The Adoption of Job Rotation: Testing the Theories

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Abstract. The aim of this paper is to test three theories for why firms introduce job rotation schemes: employee learning, employer learning, and employee motivation. The earlier literature has made use of either information about establishment characteristics or data coming from personnel records of a single firm. In order to improve upon this, we make use of a unique data set constructed by merging information from a fairly detailed survey directed at Danish private sector firms with a linked employer-employee panel data. This allows us to include firm and workforce characteristics as well as firms HRM practices as explanatory variables, and hence to carry out a more comprehensive analysis.

I.   Introduction

Why do some firms introduce job rotation while others choose not to? 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, such papers are typically able to study merely one firm at a time (Campion, Cheraskin and Stevens 1994; Kusunoki and Numagami 1998), which raises the issue of whether the results that they find 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 register data on each of these firms' employees. The resulting database is richer than most surveys of establishments, and although the information on employees is not as detailed as in case studies, it is certainly more representative.

We concentrate on three theories of job rotation. The first theory claims that employees who rotate accumulate more human capital because they are exposed to a wider range of experiences. The more an employee moves, the more he learns. We refer to this as the employee learning theory. The second theory is that the firm itself learns more about its own employees if it can observe how they perform at different jobs. To find the job that an employee is best at, the employer needs to move the employee around and observe how he performs at each position. We call this the employer learning theory. The last theory is that job rotation motivates employees who would otherwise become bored and tired of always performing the same tasks. The theories deliver different predictions regarding the types of employees who are more likely to rotate and the types of firms where rotation is more likely. In our data, we are not able to distinguish which employees rotate and how often they do it. But we can characterize the average employee in each firm and examine whether this affects the probability of rotation in that firm.

The remainder of the paper is organized as follows. In section 2 we describe the three theories in more detail and discuss briefly existing evidence regarding the

determinants of the adoption job rotation. The third section starts with a description of the data sources used, followed by a discussion of how the variables used in testing are operationalized. The second half of section 3 gives the results of the econometric analysis and our interpretation of them. Some concluding remarks are offered in section 4.

II.   Theories and Empirical Implications

There is little theoretical work on job rotation. As Campion, Cheraskin and Stevens (1994) point out, the management literature sometimes refers to job rotation as a useful practice, but very few authors have focused their research on a detailed analysis of its costs and benefits. Hence some of the explanations we present in this section are not theories of job rotation, but claims about job rotation that appear in other areas of research.

II. A. Employee Learning

The employee learning argument is that job rotation is an effective way to develop employees' abilities. According to Champion, Cheraskin and Stevens (1994), job rotation produces two beneficial effects. First, an employee who rotates accumulates experience more quickly than an employee who does not rotate. Hence job rotation is mentioned as an effective tool for career development. Second, an employee who rotates accumulates experience in more areas than an employee who does not rotate. Hence, if an employee rotates more frequently, it is easier to train him to become a generalist. According to Ouchi (1981), the fact that Japanese employees are generalists compared to U.S. employees is due to differences in the frequencies of rotation.

If the employee learning argument is correct, we should expect job rotation to be more likely when employees have more need to be trained. First, employees with less tenure in the firm should rotate more frequently than employees with more tenure. Second, for a given level of tenure in the firm, employees who had previous work experience in the same industry are probably better trained, and should therefore rotate less frequently. Last, plants where the levels of on-the-job training are high

must be plants where employees have a high need to be trained. Hence, these plants should have higher probabilities of adoption.

II. B. Employer Learning

The employer learning argument is that job rotation provides information that the firm can use to improve the allocation of jobs among employees. If an employee can be observed performing different activities, it may be easier for the firm to find out the most appropriate job for that employee. Using a simple learning model, Ortega (2001) shows that this intuition is correct. With a job rotation policy, each time an employee rotates the employer learns about new dimensions of the employee's ability. However, if an employee does not rotate, the employer learns more and more information, but the dimensions of ability about which he learns are always the same. For that reason, the information he learns is less valuable than in the job rotation case.

Ortega (2001) also shows that the benefits of job rotation are a decreasing function of the prior information that the firm has about its employees and the profitability of different jobs. This has empirical consequences. First, employees with less tenure in the firm are more likely to rotate, because the firm will be more interested in learning about them. This implies that job rotation should be adopted with a higher probability in firms where average employee tenure is lower. This is similar to the prediction of the employee learning theory. Second, the previous work experience that current employees accumulated in other similar firms should have *no* effect on the probability of rotation: only the average tenure in the *current* firm should matter, independently of previous work experience. This is different from what the employee learning theory predicts. Last, if the firm is relatively young or is introducing innovations, the information that it has about the profitability of different jobs is not very precise, and we should expect it to use more job rotation.

