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Organization Adjustments, Job Training and Productivity: Evidence from Japanese Automobile Makers

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Organization adjustments, job training and productivity: Evidence from Japanese automobile makers[+]

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ABSTRACT

This paper considers the demand for job training and its interaction with organization adjustments through rotation within a team and relocation across teams in response to demand and supply shocks. We employ original survey data from two Japanese automobile makers. The analysis includes estimations of determinants of on-the-job training, and of how much such training contributes to improvements in individual productivity. We also investigate effects of the characteristics of workplace practices, including the behavior of foremen as well as assemblers, on the incentives for individual assemblers to seek job training and productivity improvements.

Keywords: Job training, productivity improvement, relocation, rotation, workplace practices

JEL classification: J24, M53

1. Introduction

Does job training really contribute to improvements in productivity? Do even veteran workers keep on receiving job training? If so, why? Is job training useful for accomplishing multiple tasks in response to unexpected shocks? Using original survey data from the manufacturing establishments of two Japanese automobile firms, we offer answers to these questions. The purpose of this paper is threefold. We first find that there is continuous provision of job training, including for veteran assemblers, although each task in the assembly line seems relatively simple and easily learnt. That being so, why is continuous job training necessary? Second, we estimate the determinants of the incidence and intensity of on-the-job training (OJT). Finally, we consider the impact of OJT and workplace environments and practices on an individual assembler's productivity. It is, of course, imperative to measure the costs and benefits of OJT from the viewpoint of the firm's human resources management strategy, to establish whether and by how much individual productivity improves through the provision of job training.

The main contribution of this paper is the analysis of original survey data collected from assemblers and foremen in representative Japanese automobile makers on their subjective assessment of productivity improvements. The collected data provide a direct link between the intensity of OJT and productivity improvements. Because it is difficult to measure objectively the extent and intensity of OJT and productivity improvements, we use subjectively assessed measures for those variables, even though some measurement error may be involved. To examine its appropriateness as a measure of productivity improvement, we alternatively employ the change in the number of operational tasks that assemblers can perform satisfactorily as evaluated by their foremen. According to the factory director interviewed, assemblers usually assessed their own productivity improvements when responding to the survey questionnaire in terms of an increase in the number of operational tasks they could perform. However, data on operational tasks were available only from a single automaker in the third wave of the survey. Nevertheless, while the original data have some disadvantages, they also have several redeeming qualities. For instance, many economists and business academics have long been suspicious that older workers with long tenure in Japanese automakers remain engaged in job training even though they should by then have mastered all the operations they usually perform. Using our original data, we are able to look inside the black box that until now concealed the effect of OJT on productivity.

Another distinguishing feature of this study is that it explores how the characteristics of both teams and individuals (including their workplace environment and practices) affect the determinants of job training and the extent of productivity improvements (if any). Changes in the workload and assembly line speed responded to by foremen are included in the characteristics of teams, and these capture the extent and intensity of any demand shocks. In addition, *kaizen* proposals for job efficiency improvements and the number of quality control (QC) meetings are also studied, and these capture the extent and intensity of supply shocks.[1] We predict that frequent demand and supply shocks lead to assignment changes for assemblers through rotation within their own team and/or relocation across teams. This generates a demand for job training for assemblers, even veteran assemblers, so they can adjust to the environmental changes. Importantly, while the literature includes the effects of individual characteristics on the intensity of

[1] *Kaizen* means operational improvement in Japanese. In many manufacturing sectors, including the automobile sector, assemblers are encouraged to suggest proposals to improve efficiency in their assembly line.

job training, our study also includes the interaction between individual and team characteristics.

There is some evidence that job training is highly selective, at least in OECD countries other than Japan where no systematic study yet exists. Using data from Thailand, Ariga and Brunello (2006) found that while off-the-job training (OffJT) and education were complements, OJT and education were substitutes. In general, training is most intensive in the early stages of an assembler's career and experience. As for the returns to job training, some studies found very high returns, but these were likely to suffer from selection bias. In fact, and as pointed out by Leuven and Oosterbeek (2008), past studies have relied on data collected from highly heterogeneous workplaces that they likely fail to control. Our samples, on the other hand, use original data from the manufacturing establishments of two Japanese automobile makers that are homogenous in terms of worker characteristics, underlying technology, workplace environment and organizations. Thus, our analysis should not suffer from the selection bias found elsewhere.[2]

The next section discusses why and how an automobile establishment adjusts to demand and supply shocks, and why organization adjustments frequently occur in the Japanese manufacturing sector. Section 3 explains the data, followed by descriptive statistics for job training and subjectively and objectively assessed productivity in Section 4. Section 5 discusses the econometric methodology and Section 6 includes the results. Section 7 shows a simple simulation to discuss the cost and benefit of internal

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[2] Assemblers are not usually transferred across establishments and their turnover rate is very low, but foremen are often instructed to relocate to a different establishment.

labor adjustments. The final section provides some concluding remarks and future research directions.

2. Organization adjustments in response to demand and supply shocks

Why is job training continuously provided, even for veteran assemblers, despite tasks in the assembly line being relatively simple and easy to learn? This subsection explains the linkages between unexpected productivity shocks, the provision of job training, and productivity improvements. Figure 1 depicts these linkages.

We predict that shocks from the demand or supply side induce organization adjustments in assembly lines and workload, thereby increasing the demand for training. Here we focus attention on two types of organization adjustments: job or task rotation within the same team and relocation across teams. We define rotation within the same team as a transfer between production operations in the same team, and define relocation as a broader transfer between teams but within the same establishment. Hildreth and Ohtake (1998) also deal with workforce adjustment through organization adjustments, using establishment-level data from an automobile maker. They find that this automobile maker uses two methods to accommodate changes in labor demand: either a long-term transfer indicating relocation of assemblers across establishments, or a short-term transfer between assembly lines and between production and nonproduction sectors as well as between establishments. Short-term transfers allow the automobile maker to cope with demand fluctuation, showing that it can adjust employment quickly and flexibly, contrary to the common belief that labor demand adjustment is slower in Japan than in Western countries. As this paper emphasizes within-establishment relocation, it is close to the short-term transfer model in Hildreth and Ohtake (1998).

Why is it worthwhile to undertake organization adjustments? There are three reasons to support them. The first is that assemblers rotate within the same teams or are relocated to a different team to cope with demand shocks, including the business cycle, seasonal adjustments and establishment-level shocks. Demand shocks occur regularly for a host of different reasons. Organization adjustments occur more or less continuously, as one model is experiencing growing demand, whereas others' market share is declining.[3] For example, there are fads concerning choice of color in Japan. There was a time when it looked as if every new car was white, and then black turned out to be the most popular color, then light blue, shiny pink, and so on. More (fewer) assemblers are located in the assembly line to cope with the increased (decreased) workload. Flexible organization adjustments reduce the number of redundant assemblers and the surplus of human resource, thereby raising production efficiency.

The second reason is that assemblers are relocated to a new team and receive job training beforehand, so they can perform multiple tasks whenever exogenous shocks occur in the future. Alternatively, to cope with future shocks, a foreman *ex ante* provides his own assemblers with job training to perform multiple tasks through rotation within their own team. For these reasons, even old and veteran assemblers continuously receive training to perform multiple tasks, as shown shortly below.[4]

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[3] For example, buyers began to receive tax credits for buying hybrid cars or ecofriendly cars in April 2009 in Japan. Since then, the demand for those cars (the Toyota Prius in particular) has been rapidly growing.

[4] A major alternative reason to provide old and veteran assemblers with training is to develop talent that can handle "unusual operations" (Koike 1994, 2002). The depth of the skill (as opposed to the width) is such that the highest (deepest) skill involves capability to deal with accidents, and machine malfunctions

The third reason is that *kaizen* proposals encourage the reorganization of operational procedures through rotation within a team and the relocation of assemblers across teams, which leads to increases in team productivity and production efficiency. Monden (1997), which gives detailed examples of the workings at one of the representative automakers in Japan, *Toyota Motor Co.*, shows that through QC meetings, a team scrutinizes the whole operations and proposes which operation is wasteful and should be eliminated, or which operative machine should be refined to improve team efficiency.[5] These raise labor productivity of an assembler in a team and therefore enable the team to produce the same amount of output with a smaller number of assemblers. Moreover, not all *kaizen* proposals are productivity enhancing. Some of them are designed to create a healthier workplace, reduce health hazards, or to enhance the amenity of the workplace. To the extent that some of them necessitate substantive changes in workload distributions, task assignments, and other parameters of the working conditions, the *kaizen* proposals are the ones that capture the supply shock.

According to Monden (1997),[6] at *Toyota Motor Co*.'s Tsutsumi factory, not only assemblers but also foremen, supervisors and managers rotate within and across teams. Even after they became multiskilled, *job rotations* among all assembly line processes occurred every 2–4 hours. The main purpose of this job rotation is to prepare for flexible personnel arrangement in response to exogenous shocks. Monden also suggests

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that need to be resolved quickly on the spot. The "depth" enhances the team productivity by minimizing the delay or stoppage of operation after the incidence. Unlike multiskilling, it seems there is a need for some of the assemblers in the team to have this capability. Note that our original data are not applicable for testing the implications from Koike (1994, 2002).

[5] For example, to identify which operation is wasteful, a foreman and his assemblers measure how many minutes it takes each operation to produce a unit of output by stopwatch. As another example, a grinder machine is modified so that a dust collection cover is installed below the grinder. This reduces assemblers' cleanup time.

[6] See Chapter 11.

some additional merits of job rotation, such as that it prevents assemblers from becoming bored, and that by assigning different tasks, foremen can assign assemblers across operations fairly. Thus veteran assemblers are encouraged to hand down various skills to young assemblers, and assemblers can see the whole picture of the operation process and feel responsible for their own team's goals, while newly assigned assemblers can address problems in a new operation and put forward a *kaizen* proposal for improvements. Channels [1] and [2] in Figure 1 represent this process. Monden (1997) also discusses why multiskills are cultivated in Japan, but not in the US. He points out that in US automakers, jobs are excessively classified and that the wage is determined for each job, which encourages assemblers to specialize in a single operation and does not give assemblers an incentive to learn a range of skills. He finds that because of a lack of OJT, blue-collar assemblers do not have an opportunity to obtain a range of skills.

We should be aware of the cost incurred by undertaking organization adjustments. According to Hildreth and Ohtake (1998), such adjustments incur direct and indirect costs. The direct cost is the transaction cost involved in transfers. There are two types of indirect cost. The first is the efficiency loss of having an incoming assembler assigned to a different operation process; the other is the loss of the gain that the assembler would have produced in the former operation without his/her transfer.

What the firm can do to minimize possible loss of efficiency is to provide job training to assemblers assigned to new operations, thereby minimizing the initial indirect cost or lowering the efficiency loss. Assemblers relocated to a new team in response to a demand or supply shock are required to perform new tasks, and this encourages those assemblers, even veterans, to receive job training to acquire new skills.

Channel [3] in Figure 1 represents this process. In a similar manner, the need for job training arises when assemblers rotate to work on new operations within their own team.

Assemblers provided with job training acquire new skills and should then assess their improvements in productivity. Channel [4] in Figure 1 represents this process. However, relocated assemblers may not have mastered new skills immediately after they have received job training. If so, they may subjectively assess a low productivity gain in the new team.

3. The survey of workers at two automobile assembly plants in Japan

We conducted unique surveys of the manufacturing establishments of two different Japanese automobile makers, referred to as Firm A and Firm B to preserve anonymity. The two firms are typical of other automobile makers listed in the First Section of the Tokyo Stock Exchange. The two firms have establishments in Japan and abroad. Each establishment is an independent production unit, producing several different products under the "just-in-time" production system. Thanks to the generous cooperation from the personnel departments of Firm A and B, we completed three waves of the survey for both firms, so that we have two sets of panels for assemblers and foremen. The distinguishing feature of the surveys is that they cover both assemblers who worked in the assembly line and their foremen,[7] and that both assemblers and foremen subjectively assessed the extent of productivity improvements at the individual level.[8] This allows us to estimate directly the impact of various types of job training on productivity improvements at the individual level.

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[7] Thus, we have generated matched sets of assembly workers and their foreman for 20 to 30 teams in each assembly plant.

[8] The wage level is used as an alternative variable indicating the extent of individual productivity to identify the effect of training on individual productivity (Kawaguchi 2006, Yoshida 2004).

We conducted the first wave of the survey of manufacturing establishments for Firm A in September 2006, with the second and third waves carried out in May 2007 and May 2008, respectively. We collected valid responses from 22 foremen and 100 assemblers in the first wave, 23 foremen and 95 assemblers in the second wave, and 17 foremen and 101 assemblers in the final wave. During this time, the entire auto industry was operating at peak capacity, with Firm A especially in constant need of temporary workers. The firm was chronically short of labor, hiring so many temporary workers that regular full-time workers needed to devote much of their time to teaching these irregular workers, and so lacked any spare time to train themselves. It therefore appears conceivable that the sample period is somewhat unusual in terms of the heavy workloads and the large share of untrained irregular workers. It may also be of some relevance that the sample establishment in the Firm A survey had plans in the near future to undergo a very fundamental and thorough redesign and retooling of its production line. This may also have had some impact on work allocation, as well as on the assignments of regular assemblers and foremen. The survey targeted only full-time employees.

