Multiskilling and Firm Performance

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In this study, we examined uncertainty factors and human resource management practices that foster multiskilling of the workforce and the effect of multiskilling on labor productivity growth of the firm. An empirical analysis of 206 Korean manufacturing firms in 22 three-digit KSIC's showed the following results. First, two uncertainty factors, the product-demand variability in the industry and the occurrence of abnormal situations at the workplace, were positively associated with multiskill formation in the sample firms. Second, human resource management practices such as mutual learning among coworkers, delegation of authority, and interworkshop mobility were positively associated with multiskill formation. Third, the degree of multiskill formation was positively associated with the firm's labor productivity growth from 1988 to 1993. Fourth, uncertainty had an indirect impact on labor productivity growth only through multiskill formation. When both uncertainty and multiskilling were included in the regression models, uncertainty had no impact on labor productivity growth. Fifth, we found growth effect of multiskilling but no level effect after controlling other factors.

Keywords: Multiskilling, Human resource management practices, Environmental uncertainties, Labor productivity, Firm growth

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I. Introduction

Until the mid-80s, there were two dominant streams of the theory of the firm in economics. While the most popular one is microeconomic theory that explains a firm as a production function, the less popular one is transaction cost economics that explains it with the boundary of the firm (Coase 1937; and Williamson 1985). More recently, Lucas (1988) proposed a theory of learning that emphasizes the interactions within and between human groups in the workplace. To this view, people join in a firm to learn, and a firm exists to provide its members with a venue for learning through interactions. The learning perspective implies that the success and growth of the firm depend on HRM practices that stimulate interactions and learning among people.

In recent management theories, it has been consistently argued that human resources contribute to firm's sustained competitive advantage. According to resource-based view of the firm, firms can build sustained competitive advantage by creating value in such a way that is rare and difficult for competitors to imitate (Barney 1986, 1996).

Although traditional sources of competitive advantage create value of the firm such as natural resources, plant facilities, patents, and economy of scale, they are usually imitable by the competitors, tradable through transactions in the market, and mobile from one place to another. Contrarily, a firm's intangible assets such as organizational culture and the unique ways of developing and managing human resources are strategic assets. Strategic assets are difficult to imitable, non-tradable through transactions in the market, and immobile from one place to another. Once strategic assets are built, they act as core competencies and sustain competitive advantage over time (Amit and Schoemaker 1993; and Barney 1996).

Based on Collis and Montgomery's (1995) work, Becker and Gerhart (1996) suggest causal ambiguity and path dependence as two key factors that render a firm's HRM practices inimitable by the competitors. First, causal ambiguity refers to the difficulty of grasping the precise mechanisms by which the interplay of HRM practices and policies creates value. Without comprehensive understanding how a certain HRM system work, it is extremely difficult for competitors to imitate. Second, HRM practices are path

dependent in that they are developed over time in a unique way so competitors cannot purchase them in the market.

According to the scholars in strategic human resource management, human resources are not simply an input of production, but a factor that constitutes organizational core competencies. Based on this view, there have been numerous efforts to investigate empirically the relationships between HRM practices and firm performance (*cf.* Arthur 1994; Delery and Doty 1996; Huselid 1995; Huselid, Jackson, and Schuler 1997; and Ichniowski *et al.* 1997). Empirical research in strategic HRM has shown that various HRM practices of American firms emphasizing flexible adaptation to changing environments have a positive effect on firm performance (Becker and Gerhart 1996; Huselid *et al.* 1997; and Youndt, Snell, Dean, and Lepak 1996). These practices include job rotation, small groups, self-managing teams, cross-functional teams, multiskilling, group incentive systems, skill formation, training and development, and participative management.