II. C. Employee Motivation

The employee motivation argument is that job rotation contributes to make work more interesting. This argument was sometimes mentioned in the literature on "plateaued" employees that developed in the late 1970s. Plateaued employees are those with little prospects of promotion. According to Ference, Stoner and Warren (1977), job rotation is a potential solution to these employees' lack of motivation.

More recently, Cosgel and Miceli (1999) have pointed out increased satisfaction as one of the benefits of rotation. In their model, employees prefer to perform a variety of tasks rather than specializing in a single task and, as a consequence, job rotation increases job satisfaction. This is beneficial to the firm because it can afford to pay lower salaries when employees are more satisfied.[1] In fact, contrary to the employee learning argument, Cosgel and Miceli (1999) argue that employees learn more when they specialize in a single job and do not rotate.

If the employee motivation theory is correct, we would expect job rotation to be adopted by firms where employees have poorer prospects of promotion. This is a key difference with respect to the employee learning argument: if job rotation is a way to train employees, employees will expect to be promoted after completing their rotation. If there are few possibilities of promotion, they might decide to leave the firm and look for a higher level job elsewhere. Therefore, in the employee learning theory job rotation is more likely in forms with better promotion opportunities.

II. D. Existing Evidence

Several authors have recently provided evidence on the adoption of job rotation practices: see *Table 1* for a review of the surveys, their methodology and findings. Considerably fewer studies have been able to test the theories. In fact, as can be seen from the summary in *Table 2*, previous papers analysing the decision to introduce job rotation do not speak to the question why rotation is useful. Earlier work has rather focused on the degree of product market competition, firm strategy (quality versus cost reduction), cultural values in the firm, complementary human resources management (HRM) practices, and the use of advanced technology. Although interesting in their own right, these studies do no inform us about the types of benefits job rotation provides. This is due to the fact that it is difficult to test the theories in this respect without data on employee characteristics. Two exceptions are Campion, Cheraskin and Stevens (1994) and Kusunoki and Numagami (1998).

Campion, Cheraskin and Stevens (1994) study job rotation inside the finance department of a large U.S. pharmaceutical company, and we can use some of their findings to test the theories. First, they find that tenure has a negative effect on the rate of job rotation: junior employees rotate more frequently than senior employees.

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[1] This will be tested in the next version of the paper.

Second, the educational level has no significant effect on the rate of job rotation. Third, individual performance has a significant positive effect on the rate of rotation. Fourth, the rate of rotation has a moderate positive effect on the rate of promotion. Last, the authors use a questionnaire to complete the data that they have collected from personnel records. In that questionnaire employees are asked their opinion about the benefits of job rotation. According to the employees, job rotation provides increased knowledge.

Kusunoki and Numagami (1998) study the patterns of interfunctional mobility of engineers in one of the largest Japanese companies. First, they find that employees with fewer years of tenure do not rotate more than more senior employees. In fact, rotation frequencies seem to vary very little during the first fourteen years of an employee's career. Second, the educational level has no significant effect on rotation. Third, there is a positive relationship between the employee's speed of promotion and the rate of rotation. Last, they find that the directions and patterns of rotation are complex and vary significantly according to promotion speeds.

III. Testing the Theories

III. A. Data Description

The data used in this paper have been constructed by merging information from two different sources. The first is a survey directed to firms and the second is 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 some background information about the firm, the firms were asked about their work organization, compensation systems, recruitment, internal training practices and how they evaluate their employees, as well as about recent changes in these. 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

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

employees) and industry. The survey over-sampled large and medium-sized firms: all firms with 50 employees or more were included, and 35 per cent of firms in the 20-49 employees range.

The response rate was 51 per cent, which is relatively high for a long and detailed questionnaire, and provides 1,605 useful observations. The response rates for the size and industry cells vary only little: between 47 and 53 per cent. Concerning organization of work within the company, the firm was asked whether it had adopted the following work practices: self-managed teams, job rotation, 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 other data source, the employer-employee linked panel has been constructed by Statistics Denmark by merging a number of registers utilizing 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 of firms' workforces.

According to the survey, one out of five firms have implemented job rotation schemes for their hourly paid workers. Considerably fewer firms – about 6 per cent – have adopted them for their salaried employees.[3] As can be seen from *Table 3*, about 20 per cent of the firms had already job rotation schemes (for either hourly paid or salaried workers, or both) before 1990 (most of which had introduced them in the eighties), 40 per cent implemented them during the first half of the nineties and equally many during the second half. The pace of adoption does 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 4*. Firms in the services and manufacturing sectors are much more likely than firms in other industries to have implemented them for their hourly paid employees. Firms in the business and finance sector are more likely to

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[3] Compared to other new work practices, job rotation is quite common for the hourly paid workers; only teams are more frequently implemented. In contrast, for the salaried workers job rotation is among the least used.

have introduced them for the salaried employees. For both categories of workers, the share of adopters clearly increases with firm size.

