% of wage earners and 50% of private sector employers are organized in trade unions or employers' federations. Hence, the introduction of new work practices has in many firms been part of the regular discussions and cooperation between employers and unions.

Our data were constructed by merging information from two different sources: a survey directed to firms, and an employer-employee linked panel.

The *survey* (see Eriksson 2000 for details) represents a unique source of information on Danish firms' internal labor markets and changes therein. In addition to a request for some background information about the firm, the firms were asked about their work organization, compensation systems, recruitment, internal training practices, and methods for evaluating their employees, as well as about recent changes in any of these structures and practices. This paper makes use of the firms' answers to questions regarding their use of job rotation schemes.² The survey was administered by Statistics Denmark as a mail questionnaire that was sent out in May and June 1999 to 3,150 private sector firms with more than 20 employees. The firms were chosen

from a random sample, stratified according to size (as measured by the number of full-time employees) and industry. The survey over-sampled large and medium-sized firms: it included all firms with 50 employees or more, but only 35% of firms in the 21–49-employee range.

The response rate was 51%—relatively high for a long and detailed questionnaire—and there are 1,605 usable observations. The response rates by size and industry cell vary only slightly: between 47% and 53%. Concerning organization of work within the company, the firm was asked whether it had adopted the following work practices: self-managed teams, job rotation,³ quality circles, Total Quality Management, benchmarking, and project organization. In answering this question, the firm was furthermore asked to distinguish between adoption of the work practices for hourly paid workers and for salaried employees (including managers).

The survey also provides information about other firm characteristics that, according to the theories, should affect the adoption of job rotation. The hierarchical structure of the firm pertains only to the salaried employees and is measured as the *number of job levels* in the firm within this category. This information is derived from responses to the survey's request for the number of job levels for non-production workers. The age of the firm and the presence of unions are also derived from the survey. The presence of unions is proxied by a positive answer to the question whether the firm had signed a local wage agreement with its workers, as this is typically the case when there are particularly active and strong unions in the workplace.

The questionnaire asked the firms how much money they spent on employee training. From the responses to this question we

²In addition, several of the explanatory variables in our empirical analysis are constructed from the firms' answers to the survey questionnaire.

³Generally, interfunctional rotation is used mostly for white-collar workers, whereas intrafunctional rotation is more frequent for blue-collar workers. The survey, however, does not distinguish between different types of rotation.

Table 2. Percentage of Firms Using Job Rotation, by Industry and Size.

<i>Group of Firms</i>	<i>Hourly Paid</i>	<i>Salaried</i>
<i>By Industry:</i>		
Manufacturing	28.1	4.4
Construction	4.5	2.2
Wholesale and Retail Trade	5.7	8.6
Transportation and Communication	7.1	6.0
Business and Finance	3.1	13.1
Other Services	5.0	4.0
<i>By Firm Size (No. of Employees):</i>		
21-50	10.2	3.1
51-100	21.1	4.2
101-350	23.1	6.6
351-500	33.3	15.4
501+	37.0	18.5
All	19.5	5.7

have constructed a variable showing the firm's per capita training costs relative to the average for all firms. In the survey the firms were also asked about the number of hours spent on on-the-job training during ordinary working time. From this, a measure of corresponding relative training costs (in terms of hours) can be constructed. The advantage of the latter is that it is specifically about training on-the-job, whereas the advantage of the former is that it is in money terms. The two measures are strongly correlated, and they yield similar estimation results. In what is presented below, we use the relative per capita training costs variable.

Finally, the survey is also the source of our data on the firm's recruitment and compensation policies. In the survey, the firms were asked where they recruited different groups of personnel. Four different recruitment venues are of interest here: within the firm, within the local labor market, within the same industry, and across all of Denmark. As far as compensation policies are concerned, the survey provides information about the relative levels of compensation and about the use of performance-related pay systems. Based on the survey, we constructed two relative com-

pensation variables, one indicating whether the firm paid higher salaries than its local competitors, the other indicating whether it paid the industry average.⁴ In addition, the survey provides us with dummy variables for whether the firm implemented one or more of three performance-related pay systems: team bonuses, individual bonuses, and either stock sharing or stock options.