An increasing number of American firms have recently adopted various HRM practices from Japanese firms. In the past, firms in the two countries established radically different HRM systems. While Japanese firms operated seniority based HRM systems, American counterparts operated HRM systems emphasizing individual ability and performance. However, firms in both countries now seem to exchange merits each other. Japanese firms now try to integrate American firms' flexibility into their rigid internal labor markets. American firms, on the one hand, selectively adopt certain Japanese HRM practices that foster group activities and group learning. Recognizing that the development of skills and knowledge of human resources is the key to building core competencies, firms in both countries have narrowed the gaps in HRM practices.

Reflecting the recent development of economic growth models based on human capital theory and resource-based view, we investigate empirically the relationships between human capital accumulation through interactions among workers and firm performance. Specifically, the purposes of our study are the following. First, we investigate the determinants of multiskill formation in the workplace. We view multiskilling as an important human accumulation mechanism in the firm that emphasizes interactions among people within and between groups. In this study, we examine the determinants of multiskill formation in two

major areas: environmental uncertainty and HRM practices. Second, we examine whether there is a positive influence of multiskilling on firm growth.

II. The Determinants of Multiskilling

A. Variability in Product Demand and Multiskilling

One of the most important management principles in the U.S. firms is specialization. Jobs are divided as small as possible so that firms easily hire workers from the labor market just like people buy the parts of the machine in the market. Firms lay off workers any time they become unnecessary, and hire them again when they become necessary.

Although some of the subdivided jobs require a high level of knowledge and skills, many of them are simple and repetitious without requiring such knowledge or skills. In a simple or a highly complicated job, one can improve productivity to a certain level by the repetition. This is the advantage of division of labor, or specialization. Economic development in the United States, until the 1960s, had been largely indebted to mass production based on division of labor or specialization. Firms in the United States maximized the effects of division of labor by specialization in order to mass-produce standardized commodities at the lowest costs possible. This is why Taylorism, a scientific management, and Fordism in its concrete realization, were highlighted (Piore and Sable 1984). In the economic literature, division of labor has been regarded as one of main causes for productivity improvement since Adam Smith. Becker and Murphy (1992) recently proposed a theoretical model in which division of labor or specialization is a source of economic growth.

Why, then, did the U.S. firms utilizing division of labor and specialization suffer from difficulties and was challenged by Japanese firms in 1980s? First of all, the nature of demands has been changed. In these days, people demand diverse commodities that reflect their own individualities. As a result, the demands become volatile. Every moment new products are introduced and new products substitute for existing ones, demands for the existing products can decrease drastically. Where jobs are subdivided and

job demarcations are strict, firms have certain limitations in coping with diverse and volatile market demands immediately. In order to cope with rapidly changing situations, workers are required to be multiskilled rather than to be specialized on narrowly defined jobs, so that they can perform various tasks according to changing situations (Aoki 1988). Multiskilling means not only that a worker has several skills beyond one skill area but also that he has the capability to cope with unusual situations at the workplace (Koike 1988).

Changes in demand by the continuous introduction of new products bring immediate shocks to the production system. The introduction of new products or models requires changes in manufacturing processes, setups of new production lines, new machines, equipment, or tools, and the adjustment of existing lines, and creates new tasks, and so on. Since these are usually accompanied by unexpected situations such as malfunctioning of machines and equipment, conflicts between processes, and frequent changes of machinery and tooling, the frequency of unusual situation occurrence is expected to increase.

In order to cope effectively with the above situations, workers should be multiskilled to understand overall processes of production and to exactly grasp causes of problems and solve them by themselves. Relatively speaking, single-skilled workers who are specialized on one or two tasks cannot effectively cope with exceptional situations that are caused by the introduction of new products or models. Coping with environmental uncertainties, that is, frequent and rapid changes of product demands, needs flexibility at the workplace. The flexibility requires workers to have intellectual capabilities to actively perform tasks according to situation changes rather than simple skills. Koike (1988) hence calls multiskilling intellectual skills.