Table 5 gives some summary statistics for the firms that responded to the survey questionnaire as well as some information concerning their workforces. By construction, the sample firms are, on average, larger than Danish companies in general. Likewise, as the firms are from the private sector, the proportion of female employees is considerably lower than of total employment. Moreover, the workforce turnover rate of firms (which will be explained more below) is relatively high; during a year on average 30 and 24.5 per cent of hourly paid and salaried employees, respectively leave their firms. Seventy per cent of the firms have a local wage agreement for their hourly paid workers, implying a relatively strong presence of unions. As for other new work practices, we may note that about one fourth of the firms have self-managed teams, whereas TQM and quality circles are clearly less common.

From the table it can be seen that firms that have adopted job rotation for their workers on hourly pay differ in various ways from those that have not. The adopting firms are slightly younger, considerably larger and faster-growing, and are more likely to have a local wage agreement with the trade unions. These firms are also more prone to recruit new personnel from within the company and/or the local labor market. Furthermore, the adopters are much more probable to have implemented new work practices. Adopters have more frequently introduced performance related pay systems than non-adopters. As for the workforce characteristics, the main difference regards the share of female employees in the firms' workforces.

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

We have carried out a set of logit model estimations for whether the firms have adopted job rotation or not. We have used two separate dependent variables, one for job rotation adoption for hourly paid workers, and another for the salaried employees. As explanatory variables we use three groups of regressors: (i) firm

characteristics, (ii) workforce characteristics, and (iii) other HRM practices and some controls. We next describe them briefly.

Beginning with the firm characteristics, one is *firm size* as measured by the number of employees in the company. Size may matter for two reasons. One is that there are technical constraints to the implementation of job rotation; in order to operate a stable rotation scheme, it is necessary that there are a certain minimum number of jobs. This implies that the job rotation probability increases in firm size. The other reason why size may affect the adoption of job rotation, and moreover in the opposite direction, is that multi-tasking and flexibility is less valuable in larger establishments or firms; see Lazear (1998; 445-46, 473-74).

Another firm characteristic we consider is the hierarchical structure of the firm. Our measure for this pertains only to the salaried employees and is the *number of job levels* in the firm within this category.[4] According to the motivation hypothesis, the fewer the number of levels in the hierarchy, and hence less promotion opportunities there are, the higher is the likelihood of the firm having implemented a job rotation scheme. The less levels in the hierarchy, the more plateaued workers are there. In contrast, the employee and employer learning hypotheses suggest that a positive hierarchy-job rotation relationship could arise as a result of employers using job rotation as a prerequisite for promotions into higher rung jobs with multiple tasks (Ouchi, 1981).

The *age of the firm*, and particularly the extent to which this coincides with the introduction of job rotation, is a potentially important variable. Younger firms that have had job rotation as part of their HRM schemes as from the beginning are likely to have a relatively new technology, and consequently, use job rotation as a means of learning about their employees. Hence, finding a higher probability of job rotation in younger firms is compatible with the employer learning story. In addition to size and age of the firm, we have also included the (5-year average) *growth rate of the* (employment of the) *firm*. This is expected to be positively related to job rotation as expanding firms are in a similar situation as young firms when it comes to learning about new employees in new jobs.

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[4] This information is derived from the survey in which the firms were asked about the number of job levels for non-production workers.

Other features of the companies entered as explanatory variables are the presence of *unions* in the firm, the *relative wage* of the firm and the firm's expenditure on *on-the-job training* of its employees. The presence of unions is proxied by a positive answer to the question whether the firm has 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. Unions occasionally resist more flexible work practices because they are said to increase the pace and stressfulness of work without accompanying higher compensation. We include two alternative measures of the firm's relative wage; the first is relative to local competitors, and the second is relative to industry average.[5] Of course, as the analysis is cross-sectional, we cannot claim unidirectional causality. (That is the topic of a fuller and separate analysis.)

The questionnaire asked the firms how much money they spend on training their employees. From the responses to this question we 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 corresponding relative training costs measure (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. They are strongly correlated and both yield similar estimation results. Hence in what is presented below, we use the relative per capita training costs variable. A positive relation between training costs and job rotation would indicate that rotation is used as a part of employee training programs, which is in accordance with the employee learning hypothesis.

Other firm characteristics included as controls are the already mentioned average rate of employment growth during 1990-95, and industry dummies.