In a similar manner, we conducted consecutive yearly surveys of the manufacturing establishment of Firm B in October 2007, October 2008, and October 2009. The first wave collected valid responses from 27 foremen and 140 assemblers belonging to one of the assembly teams under the supervision of foremen in the manufacturing establishment. The second wave collected information from 26 foremen and 139 assemblers working in the same establishment. For the final wave, we collected data from 24 foremen and 127 assemblers.

The assembler's questionnaire consisted of 20 questions classified into four categories.[9] These are (1) the extent of individual-level training intensity (OJT, OffJT, and self-development), (2) the extent of productivity improvements, the acquisition of skills, and the number of fully fledged operational processes that one can perform, (3) the number of *kaizen* proposals for job efficiency improvement, and (4) evaluation of one's own foreman, workplace environment, and practices. The questionnaire for foremen consisted of nine questions on the workplace environment and practices in their assembly team, the number of QC meetings, and the productivity improvements in their own team. Because the personnel departments of both firms strongly encouraged their assemblers and foremen to participate in the survey, their response rates are almost 100%.

It is technically difficult to measure individual productivity improvement, so we asked for subjective assessments over the past year.[10] The survey asked the sample assemblers the following question: "Assuming that your current work proficiency is 100 and that your productivity immediately after you joined the firm and were assigned to a workplace was zero, what do you think your proficiency level was six months and one year ago?" In response, assemblers were required to choose from the following five categories: (1) 100–95, (2) 95–90, (3) 90–85, (4) 85–80, and (5) less than 80.[11] We used this as a proxy measure of the individual productivity improvement.[12]

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[9] The questionnaires for both assembler and foreman are given in the appendix.

[10] Krueger and Rouse (1998) also use subjective data to measure the extent and intensity of individual productivity and then estimate the effects of corporate training consisting of basic skills development, including reading, writing, and mathematics.

[11] This survey rules out the possibility that an assembler perceives that productivity has deteriorated during the past year. We justify this on the basis that human capital accumulates year by year through job training and barely depreciates in the short run.

[12] The sampled foremen were also questioned about the improvement in productivity in their own team in a subjective way as follows: "If the productivity of your workplace 12 months ago was 100, what

To supplement the subjective measure of individual productivity, we alternatively use the extent of how many operational tasks an assembler had newly acquired over the past year as the objective measure of productivity improvements at the individual level.[13] Because it is not difficult for assemblers to count the number of operational tasks they can perform satisfactorily, we regard this variable as an objective measure with little measurement error. Unfortunately, we could obtain the data on operational tasks only from the third wave of the survey from Firm B. The factory director of Firm B told us that assemblers measured their own productivity improvement based on the increase in the number of operational tasks approved by their own foreman. A table of accomplished operational tasks was prepared for all assemblers and posted on the bulletin board, so everyone understood who had acquired new tasks and how many. We will show the factory director's evidence that the subjective assessment of productivity improvement is correlated positively with this objective measure of the operational tasks, using our data in Section 4.4.

We collected data on the extent of various types of job training, including OJT, OffJT and self-development. Due to space limitation and our priority for informal job training within an establishment, however, we restrict the subsequent analysis to the extent and intensity of OJT and its effect on improvements in productivity at the individual level. Measuring the intensity of individual-level OJT is subjective and self-explanatory in this study, despite the fact that tenure or years of service has often been

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do you think the productivity levels were 6 months ago and today?" In response, the foremen were to fill in any number, implying productivity improvements if the number exceeded 100, otherwise a productivity decline. Because we focus on the impact on an individual employee's productivity, we preclude the analysis of team productivity in this research.

[13] Note that an operational task is different from an operational process in that one operational process comprises multiple operational tasks.

used to proxy the extent of training on the assumption that assemblers in the workplace are provided with training.[14] We asked assemblers several questions concerning OJT intensity.[15] The OJT dummy took a value of one if an assembler responded with nonzero hours for OJT in the previous month or if the assembler responded that there was less OJT than usual, even if the OJT hours in the previous month were zero; otherwise zero. Since our purpose is to capture the provision of OJT for the entire past year, if a person's receipt of zero OJT hours in the previous month is perceived to be less OJT than usual, we interpret this person to have received some OJT in the past year. Moreover, we calculate the hours spent in OJT by multiplying the hours of OJT in the previous month by 12, and then divide by 2.5, 1.5, 1, 0.5, or 0.33, if the assembler responded that the hours of OJT in the previous month were more than double, one and a half times, the same amount, about half, or less than half the average, respectively.

However, we need to recall that these methods cannot accurately measure the extent and intensity of OJT, because it is difficult for assemblers to correctly identify whether job activities are considered as OJT, which in turn leads to measurement error. We also gathered data on demographic and individual characteristics, including age, tenure, education, and duty position. We merge the surveys for foremen and assemblers to estimate the impact of workplace environment and practices on individual productivity.[16]

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[14] In a similar manner, Kurosawa (2001) collected explicit data on the extent of intensity of training from 44 establishments in Kitakyushu City, Fukuoka between 1993 and 1994.

[15] We asked how many hours of OJT were received in the previous month; who provided the OJT (either colleagues or foremen) and how much; and whether they participated in OJT voluntarily or under instructions from their own foreman.

[16] To be comparable, Kurosawa, Ohtake and Ariga (2005) originally collected two-period panel data from 830 randomly selected manufacturing establishments, including information on workplace practices, human resource management and training.

4. Preliminary data analysis

4.1. Organization adjustments (Channels[1] and[2])

We begin with Channels [1] and [2] as depicted in Figure 1. Figure 2 shows the relationship between the number of assemblers within a team and the assembly line speed, as evaluated by the sampled foremen. Assembly line speed is one of the proxies capturing the extent of the demand shock. This analysis also includes data from both Firms A and B. As shown, the number of assemblers increases in a team when the speed of the assembly line also increases, while the number of assemblers decreases in a team with a low assembly line speed. Assemblers were then relocated from the slack team to the busy team to meet the increasing product demands. This implies that assemblers are located across teams efficiently and flexibly in response to frequently arriving shocks.

Alternatively, an increase in the assembly line speed might encourage a foreman to rotate his assemblers within the same team to cope with this demand shock. Our speculation is that the speed of the assembly line would rather be considered as the proxy indicating the extent of the *cross-team* demand shock; that is, this shock spreads to the whole operation across all teams through a change of assembly line speed. When assembly line speed increases, relocations across teams may not be an effective means for adjustments because all teams suffer from a shortage of hands. Therefore, each foreman copes with plant-level demand shocks through rotation within their own teams.

Figure 3 shows the relationship between the number of assemblers within a team and the workload of the team as evaluated by the sampled foremen. It might be that unlike assembly line speed, the workload evaluated by the foremen is one indication of the extent of the *within-team* demand shock, so this shock may be team specific. As shown, the number of assemblers increases in a team where the workload increases, but is reduced in a team where the workload decreases. This strengthens the view that assemblers are transferred from slack teams to busy teams to cope with frequent demand changes. It should be noted that a change of the workload evaluated by the foremen may also be in response to the cross-team demand shock by some measures.

We now explore exactly who is relocated across teams through organization adjustments in response to these demand and supply shocks, using the data of individual assemblers. We predict that assemblers relocated to a different team are more likely to receive job training because they must now perform different tasks. Figure 4 shows a difference in the average tenure within the firm by assemblers relocated to different teams and those who are not. According to Figure 4, the average tenure is longer for relocated assemblers, particularly in 2007 and 2009. One possible interpretation to support this result is that older and veteran assemblers can adjust to the environmental changes more quickly than the younger assemblers.

4.2. Training (Channel[3])

As depicted in Channel [3] in Figure 1, we explore here if and when assemblers relocated to a different team receive job training. Figure 5 displays the extent and intensity of OJT, depending on the timing of the relocation across teams. We find that assemblers relocated more recently to a different team are more likely to receive OJT. This is perhaps because newcomers needed to receive job training to accommodate new tasks in the assembly line. However, the difference in the timing of job training within six months and within one year is minimal. A similar phenomenon is evident in the relationship between average training hours and the timing of relocation. Here, assemblers relocated within six months spend more hours on OJT than those relocated within one year.

According to Figures 4 and 5, we find that older and veteran assemblers are more likely to be relocated than young assemblers, and that assemblers relocated to a different team are more likely to receive job training. This therefore implies that even old and veteran assemblers are continuously provided with training to perform multiple and new tasks. Figures 6 and 7 display the incidence and intensity of OJT by tenure within the firm. As shown in Figure 6, more than 80% of assemblers received OJT, regardless of the length of tenure within the firm. According to Figure 7, the OJT duration would be longer for veteran assemblers than for nonveteran assemblers. Our finding confirms that older and veteran assemblers are more likely to be relocated to a different team because they adapt themselves to a new workplace environment more quickly, thereby encouraging even older and veteran assemblers to receive job training to perform different tasks following relocation.

4.3. Productivity improvements (Channel[4])

This subsection provides descriptive statistics of the improvement in productivity as measured by subjective assessment. Recall that the survey requested the sampled assemblers to respond about their work proficiency of a year before using the following five categories: (1) 100–95, (2) 95–90, (3) 90–85, (4) 85–80, and (5) less than 80, assuming that the current work proficiency is 100. We then calculate the class values of work proficiency according to a lognormal distribution function. Table 1 provides these class values. We consider the increase in work proficiency as a proxy for productivity improvements. We assume that assemblers interpret work proficiency in the same manner. We show the evidence supporting this assumption in the next subsection.

We now explore the relationship between the improvement in individual productivity and job training. Figure 8 displays the proportion of assemblers receiving OJT and its average hours by category of productivity improvement. The horizontal axis represents the categories of work proficiency of a year before, assuming that the current work proficiency is 100, and therefore implies that productivity improves as we move further away from the origin on the horizontal axis. We combine data from both firms in Figure 8. As shown, assemblers who stayed in the lower category of work proficiency a year before are more likely to receive OJT. We reject the null hypothesis that the OJT incidence does not vary by the category of work proficiency at the 1% significance level. However, over 80% of assemblers receive OJT, regardless of the extent of work proficiency. This is consistent with the practice of continuous training for any productivity level. According to the relationship between productivity improvements and hours spent in OJT, assemblers spend on average at least 100 hours per year in OJT. Assemblers who perceive lower improvements in productivity (a 90–95 work proficiency level a year before) spend the longest hours in OJT.

Figure 9 displays the extent of subjectively assessed productivity improvement by participation in OJT over the previous year, using data from both firms. We compute the class values of current work proficiency, assuming that the work proficiency of a year ago is 100, shown on the left vertical axis. The horizontal axis is then an indicator of whether an assembler received OJT over the previous year. As shown, assemblers who received OJT perceived higher productivity improvements than those who did not. This implies that OJT is effective in raising productivity.

4.4. Operational tasks (Channel [4])

To supplement the subjective assessment of productivity improvement at an individual level, we alternatively assess how many more operational tasks an assembler newly acquired over the previous year. This is because we consider additional operational tasks as productivity improvements at the individual level. This variable can also be objective with little measurement error because both assemblers and their foreman can correctly enumerate the operational tasks they can sufficiently perform. Unfortunately, the data on operational tasks are available only from the third wave of the survey from Firm B. Whether an operational task is accomplished or not is determined by one's own foreman. A table of accomplished operational tasks is posted on the bulletin board, so everyone knows who acquires how many operational tasks.

Table 2 provides the correlations between the subjectively assessed productivity improvement and an increase in the number of operational tasks using the data from the third wave of Firm B. As shown, assemblers acquiring more (fewer) operational tasks respond with higher (lower) productivity improvements. This implies that the subjective and objective measures of productivity improvement are strongly correlated. This is consistent with the evidence provided by the factory director of Firm B, who stated in the interview that assemblers measured their own productivity improvement based on the increase in the number of operational tasks posted on the bulletin board when completing the questionnaire. This ensures that the sampled assemblers responded on the subjective measure of their work proficiency in the same way.[17]

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[17] Because we could not obtain data indicating how many additional operational tasks assemblers acquired over the previous year in Firm A, it may not be guaranteed that these assemblers interpret subjectively measured work proficiency in the same manner. However, we found from the literature on

We are interested in the relationship between productivity improvements, as measured by an increase in the number of operational tasks, and the extent and intensity of OJT.