According to the survey, how frequent was job rotation, and which firms had adopted it? When had adoption taken place? The data show that one out of five firms had implemented job rotation schemes for hourly paid workers. Considerably fewer firms—about 6%—had adopted them for their salaried employees. About 20% of the firms had already implemented job rotation schemes (for hourly paid workers, salaried workers, or both) before 1990 (mostly in the 1980s), 40% had implemented them during the first half of the 1990s, and another 40% had done so in the latter half of that decade. The pace of adoption did not differ much between domestic and foreign-owned firms.

The share of firms that adopted job rotation schemes varies across industries and by firm size (see Table 2). Firms in the services and manufacturing sectors were much more likely than firms in other industries to have implemented them for their hourly paid employees. Firms in the business and finance sector were more likely to have introduced them for the salaried employees. For both categories of workers, the share of adopters clearly increased with firm size.

Table 3 gives some summary statistics for the firms that responded to the survey questionnaire as well as some information concerning their work forces. As remarked above, by construction, the sample firms

⁴Both are dummies created based on responses to pertinent questions in the survey. An alternative source of such information is the employer-employee linked data set. From other work on the data, we know that the answers to these questions in the survey are quite accurate.

Table 3. Summary Statistics.

<i>Variable</i>	<i>Hourly Paid Adopters</i>	<i>Hourly Paid Non-Adopters</i>	<i>Salaried Adopters</i>	<i>Salaried Non-Adopters</i>
<i>Established (%)</i> :				
Before 1980	75.1	77.0	75.0	76.6
In the 1980s	19.6	20.0	19.0	20.0
In the 1990s	5.3	3.0	6.0	3.4
Size (Number of Employees)	184.8	70.9	238	77.2
Annual Employment Growth (%)	0.33	0.24	0.24	0.24
<i>Number of Job Levels (%)</i> :				
3-5			46.8	39.2
6+			35.7	35.4
Training Costs Relative to Industry	-1.50	-1.56	-0.58	-1.45
Local Wage Agreement (%)	87.4	70.2	8.2	7.5
Average Turnover Rate	35.8	32.8	24.0	24.0
Average Tenure in Firm (years)	5.2	4.8	5.3	5.3
Average Tenure in Industry (years)	5.5	5.4	5.7	5.7
Proportion with More Than Compulsory Education	78.6	81.4	84.8	81.2
Proportion Female Employees	29.6	19.1	30.2	22.3
<i>Recruits from (%)</i> :				
Within the Firm	88.6	65.4	63.1	37.4
Local Labor Market	18.4	11.8	14.3	14.1
All of Denmark	11.4	14.9	69.0	54.4
Same Industry	16.7	17.9	31.0	18.6
<i>Work Organization (%)</i> :				
Teams	37.6	18.6	57.1	24.8
TQM	11.0	2.8	28.6	7.4
Quality Circles	10.6	2.3	14.3	3.3
<i>Pay Systems (%)</i> :				
Team Bonus	29.0	16.2	13.1	6.3
Individual Bonus	9.8	7.5	46.4	29.1
Stock/Stock Options	2.9	1.3	16.7	7.1
<i>Industry (Share in %)</i> :				
Manufacturing	78.4	41.8	29.8	45.7
Construction	3.3	13.7	4.8	10.7
Wholesale and Trade	13.1	33.4	47.6	30.7
Transportation and Communication	2.4	5.5	4.7	5.4
Business and Finance	1.2	5.4	13.1	6.9
Services	1.6	0.2	0.0	0.6

were, on average, larger than Danish companies in general. Also, the proportion of female employees was considerably lower in these private-sector firms than across the entire Danish work force (including Denmark's large public sector). Moreover, the work force turnover rate (which will be further explained below) was relatively high in the sample firms; over an average year,

30% and 24.5% of hourly paid and salaried employees, respectively, left their firms. Seventy percent of the firms had a local wage agreement for their hourly paid workers, implying a relatively strong union presence. As for other new work practices, we note that about one-fourth of the firms had self-managed teams, whereas TQM and quality circles were clearly less common.