Turning next to the workforce characteristics, it should first be noticed that this information emanates from the linked panel data set. Both employer and employee learning explanations would lead us to expect a negative relation between the average *tenure* of the firm's workforce and the probability of having job rotation schemes. Short average tenure may reflect the age of the firm. However, as we control for that, a low average tenure is more likely to be a consequence of a high

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[5] Both are dummies created from questions in the survey asking firms on this. An alternative source to this 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.

workforce turnover. The distribution of tenure in firm is typically rather skewed, and so the mean is not necessarily a good measure to characterize it. Thus, we have also tried out two alternative workforce turnover measures as explanatory variables: (i) ½(hires in year t + hires in year t-1)/number of employees in year t, and (ii) ½(hires in year t + separations in year t)/number of employees in year t. The measure we use in estimations is an average taken over the annual observations for the period 1985-95.

A third measure used is the share of employees that have been employed less than two years. The motivation for including this variable is that learning does not occur at a constant rate but is mainly concentrated to the first years of an employment relationship after which it declines considerably. Finally, a fourth measure employed is the average *tenure in industry*. This is potentially a key variable, since it allows us to discriminate between the 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.

The gender composition of the firm's workforce is included as the proportion of female employees in respective workforce category. In order to control for differences in skill composition we use the proportion of employees in the relevant category with more than compulsory education, that is 10 years of schooling.

 Beside average characteristics of the firms' workforces, we have computed their standard deviations as measures of the *heterogeneity* of each firm's employees. The idea is that a firm, the workforce of which differs substantially with respect to age, tenure and education, is more likely to benefit more from obtaining information about its employees by rotating them than a firm with a more homogeneous workforce; Lazear (1999), pp. 473-74. Consequently, the employer as well as the employee learning hypotheses imply that the likelihood of job rotation increases with worker heterogeneity.

The HRM practices that are included in our analysis refer to *the firm's recruitment strategy* and to *other new work practices* implemented by the firm. In order to distinguish between the alternative explanations for why firms use job rotation, information about the source of new employees in the firm may be useful. In the survey, the firms were asked about wherefrom they recruited different staff groups. Four different sources of recruitment are of interest here: (i) from within the firm, (ii) the local labour market, (iii) the same industry, and (iv) whole Denmark.

Information about how the firm recruits new personnel can help in distinguishing between competing explanations. In general, one would expect that job rotation is more common in firms that hire their workers from outside. The longer the "distance" between the firm and the recruitment source, the lower is the precision of the knowledge the firm has about its new employees. When the employees are predominantly hired from within, employers need to learn less about them. Consequently, the employer learning hypothesis predicts that job rotation is more common in firms recruiting outside the firm or the local labour market.

Of the other work practices used by the firms, we have entered self-managed teams, TQM and quality circles as additional control variables into the logit models. The motivation for including them is to examine whether these new work practices are complementary as has been argued by e.g. Milgrom and Roberts (1995). As total quality management and quality circles aim at controlling quality at different stages of the production process, it seems natural that employees in firms using these practices need experience of different tasks and in communication with other employees have some familiarity with other jobs and tasks. In addition we have included dummy variables for whether the firm implements the following performance related pay systems: team bonuses, individual bonuses and stock/stock options. The purpose is to examine whether the performance pay schemes provide incentives for employees to engage in job rotations.

III. B. Econometric Analysis

A first set of estimation results are found in *Table 6*. The first four columns present estimates from models including a relatively large number of regressors, whereas the last two columns contain more parsimonious specifications that include only statistically significant coefficient estimates (arrived at by a stepwise estimation procedure). A first thing worth noting is that several of the variables which turned out to be important in explaining firms' adoption of job rotation schemes for the hourly paid workers are also the central explanatory factors for whether the firms have implemented them for salaried employees.

As can be seen from the table, firm size matters. The positive coefficient estimate indicates that there is a minimum scale needed to operate job rotation schemes and that the larger the firm, the more likely is it that this threshold is passed.

The age of the firm variable attaches a positive coefficient, but as this does not differ from zero, this yields little support for the employer learning hypothesis.[6] On the other hand high growth firms, which presumably are in a similar situation as young firms insofar that they also need to learn about their new employees, are more likely to have implemented job rotation schemes. Both the employer learning hypothesis and the employee learning story receive some, albeit limited, support from the estimates to the number of job levels. The rotation probability is significantly higher for firms with a more hierarchical structure.[7]

Other aspects of the firms that are associated with a higher likelihood of job rotation are the presence of unions (for hourly paid workers), higher than average per capita training costs, and a higher relative-to-industry wage (for salaried workers), and a higher employment growth (for the hourly paid). The finding that firms spending more on training their employees are more likely to have job rotation schemes is favourable to the employee learning hypothesis. The fact that the salaried employees are paid more in firms that have adopted job rotation schemes is noteworthy. 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.[8]