According to Koike's observations, Japanese workers have wider range of skills, less strict job demarcations, can perform more various tasks, and hence more frequently solve problems by themselves in unusual situations than the U.S. workers, so that the flexible production system can be well-operated in Japan. The flexible production system requires workers to solve problems frequently without other workers' help. For example, operators are required to frequently find abnormalities and repair or adjust machines and equipment without other technicians' help when their

machines and equipment are malfunctioning or need adjustment. Koike (1988) points out as one of Japanese workers' characteristics that they are charged not only with normal operations but also with unusual tasks.

An increasing number of American firms have recently introduced cross-functional teams and cross-training programs to cope with fast changing environments (Robey and Sales 1994). Also, Nemetz and Fry (1988) argued that in order to cope effectively with changing customer taste and technology, modern flexible manufacturing systems require organic structure rather than mechanistic structure. In addition, flexible production systems require workers to possess knowledge and skills of a broad range. To deal with fast changing demand and technology, American workers trained with the principle of division of labor are now faced with the need to possess broader knowledge and skills. Based on the above discussion, the following research hypothesis is presented.

Hypothesis 1: *Variability in product demand will be positively associated with multiskilling.*

B. HRM Practices and Multiskilling

Multiskill formation is one of the main processes of human capital accumulation that broadens workers' skills and knowledge to cope with diverse situations. In the economic literature, there are two types of human capital accumulation models: the time allocation model and the learning-by-doing model. In the former time or materials are allocated to invest in human capital instead of physical capital (Becker 1962; and Ben-Porath 1967) and in the latter human capital is accumulated with production on the job (Arrow 1962; and Rosen 1972). Both types of models, however, rarely mention the processes of human capital accumulation or skill formation. In an effort to uncover the processes that have been left as black boxes, we try to examine what causes multiskilling.

When Becker (1962) and others proposed the concept of human capital in 1960s, they emphasized that human capability is improved by investment like physical capital. They saw no economic difference between improving the students' capability by schooling and expanding production capacity by investing in production

equipment. Therefore, they thought that the framework of analysis for physical capital is also used for human capital. This human capital theory has been applied to human behaviors such as education, labor market activities, economic growth, fertility, and addiction, so that there has been big progress in our understanding human behaviors.

Then, isn't there any essential difference between human capital investment and physical capital investment? Lucas (1988, p. 19) emphasizes that "human capital accumulation is a social activity, involving groups of people in a way that has no counterpart in the accumulation of physical capital." As an example, citing Jacobs (1984), he suggests the formation and development of cities: people get together in cities for such interaction as learning and teaching one another in spite of high rents, traffic jam, and other urban problems.

In the similar context, Park (1997b) argues that the interaction among workers plays a key role in human capital accumulation on the job, and more concretely, suggests a theoretical model in which senior workers teach junior workers on the job and this on-the-job learning is a source of endogenous growth.

This argument suggests a new perspective on the nature of the firm other than Coase's (1937) transaction cost perspective. Workers get together in the firm to produce output and to learn and teach one another through interaction on the job. The firm provides people with a venue for them to accumulate human capital by on-the-job interaction and people come together into the firm in order to increase the value of their human capital through on-the-job learning (Park 1997a).

Interactive learning and Multiskilling: If you accept the view that human capital is accumulated by interaction involving groups of people, the firm's human resource management practices promoting interaction among workers are seen to play an important role in multiskill formation as a mechanism of human capital accumulation. The firm with such human resource management practices can be seen to be more advantageous in multiskill than single-skill formation.

Ban or Jo, which is a basic unit of production with 15-30 workers, is rarely composed of workers with the same single-skill. The workshop is composed of workers with different single-skills to each other or diverse skills and interactive learning among them

necessarily promotes them to accumulate interactively diverse skills and knowledge. While specialization is an efficient mode of production in a firm that produces existing products, multiskilling is a more efficient production mode in a firm where new products are continuously introduced. The introduction of new products provides workers with new learning opportunities in the process of production (Stokey 1988; Young 1991; and Park 1996).