Figure 9 shows the productivity improvement as measured by the increase in the number of operational tasks and participation in job training in the previous year. The right vertical axis represents the number of operational tasks that one could perform currently, assuming that its number a year before is normalized at 100. The horizontal axis is an indicator of participation in job training over the previous year. Assemblers who received OJT tend to be able to accomplish more operational tasks than those who do not, although the null hypothesis that there is no difference in terms of an increase in the number of operational tasks is not significantly rejected. This partially implies that OJT is effective in improving productivity as measured by the number of operational tasks at the individual level.

5. Estimation strategy

We pool the data for each firm for estimation purposes. The appendix gives a list of independent and dependent variables, their definitions and descriptive statistics. We first attempt to estimate the relationship between the productivity shock and organization adjustments, including rotation within the same team and relocation across teams, mainly using the data collected from the responses in the foremen's questionnaire. Here, we employ the extent of assembly line speed (*speed*) and the workload (*workload*) responded by foremen as variables capturing the demand shocks that occur to each team. *Kaizen* proposals suggested from inside and outside the same

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Firm A's business strategy that it employs the same measurement system to capture how many operational tasks are newly acquired.

team (*kaizen_in* and *kaizen_out*) and change in the way of conducting QC meetings within the same team (Δqc) are used as variables capturing supply shocks that occur to each team. Here, *kaizen_in* and *kaizen_out* are, roughly speaking, considered as the *within-team* supply shock and the *cross-team* supply shock, respectively. The dependent variable of rotation is a categorized variable indicating that foremen responded that the opportunities for rotation for their own assemblers within the team increased, remained the same, or decreased over the year (*rotation*). Unfortunately, there are no corresponding variables indicating that foremen responded on how relocation of own assemblers occurred. Using instead the data collected from the responses in the assemblers' questionnaire, we substitute the years assigned in the current team averaged across assemblers within each team as a dependent variable indicating the extent of relocation across teams (*avg_tenure_team*). The short average years of tenure in the current team across assemblers implies that relocation takes place less frequently in this team. It may be possible that we observe the short average years of tenure in a team across assembler because many young newcomers just join in the team. To deal with this problem, we add the average age of assemblers by team as an independent variable.

We next use a probit model for estimating the propensity that an individual assembler receives training while a Tobit model yields the equation for hours of training. The dependent variable is the propensity to receive job training in the probit model (*ojt*) and the censored variable of hours spent in job training in the Tobit model (*ojthour*). Explanatory variables indicate individual characteristics and workplace environments and practices. The individual characteristics include education (*education*), tenure within the firm (*tenure*), tenure within the current team (*indv_tenure_team*), and skill level (*skill*). The workplace environments and practice include the number of operational processes in the same team (*#operation*), its change over the year (*Δ#operation*), whether there is an increase in opportunities for rotation for assemblers within the same team from foremen's viewpoint using the data from the responses in the foremen's questionnaire (*rotation2*), a change in the way of conducting QC meetings within the same team (*Δqc*), and the extent of OJT for other assemblers within the same team and for all other teams (*ojt_team*, *ojthour_team*, *ojt_all*, and *ojthour_all*). For these characteristics, we collected subjectively assessed data from assemblers and foremen.

There are two points on variables regarding rotation and relocation in the probit model. First, we here use the length of tenure of an individual assembler in their current team (*indv_tenure_team*) as a proxy indicating the extent of relocation at the individual level. If the assembler is simply transferred into a new team, his *indv_tenure_team* is zero. On the other hand, staying in the same team for longer implies that relocation across teams has occurred less frequently. The second point is that because there are no corresponding variables indicating how an assembler responded he rotated within the team, we instead use a dummy variable indicating a value of one if foremen responded that the opportunities for rotation for their own assemblers within the team increased, or a value of zero if they remained the same or decreased over the year (*rotation2*). We assume that *rotation2* not only describes the overall extent of rotation in the whole team, but proxies how an assembler rotates within the team.

In this case, rotation within the same team should arguably be treated as endogenous because the decision rests on the foreman of the team. In other words, unobserved foreman's characteristics may not only affect the provision of OJT to own team assemblers, but also the choice of rotation within own team. To control for the potential endogeneity of rotation within the same team, we employ two approaches for the two-stage estimation. The first is a standard model with instruments, where the first stage consists of an OLS estimation of the choice of rotation to derive the predicted value, which is then used as an instrument variable in the probit estimation of OJT incidence and the OLS estimation of OJT duration. As the second approach, we employ the recursive maximum likelihood method. The first stage uses a probit estimation of the choice of rotation, and then the predicted value is included as an instrument variable in the second stage. Excluded instruments we employ in the first stage are *speed*, *workload*, the number of absentees in a team (*injury*), *kaizen_in*, and *kaizen_out*. These instruments are closely correlated with the choice of rotation but do not directly affect the determinants of OJT. The changes of these instruments first affect the organization adjustment to produce more efficiently, then encouraging foremen to provide OJT with their assemblers to cope with the organization adjustment. We confirmed the validity of excluded instruments in the first stage of estimations.

The primary focus is on measuring the effects of rotation and relocation (as measured by tenure within the current team) on the provision of job training. Another hypothesis is that the frequent meetings and opportunities for individual development through QC meetings and *kaizen* proposals raise assembler morale, thereby encouraging them to participate in and spend more hours in job training.

Our attention now turns to the estimation of the effect of training on the improvement in productivity at the individual level. The propensity for productivity improvement is determined by vectors of explanatory variables reflecting individual characteristics, the workplace environment and practices, and either a continuous variable for training hours (*ojthour*) or a dummy variable taking a value of one if assemblers received training (*ojt*). The dependent variable represents the likelihood of productivity improvement with respect to either subjective or objective measurement (Δp and *Δ#task*). Our principal focus is the estimated coefficient of the training variable. Our hypothesis is that productivity improvements are positively associated with the extent and intensity of training.

6. Results

6.1. Relocation across teams and rotation within the same team

We begin by estimating the determinants of relocation across teams and rotation within the same team. We hypothesize that organization adjustments, such as relocation and rotation, are caused by exogenous shocks from both the demand and supply sides, which thereby demand that assemblers receive job training to acquire different skills.

Table 3 provides the results of the ordered probit model estimating the determinants of rotation within the same team. For each team in the sample, the dependent variable is categorized as –1 for a decrease in rotation opportunities, 0 for unchanged and 1 for an increase in rotation opportunities conducted to foremen over the past year (*rotation*). The assembly line speed (*speed*) has a positive effect on the extent of rotation within the same team at the 1% level of significance in columns (1) and (3), while the workload (*workload*) is statistically insignificant for rotation. It would then appear that to cope with demand shocks, foremen rotate assemblers across different operations within the same team. The variables capturing supply shocks are statistically insignificant for rotation in columns (2) and (3). Foremen rotate their own assemblers across various operations within their own teams, regardless of whether *kaizen* proposals are put forward.

Table 4 displays the results of the OLS models used to estimate the determinants of relocation across teams over the past year. As mentioned before, we substitute the team-assigned tenure of years averaged across assemblers within each team as the dependent variable because there are no variables indicating the extent of relocation across teams from the foremen's questionnaire. We obtain the dependent variable from the responses in the assemblers' questionnaire. Note that F-values are not large enough to pass an F test except for column (2). We find that the workload has a negative but marginal effect at the 10% level of significance in column (1) although the assembly line speed remains insignificant. Here, as a foreman has a greater workload in his own team, he demands an increase in the number of assemblers in his own team, and this reduces average tenure across assemblers within the current team. The variables capturing supply shocks remain statistically insignificant. It thus appears that demand shocks induce organization adjustments, including relocation of assemblers across teams and rotation of assemblers within the same team.

In a nutshell, we interpret that these two results may indicate the selective use of job rotations and relocations, depending upon the nature of the demand shock. Assuming that a change in the line speed is relatively considered as the proxy indicating the extent of cross-team demand shocks as discussed in Sevtion4.1, it makes sense that job rotation within the team is used when this demand shock arrives. Reshuffling task assignments can be used in each team to cope with the establishment -wide changes in the workload, but relocation across teams cannot cope with such a demand shock affecting all the teams in the same plant. For example, in slack periods, each team can make use of a lower workload to assign line workers to new tasks (OJT), whereas the foreman reshuffles team assemblers to maximize their output in meeting demand.

On the other hand, assuming that a change in the workload of a team is relatively considered as the proxy indicating the extent of team-specific demand shocks, we suspect that relocation is primarily used to accommodate this shock. We guess that as the shock is localized, the best way to cope with such shocks is to use worker reallocation across teams to smooth workload distribution across teams. Unfortunately, the estimates in Table 4 are not robust or strong enough to confirm our guess. Nevertheless, it might be fair to say that the result in Table 4 at least shows that the localized or team-specific shock (*workload*) induces relocation, but not the cross-team shock (*speed*).

6.2. Determinants of job training

Tables 5 and 6 display the estimated results of the probit and Tobit models for the determinants of OJT incidence and the hours spent in OJT. We pooled data from both firms and estimated each model. When we look closely at the factors that individually and significantly affect the determinants of job training and its duration, there are certain characterizations of the workplace and the team that affect OJT incidence and its duration for both automobile makers.

It is worth noting from column (5) in Table 5 that the extent of rotation within the same team (*rotation2*) has a positive effect on OJT incidence at the 5% level of significance. This result supports the hypothesis that assemblers are encouraged to receive OJT and acquire new skills to perform different tasks assigned from transfers through rotation. As discussed, because organization adjustments such as rotation within the same team are efficiently and flexibly undertaken in response to demand shocks, assemblers receive OJT after rotation whenever shocks occur or are expected to occur. Remind that the variable indicating the extent of rotation within the same team (*rotation2*) is collected from the responses in the foremen's questionnaire because there are no variables measuring how an individual assembler rotates within his team from the responses in the assemblers' questionnaire. Therefore, the extent of rotation within the same team (*rotation2*) is endogenously biased in such a way that unobserved foreman's characteristics may not only affect the provision of OJT to own team assemblers, but also the choice of rotation in own team.

Columns (6) and (7) take into account this endogenous problem, which thus gives unbiased estimates of the effect of rotation within the same team on OJT participation. Columns (6) and (7) display results of a standard model with instruments and a recursive maximum likelihood method, respectively. Similar to column (5), rotation within the same team (*rotation2*) remains positively significant in column (6), but rotation within the same team turns out to be insignificant in column (7). After controlling for the endogeneity of rotation, the effect of *rotation2* on the incidence of OJT is mixed.

According to Table 6, tenure within the current team (*indv_tenure_team*), which proxies the extent of relocation that an individual assembler has experienced, has a negative effect on the average hours of OJT at the 5% level in columns (4) to (7). This indicates that as assemblers are relocated to a different team, they spend more time learning new skills through OJT. Rotation within a team (*rotation2*) is statistically insignificant for the OJT duration when rotation within a team is treated as exogenous. Even after controlling for the endogeneity of rotation, the significance of both variables remains unchanged in columns (6) and (7), comparable with column (5), although the magnitudes of some coefficients are different.

In conjunction with measurement error, there may be “recall bias” among assemblers. There are two possible types of OJT. First, through OJT, assemblers acquire new skills for newly assigned tasks, and secondly, assemblers repeatedly operate the same tasks and thus polish skills that they have already acquired. The assemblers are more likely to recall the former as OJT, thereby underreporting the intensity of OJT. In these estimations, as we repeat, the variable indicating the extent of rotation within the team (*rotation2*) does not imply the extent of how an individual assembler has rotated within his team, but the extent to which the team as a whole has undertaken rotation within the team from the viewpoint of each foreman. Therefore, it is fair to say that recall bias is not a serious issue in our estimations. Moreover, there is the collateral evidence that also indicates recall bias is not an issue. According to the appendix (descriptive statistics), on the one hand, approximately 50% of foremen responded that rotation increased across their own assemblers within the team, and the mean probability for an assembler being relocated across teams is calculated as 38.8%.[18] On the other hand, at least 80% of assemblers responded that they received OJT, regardless of the length of tenure within the firm (see Figure 6). This comparison implies that some assemblers not only received OJT to acquire new skills for newly assigned tasks through rotation or relocation, but also that other assemblers were aware they needed to receive OJT to polish their skills for the same task. Therefore, again, it is fair to say that assemblers considered training just to polish skills as OJT.

[18] According to the appendix, the mean of tenure within the firm (*tenure*) is 13.537 years, while the mean of tenure that an assembler has belonged to the current team (*indv_tenure_team*) is 5.252 years. Therefore, the mean probability of an assembler being relocated across teams is calculated by 5.252 divided by 13.537.