Average tenure, both in firm and in industry typically obtain positively signed, but insignificant, coefficient estimates. Also the share of employees with less than 2 years of tenure with the firm did not obtain a coefficient differing significantly from zero. These findings are contradictory to the employer and employee learning hypotheses, which both predict a negative relationship.[9] On the other hand, the coefficient for the average workforce turnover rate is almost significant (at the ten per cent level) for the hourly paid. This could be because high turnover implies several short durations, but a positive relation with turnover could also arise from firms with

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[6] Note, however, that only 13.6 per cent of the firms have introduced rotation schemes as from the year the firm was established, and 15 per cent during the first ten years of the firm's existence.
[7] The estimate for six or more job levels is positive but does not differ significantly from zero. It should be noted, however, that this coefficient may be imprecisely estimated because there are rather few firms using job rotation for their salaried workers and moreover, also not many firms with six or more job levels.
[8] The evidence from the small but growing literature on the benefits of new work practices is something of a mixed bag. Black and Lynch (1999) find positive wage effects, whereas Cappelli and Neumark (2001) find only small wage effects, and Osterman (2000) no effects at all.
[9] Besides those shown in Table 4, we have also tried other measures mentioned in IIIA above, to capture differences in the tenure distributions between firms' workforces, obtaining similar results.

a high turnover rate needing more flexibility in assigning people to jobs and tasks than more stable firms.

The employer learning hypothesis does not receive support from the results concerning the sources of new personnel recruitment. The hypothesis predicts that firms that chiefly recruit from their own ranks or from the local labour market need less job rotation since they possess better information about their new employees than other employers. However, for the hourly paid workers we find the opposite pattern: firms recruiting from within or locally are more likely to have implemented a job rotation scheme. The positive relationship for within-recruitment is not consistent with the motivation hypothesis, either. This suggests that job rotation is less needed when there are better prospects of promotion. On the other hand, the positive relation is compatible with the employee learning argument that job rotation is a way to train employees that can expect to be promoted after completing their rotation. How can the estimates to local labour market and all of Denmark as sources of recruitment be explained? One possibility, consistent with employee learning, is the following. Firms look beyond the local market when recruiting employees with special skills and when it would be more costly to train local candidates. Thus, once they are hired, outside candidates need only little, if any, training. Note, however, that this story also accords with employer learning, since when employing the outside worker with special skills, the firm has a good idea of where she should be placed in the organization.

As for other workforce characteristics, we find that the proportion of females in the firm's workforce 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.[10] We have checked whether the proportion of females is particularly high in some industries or correlated with high workforce turnover, and it turned out not to be. The estimates to the share of workers with more than compulsory education also have relatively large marginal effects, although the coefficients, which differ in sign between the hourly paid and the salaried employees, carry rather large standard errors. Heterogeneity (with respect to age or experience) is contrary to the employer and employee learning hypotheses negatively related to job rotation. This is puzzling as

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[10] Our female colleagues have offered one according to which the results simply confirm the hypothesis that women are inherently more "flexible".

one would expect that rotating employees possessing different pieces of knowledge would be useful.

The estimations do indeed provide evidence of the notion of complementarity between different work practices: teams[11], quality circles and TQM are all positively related to the adoption of job rotation schemes.[12] The adoption of job rotation does not seem to be associated with firms having implemented performance related pay schemes.

Table 7 reports some of our efforts to check the robustness of the estimation results. The first two columns give estimates based on smaller samples obtained by excluding those firms that have implemented rotation schemes prior to 1990. The motivation for imposing this restriction on the data is that most of the explanatory variables refer to the nineties, and in several cases more precisely to the second half of the decade. The exclusion of about one fifth of the firms lead to only marginal changes in the coefficient estimates. The same applies to the two other restrictions that were enforced in the estimations shown in columns (3) to (6). Here we have excluded the most heterogenous firms in order to have the empirical analysis to conform more to the representative firm assumption. This was implemented by first computing for each firm the standard deviation of education years and age of their workforces, and next excluding the 15 per cent of firms in both tails of the standard deviations distributions. As can be seen from the table, the estimates from these more homogenous firm samples resemble those obtained from the full sample closely and their precision is affected only little.

IV.   Conclusions

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[11] The fact that rotation is more likely in firms where teams are being used indicates that the firms are not using the information it learns to re-allocate tasks since their employees work in teams anyway. This would speak against the employer learning hypothesis. However, the firm might use rotation to learn the best way to assign tasks within teams.

[12] In fact, the complementarity is so strong, that it is possible that the inclusion of these other work practices is capturing the effects of other variables "explaining" the adoption of job rotation. We have 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 obtained before; only the explanatory power is significantly reduced.