As the interactive learning among workers becomes active with the introduction of new products, multiskill rather than single-skill formation becomes more active. For single-skill formation the interactive learning works to a certain degree. Once workers' single skills advance to a certain level, learning by themselves plays an important role. For multiskill formation, in order to accumulate new skills beyond a certain level learning from coworkers or senior workers plays a key role. Therefore, interactive learning among coworkers and between senior and junior workers can have a positive effect on multiskill formation.

Job Rotation and Multiskilling: Another practice of human resource management affecting multiskilling is job rotation. Koike (1988) sees job rotation as the most important practice of human resource management for skill formation. While in large U.S. firms workers scarcely move to closely related workshops, workers move frequently not only within workshops (intraworkshop mobility) but also to other workshops (interworkshop mobility) in Japanese large firms, relative to U.S. workers. Carmichael and Macleod (1993) also describe these Japanese practices.

Intraworkshop and interworkshop mobility are difficult to implement in the production system based on specialization but can be actively implemented in the firm with the frequent introduction of new products. Multiskilling is more progressed in the firm with active intraworkshop mobility than the firm without it. Multiskilling is, however, less progressed with intraworkshop mobility than with interworkshop mobility because the former is practiced among more similar jobs than the latter. Therefore the order of the progress of multiskilling is the following: interworkshop, intraworkshop mobility, and non-mobility with specialization. Recently there have been several research reports that the U.S. firms introducing job rotation performed better than those who did not. That is conceived to be the case because the firm with multiskilled human resources can cope with environmental

uncertainty more flexibly than otherwise.

Group Incentives and Multiskilling: Firms with job-based pay system develop specialized human resources. A reward system focusing on individual outcomes may undermine the social foundations needed to succeed in a cooperative setting. One of the drawbacks of job-based pay system is that it cannot elicit cooperation among group members when cooperation is required to produce a group product (Kelly and Thibault 1969). Also, job-based pay system makes it difficult to stimulate interactive learning among workers.

On the other hand, a reward system based on team performance may entice cooperation among members of a team. With group pay, team spirit or team cohesiveness is enhanced and members' skills and knowledge are improved through interactive learning on the job. Kelly and Thibault (1969) showed in their experiments that when individual pay was directly proportional to the quality of work groups, cooperation and performance of a given group increased. Also, when it is difficult to measure the contribution of an individual to group performance, or when the nature of the technology and workflows become more interwined, group based incentives are more effective (Gomez-Mejia and Balkin 1992).

Summing up the discussion above, group-based incentive system may enhance group cohesiveness and cooperation when group members are interdependent in performing their tasks. In addition, since a portion of individual pay is dependent on group performance, interactions and mutual learning are promoted among group members. This incentive scheme creates work environments that foster multiskilling.

Delegation of Authority and Multiskilling: Numerous studies have shown that participation in decision making processes increases productivity (cf. Black and Lynch 1997; Banker, Field, Schroeder, and Sinha 1996; Delery and Doty 1996; Mohrman and Novelli 1985; and Pfeffer 1994). Delery and Doty (1996) identify two employment systems: the market type system and internal system. Of the two employment systems, internal system is worth mentioning. Internal system is characterized by the existence of an internal labor market. It operates HRM practices such as hiring mainly from within the organization, extensive formal training, participative management, and employment security. In this system, employees are viewed as valuable information and are provided a great deal of voice.

Mohrman and Novelli (1985) showed that workers' participation in quality circle improved productivity through the increased degree of idea generation and implementation. Banker and his colleagues (1996) reported that after high performance work teams were formed with higher degree of autonomy, both the quality and labor productivity improved over time.

If workers in a team are given authority to decide on quality control and work procedures, there will be a higher degree of interactions and thus learning activities among workers. With higher discretion, workers can have an increased capability to solve problems and cope with abnormal situations occurring at the workplace. This process stimulates interactive learning among workers and fosters multiskill formation at the workplace. Based on the above argument, we suggest the following research hypothesis.