Looking at Table 6, the number of operational processes in a team (*#operation*) is negative for OJT hours at the 1% level of significance in columns (3)–(5). This implies that assemblers either cannot afford to spend time on OJT in a busy team in which there are many operational processes or, because they operate only a few simple tasks in one operation process if operational tasks are segmented into many operation processes, they do not need to spend time on OJT. Columns (5)–(7) in Table 5 and columns (5) and (6) in Table 6 indicate that the average OJT incidence and duration of any other assembler across all teams (*ojt_all* and *ojthour_all*) are significantly negative for an assembler's own OJT incidence and its duration. This implies that one assembler receives OJT when other assemblers do not. It would then appear that OJT is substitutable between assemblers; that is, one receives OJT while another cannot. In contrast with our prediction, skill level and tenure within the firm are statistically insignificant for both OJT incidence and its duration.[19]

6.3. Does job training improve productivity?

This subsection reports the effect of job training on the improvements in subjective and objective productivity. We estimate OLS models where the dependent variable represents the extent of productivity improvement over the past year.

We begin with explaining the estimated results shown in Tables 7 and 8. The incidence of job training is included in the explanatory variable vector in the former while the duration of job training is included in the latter. Of foremost interest among the dependent variables are the dummies indicating the incidence of job training and the continuous variables for hours of job training. As shown in Table 7, the incidence of

[19] According to Kurosawa (2006), assemblers with shorter tenure are more likely to participate in OffJT and self-development programs. However, the impact on the incidence of OJT is not addressed.

OJT (*ojt*) has a positive effect on improvement in productivity at the 1% level of significance. As one would expect, this supports the hypothesis that OJT contributes to making an individual assembler more productive from a subjective viewpoint. This result is partially comparable with those obtained in Kurosawa (2001) and Kurosawa, Ohtake and Ariga (2005). In the former, the effect on wages does not clearly differ by form of training,[20] and in the latter, OJT participation has an insignificant effect on establishment-level productivity.[21] Our concern now is with the effects of OJT duration. In contrast with our prediction, OJT duration (*ojthour*) is statistically insignificant for the improvement in productivity, except in column (1) in Table 8.

Some other factors affect improvements in productivity. The improvement in productivity assessed from a subjective viewpoint in the one-year lagged period (Δp_past) has a positive effect on that subjectively assessed over the previous year at the 1% level of significance, as shown in both Tables 7 and 8. This result implies that assemblers who assess higher improvements in productivity in the past tend to assess higher improvements now. A change in the way of conducting QC meetings over the previous year (Δqc) is statistically insignificant, which is comparable with Kurosawa, Ohtake and Ariga (2005) where participation in suggestion meetings has a significantly positive effect on establishment-level productivity.

Here we examine the effect of job training at an individual level on improvements in productivity from an objective viewpoint using the data on the operational tasks that assemblers can sufficiently perform. Recall that the data are only available from the

[20] The exception is that the effect of formal training on wages was significantly negative for assemblers over 45 years of age.

[21] However, the effect of OffJT participation is significantly positive on establishment-level productivity.

third wave of the survey from Firm B. Because the sample size is small, the standard error may be large, thereby reducing the significance of the variables. Before estimating the effect of job training on productivity improvement as measured by the increase in the number of operational tasks, we examine the relationship between the productivity improvements from the subjective and objective viewpoints. According to Table 9, an increase in operational tasks is positively correlated with a subjectively assessed improvement in productivity at the 1% level of significance. Therefore, we consider the increase in operational tasks to be an objective variable representing an improvement in productivity.

Tables 10 and 11 display the OLS estimates where the dependent variable is continuous, indicating the change in the number of operational tasks that assemblers can sufficiently perform (*Δ#task*). First, except for column (1) in Table 11, we cannot significantly reject the joint hypothesis that the coefficients on all explanatory variables are zero according to the F test. Our estimations thus do not explain much of the variation. Despite this, we report estimated results. The incidence of OJT (*ojt*) is statistically insignificant for an increased rate of operational tasks. The incidence of OJT is significantly positive for the subjectively assessed improvement in productivity, as shown in Table 7, but insignificant in the model where the increase in operational tasks is the dependent variable. One possible reason is that, as discussed earlier, the small sample size may increase the standard error of the coefficient and therefore reduce the significance. Because the estimates cover the three waves of the survey from both Firms A and B in Table 7, while the estimates in Table 10 include only the third wave of the survey from Firm B, we cannot directly compare the estimated results. We at least obtain a positive sign of the coefficient on OJT, which is consistent with the results in Table 7. The OJT hours (*ojthour*) are marginally and significantly positive in column (1) in Table 11, but the significance declines when including other explanatory variables.

Although the subjectively assessed improvement in productivity is correlated significantly with the increase in operational tasks, we have different results for the effect of OJT incidence depending on the measure of productivity improvement used as the dependent variable in Tables 10 and 11. This may be a result of the small sample size increasing the standard error of the coefficient on OJT.

7. Cost effects of organization adjustments

This section briefly discusses a comparison of labor adjustment costs by internal transfer (organization adjustment) with hiring/firing from the external labor market. Table 12 shows that 32.68% and 19.86% of assemblers are on average relocated to a different team over one year in Firms A and B, respectively. We calculate the cost that the firm would have incurred if the same percentages of assemblers had been replaced by hiring or firing from the external labor market and then compare it with the adjustment cost of the internal transfer.

Table 12 shows the cost adjusted through the external labor market, normalizing the training cost for an internal assembler to be one, regardless of whether or not relocated. The assembler size is normalized at one for simplicity. We consider cases in which the individual cost for job training is higher for a newly hired assembler than for an incoming internal assembler by 10%, 25%, 50% and 100%.

In the case of 10%, Firm A would have increased its total training cost by 3.3% if 32.68% of assemblers had been obtained from the external labor market.[22] In a similar manner with 25%, 50% and 100%, Firm A has the greater burden of training costs by 8.2%, 16.3% and 32.7%, respectively. Firm B would also have incurred a larger burden of training costs by hiring assemblers from the external labor market. This exercise implies that when labor adjustment frequently and largely occurs in response to demand shocks, labor adjustment through internal transfer such as relocation is cheaper than labor adjustment by hiring from the external labor market.

8. Concluding remarks

It is difficult to measure the effect of job training on productivity at the individual level, but there is no doubt that it is very important for constructing and evaluating a job training strategy to enhance human resource development. We collected unique data on job training and productivity improvements from the establishments of two Japanese automobile makers and evaluated the subjective impact of OJT on individual productivity improvements. We investigated (1) whether OJT is continuously provided to any assembler, even when each task is relatively easy to learn, (2) the determinants of the extent and intensity of firm-level training such as OJT, and (3) the impact of training and workplace environments and practices on subjective and objective individual productivity improvements.

Our main findings are as follows. (1) Firms provide OJT to assemblers when they are assigned to different operations in which the skills they have thus far obtained become

[22] The cost that Firm A would have paid if 32.68% of assemblers in the establishment were hired from the external labor market is calculated as follows: 0.3268×(1+0.1)+(1–0.3268)=1.033, assuming that the adjustment cost of internal transfer is normalized to one. In cases of 25%, 50% and 100%, 0.1 are replaced by 0.25, 0.5, and 1 in the above equation, respectively.

useless, through both rotation within the same team and relocation to a different team. (2) Firms undertake organization adjustments in response to productivity shocks. (3) Assemblers who receive OJT perceive their gains in productivity from a subjective viewpoint. Another finding is that older and veteran assemblers are more likely to be relocated to a different team because they adapt to change more quickly than do the young, implying that even older and veteran assemblers need to receive job training to perform different tasks following relocation.

Our original data allow us to gauge measures that are important but difficult to obtain, such as OJT incidence and productivity improvement at an individual level. Our paper's novel contribution is to detect the relationships between the incidence of OJT and productivity improvement. It may be problematic that the period within which we are measuring the impact of training activities on productivity is too short; we cannot therefore capture the long-term effects of OJT on productivity improvements. Those questions will be topics for future research.

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Table 1: Distribution of improvement of productivity with a subjective viewpoint

response		Total	Firm A	Firm B
1	95-100	149[21.88]	40[13.61]	109[28.17]
2	90-95	159[23.35]	66[22.45]	93[24.03]
3	85-90	124[18.21]	63[21.43]	61[15.76]
4	80-85	103[15.12]	53[18.03]	50[12.92]
5	-80	146[21.44]	72[24.49]	74[19.12]

The categories represent productivity level of one year ago, assuming that the current productivity level is 100. Standard deviations are in parentheses.

Table 2: Correlation between productivity improvement with a subjective viewpoint and an increase in operational tasks that an assembler can perform

Productivity	Operational tasks					
Improvement	95-100	90-95	85-90	80-85	-80	Total
95-100	12	0	1	1	3	17
90-95	7	1	1	1	7	17
85-90	6	0	2	0	9	17
80-85	4	0	0	0	8	12
-80	0	1	0	0	23	24
Total	29	2	4	2	50	87

The third wave of the survey from Firm B was used. The horizontal categories indicate the number of operational tasks that one could perform one year ago, assuming that the current number is normalized 100. On the other hand, the vertical categories represent subjectively-assessed productivity level of one year ago, assuming that the current productivity level is 100.

Table 3: Determinants of rotation

	(1)		(2)		(3)	
	Coefficient	p value	Coefficient	p value	Coefficient	p value
firm_A	-0.147	[0.519]	-0.247	[0.268]	-0.153	[0.522]
speed	0.399	[0.002]***			0.394	[0.002]***
workload	-0.04	[0.807]			0.017	[0.921]
injury	0.084	[0.669]			0.009	[0.963]
kaizen_in			0.258	[0.432]	0.313	[0.349]
kaizen_out			-0.236	[0.324]	-0.175	[0.482]
Δqc			0.109	[0.674]	0.087	[0.751]
	obs = 118		obs = 116		obs = 114	
	LR chi2(4) = 11.810		LR chi2(4) = 3.230		LR chi2(7) = 13.140	
	Prob > chi2 = 0.019		Prob > chi2 = 0.520		Prob > chi2 = 0.069	
	Pseudo R2 = 0.054		Pseudo R2 = 0.015		Pseudo R2 = 0.061	

*** 1%, ** 5%, * 10% significance. Standard errors are in parentheses. The dependent variable is categorized as -1 for decease, 0 for unchanged and 1 for increase obtained from the responses in the foremen's questionnaire (*rotation*). The ordered probit estimation method is employed. Independent variables: dummy for Firm A (*firm_A*), assembly line speed in a team (*speed*), the burden of workload in a team (*workload*), the number of absentees in a team (*injury*), Kaizen proposals suggested from inside the team (*kaizen_in*), Kaizen proposals suggested from outside the team (*kaizen_out*), and a change in the way of conducting the Quality Control meetings (*Δqc*)

Table 4: Determinants of relocation

	(1)		(2)		(3)	
	Coefficient	p value	Coefficient	p value	Coefficient	p value
constant	3.282	[0.260]	-0.173	[0.954]	2.142	[0.482]
firm_A	-0.93	[0.094]*	-1.327	[0.021]**	-1.156	[0.043]**
avg_age_team	0.085	[0.312]	0.16	[0.067]*	0.103	[0.230]
speed	-0.109	[0.719]			-0.009	[0.975]
workload	-0.715	[0.081]*			-0.691	[0.107]
injury	-0.424	[0.369]			-0.57	[0.244]
kaizen_in			0.594	[0.487]	0.351	[0.664]
kaizen_out			0.818	[0.186]	0.71	[0.235]
Δqc			0.195	[0.769]	0.413	[0.517]
	obs = 117		obs = 115		obs = 113	
	F(5, 111) = 1.80		F(5, 109) = 1.96		F(8, 104) = 1.72	
	Prob > F = 0.119		Prob > F = 0.090		Prob > F = 0.103	
	R-squared = 0.075		R-squared = 0.083		R-squared = 0.117	
	Adj R-squared = 0.033		Adj R-squared = 0.041		Adj R-squared = 0.049	

*** 1%, ** 5%, * 10% significance. Standard errors are in parentheses. The dependent variable is the average tenure across assemblers within the current team obtained from the data of responses in the assemblers' responses (*avg_tenure_team*). The OLS estimation method is employed.