All in all our econometric analysis provides no support for the motivation hypothesis. Job rotation schemes are not more common in firms with a higher proportion of long-tenured employees, nor in firms with a relatively flat hierarchy and hence little promotion prospects.

The statistical evidence is not favourable to the employer learning hypothesis either. First, there is the absence of a negative job rotation-tenure relationship, which we have been unable to isolate despite the access to a rich data set allowing us to try out several alternative measures of tenure. However, we do find that firms expanding their employment are more likely to rotate their employees. Second, firms that recruit from within use job rotation schemes more frequently than other firms. This is the opposite of what is predicted by the hypothesis.

The only of the three hypothesis that gained some, although rather limited, support from the logit model estimations is the employee learning argument. In particular we found that firms that spend relatively much on training their employees are more likely to rotate workers. On the other hand, we have not been successful in unearthing an inverse relationship between job rotation and tenure in firm or industry. Another negative finding from the perspective of theory, is that there is a negative association between worker heterogeneity, which is a proxy for the potential for information transfer, and job rotation.

In addition to these hypotheses the estimation results also shed some light on other factors influencing firms' decisions to adopt job rotation. Thus, we find that larger firms are more likely to have implemented job rotation schemes. This would indicate that a certain size of the workplace is needed to operate these schemes. It is also possible that in smaller firms, employees carry out multiple tasks and there is therefore less need for a formalized rotation scheme.

We also find that job rotation is complementary with respect to other work practices like self-managed teams, TQM and quality circles. Two of our control variables turned out to be quite important too, although we do not feel we have good explanations for why that is the case. Firms with a higher proportion of female workers are found to be more likely to rotate their employees. This holds even after controlling for industry and workforce turnover. Finally, firms in which the unions are more strongly present are more likely to have rotation schemes for their hourly paid workers.

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Table 1

Empirical Evidence on the Adoption of Job Rotation

SURVEY	Year	Country	SAMPLE	RESP RATE	N	%Rot	DEFINITION
Osterman (1994) National Establishmt Survey	1992	USA	Private sector establishments with +50 employees	65%	875 (694)	26.6	Rate of adoption at 50% rate of penetration.
Educational Quality of Workforce (EQW) Survey (1995)	1994	USA	Private sector establishments with +20 employees	72%	3,347	18.0	Ave. rate of penetration. Ave. rate of penetration for core employees and plants with +50 employees: 21%.
Gittleman, Horrigan and Joyce (1998) [BLS Survey of Employer Provided Training]	1993	USA	Private sector establishments of all sizes	71.3 %	7,895 (5,987)	12.6	Rate of adoption. Rate of adoption for plants with +50 employees: 24.2%
Bailey (1994)		USA	Apparel production sites		480		
Jenkins and Florida (2001)		USA	US-located Japanese manufacturing transplants	40%		63.2	Rate of adoption at 50% rate of penetration.
Pil and MacDuffie (1996)	1989 and 1993	World (17 countries)	Automobile assembly plants	77% and 79%	43 (39)	3.0 and 3.2	Average rate of penetration on a 1-5 scale.
Osterman (2000) National Establishmt Survey	1997	USA	Establishments with +50 employees	57.7 %	683	55.5	Rate of adoption at 50% rate of penetration.
Nordflex (1999) DISKO	1996	Denmark	Establishments with +10 employees		1,900	38.8 14.7 7.0	Rates of adoption at different rates of penetration: 0%, 25%, and 50%.
Eriksson (2000)	1999	Denmark	Private sector firms with +20 employees	51 %	1,605	20.0 6.0	Rate of adoption for hourly paid and salaried employees.

Rate of adoption = Percentage of establishments using job rotation
Rate of penetration = Percentage of employees involved in job rotation

Table 2
Papers that estimate the determinants of adoption:

PAPER	DEPENDENT VARIABLE	DETERMINANTS OF ADOPTION	CONCLUSIONS
Osterman (ILRR 1994)	Bundle of new work practices	- Product market competition - International competition - Competitive strategy (cost, quality, variety, service) - High skill technology - Worker oriented values. - Time horizon (pressures from investors) - Establishment is part of a larger organization - Establishment size - Union - Pay for performance -Training	No Yes - "High road" strategy (quality, variety, service) Yes Yes No Yes No No Yes Yes
Campion, Cheraskin, and Stevens (AMJ 1994)	Rate of job rotation	Career background antecedents: - Tenure - Age - Education - Performance	 Yes Yes Yes Yes
Pil and MacDuffie (IR 1996)	Bundle of new work practices	- Index of complementary HR practices (criteria for selection and hiring, pay for performance, training, status differentiation of employees). - Flexible automation (number of robots) - Log productivity - Log plant quality - Average tenure (negative effect is predicted: more senior, more reluctant to change) - "Broken trust" (layoffs) - Disruptions: major product or process innovations.	Yes No No No No: positive effect of average managerial tenure No Yes
Gittleman, Horrigan and Joyce (ILRR 1998)	Dummy for the use of job rotation	- Establishment size (fixed costs) - Unions - New technology - Supporting HR practices: training, compensation policies, nonmonetary benefits	No No Yes - Wellness programs - Flexible work schedules - Profit sharing - Pay for knowledge - Retention policies (training) - Specific training - Technology-driven training
Kusunoki and Numagami (IEEE T. Eng. Man. 1998)	Frequency of interfunctional transfers	- Tenure - Speed of promotion in previous years - Educational level	No (rotations at all times) Yes No