From the table it can be seen that firms that had adopted job rotation for their workers on hourly pay differed in various ways from those that had not. The adopting firms were slightly younger, considerably larger and faster-growing, and more likely to be in the manufacturing sector⁵ and to have a local wage agreement with the trade unions. These firms were also more prone to recruit new personnel from within the company or the local labor market (or both). Furthermore, the adopters were much more likely to have implemented new work practices. Adopters had more frequently introduced performance-related pay systems than had non-adopters. With regard to work force characteristics, the main difference is in the share of female employees in the firms' work forces, which was much higher for adopters than for non-adopters.

In the main, the firms that rotated their salaried employees shared many characteristics with those that rotated workers on hourly compensation. The only notable differences are in relative training costs, which were higher for adopting firms, and recruitment from sources outside the internal or local labor markets, which was more common among adopters. Finally, we note that firms with a pronouncedly flat hierarchy were less likely than others to have job rotation schemes.

The other data source, the *employer-employee linked panel*, has been constructed by Statistics Denmark by merging a number of registers using the unique identification numbers of individuals and plants (firms). The panel contains detailed information about all employees and their wage earnings in all Danish firms during the period 1980–98, as well as economic information about the firms since 1992. This data source enables us to create measures describing the composition and other characteristics—notably for our purposes, tenure and gen-

der—of firms' work forces. The employer-employee linked panel also provides us with information about two firm characteristics: the size of the firm and its employment growth rate. The size of the firm is measured as the number of employees in the firm and the employment growth rate is measured as the five-year average employment growth rate from 1990 to 1995. But the main role of the employer-employee linked data in our analysis is to provide information about work force characteristics, particularly tenure.

The average tenure of the firm's work force, defined as the average number of years that an employee had been working for his current employer, is computed across all employees of the same category (hourly paid or salaried). Moreover, since the distribution of tenure in a firm is typically rather skewed, and therefore the mean is not necessarily a good measure with which to characterize it, we also tried two alternative work force turnover measures as explanatory variables: $1/2 \cdot (\text{hires in year } t + \text{hires in year } t-1) / (\text{number of employees in year } t)$, and $1/2 \cdot (\text{hires in year } t + \text{separations in year } t) / (\text{number of employees in year } t)$. The measure we used in the estimations was an average taken over the annual observations for the period 1985–95. However, neither of the alternative work force turnover measures yielded results that differed from those obtained with average tenure as the measure.

A third measure used was the share of employees who had been employed less than two years. We include this variable because learning does not occur at a constant rate but is mainly concentrated in the first years of an employment relationship, after which it declines considerably.

All three measures mentioned above refer to tenure in the firm. An additional measure employed is the average *tenure in industry*. This is potentially a key variable, since it allows us to discriminate between employer and employee learning theories. In the latter, both previous and current tenure matter, whereas in the former previous experience should not affect the firm's use of job rotation.

⁵Gittleman et al. (1998) also found more of the new work practices in the manufacturing sector and in larger firms. U.S. wholesale and trade firms have adopted new work practices to a considerably greater extent than have such firms in Denmark.

The *gender composition* of the firm's work force is, for each of the two work force categories, the proportion of female employees. In order to control for differences in skill composition, we include a variable indicating the proportion of employees in the relevant category with more than the compulsory 10 years of schooling.

Besides average characteristics of the firms' work forces, we computed their standard deviations as measures of the *heterogeneity* of each firm's employees. As discussed above, the employee and employer learning theories imply a positive effect of such heterogeneity on job rotation.

Analysis and Results

We carried out a set of logit model estimations for whether or not the firms had adopted job rotation. As explanatory variables we use four groups of regressors: firm characteristics, work force characteristics, other HRM practices, and controls.