Independent variables: dummy for Firm A (*firm_A*), average age of assemblers in a team (*avg_age_team*), assembly line speed in a team (*speed*), the burden of workload in a team (*workload*), the number of absentees in a team (*injury*), Kaizen proposals suggested from inside the team (*kaizen_in*), Kaizen proposals suggested from outside the team (*kaizen_out*), and a change in the way of conducting the Quality Control meetings (Δqc)

Table 5: Determinants of OJT incidence

	(1)		(2)		(3)		(4)		(5)		(6)		(7)	
	Coefficient	p value	Coefficient	p value	Coefficient	p value	Coefficient	p value	Coefficient	p value	Coefficient	p value	Coefficient	p value
Constant	1.966	[0.000]***	1.278	[0.000]***	2.147	[0.000]***	2.381	[0.001]***	33.22	[0.000]***	39.740	[0.000]***	36.735	[0.000]***
firm_A	-0.152	[0.371]	-0.022	[0.908]	-0.28	[0.262]	-0.343	[0.206]	-0.559	[0.074]*	-0.580	[0.032]**	-0.685	[0.025]**
#operation	-0.032	[0.028]**			-0.039	[0.097]*	-0.048	[0.065]*	-0.046	[0.105]	-0.070	[0.004]***	-0.064	[0.028]**
Δ#operation			-0.009	[0.634]	0.013	[0.559]	0.02	[0.424]	0.017	[0.529]	0.024	[0.298]	0.023	[0.383]
tenure							0.008	[0.680]	0.002	[0.933]	0.000	[0.996]	0.002	[0.905]
skill							0.005	[0.982]	0.082	[0.717]	0.066	[0.728]	0.066	[0.765]
indv_tenure_team							-0.032	[0.087]*	-0.033	[0.100]	-0.013	[0.523]	-0.029	[0.205]
rotation2									0.401	[0.026]**	1.733	[0.000]***	1.019	[0.137]
Δqc									-0.379	[0.187]	-0.506	[0.035]**	-0.398	[0.178]
ojt_team									0.231	[0.705]	-0.275	[0.614]	0.021	[0.973]
ojt_all									-34.292	[0.000]***	-41.668	[0.000]***	-38.000	[0.000]***
	Obs = 566		Obs = 317		Obs = 317		Obs = 291		Obs = 285		Obs = 268		Obs = 268	
	LR chi2(2) = 4.88		LR chi2(2) = 0.24		LR chi2(3) = 3.03		LR chi2(6) = 6.35		LR chi2(10) = 24.23		Wald chi2(10) = 57.25		Wald chi2(10) = 2.80	
	Prob > chi2 = 0.087		Prob > chi2 = 0.887		Prob > chi2 = 0.388		Prob > chi2 = 0.385		Prob > chi2 = 0.007		Prob > chi2 = 0.000		Prob > chi2 = 0.012	
	Pseudo R2 = 0.013		Pseudo R2 = 0.001		Pseudo R2 = 0.014		Pseudo R2 = 0.032		Pseudo R2 = 0.121					

*** 1%, ** 5%, * 10% significance. Standard errors are in parentheses. The dependent variable is the dummy indicating whether or not to receive OJT (*ojt*). The dummy variable (*rotation2*) is treated as exogenous in columns (1)-(5) but as endogenous in columns (6) and (7). In column (6), the first stage is an OLS estimation, while a probit estimation is employed in the first stage in column (7). Both columns employ a probit estimation for the OJT incidence in the second stage. Instruments: assembly line speed in a team (*speed*), the burden of workload in a team (*workload*), the number of absentees in a team (*injury*), Kaizen proposals suggested from inside and outside the team (*kaizen_in* and *kaizen_out*). Independent variables: dummy for Firm A (*firm_A*), the number of operation processes in team (*#operation*), a change in the number of operation processes in a team (*Δ#operation*), tenure within the firm (*tenure*), skill level (*skill*), tenure of an assembler in the current team (*indv_tenure_team*), dummy for rotation (*rotation2*), a change in the way of conducting the Quality Control meetings (*Δqc*), team-average of OJT reception except self (*ojt_team*), and average OJT (*ojt_all*). Education is dropped because of perfect collinearity.

Table 6: Determinants of OJT hours

	(1)		(2)		(3)		(4)		(5)		(6)		(7)	
	Coefficient	p value	Coefficient	p value	Coefficient	p value	Coefficient	p value	Coefficient	p value	Coefficient	p value	Coefficient	p value
constant	125.909	[0.003]***	49.623	[0.008]***	240.455	[0.001]***	301.275	[0.002]***	543.897	[0.002]***	2872.137	[0.064]*	2459.549	[0.091]*
firm_A	38.4	[0.071]*	55.402	[0.027]**	2.77	[0.928]	-11.165	[0.729]	13.095	[0.713]	-39.490	[0.279]	-36.562	[0.314]
#operation	-3.89	[0.042]**			-8.967	[0.005]***	-10.068	[0.002]***	-8.577	[0.008]***	-8.302	[0.03]**	-7.677	[0.041]**
Δ#operation			-0.137	[0.952]	4.68	[0.101]	5.156	[0.072]*	4.235	[0.142]	4.999	[0.096]*	4.905	[0.104]
tenure							0.009	[0.997]	0.259	[0.898]	0.382	[0.855]	0.430	[0.838]
education							-26.341	[0.608]	-42.858	[0.387]	-64.110	[0.226]	-68.158	[0.197]
skill							13.027	[0.600]	14.056	[0.560]	21.646	[0.395]	21.857	[0.393]
indv_tenure_team							-6.005	[0.012]**	-5.378	[0.022]**	-6.065	[0.034]**	-6.501	[0.021]**
rotation2									-22.06	[0.262]	-26.424	[0.801]	-62.797	[0.502]
Δqc									-51.997	[0.129]	-54.963	[0.169]	-47.630	[0.222]
ojthour_team									0.169	[0.166]	124.692	[0.112]	130.109	[0.097]*
ojthour_all									-2.197	[0.074]*	-2943.250	[0.086]*	-2483.281	[0.123]
	Obs = 565		Obs = 317		Obs = 317		Obs = 311		Obs = 305		Obs = 287		Obs = 287	
	LR chi2(2) = 14.380		LR chi2(2) = 4.940		LR chi2(3) = 13.010		LR chi2(7) = 21.220		LR chi2(11) = 30.580		Wald chi2(10) = 36.04		Wald chi2(11) = 36.11	
	Prob > chi2 = 0.001		Prob > chi2 = 0.084		Prob > chi2 = 0.005		Prob > chi2 = 0.004		Prob > chi2 = 0.001		Prob > chi2 = 0.000		Prob > chi2 = 0.000	
	Pseudo R2 = 0.002		Pseudo R2 = 0.002		Pseudo R2 = 0.004		Pseudo R2 = 0.006		Pseudo R2 = 0.009					

*** 1%, ** 5%, * 10% significance. Standard errors are in parentheses. The dependent variable is the OJT duration (*ojthour*). The dummy variable (*rotation2*) is treated as exogenous in columns (1)-(5) but as endogenous in columns (6) and (7). In column (6), the first stage is an OLS estimation, while a probit estimation is employed in the first stage in column (7). Both columns employ an OLS estimation for the OJT duration in the second stage. Instruments: assembly line speed in a team (*speed*), the burden of workload in a team (*workload*), the number of absentees in a team (*injury*), Kaizen proposals suggested from inside and outside the team (*kaizen_in* and *kaizen_out*). Independent variables: dummy for Firm A (*firm_A*), the number of operation processes in team (*#operation*), a change in the number of operation processes in a team (*Δ#operation*), tenure within the firm (*tenure*), education (*education*), skill level (*skill*), tenure of an assembler in the current team (*indv_tenure_team*), dummy for rotation (*rotation2*), a change in the way of conducting the Quality Control meetings (*Δqc*), team-average of OJT reception except self (*ojt_team*), and average OJT (*ojt_all*)

Table 7: Determinants of productivity improvement -subjective viewpoint (independent variables: incidence of job training)

	(1)		(2)		(3)		(4)		(5)		(6)	
	Coefficient	p value	Coefficient	p value	Coefficient	p value	Coefficient	p value	Coefficient	p value	Coefficient	p value
constant	109.871	[0.000]***	109.587	[0.000]***	70.595	[0.000]***	70.593	[0.000]***	70.592	[0.000]***	299.978	[0.006]***
firm_A	3.116	[0.000]***	2.189	[0.125]	1.272	[0.350]	1.202	[0.395]	1.205	[0.397]	7.59	[0.025]**
ojt	4.255	[0.001]***	6.223	[0.001]***	5.496	[0.002]***	6.126	[0.001]***	6.123	[0.001]***	6.175	[0.001]***
#operation			-0.058	[0.684]	-0.015	[0.913]	-0.024	[0.862]	-0.024	[0.868]	-0.02	[0.890]
Δ#operation			0.027	[0.844]	-0.071	[0.595]	-0.077	[0.566]	-0.077	[0.573]	-0.066	[0.641]
Δp_past					0.341	[0.000]***	0.331	[0.000]***	0.331	[0.000]***	0.327	[0.000]***
tenure							-0.066	[0.485]	-0.066	[0.485]	-0.074	[0.434]
education							1.284	[0.551]	1.277	[0.557]	1.227	[0.571]
skill							0.214	[0.845]	0.217	[0.845]	0.339	[0.759]
Δqc									-0.038	[0.979]	0.129	[0.931]
Δp_team											-0.07	[0.481]
Δp_all											-1.947	[0.044]**
	Obs = 680		Obs = 311		Obs = 305		Obs = 304		Obs = 304		Obs = 303	
	F(2, 677) = 13.54		F(4, 306) = 4.25		F(5, 299) = 11.51		F(8, 295) = 7.27		F(9, 294) = 6.44		F(11, 291) = 5.76	
	Prob > F = 0.000		Prob > F = 0.002		Prob > F = 0.000		Prob > F = 0.000		Prob > F = 0.000		Prob > F = 0.000	
	R-squared = 0.039		R-squared = 0.053		R-squared = 0.161		R-squared = 0.165		R-squared = 0.165		R-squared = 0.179	
	Adj R-squared = 0.036		Adj R-squared = 0.040		Adj R-squared = 0.147		Adj R-squared = 0.142		Adj R-squared = 0.139		Adj R-squared = 0.148	

*** 1%, ** 5%, * 10% significance. Standard errors are in parentheses. The dependent variable is the extent of improvement in productivity from a subjective viewpoint (*Δp*). Independent variables: dummy for Firm A (*firm_A*), dummy for OJT (*ojt*), the number of operation processes in team (*#operation*), a change in the number of operation processes in a team (*Δ#operation*), productivity improvement in the one-year lagged period (*Δp_past*), tenure within the firm (*tenure*), education (*education*), skill level (*skill*), a change in the way of conducting the Quality Control meetings (*Δqc*), team-average of productivity improvement (*Δp_team*), and average productivity improvement (*Δp_all*)

Table 8: Determinants of productivity improvement - subjective viewpoint (independent variables: hours of job training)

	(1)		(2)		(3)		(4)		(5)		(6)	
	Coefficient	p value	Coefficient	p value	Coefficient	p value	Coefficient	p value	Coefficient	p value	Coefficient	p value
constant	113.376	[0.000]***	115.292	[0.000]***	75.038	[0.000]***	75.732	[0.000]***	75.713	[0.000]***	288.501	[0.010]***
firm_A	2.909	[0.000]***	1.858	[0.199]	0.957	[0.487]	0.868	[0.546]	0.887	[0.539]	6.796	[0.049]**
ojthour	0.004	[0.054]*	0.004	[0.202]	0.003	[0.415]	0.003	[0.374]	0.003	[0.389]	0.002	[0.440]
#operation			-0.082	[0.570]	-0.041	[0.763]	-0.054	[0.702]	-0.051	[0.723]	-0.053	[0.715]
Δ#operation			0.037	[0.793]	-0.061	[0.654]	-0.063	[0.640]	-0.068	[0.626]	-0.053	[0.710]
Δp_past					0.348	[0.000]***	0.342	[0.000]***	0.342	[0.000]***	0.338	[0.000]***
tenure							-0.061	[0.525]	-0.061	[0.523]	-0.071	[0.463]
education							0.774	[0.723]	0.734	[0.740]	0.679	[0.758]
skill							0.208	[0.853]	0.224	[0.842]	0.332	[0.769]
Δqc									-0.219	[0.885]	-0.083	[0.957]
Δp_team											-0.082	[0.422]
Δp_all											-1.788	[0.069]*
	Obs = 676		Obs = 311		Obs = 305		Obs = 304		Obs = 304		Obs = 303	
	F(2, 673) = 9.36		F(4, 306) = 1.76		F(5, 299) = 9.36		F(8, 295) = 5.67		F(9, 294) = 5.03		F(11, 291) = 4.54	
	Prob > F = 0.0001		Prob > F = 0.137		Prob > F = 0.000		Prob > F = 0.000		Prob > F = 0.000		Prob > F = 0.000	
	R-squared = 0.027		R-squared = 0.023		R-squared = 0.135		R-squared = 0.133		R-squared = 0.133		R-squared = 0.147	
	Adj R-squared = 0.024		Adj R-squared = 0.010		Adj R-squared = 0.121		Adj R-squared = 0.110		Adj R-squared = 0.107		Adj R-squared = 0.114	

*** 1%, ** 5%, * 10% significance. Standard errors are in parentheses. The dependent variable is the extent of improvement in productivity from a subjective viewpoint (*Δp*). Independent variables: Firm A=1 (*firm_A*), hours of OJT (*ojthour*), the number of operation processes in team (*#operation*), a change in the number of operation processes in a team (*Δ#operation*), productivity improvement in the one-year lagged period (*Δp_past*), tenure within the firm (*tenure*), education (*education*), skill level (*skill*), change in the way of conducting the Quality Control meetings (*Δqc*), team-average of productivity improvement (*Δp_team*), and average productivity improvement (*Δp_all*)