Table 3

Time of Adoption of Job Rotation

Type of ownership	Before 1991	1991-95	After 1995	Total
Domestic	23.5	39.3	37.2	100.0
Foreign	19.3	42.1	38.6	100.0
All	22.3	40.1	37.6	100.0

Table 4

Percentage of Firms Using Job Rotation

Industry	Hourly paid	Salaried
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
Services	50.0	0.0
Firm size (No. of employees)	Hourly paid	Salaried
-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
Total	19.5	5.7

Table 5

Summary Statistics

Variable	Hourly paid Adopters	Hourly paid Non-adopters	Salaried Adopters	Salaried Non-adopters
Established (%):				
Before 1980	75.1	77.0	75.0	76.6
In 1980s	19.6	20.0	19.0	20.0
In 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
Number of job levels (%):				
3-5			46.8	39.2
6 or more			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
Av. tenure in firm (years)	5.2	4.8	5.3	5.3
Av. tenure in industry (years)	5.5	5.4	5.7	5.7
Prop. with more than comp. educ.	78.6	81.4	84.8	81.2
Prop. female employees	29.6	19.1	30.2	22.3
Recruits from (%):				
Within	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
Work organization (%):				
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
Pay systems (%):				
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
Industry (share in %):				
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

Table 6

Logit Results for the Adoption of Job Rotation

	Hourly paid	Hourly paid	Salaried	Salaried	Hourly paid	Salaried
Number of employees in the firm	0.0005**	0.0010*	0.0004**	0.0006*		
	(0.0000)	(0.0005)	(0.0002)	(0.0003)		
	(0.00006	*(0.0001)*	*(0.00002)*	*(0.00003)*		
Established in the 90s	0.172	0.217	0.653	0.313		
	(0.352)	(0.444)	(0.483)	(0.610)		
	(0.023)	*(0.032)*	*(0.033)*	*(0.014)*		
Established in the 80s	-0.039	-0.174	-0.191	-0.048		
	(0.224)	(0.239)	(0.395)	(0.366)		
	(-0.005)	*(-0.023)*	*(-0.007)*	*(-0.002)*		
3-5 job levels			0.626*			
			(0.362)			
			(0.025)			
6+ levels			0.233			
			(0.404)			
			(0.009)			
Local wage agreement	0.697***	0.561**	0.189			
	(0.238)	(0.258)	(0.487)			
	(0.087)	*(0.077)*	*(0.007)*			
Wage above local competitors	-0.105		-0.227			
	(0.271)		(0.454)			
	(-0.013)		*(-0.010)*			
Wage above industry mean	0.123		0.628			1.365**
	(0.246)		(0.470)			(0.525)
	(0.015)		*(0.020)*			*(0.065)*
Training costs relative to industry	0.172***	0.167***	0.149*	0.120	0.151**	
	(0.057)	(0.059)	(0.083)	(0.080)	(0.065)	
	(0.021)	*(0.023)*	*(0.006)*	*(0.005)*	*(0.006)*	
The firm's growth rate (5-year average) in employment		0.361**		0.197	0.420***	
		(0.157)		(0.211)	(0.142)	
		(0.050)		*(0.008)*	*(0.011)*	
Average tenure in the firm	-0.063		0.040			
	(0.045)		(0.068)			
	(-0.008)		*(0.002)*			
Average tenure in the industry		0.009		0.014		
		(0.043)		(0.067)		
		(0.001)		*(0.0006)*		
Average workforce turnover		0.599		-0.340		
		(0.375)		(0.950)		
		(0.082)		*(-0.014)*		
Proportion of females	1.843***	1.643***	1.735***	1.318**	1.431***	
	(0.424)	(0.390)	(0.668)	(0.564)	(0.432)	
	(0.230)	*(0.225)*	*(0.068)*	*(0.053)*	*(0.055)*	
Proportion with education > 10 years		-1.705		2.846*	-2.296*	4.450**
		(1.131)		(1.687)	(1.188)	(1.802)
		(-0.234)		*(0.115)*	*(-0.099)*	*(0.211)*
Teams	0.197	0.697***	0.719***	0.983***		1.252***
	(0.182)	(0.301)	(0.267)	(0.266)		(0.273)
	(0.026)	*(0.145)*	*(0.033)*	*(0.049)*		*(0.071)*
TQM	0.700**	1.016***	1.049***	0.834**	1.295***	0.811**
	(0.319)	(0.343)	(0.329)	(0.336)	(0.353)	(0.345)
	(0.108)	*(0.183)*	*(0.061)*	*(0.046)*	*(0.194)*	*(0.066)*
Quality circles	1.070***	1.118***	1.059**	0.944**	1.075***	1.024**
	(0.358)	(0.379)	(0.466)	(0.457)	(0.382)	(0.447)
	(0.183)	*(0.206)*	*(0.066)*	*(0.049)*	*(0.052)*	*(0.050)*