Separate regressions were estimated for hourly paid and salaried workers, with and without distinguishing by firm size (firms with fewer or more than 100 employees). Estimation results are shown in Table 4. The distinction between hourly paid and salaried employees is needed because jobs across these two categories differ substantially: since hourly paid jobs are essentially low-level, whereas salaried jobs are for the most part high-level, job rotation may differ in type and purpose between hourly paid and salaried workers. The distinction between small and large firms is also important, because it is often unfeasible for relatively small companies to implement stable job rotation policies. If there are few employees and few positions, the extent to which employees can rotate is limited. In addition, smaller companies know their employees much better, which greatly reduces the employer learning motive for rotation. In any case, the estimation approach does not constrain the results to be different for each of the four groups; it just allows for that possibility. In the two first columns of the table, we report the estimates for all firms, with firm size included

as an explanatory variable. We can see that the probability of having job rotation schemes increased with the number of employees in the firm. As we distinguish between small and larger firms (the next four columns of Table 4), we find, with a few exceptions, a pattern similar to that for all firms. However, the estimates are more precisely determined for the larger firms.

The number of job levels had a statistically significant effect on the rotation of salaried employees of large firms.⁶ Firms with 3–5 levels were significantly more likely to use job rotation for their salaried employees than were firms with fewer levels.⁷ Moreover, the effect is in the direction predicted by the employee and employer learning theories: when the number of job levels was higher, the adoption of job rotation schemes was more likely. This is because both theories view job rotation as a prerequisite for a worker to be promoted to higher-level jobs. The greater the likelihood of promotion, the greater the value of job rotation. However, the result is contrary to the employee motivation theory, according to which, if there are greater promotion opportunities, there should be less need for job rotation.

The variable for firm age has a positive coefficient, but as this coefficient does not differ from zero at a statistically significant level, it yields little support for the employer learning hypothesis.⁸ On the other hand, high-growth firms are presumably in a situation similar to that of young firms inasmuch as they also need to learn about their new employees, and are hence more likely to have implemented job rotation

⁶As noted before, the number of job levels refers only to the salaried employee category. Hence the regressions for the hourly paid employees do not include this variable.

⁷The coefficient corresponding to 6+ levels is not statistically significant, but very few firms have so many levels, which makes it very difficult to obtain precise estimates.

⁸Note, however, that only 13.6% of the firms had introduced rotation schemes the first year the firm was established, and an additional 15% had done so during the firm's first ten years.

Table 4. Logit Results for the Adoption of Job Rotation.

<i>Explanatory Variable</i>	<i>Hourly Paid; All Firms</i>	<i>Salaried; All Firms</i>	<i>Hourly Paid; Small Firms</i>	<i>Hourly Paid; Larger Firms</i>	<i>Salaried; Small Firms</i>	<i>Salaried; Larger Firms</i>
<i>Number of Employees in the Firm:</i>						
51–100	0.0004* (0.0002) (0.00003)	0.0002* (0.0001) (0.00002)				
101–350	0.0008** (0.0004) (0.00006)	0.0005** (0.0002) (0.00003)				
350+	0.0011*** (0.0003) (0.00008)	0.0006** (0.0003) (0.00003)				
Established in the 1990s	0.165 (0.299) (0.021)	0.298 (0.664) (0.010)	0.139 (0.301) (0.019)	0.178 (0.374) (0.020)	0.307 (0.295) (0.039)	0.343 (0.578) (0.034)
Established in the 1980s	-0.028 (0.211) (-0.005)	-0.013 (0.313) (-0.001)	0.047 (0.219) (0.008)	-0.057 (0.101) (-0.010)	-0.011 (0.298) (-0.001)	-0.027 (0.434) (-0.002)
3–5 Job Levels		0.574** (0.229) (0.026)			0.139 (0.277) (0.008)	0.845*** (0.183) (0.033)
6+ Levels		0.104 (0.331) (0.007)			-0.019 (0.347) (-0.001)	0.154 (0.279) (0.010)
Local Wage Agreement	0.537*** (0.194) (0.070)	0.121 (0.533) (0.006)	0.299 (0.212) (0.035)	0.548*** (0.163) (0.070)	0.087 (0.445) (0.015)	0.103 (0.393) (0.006)
Wage above Local Competitors	-0.104 (0.270) (-0.013)	-0.124 (0.533) (-0.007)	-0.114 (0.315) (-0.012)	-0.154 (0.294) (-0.016)	-0.125 (0.444) (-0.015)	-0.098 (0.273) (-0.011)
Wage above Industry Mean	0.099 (0.238) (0.014)	0.427 (0.454) (0.014)	0.087 (0.214) (0.014)	0.079 (0.188) (0.013)	0.379 (0.401) (0.026)	0.275 (0.574) (0.024)
Training Costs Relative to Industry	0.179*** (0.057) (0.022)	0.180** (0.087) (0.009)	0.164* (0.081) (0.056)	0.245*** (0.079) (0.026)	0.111* (0.060) (0.018)	0.212*** (0.065) (0.029)
The Firm's Growth Rate (5-year avg.) in Employment	0.411*** (0.143) (0.013)	0.424*** (0.138) (0.014)	0.306** (0.151) (0.010)	0.584*** (0.148) (0.016)	0.311** (0.147) (0.011)	0.696*** (0.127) (0.017)
Average Tenure in the Firm	-0.024 (0.037) (-0.005)	0.026 (0.087) (0.001)	-0.019 (0.038) (-0.003)	-0.036** (0.018) (-0.009)	0.028 (0.094) (0.004)	0.014 (0.057) (0.005)
Average Tenure in the Industry	0.011 (0.049) (0.001)	0.020 (0.059) (0.0009)	0.009 (0.050) (0.001)	0.012 (0.052) (0.001)	0.031 (0.067) (0.010)	-0.037 (0.041) (-0.001)
Proportion of Women	1.599*** (0.382) (0.224)	1.386*** (0.543) (0.055)	0.887*** (0.332) (0.156)	1.614** (0.832) (0.217)	1.478*** (0.363) (0.207)	1.596*** (0.544) (0.229)