Table 9: Subjective and objective productivity

	Coefficient	p value	Coefficient	p value
constant	109.373	[0.000]***	105.321	[0.000]***
Δ#task	0.016	[0.000]***	0.016	[0.000]***
tenure			-0.316	[0.039]**
education			7.271	[0.029]**
skill			0.813	[0.647]
	Obs = 95		Obs = 92	
	F(1, 93) = 18.83		F(4, 87) = 7.24	
	Prob > F = 0.000		Prob > F = 0.000	
	R-squared = 0.168		R-squared = 0.250	
	Adj R-squared = 0.160		Adj R-squared = 0.215	

*** 1%, ** 5%, * 10% significance. Standard errors are in parentheses.

The dependent variable is the extent of improvement in productivity from a subjective viewpoint (*Δp*). Independent variables: a change in the number operational tasks in Firm B (*Δ#task*), tenure within the firm (*tenure*), and education (*education*), and skill level (*skill*)

Table 10: Determinants of a change in the number of operational tasks (independent variables: incidence of job training)

	(1)		(2)		(3)		(4)	
	Coefficient	p value	Coefficient	p value	Coefficient	p value	Coefficient	p value
constant	101.786	[0.265]	-94.676	[0.537]	-160.881	[0.356]	-211.498	[0.218]
ojt	64.034	[0.499]	92.195	[0.342]	78.49	[0.255]	74.576	[0.264]
tenure			6.431	[0.146]	-4.363	[0.223]	-4.171	[0.229]
education			89.475	[0.353]	115.884	[0.088]*	102.606	[0.120]
skill			6.157	[0.906]	75.099	[0.062]*	81.058	[0.039]**
#operation					3.365	[0.445]	6.422	[0.161]
Δ#operation					-6.342	[0.130]	-6.569	[0.107]
Δqc							-101.673	[0.054]*
	Obs = 95		Obs = 92		Obs = 51		Obs = 51	
	F(1, 93) = 0.46		F(4, 87) = 1.22		F(6, 44) = 1.33		F(7, 43) = 1.78	
	Prob > F = 0.499		Prob > F = 0.308		Prob > F = 0.265		Prob > F = 0.117	
	R-squared = 0.005		R-squared = 0.053		R-squared = 0.153		R-squared = 0.225	
	Adj R-squared = -0.006		Adj R-squared = 0.010		Adj R-squared = 0.038		Adj R-squared = 0.098	

*** 1%, ** 5%, * 10% significance. Standard errors are in parentheses. The dependent variable is an increase in the number of operational tasks (productivity improvement with an objective viewpoint) (*Δ#task*). Independent variables: dummy for OJT (*ojt*), tenure within the firm (*tenure*), education (*education*), skill level (*skill*), the number of operation processes in team (*#operation*), a change in the number of operation processes in a team (*Δ#operation*), and a change in the way of conducting the Quality Control meetings (*Δqc*)

Table 11: Determinants of a change in the number of operational tasks (independent variables: hours of job training)

	(1)		(2)		(3)		(4)	
	Coefficient	p value	Coefficient	p value	Coefficient	p value	Coefficient	p value
constant	138.568	[0.000]***	-18.244	[0.870]	-32.971	[0.839]	-85.227	[0.594]
ojthour	0.232	[0.096]*	0.224	[0.115]	-0.024	[0.843]	-0.033	[0.781]
tenure			5.931	[0.176]	-4.922	[0.176]	-4.729	[0.179]
education			97.686	[0.308]	104.033	[0.145]	89.414	[0.197]
skill			-3.274	[0.950]	70.637	[0.082]*	76.868	[0.052]*
#operation					2.024	[0.668]	5.074	[0.295]
Δ#operation					-5.371	[0.217]	-5.557	[0.187]
Δqc							-103.941	[0.052]*
	Obs = 95		Obs = 92		Obs = 51		Obs = 51	
	F(1, 93) = 2.83		F(4, 87) = 1.64		F(6, 44) = 1.08		F(7, 43) = 1.56	
	Prob > F = 0.096		Prob > F = 0.171		Prob > F = 0.388		Prob > F = 0.172	
	R-squared = 0.030		R-squared = 0.070		R-squared = 0.129		R-squared = 0.203	
	Adj R-squared = 0.019		Adj R-squared = 0.028		Adj R-squared = 0.010		Adj R-squared = 0.073	

*** 1%, ** 5%, * 10% significance. Standard errors are in parentheses. The dependent variable is an increase in the number of operational tasks (productivity improvement with an objective viewpoint)(*Δ#task*). Independent variables: hours of OJT (*ojthour*), tenure within the firm (*tenure*), education (*education*), skill level (*skill*), the number of operation processes in team (*#operation*), a change in the number of operation processes in a team (*Δ#operation*), and a change in the way of conducting the Quality Control meetings (*Δqc*)

Table 12: Comparison of labor adjustment costs from internal transfers and external labor markets

	Firm A		FirmB		Total	
relocated	32.68%		19.86%		25.17%	
non-relocated	67.32%		80.14%		74.83%	
	internal adjustment	external adjustment	internal adjustment	external adjustment	internal adjustment	external adjustment
10%	1	1.033	1	1.020	1	1.025
25%	1	1.082	1	1.050	1	1.063
50%	1	1.163	1	1.099	1	1.126
100%	1	1.327	1	1.199	1	1.252

We assume that the number of assemblers is normalized one. The cost of training is assumed to be one for an internal assembler, regardless of whether she/he is relocated from a different team or remains in the current team. Therefore, the total cost of training is normalized to be one for internal labor adjustments. The cost that Firm A would have paid if 32.68% of assemblers in the establishment are hired from the external labor market is calculated as follows: 0.3268×(1+0.1)+(1－0.3268)＝1.033.

Figure 1: Chart of demand of job training and its impact on productivity

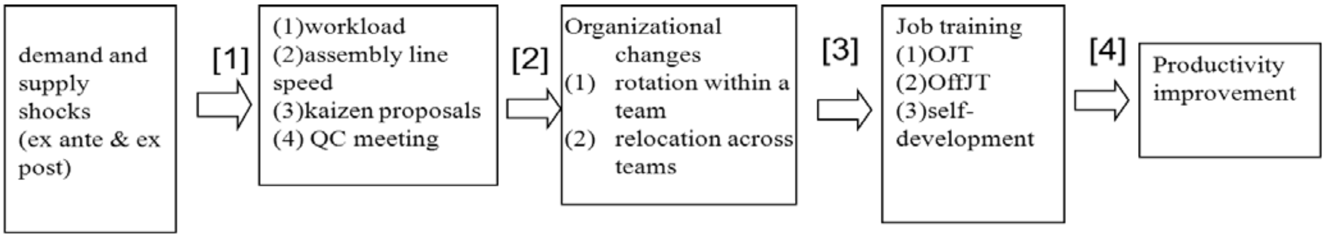


Figure 2: Change in the number of assemblers within a team by the assembly line speed

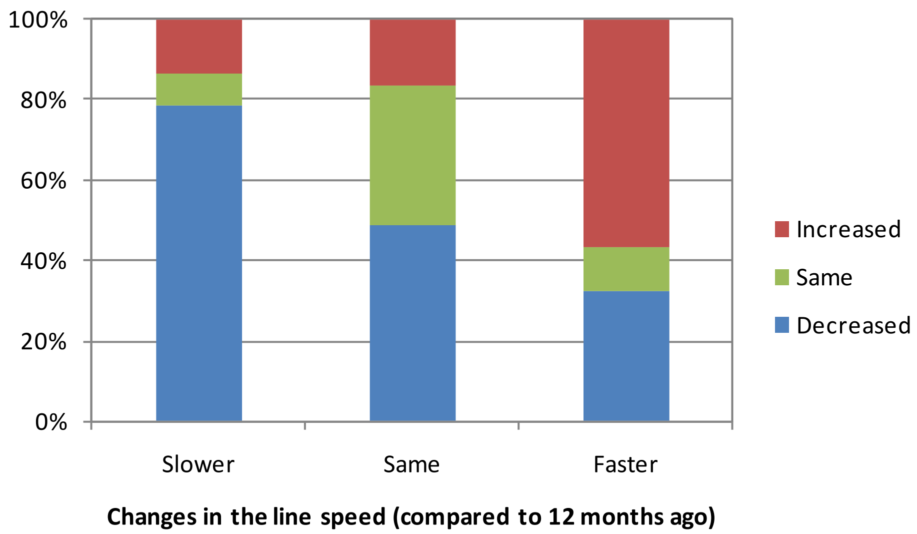


Figure 3: Change in the number of assemblers by the burden of workload within a team

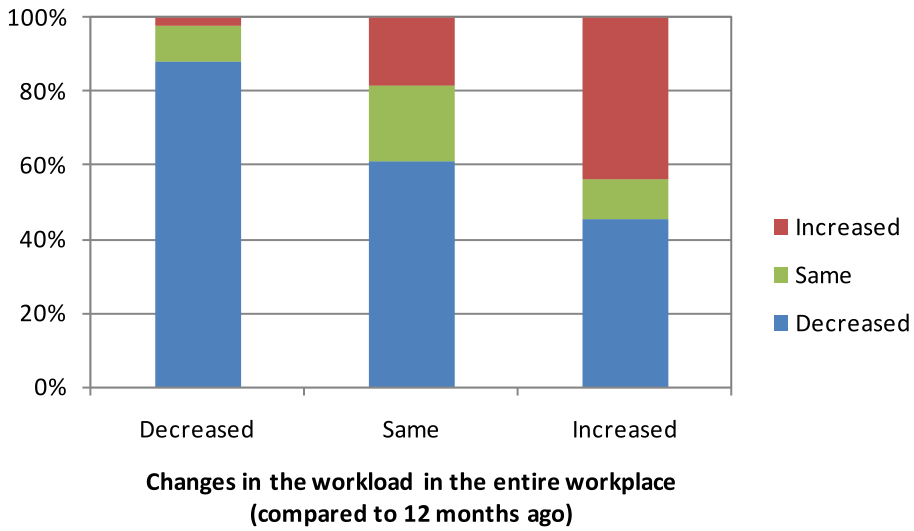
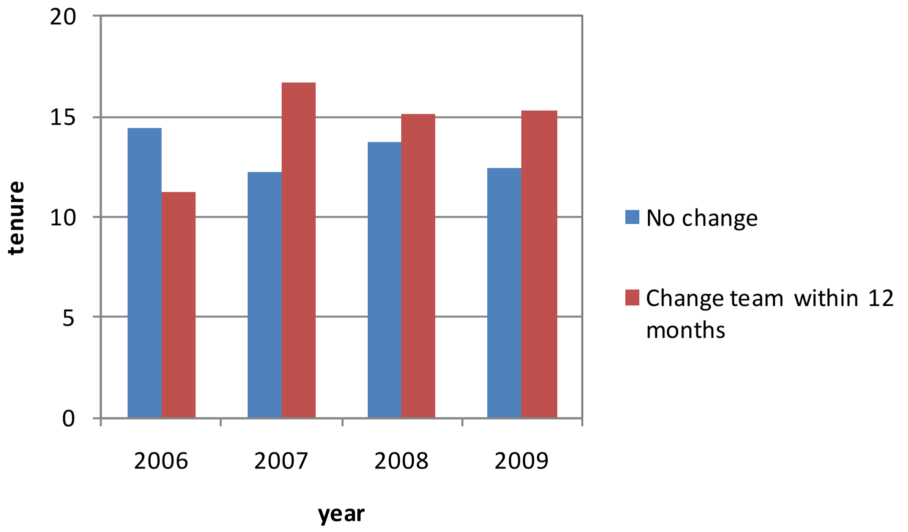
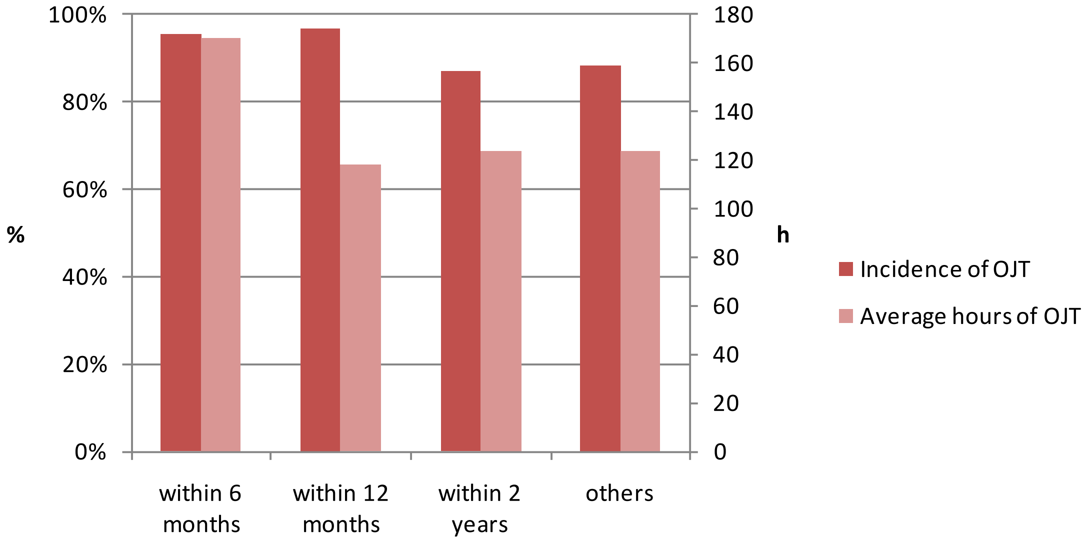