Hypothesis 2: *HRM practices promoting interaction among workers (interactive learning with senior workers/coworkers and with junior workers, group incentives, intraworkshop and interworkshop mobility, and delegation of authority) will be positively associated with multiskill formation.*

III. Multiskilling and the Firm's Growth

Multiskilling and the Firm's Growth: Using the *Skill Formation Survey* data set, Park (1996) found the role differences between multiskilled and single-skilled workers. Multiskilled workers understand the overall production processes better and grasp the causes of problems more precisely than single-skilled workers. Multiskilled workers are more likely to repair or adjust their malfunctioning machines or equipments and disassemble and assemble them better than single-skilled workers.

However, wage rates of multiskilled workers are not significantly higher than those of single-skilled workers if human capital variables such as gender, schooling, experience and firm tenure are controlled. Workers' wage rates are neither significantly different between workers who can operate machines and equipments and those who cannot. These findings indicate an existence of seniority wage system (Park 1996), which is a unique feature of the Korean

labor markets. It is likely that workers' wage rates are not determined by the characteristics of their individual jobs.

The introduction of new products or the improvement of existing brings shocks to the workplaces. It changes production processes, reshuffles production lines, and introduces new tasks. Accordingly, many problems in production processes occur such as malfunctioning of machines or equipment, defects, and difficulties in coordinating tasks with other processes. Multiskilled workers, who understand overall production processes and deal with malfunctioning problems by themselves better than single-skilled workers, handle these situations caused by the production of new products or model improvement better than single-skilled workers.

Multiskill formation bears cost, at the same time. Since single-skilled workers continue to perform a job, their productivity is expected to increase. This is the productivity improvement through the division of labor or specialization pointed out by Adam Smith. On the other hand, multiskilled workers are hardly expected to improve their productivity through the division of labor or specialization. And this is the opportunity cost associated with multiskill formation.

With this opportunity cost, maintaining multiskilled workers at a certain level is important because, as pointed out above, they perform a particular role that single-skilled workers cannot perform. With new demands occurring more frequently, or with new products and models introduced more frequently, there is an increasing need for a particular role of multiskilled workers. As uncertainty caused by the introduction of new products increases, the optimal ratio of multiskilled workers to total workers increases.

When a new product is introduced, the average productivity of workers increases with the ratio of multiskilled workers. And this increased productivity is transferred to junior workers or next period's workers through on-the-job learning, so that the productivity growth increases. Therefore, as the multiskilled workers' ratio increases, the expected growth of productivity increases. Based on the observations and discussions above, we can set up the following hypothesis.

Hypothesis 3-a: *Multiskilling will be positively associated with labor productivity growth.*

Uncertainty and the Firm's Growth: Uncertainty in product demand caused by the introduction of new products basically provides the firm with an opportunity for productivity growth. However, if the firm does not have human resources that can promptly cope with the environmental uncertainty, it hardly attains firm growth, namely, productivity growth. The firm that trains workers to be multiskilled is able to fully utilize the learning opportunity occurring from the introduction of new products. Higher learning capability leads to higher productivity. On the other hand, in spite of the opportunity for growth, if the firm is not prepared to utilize the learning opportunity with multiskilled labor, it cannot turn this opportunity into growth. Therefore, we can set up the following hypothesis.

Hypothesis 3-b: *The firm's uncertainty (sales variations by products, sales portion variations, and frequency of unusual situation occurrence) does not have a direct association with its labor productivity growth.*

Multiskilling and Labor Productivity Level: Multiskilling affects the growth but does not directly affect the level of labor productivity. The argument that the level and growth effects are different (Lucas 1988) can be justified by the following. If all firms have the same initial level of productivity, the effect of multiskilling on growth is transmitted as it is on level, so that the two effects can be observed identically. However, the assumption that all firms have the same initial level of productivity is unrealistic and the two effects are hence to be separated. Neither anyone can tell that a firm with a lower level of productivity grows slowly, nor a firm's higher level of productivity cannot guarantee the fast growth of its labor productivity. Therefore, the firm's multiskilling affects its growth but does not have a direct relationship with its level of labor productivity.