Continued

Table 4. Continued.

<i>Explanatory Variable</i>	<i>Hourly Paid; All Firms</i>	<i>Salaried; All Firms</i>	<i>Hourly Paid; Small Firms</i>	<i>Hourly Paid; Larger Firms</i>	<i>Salaried; Small Firms</i>	<i>Salaried; Larger Firms</i>
Proportion with Education > 10 Years	-1.393 (1.456) (-0.177)	2.012* (1.114) (0.101)	-0.978 (1.584) (-0.144)	-1.485 (1.937) (-0.166)	-1.856* (1.014) (-0.165)	2.437** (1.215) (0.132)
Teams	0.543*** (0.212) (0.133)	0.811*** (0.241) (0.032)	0.343* (0.179) (0.098)	0.609*** (0.214) (0.140)	0.797*** (0.216) (0.149)	0.847*** (0.304) (0.147)
TQM	0.988*** (0.337) (0.179)	0.927*** (0.315) (0.057)	0.314 (0.4249) (0.060)	1.245*** (0.299) (0.199)	1.434 (0.945) (0.231)	1.613*** (0.679) (0.231)
Quality Circles	1.253*** (0.360) (0.212)	0.954** (0.448) (0.050)	0.303* (0.159) (0.055)	0.979*** (0.283) (0.204)	0.714 (0.434) (0.169)	0.993** (0.393) (0.183)
Team Bonus Schemes	0.290 (0.222) (0.040)	0.300 (0.414) (0.012)	0.097 (0.453) (0.012)	0.194 (0.245) (0.036)	0.144 (0.241) (0.020)	0.127 (0.259) (0.021)
Individual Bonus Schemes	0.061 (0.307) (0.009)	0.098 (0.354) (0.004)	0.057 (0.214) (0.008)	0.039 (0.299) (0.004)	0.113 (0.274) (0.017)	0.051 (0.265) (0.003)
Stock and Stock Option Plans	0.066 (0.547) (0.009)	0.198 (0.653) (0.010)	0.014 (0.797) (0.002)	0.088 (0.393) (0.011)	0.041 (0.173) (0.007)	0.015 (0.191) (0.002)
<i>Recruitment:</i>						
From within	0.214 (0.143) (0.050)	0.384 (0.244) (0.015)	0.089 (0.367) (0.023)	-0.067 (0.089) (-0.012)	0.396 (0.445) (0.059)	0.094 (0.115) (0.017)
Local Labor Market	0.311 (0.227) (0.039)	-0.575 (0.499) (0.019)	0.167 (0.305) (0.017)	0.143 (0.279) (0.015)	-0.274 (0.389) (-0.034)	-0.433 (0.344) (-0.015)
All of Denmark	-0.114 (0.207) (-0.019)	0.018 (0.302) (0.001)	-0.024 (0.654) (-0.004)	0.207 (0.156) (0.023)	0.015 (0.095) (0.001)	0.064* (0.033) (0.015)
Same Industry	-0.098 (0.164) (-0.011)	0.008 (0.214) (0.001)	-0.147 (0.212) (-0.018)	-0.037 (0.198) (-0.003)	0.043 (0.105) (0.005)	-0.009 (0.064) (-0.001)
Std. Dev. of Experience of Employees	-0.357*** (0.096) (-0.026)	-0.396** (0.123) (-0.030)	-0.137 (0.145) (-0.012)	-0.456** (0.229) (-0.030)	-0.243 (0.156) (-0.020)	-0.357* (0.189) (-0.021)
Industry Dummies	yes	yes	yes	yes	yes	yes
Pseudo R-Squared	0.212	0.174	0.132	0.244	0.142	0.196
Log Likelihood	-375.43	-221.37	-656.79	-593.17	-254.33	-497.10
Observations	1,076	1,261	347	729	427	834