Figure 4: Average tenure within the firm by assemblers relocated to a different team and those who are not over the past 12 months



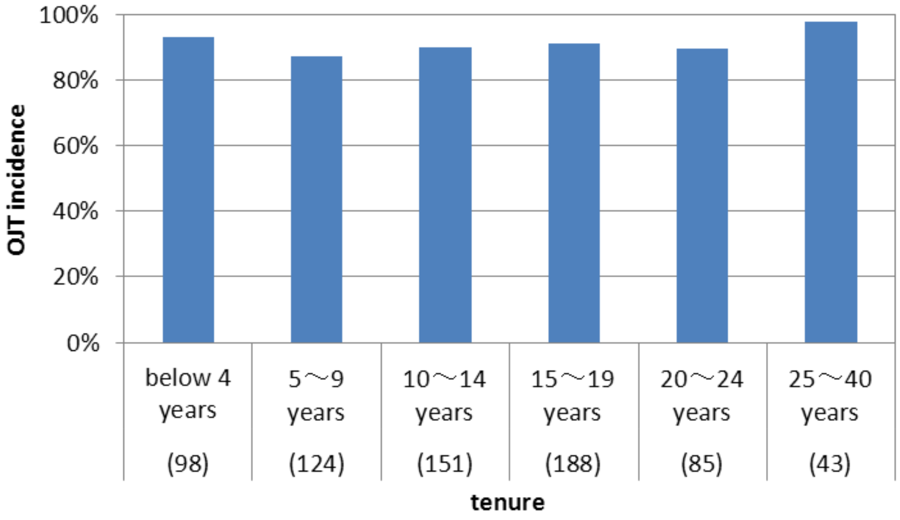
The 2007 and 2008 data are from both Firm A and B. However, the 2006 data are only from Firm A while the 2009 data are only from Firm B. Test for difference=0: 2006: t(100) = 1.831, p = 0.070, 2007: t(233) = -3.346, p = 0.001, 2008: t(235) = -1.342, p = 0.181, 2009: t(124) = -2.249, p = 0.026

Figure 5: Incidence and average hours of job training by the timing of relocation across teams



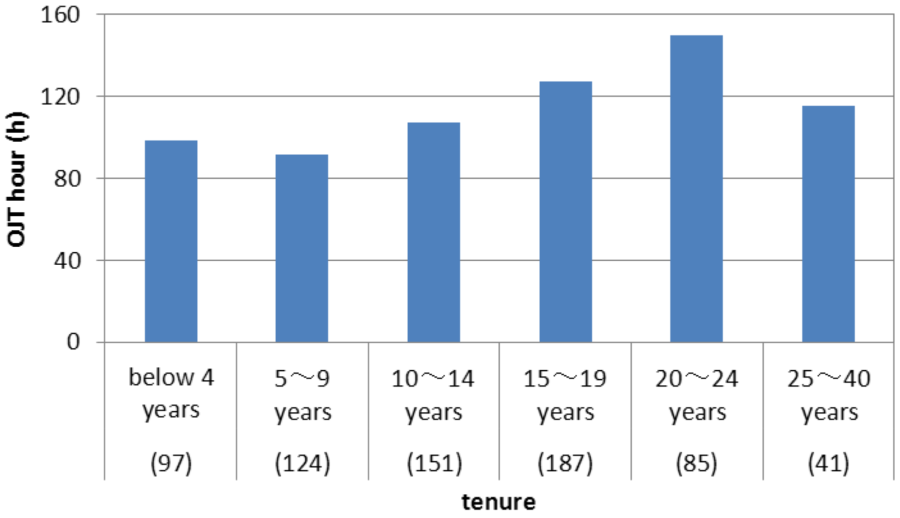
Test for difference=0: Incidence of OJT: F(3, 689) = 3.32, p = 0.019, Average hours of OJT: F(3, 685) = 3.13 p= 0.025

Figure 6: Incidence of OJT by tenure within the firm



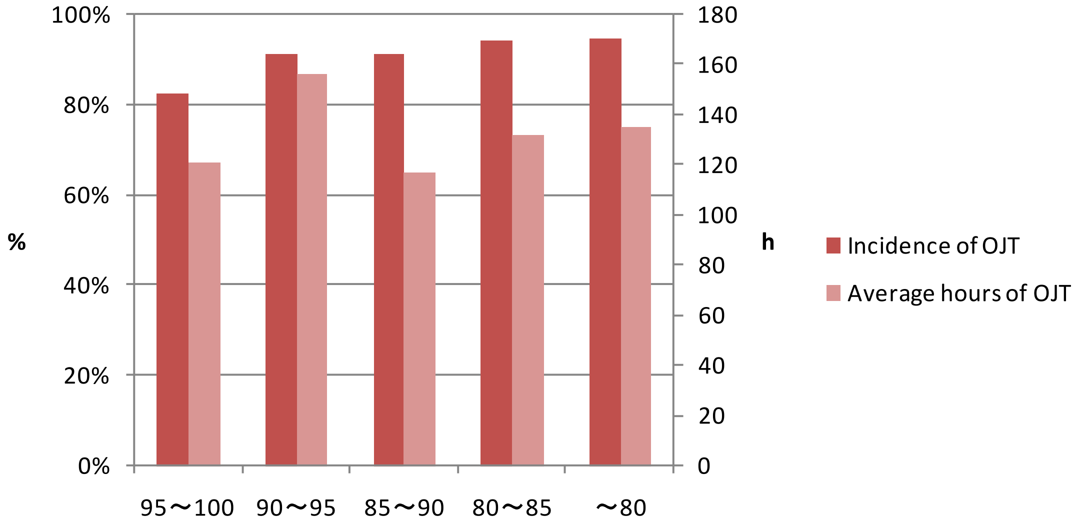
The data are from both Firm A and B. Test of difference of the OJT incidence by tenure within the firm=0: $F(5, 683) = 1.02$, $p = 0.405$

Figure 7: Intensity of OJT by tenure within the firm



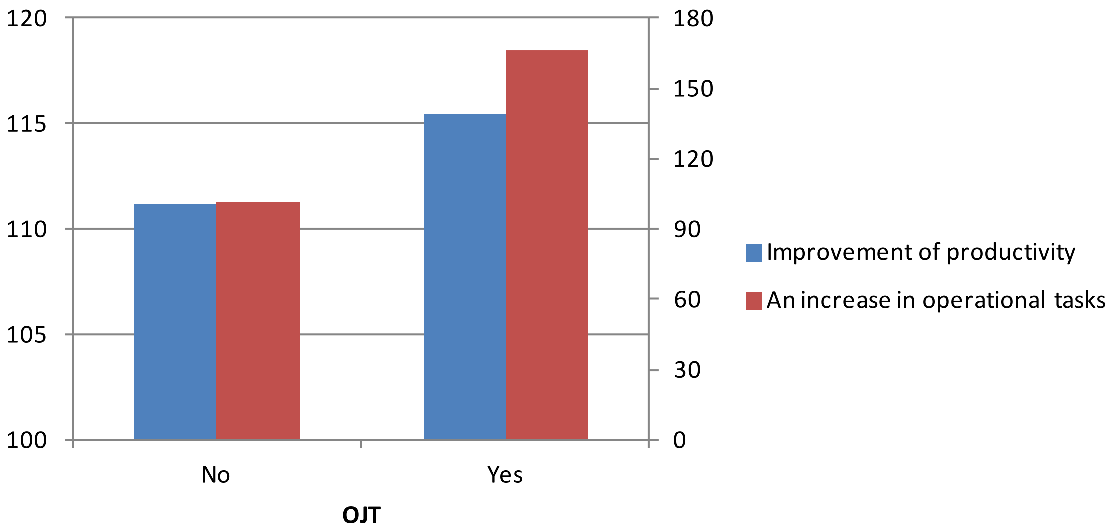
The data are from both Firm A and B. Test of difference of the intensity of OJT by tenure within the firm=0: $F(5, 679) = 1.33$, $p = 0.251$

Figure 8: Incidence and average hours of job training by productivity improvement



The horizontal categories represent productivity level a year ago, assuming that the current productivity is 100. Test for difference=0: Incidence of OJT: $F(4, 675) = 3.90$, $p = 0.004$, Average hours of OJT: $F(4, 671) = 1.28$, $p = 0.276$

Figure 9: Improvement of productivity and an increase in operational tasks by the incidence of training



The left vertical axis represents the current productivity level, assuming that productivity level of a year ago is 100, while the right vertical axis indicates the number of operational tasks that one can currently perform, assuming that its number of a year ago is normalized 100. The horizontal axis represents the OJT incidence over the past year. Test for difference=0: Improvement of productivity $t(678) = -3.27$, $p < 0.000$, An increase in operational tasks: $t(93) = -0.68$, $p = 0.450$.

Appendix: Definitions of variables

Variables	Data collected from the responses in the foremen's questionnaire
rotation	category variable indicating a change in rotation within a team –1 (decrease) 0 (unchanged) 1(increase)
rotation2	dummy variable indicating 1 if the extent of rotation increases or 0 if the extent of rotation decreases or remains unchanged
injury	the number of absentees in a team –1(decrease) 0 (same) 1(increase)
workload	category variable indicating the burden of workload in a team –1 (decrease) 0 (same) 1(increase)
speed	category variable indicating assembly line speed in a team –1 (decrease) 0 (same) 1(increase)
kaizen_in	*kaizen* proposals put forward within the team raise efficiency =1
kaizen_out	*kaizen* proposals put forward from outside the team raise efficiency =1
Δqc	change in the way of conducting the Quality Control meetings =1
#operation	the number of operation processes in own team
Δ#operation	a change in the number of operation processes in own team
Variables	**Data collected from the responses in the assemblers' questionnaire**
avg_tenure_team	years of tenure in the current team averaged across assemblers within the team calculated using the data collected from the responses in the assemblers' questionnaire.
indv_tenure_team	years of tenure an individual assembler has belonged to the current team
avg_age_team	average age of assemblers in a team calculated using data collected from the responses in the assemblers' questionnaire
tenure	tenure within the firm
skill	skill level
education	education level, high school or above=1
ojt	dummy indicating 1 if an assembler responded with nonzero hours for OJT in the previous month or if the assembler responded that there was less OJT than usual, even if the OJT hours in the previous month were zero
ojthour	OJT hours in the previous one year
ojt_team	team average of the dummy indicating whether received OJT, except a person's self
ojt_all	all sampled average of the dummy indicating whether to receive OJT, except a person's self
ojthour_team	team-average of OJT hours, except a person's self
ojthour_all	all sampled average of OJT hours, except a person's self

Δp	improvement in productivity from a subjective viewpoint over the previous year
Δp_past	improvement in productivity from a subjective viewpoint in the one-year lagged period
Δp_team	team-average improvement in productivity over the previous year from a subjective viewpoint
Δp_all	all sampled average improvement in productivity over the previous year from a subjective viewpoint
Δ#task	a change in the number of operational tasks over the previous year from Firm B
Variable	**Data collected from the responses in both the foremen's and the assemblers' questionnaires**
firm_A	dummy indicating Firm A=1 and Firm B=0

Appendix: Descriptive statistics

Variables	N	Mean	SD
rotation	577	0.414	0.637
rotation2	577	0.496	0.500
injury	566	0.095	0.566
workload	578	0.452	0.652
speed	566	–0.012	0.895
kaizen_in	555	0.879	0.326
kaizen_out	557	0.388	0.488
Δqc	566	0.214	0.410
#operation	592	18.409	6.017
Δ#operation	342	0.750	6.044
avg_tenure_team	709	5.248	2.973
indv_tenure_team	688	5.252	5.423
avg_age_team	710	33.313	3.409
tenure	700	13.537	7.378
skill	691	1.754	0.692
education	700	0.937	0.243
ojt	693	0.905	0.294
ojthour	689	113.608	188.572
ojt_team	722	0.906	0.161
ojt_all	739	0.905	0.016
ojthour_team	722	127.033	208.150
ojthour_all	739	130.839	18.992
Δp	681	115.052	10.181
Δp_past	450	114.653	9.972
Δp_team	722	114.874	5.829
Δp_all	739	115.013	1.605
Δ#task	95	161.101	239.456
firm_A	739	0.414	0.493

Appendix: Questionnaire of Assemblers

Questionnaire No.1 on Skills Development in the Workplace

(For Employees)

September 2006

Osaka University, Institute of Social and Economic Research
Kyoto University, Institute of Economic Research

〔Request for cooperation in the questionnaire〕

The purpose of this questionnaire is to survey how employees in the workplace acquire knowledge and skills required for the job, and to measure the effectiveness of these activities.