Hypothesis 3-c: *Multiskilling will not have a significant positive association with the level of labor productivity.*

IV. Data and Measurement of the Variables

A. Data

In our study, we used the data on multiskilling and HRM practices from the *Skill Formation Survey* conducted by the Korea Labor Institute in 1992. The sampling procedure in *Skill Formation Survey* is the following. Out of 5,276 firms listed in *Financial Report of Korean Firms 1991* (Korean Investors Service 1992), 450 firms were selected by the stratified random sampling procedure according to region and firm size. Then, questionnaires were sent to these firms by mail. Out of 306 questionnaires that were returned (68% response rate), 206 were used for our empirical analyses. 100 firms were dropped from our analyses due to the missing records.

There were two types of *Skill Formation Survey*. One was a *Survey for Employer* that contained survey items regarding HRM practices of a firm. A firm's HRM manager filled out this survey. The other was a *Survey for Employee* that contained survey items regarding individuals' skill formation. In order to survey the individual workers, the HRM manager was asked to select either 1 production line for a medium sized firm with less than 500 employees, or 2 production lines for a large firm with more than 500 employees. These lines were to represent the most typical production lines of the firm. For each selected production line, the HRM manager was then asked to randomly select 7-10 workers for a medium sized firm, and 10-15 workers for a large firm, to respond to the survey. After excluding the missing cases, the total number of employees was 2,220. The average number of workers who responded to the survey in the sample firms was 10.2. The total number of employees used in our analyses was 2,220.

B. Measurement of the Variables

a) Measurement of the Control Variables

Industry concentration ratio, sales, tangible fixed asset per employee, tangible fixed asset Growth, union, workers' average tenure, workers' average education, and characteristics of the machines were used for the control variables.

Concentration Ratio (CR3): Industry concentration ratio was

calculated from the KDI (Korea Development Institute) CR3 data.[1] KDI's CR3 data contained the value of shipments of the largest three firms and of industry in 4-digit KSIC (Korean Standard Industry Code) in 1989. Since our sample firms were classified in 3-digit KSIC, the weighted average of CR3 on the value of shipments was calculated at 3-digit KSIC. KDI CR3 data in 1989 were the most current one. Concentration ratio was used in our analyses to control for the possible differences in skill formation mechanism between monopolistic and non-monopolistic industries (Nam 1994).

Sales: Sales was used to control for the effects of scale economy on firm performance. To correct the skewness, log sales in million wons was used in the analyses. Data were drawn from *Financial Report of Korean Firms* in each year published by Korean Investors Service.

Tangible Fixed Asset per Employee: Tangible fixed asset per employee was calculated as the total fixed asset in million wons divided by the total number of employees at the yearend of 1992. Then, the log was taken to remedy the skewness. Data were drawn from *Financial Report of Korean Firms*. Tangible fixed asset per employee was used to control for the effects of investment in automation or advanced production facilities on the level of labor productivity. This variable was included in the analyses of the determinants of multiskilling ratio and the labor productivity level.

Tangible Fixed Asset Growth Rate: Tangible fixed asset growth rate was calculated as the 6-year average growth rate of tangible fixed asset per employee during 1987 and 1993. This variable is used to control for the effects of additional investment in machines and tools on the growth of labor productivity.

Union: Union as a dummy variable was included in our analyses to control for the effect of union on firm performance. The variable was measured by one item in *Survey for Employer* and coded 1 if a union exists in a firm, and 0 otherwise. Unions may resist rearrangements of human resources or the adoption of new HRM practices (Black and Lynch 1997). Hence it is expected to have a negative influence of union on firm performance.

Workers' Average Tenure: Workers' average tenure in the firm was calculated from an item in *Survey for Employer*. Average tenure was

[1]We obtained the CR3 data with the help of Dr. Seung-Min Yu at KDI.

measured as workers' average number of years of service in the firm, and used to control for the effects of tenure on the level and the growth of labor productivity.