Team bonus schemes		0.297 (0.211) *(0.043)*		0.323 (0.404) *(0.015)*		
Individual bonus schemes		0.055 (0.334) *(0.008)*		0.139 (0.276) *(0.006)*		
Stock and stock option plans		0.061 (0.661) *(0.009)*		0.300 (0.395) *(0.014)*		
Recruitment						
From within	0.618*** (0.234) *(0.070)*	0.691*** (0.259) *(0.085)*	0.418 (0.279) *(0.017)*	0.512* (0.277) *(0.022)*	0.731** (0.299) *(0.092)*	
Local labor market	0.440** (0.221) *(0.061)*	0.434* (0.237) *(0.066)*	-0.825 (0.473) *(-0.025)*			
All of Denmark	-0.210 (0.261) *(-0.025)*		-0.026 (0.277) *(-0.001)*		-0.537* (0.305) *(-0.032)*	
Same industry	-0.138 (0.220) *(-0.016)*		-0.029 (0.318) *(-0.001)*			
Std dev of experience of employees					-0.367*** (0.098) *(-0.027)*	-0.496** (0.114) *(-0.032)*
Industry dummies	yes	yes	yes	yes	yes	yes
Pseudo R-squared	0.174	0.187	0.160	0.146	0.197	0.180
Log likelihood	-474.56	-400.58	-226.64	-225.03		
Observations	1,151	943	1,269	1,106	825	1,07

The numbers in parenthesis are the standard errors and the numbers in curly brackets are the marginal effects (evaluated at the mean for continuous variables, and for a discrete change for the discrete variables).

Table 7 Some Robustness Checks

	Hourly paid; firms adopting since 1990	Salaried employees; firms adopting since 1990	Hourly paid; homogenous firms wrt education of employees	Salaried; Homogenous firms wrt education of employees		
Number of employees in firm	0.0007 (0.0008) *(0.0001)*				TBF	TBF
Local wage agreement	0.578* (0.337) *(0.068)*					
Wage above industry mean		1.099** (0.544) *(0.031)*		1.148** (0.551) *(0.033)*		
Training costs rel. to industry	0.184*** (0.072) *(0.022)*		0.217** (0.091) *(0.025)*			
Firm growth (5-year average)	0.410*** (0.155) *(0.048)*		0.368** (0.174) *(0.046)*			
Average work-force turnover rate	0.500 (0.349) *(0.059)*					
Proportion of females	1.720*** (0.497) *(0.203)*	5.687*** (2.057) *(0.159)*	2.039*** (0.588) *(0.303)*			
Prop. with education > 10 years		1.114*** (0.301) *(0.031)*	-2.295 (1.498) *(-0.027)*	5.123** (2.009) *(0.055)*		
Teams		0.663* (0.394) *(0.019)*		1.234*** (0.300) *(0.043)*		
TQM	1.215*** (0.400) *(0.144)*	0.897* (0.513) *(0.025)*	1.418*** (0.439) *(0.152)*	0.832** (0.379) *(0.024)*		
Quality circles	1.356*** (0.414) *(0.160)*		1.098** (0.467) *(0.131)*	0.545 (0.516) *(0.071)*		
Recruitment: From within	0.798** (0.337) *(0.094)*		0.653* (0.371) *(0.087)*			
The local labour market	0.282 (0.281) *(0.033)*					
All of Denmark			-0.572 (0.356) *(-0.037)*			
Std dev of age of employees	-0.170 (0.163) *(-0.020)*	-0.564*** (0.121) *(-0.016)*	-0.344*** (0.118) *(-0.041)*	-0.477*** (0.128) *(-0.014)*		
Industry dummies	yes	yes	yes	yes		

Pseudo R-squared	0.206	0.172	0.192	0.160		
N of obser-vations	728	1,026	509	718		