Notes: Roman numbers in parentheses are standard errors, and italicized numbers in parentheses are marginal effects (evaluated at the mean for continuous variables, and for a discrete change for the discrete variables). A Wald test rejected the equality of coefficients common to equations for hourly paid and salaried workers, respectively, in all three cases.

*Statistically significant at the .10 level; **at the .05 level; ***at the .01 level.

schemes. This is also what we find for the hourly paid workers, and it is consistent with the employer learning theory.

Other aspects of the firms that were associated with a higher likelihood of job rotation were the presence of unions (for hourly paid workers) and higher than average per capita training costs. The finding that firms spending more to train their employees were more likely to have job rotation schemes is favorable to the employee learning hypothesis.

For average tenure in the firm, we obtain statistically significant and negative estimates for the hourly paid in large firms, which is consistent with both the employer and employee learning hypotheses: firms in which average tenure is smaller have a greater need to train their employees (the employee learning argument) or need to learn more about them (the employer learning argument).⁹ Whereas tenure in the firm has a statistically significant effect on rotation, tenure in the industry does not. This is consistent with the employer learning theory, and contradicts the employee learning theory.

The employer learning hypothesis receives some support from the results concerning the sources of new personnel recruitment. The hypothesis predicts that firms chiefly recruiting at the national level have a greater need to learn about their new employees than do firms recruiting from their own ranks or from the local labor market. Hence, firms with broader recruitment strategies are more likely to use job rotation. Indeed, the regressions show that for the larger firms, recruiting at the national level has a positive effect on the use of job rotation. The effect of recruiting internally or locally, however, is not statistically significant. This contradicts the employer learning theory (which predicts a negative sign) and maybe the employee learning theory (which would predict a positive sign if internal recruit-

ment implies better promotion opportunities for current employees).

As for other work force characteristics, we find that the proportion of women in the firm's work force is positively and strongly correlated with the probability that the firm rotates its workers. We are not able to offer any obvious explanations for this pattern.¹⁰ Tests to see if the proportion of women was particularly high in specific industries or was correlated with high work force turnover showed no such patterns. The estimates also show that the share of workers with more than compulsory education has relatively large marginal effects, although the coefficients, which differ in sign between the hourly paid and the salaried employees, carry rather large standard errors. Contrary to the employer and employee learning hypotheses, heterogeneity (with respect to experience, as measured by age) is negatively related to job rotation. This is puzzling, as one would expect that rotating employees who possess different sets of knowledge would be useful.