Workers' Average Education: Workers' average education was calculated from an item in *Survey for Employer*. Workers' average education was measured as workers' average number of years in school. This measure was used to control for the effects of schooling on the level and the growth of labor productivity.

Characteristics of Machines and Tools: Four categories of machines and tools were used to control their possible impact on skill formation according to Amber and Amber (1962): (1) manual tools; (2) power-driven tools; (3) semiautomatic machines; and (4) automatic machines. Data were constructed from the *Survey for Employee* and calculated as the ratio of workers in a given firm who checked each category. The range of these variables is from 0 to 1.

b) Dependent Variables and Independent Variables

Level of Labor Productivity: The measurement of the level of labor productivity was based on the value-added per employee in *Financial Report of Korean Firms*. Value-added per employee is measured by the total value-added over the total number of employees in a given firm. Then, the level of labor productivity per employee was calculated as the average labor productivity over 3 years between 1990 and 1993. All value-added measures were expressed in 1990 wons using the CPI (Consumer Price Index) as a deflator.

Labor Productivity Growth: Labor productivity growth was calculated as the 6-year average growth rate of labor productivity per employee during 1987 and 1993.

Multiskilling Ratio: Multiskilling Ratio was calculated based on *Survey for Employee*. The survey asked the workers to check one of the 7 skills categories they belonged to: (1) simple manual worker; (2) trainee; (3) single-skilled worker; (4) high quality single-skilled worker; (5) multiskilled worker; (6) high quality multiskilled worker; and (7) technical multiskilled worker. Among these, some categories need further explanation. Single skilled worker (category 3) is defined as a worker who owns skills in a narrowly defined area. High-quality single skilled worker (category 4) is a worker who owns high-quality skills among the single skilled workers. Multiskilled worker (category 5) is one who owns skills in at least

two areas. High-quality multkskilled worker (category 6) is one who has high-quality skills in at least two areas. Lastly, technical multiskilled worker (category 7) is one who not only owns skills in various areas but also has theoretical knowledge and ability to judge comprehensively.

In this study, multiskilled workers were measured as those who checked category 5, 6, or 7. Multiskilling ratio was then calculated as the total number of multiskilled workers over the total number of workers who responded to the survey.

Demand Variability: Two measures of demand uncertainty were used in the analyses: sales variation and sales proportion variation at the industry level. The measures of demand variability were computed using the sales data of 3 major product groups of 467 listed companies during 1988-92. These data were obtained from *Financial Report of Korean Firms*. The measurement process was the following. First, the ratio of sales change in each product was computed each year. The formula is given by $[(SAL_{ij}-SAL_{ij-1})/SAL_{ij-1}$: SAL=sales of each product, i=ith product, j=jth year)]. Second, standard deviation of sales change of each product for 4 years was computed. Third, the average of standard deviation weighted by each sales volume was computed. A maximum number of 6 products were used for each company since, in some firms, the list of top 3 product changed in some year. Fourth, the mean of standard deviation of sales change of each firm was then averaged at the 3-digit KSIC.

Sales proportion variation was measured in the following procedure. First, sales ratio of each major product was computed as the sales of each major product over the total sales. Second, the absolute value of the difference is computed between the sales ratio of each product in the current year and that in the past year, and then 1 was added. The absolute value was taken because both the increase and the decrease of sales proportion increases demand uncertainty. Then the value of 1 was added to reflect the increase in uncertainty in the current year relative to the past year. If there is no change in sales proportion of each product, this value becomes 1. Fourth, to capture the sales ratio change of up to six major products, all the values obtained in the third stage were multiplied. Fifth, the 4-year (1989-92) average of the value obtained in the fourth stage was then calculated. The formula is given by $\{\Pi_{ij}(1+|P_{ij}-P_{ij-1}|)$: P=sales ratio of each product, i=ith product,

j=jth year]. Sixth, the sales proportion variation obtained in the fifth stage was then averaged at the 3-digit KSIC.