We would appreciate your taking the time from your busy schedule to answer the questionnaire with your frank opinions. This questionnaire will be **conducted 3 times in the coming 12 months.** This is the first of the three questionnaires. (Questionnaire No.2 scheduled in Feb. 2007, No.3 in July 2007)

The details of your answers will be statistically processed, and please be assured that personal information entered in this questionnaire will **NOT** be disclosed whatsoever.

〔Instructions for completing the questionnaire〕

Please follow the instructions given for each question, such as circle the number that applies. When you finish completing the questionnaire, please submit it in the attached envelope.

※ If you have any questions, please contact: Personnel Dept. (Direct) XXX-XXXX

Please tell us about yourself.

Q1. When did you graduate from your last school?

In 19 [ ]

Q2. In the system to acquire specialized technical skills, what is your level of certification?

1. Level S **2.** Level A **3.** Level B **4.** Level C **5.** Not certified

Q3. Is there anyone in your family (parents, brother/sister, child, etc) who has worked for (or is working for) this company? (Circle one answer)

1. Yes **2.** No

These are questions on how you acquire knowledge and skills required for the job.

Q4. When you are in the workplace and a senior staff or colleague teaches you how to do the job while actually showing it to you, or learning by looking at how others work or referring to work manuals is called On-the-Job Training (OJT). How many hours of On-the-Job Training did you experience in the past month? If you did not receive any training, fill in zero (0).

Calculation example: An entire day of OJT is 8 hrs About [ ] hours last month

Q5. What percent of On-the-Job Training that you received last month was hours taught by a supervisor, senior worker or colleague? (Circle one choice)

1. 0～30% (Mimimal) **2.** 40～50% (About half)
3. 60～70% (More than half) **4.** 80～100% (Almost all)

Q6. Looking at the situation in the past 6 months, was there more On-the-job Training than usual or less training than usual last month? (Circle one choice)

1. More than twice the average in the past 6 months
2. 1.5 times the average in the past 6 months
3. The same amount as in the past 6 months
4. About half the average in the past 6 months
5. Less than half the average in the past 6 months

Q7. Was the On-the-Job Training conducted last month mainly in response to your request, or did a supervisor give instructions to conduct the training? (Circle one choice)

1. I requested the training **2.** The supervisor instructed the training

Q8. Which of the following applies to the On-the-Job Training conducted last month? (Circle one choice)

1. It was training to make up for lack of skill/knowledge
2. It was training was to acquire higher skills

Q9. Did you receive Off-the-Job Training (Off-JT) in the past 6 months? Off-the-Job Training is group seminars or training conducted away from the production line.

1. Yes ↓ 2. No →→ Skip to **Q12**

Go to Q10

Q10. In the past 6 months, how many times did you experience Off-the-Job Training (Off-JT), and in average how long did each Off-JT last? (Circle one choice)

Number of times: **1.** 1 time **2.** 2 times **3.** 3 times **4.** 4 times **5.** Between 5 and 9 times **6.** More than 10 times

Average duration for each Off-JT:

1. Less than 30 min. **2.** 30 min. to less than 60 min. **3.** 60 min. to less than 90 min.

4. 90 min. to less than 2 hours **5.** 2 hours to less than 3 hours **6.** More than 3 hours

Q11. Which of the following applies to the Off-the-Job Training conducted in the past 6 months? (Circle one choice)

1. It was training to make up for lack of skill/knowledge

2. It was training was to acquire higher skills

Q12. In the past 6 months, did you do any studying on you own (Self Development) for your present job or for a job that you want to do in the future?

※"Self Development" is study done during off duty hours by reading books or textbooks, or taking classes at vocational schools or colleges, or studying by correspondence. (This does not include hobbies unrelated to your work, leisure, sports, or health maintenance or promotion activities)

1. Yes ↓ **2.** No →→ **Skip to Q14**

Go to **Q13**

Q13. What is the **frequency** and **average duration of each Self Development study** in the **past 6 months**?

[|] time(s) a month Average duration of study was about [| |] hour(s)

Additional Q13-2 Is the skill/knowledge that you acquired through Self Development study in the past 6 months useful only for your current job? Or do you think that it would also be useful for a similar type of job at another company? Choose one reply from the 5 items below and circle the number.

1. It is useful only at my current workplace **2.** It is also useful at another company

3. It is not useful at my current workplace or another company

4. It is not useful immediately at my current workplace or another company, but it will broaden my abilities as a professional in the long term

Q14. Circle all that apply to your day-to-day life in the past month.

1. Busy but fulfilling **2.** Frankly speaking, a bit overworked **3.** Enjoyed the days off
4. Exercised regularly **5.** Refrained from drinking alcohol **6.** Stopped smoking

These are questions on your job and how you work in your current and past workplaces.

Q15. How long have you belonged to the current Kumi (team)? [|] years [|] months

Q16 Assuming that your current work proficiency is 100 and that your productivity immediately after you joined the company and assigned to a workplace was zero, what do you think your proficiency level was 6 months ago and 1 year ago? Choose one reply from the 5 choices below and circle the number.

(1) Proficiency 6 months ago･･･1. 95～100 2. 90～95 3. 85～90 4. 80～85 5. Less than 80
(2) Proficiency 1 year ago･･････1. 95～100 2. 90～95 3. 85～90 4. 80～85 5. Less than 80

Q17. This is a question for those who have worked in the current workplace for more than one year. What was your proficiency level immediately after being assigned to the current workplace? This is assuming that your current work proficiency is 100 and that your productivity immediately after you joined the company and assigned to a workplace was zero. Choose one reply from the 5 choices below and circle the number.

1. 90～100 **2.** 80～90 **3.** 70～80 **4.** 60～70 **5.** Less than 60

Q18. Of all processes in your workplace, how many processes are you fully capable of doing?

Confirm with GL and fill in the total number of processes ⇒ Of all [| |] processes, I can do [| |] processes

Q19. In the past month, how many Kaizen improvement or creative proposals did you submit? Of these proposals, how many were actually adopted?

Total number of proposals [|] ,of which [|] proposals were adopted

Q20. How well do the following items describe your direct supervisor (GL or CL) in the workplace? Check the number that best describes each item.

	Does not describe the person	Somewhat does not describe	Neither	Somewhat describes	Describes the person
1. Work plans and allocations are done properly	1	2	3	4	5
2. Properly voices what needs to be said to department and section leaders and relevant departments	1	2	3	4	5
3. Makes fair evaluations	1	2	3	4	5
4. Really understands the subordinate's worries and complaints	1	2	3	4	5
5. Friendly and easy to talk to	1	2	3	4	5

6. Is a competent supervisor compared to the predecessor	1	2	3	4	5
7. Allows workers to actively experience many processes	1	2	3	4	5

Q21. How well do the following items describe your workplace? Check the number that best describes each item.

	Does not describe my workplace	Somewhat does not describe	Neither	Somewhat describes	Describes my workplace
1. The workplace is well organized	1	2	3	4	5
2. Information that needs to be shared by everyone is well communicated in the workplace	1	2	3	4	5
3. There is an atmosphere to help others even if it does not concern your own task	1	2	3	4	5
4. Meetings are conducted in an efficient and active manner	1	2	3	4	5
5. Roles and responsibilities of each member is clear and controlled	1	2	3	4	5
6. The supervisor instructs and trains each member according to his/her characteristic	1	2	3	4	5
7. The workplace is not active and the mood tends to be depressing	1	2	3	4	5

＊This is the end of the questionnaire. Thank you very much for your cooperation.

Appendix: Questionnaire of Foremen

<u>Questionnaire No.1 on Skills Development in the Workplace</u>

(For Supervisors)

September 2006

Osaka University, Institute of Social and Economic Research

Kyoto University, Institute of Economic Research

〔Request for cooperation in the questionnaire〕

The purpose of this questionnaire is to survey how employees in the workplace acquire knowledge and skills required for the job, and to measure the effectiveness of these activities.

We would appreciate your taking the time from your busy schedule to answer the questionnaire with your frank opinions. This questionnaire will be **<u>conducted 3 times in the coming 12 months.</u>** This is the first of the three questionnaires. (Questionnaire No.2 scheduled in Feb. 2007, No.3 in July 2007)

The details of your answers will be statistically processed, and please be assured that personal information entered in this questionnaire will **<u>NOT</u>** be disclosed whatsoever.

〔Instructions for completing the questionnaire〕

Please follow the instructions given for each question, such as circle the number that applies. When you finish completing the questionnaire, please submit it in the attached envelope.

※ If you have any questions, please contact: Personnel Dept. (Direct) XXX-XXXX

Please tell us about your workplace. "Workplace" here refers to the Kumi (team).

Q1. Which of the category best describes the attitude in your workplace for each item below? Circle the number that applies.

	Does not describe workplace	Somewhat does not describe	Neither	Somewhat describes	Describes workplace
① Asks employees to work according to instructions rather than to think on their own and take action on their own.	1	2	3	4	5
② Personnel allocation emphasizes putting the right person in the right place at that time, rather than on a long-term perspective to develop human resources.	1	2	3	4	5

Q2. Circle all items that apply to your workplace.

1. We have daily morning meetings
2. Hot time meetings are held daily
3. There are frequent rotations
4. **Fixed-term employees** are often hired (as full-time employees)

Q3. When was the last time a large-scale investment was made in the production line in your workplace?

Around Year [| | |] Month [|]

Q4. The following are questions on how long it takes to become proficient in the work processes in your workplace.

(1) How many processes do you have in your workplace? [| |]

(2) How long does it take for an average high school graduate to become proficient in all process in your workplace?

[|] Years [|] Months

Q5. Please tell us about the QC circle meetings held in your workplace in the past 6 months. What are the frequency and average duration of each meeting?

(1) [|] times a month (2) Average duration per meeting is about [| |] hours(s)

Q6. Has there been any changes described below in your workplace in the past 12 months? Check the item that applies.

	Compared to 6 months ago	Compared to 12 months ago
1. Changes in the total number of people in the workplace	**1** Increased **2** Same **3** Decreased	**1** Increased **2** Same **3** Decreased
2. Turnover of talented people	**1** Left **2** None **3** Joined	**1** Left **2** None **3** Joined
3. Changes in the number of rotation opportunities	**1** Increased **2** Same **3** Decreased	**1** Increased **2** No change **3** Decreased
4. Changes in the workload in the entire workplace	**1** Increased **2** Same **3** Decreased	**1** Increased **2** Same **3** Decreased
5. Revisions in the workplace target/index (i.e. changed to emphasize cost and safety instead of efficiency)	**1** Target was revised **2** No change	**1** Target was revised **2** No change
6. Orders from upper management to change the direction of human resource development in the workplace	**1** There were orders to make changes **2** No change	**1** There were orders to make changes **2** No change
7. Changes in the line speed	**1** Faster **2** Same **3** Slower	**1** Faster **2** Same **3** Slower
8. Someone in the workplace fell sick or was injured	**1** Yes **2** No	**1** Yes **2** No
9. Kaizen improvement proposals **from the workplace** were adopted and the work was made easier	**1** Yes **2** No	**1** Yes **2** No
10. Kaizen improvement proposals **from outside the workplace** were adopted and the work was made easier	**1** Yes **2** No	**1** Yes **2** No
11. Revisions were made in the personnel allocation	**1** Yes **2** No	**1** Yes **2** No
12. The work steps were changed	**1** Yes **2** No	**1** Yes **2** No
13. Operation methods for the QC circle were changed	**1** Yes **2** No	**1** Yes **2** No

Q7. If the **productivity of your workplace 12 months ago was 100**, what do you think are the productivity levels for 6 months ago and now?

(1) Productivity 6 months ago・・・・・・・・・・ [| |] %

(2) Current productivity・・・・・・・・・・・・・ [| |] %

Q8. Check all items that apply to your workplace.

1. The workplace has difficulties in responding to changes in the line speed

2. There are many processes, and a long training period is required to become proficient in all of them

3. There is a variance in the proficiency among my subordinates, and work management requires my full attention

4. There are many processes that require higher skills compared to other Kumi on the same line

5. I'm very busy and cannot find enough time to train my subordinates
6. There are many challenges, but I am fortunate to have good people and we work well together

Q9. In the past month, how many Kaizen improvement or creative proposals were submitted? Of these proposals, how many were actually adopted?

Total number of proposals [ ] of which [ ] proposals were adopted

＊This is the end of the questionnaire. Thank you very much for your cooperation.