The estimations do indeed provide evidence supporting the notion of complementarity between different work practices: teams, quality circles, and TQM were all positively related to the adoption of job rotation schemes. The fact that rotation was more likely in firms where teams were being used indicates that the firms were not using the information they learned to re-allocate tasks, since their employees worked in teams anyway. This would speak against the employer learning hypothesis. However, a firm might use rotation to learn the best way to assign tasks *within* teams.¹¹

We performed various tests to check the robustness of the estimation results. To save space, we do not report the corresponding tables. We computed estimates based on smaller samples, obtained by ex-

⁹However, the coefficient on the share of employees with less than 2 years of tenure did not differ significantly from zero, and this variable is therefore omitted from the logit models in Table 4.

¹⁰A suggestion offered by our female colleagues is that the results simply confirm the hypothesis that women are inherently more "flexible."

¹¹The complementarity between job rotation and the other work practices seems to be so strong that it is possible that the inclusion of the latter is capturing

cluding those firms that had implemented rotation schemes prior to 1990. The reason for imposing this restriction on the data is that most of the explanatory variables refer to the second half of the 1990s. With the exception of one explanatory variable, the exclusion of about one-fifth of the firms leads to fairly small changes in the coefficient estimates and their standard errors. We also tried excluding the most heterogeneous firms, in order to increase the representativeness of the empirical analysis results. Our approach was to first compute for each firm the standard deviation of employees' years of education and age, and then exclude those firms with values that put them among the 15% in either of the outer tails of the standard deviations distributions. The estimates from these more homogeneous firm samples closely resemble those obtained from the full sample, and their precision is affected only slightly. The only change worth noting is the finding that salaried employees were paid more in firms that had adopted job rotation schemes. However, causality can go both ways, as firms that are performing well and hence can afford to pay higher salaries may also have more resources for experimenting with alternative ways of organizing work.¹²

Conclusions

We have used data created by linking a questionnaire on firms' HRM and pay practices to a longitudinal matched employer-

employee data set to examine the determinants of the adoption of job rotation schemes in Danish firms. Our analysis gives separate treatment to hourly paid workers and salaried employees, as well as to small and larger firms. Our main purpose has been to identify which firms were implementing job rotation, and to explore why they did so. We distinguish between three different explanatory frameworks: employee learning, employer learning, and employee motivation.

We find only very limited support for the employee motivation hypothesis. Job rotation schemes were not more likely in firms with long-tenured employees, or in firms with a relatively flat hierarchy and hence only small promotion prospects. The statistical evidence is more amenable to the employee learning hypothesis and employer learning hypothesis. Favoring the former is our finding that firms that spent relatively more on training were more likely to rotate workers. Moreover, job rotation schemes were more common in less hierarchical firms and in firms with shorter average firm tenure. These two findings also lend support to the employer learning story.

Two findings speak against employee learning. One is the negative relationship between job rotation and worker heterogeneity. The opposite is predicted by the employee learning hypothesis, which posits that rotation and the information transfer associated with it are more useful when employees have differing sets of knowledge. Another negative finding is that average industry tenure had no statistically significant effect, a finding consistent with the employer learning hypothesis but at odds with the negative relationship predicted by employee learning theory.

On the whole, the employer learning explanation seems most solidly supported by the results. Other findings consistent with that hypothesis are that the occurrence of job rotation schemes was positively associated with both firm growth rates and nation-wide recruitment practices but not associated with the practice of recruiting from within the firm or within the local labor market.

the effects of other variables "explaining" the adoption of job rotation. We therefore also estimated the logit model without the dummies for TQM, quality circles, and teams. The results, which are not reported, turned out to be quite close to those obtained before; only the explanatory power of the estimated logit model was significantly reduced. The adoption of job rotation does not seem to have been associated with firms having implemented performance-related pay schemes.

¹²The evidence from the small but growing literature on the benefits of new work practices is mixed. Black and Lynch (2004) found positive wage effects, whereas Cappelli and Neumark (2001) found only small wage effects, and Osterman (2000) found no effects at all. For a recent, comprehensive review, see Ichniowski and Shaw (2003).

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