Occurrence of Abnormal Situations: The occurrence of abnormal situations was measured as the two items from *Survey for Employee*. The workers were asked to indicate (1) whether they encounter abnormal situations and (2) whether they deal with new tasks on the job. The proportion of the workers who responded to each item positively was computed and then the two measures were averaged.

In addition to the uncertainty from external environments, the internal sources of uncertainty within the firm may also affect the degree of multiskill formation. The inclusion of the occurrence of abnormal situations in our study was to test Koike's (1988) argument that multiskilling is fostered at the workplace where abnormal situations frequently occur.

Interactive Learning with Senior Workers/Coworkers: Interactive learning with senior workers and coworkers was measured using the two items in *Survey for Employee*. Workers were asked to indicate (1) whether they learn on the job from senior workers and coworkers and (2) whether they teach their senior workers and coworkers on the job. The proportion of the number of workers who responded to each question positively was computed and then the two measures were averaged.

Interactive Learning with Junior Workers: Interactive learning with junior workers and coworkers was measured using the two items in *Survey for Employee*. Workers were asked to indicate (1) whether they learn on the job from junior workers and (2) whether they teach their junior workers on the job. The proportion of the number of workers who responded to each question positively was computed and the two measures were averaged.

Decision Making Authority (Team): Decision making authority at the team level was constructed from 3 questions in *Survey for Employee* asking to check on a Likert 5-point scale the degree of autonomy given to the team in deciding the quantity, the speed, and the method of work (Crombach-α=0.87).

Decision Making Authority (Individual): Decision making authority at the individual level was constructed from 3 questions in *Survey for Employee* asking to check on a Likert 5-point scale the degree of autonomy given to the individual in deciding the quantity, the speed, and the method of work (Crombach-α=0.91).

Group Incentive: Group incentive was measured as a dummy and was coded 1 if a portion of worker's pay was determined by group performance, 0 otherwise.
Intraworkshop Mobility: The measure of intraworkshop mobility was from an item in *Survey for Employer*. Intraworkshop mobility was measured as a dummy and was coded 1 if a firm rotates workers within workshop, 0 otherwise.
Interworkshop Mobility: The measure of interworkshop mobility was from an item in *Survey for Employer*. Interworkshop mobility was measured as a dummy and was coded 1 if a firm rotates workers between workshops, 0 otherwise.

V. Results

Table 1 presents the means, standard deviations, correlations of the study variables. In order to test a series of hypotheses, we conducted regression analyses. Table 2 displays the results of regression analyses for the determinants of multiskilling. Sales variation as a measure for demand variability, the occurrence of abnormal situations, and various HRM practices are included in the analyses.

Table 3 displays the results of regression analyses for the determinants of multiskilling. Sales proportion variation as another measure for demand variability, occurrence of abnormal situations, and various HRM practices are included in the analyses. Two measures of demand variability, *i.e.*, sales variation and sales proportion variation, are analyzed in different regressions because of a high multicollinearity between them ($r=0.60$). In order to test further whether there are multicollinearity problems among variables in the analyses, *VIFs* (variance inflating factors) are calculated. Since all values of VIFs are less than 2, there seems to be no multicollinearity problem in the analyses.

Table 4 presents the results of regression analyses to test the relationship between multiskilling and labor productivity growth. Lastly, Table 5 displays the results of regression analyses testing the relationship between multiskilling and the level of labor productivity.

TABLE 1

MEANS, STANDARD DEVIATIONS, AND CORRELATIONS OF THE VARIABLES ($N=206$)

Variables	Mean	S.D.	1	2	3	4	5	6	7	8	9	10	11
1. Labor Productivity Growth	0.08	0.11											
2. Level of Labor Productivity (MM Wons)	23.95	11.66	0.14										
3. Multiskilling Ratio	0.50	0.22	0.20	0.12									
4. Sales Variation	0.08	0.02	0.09	0.11	0.19								
5. Sales Proportion Variation	1.16	0.04	0.03	-0.08	0.18	0.60							
6. Occurrence of Abnormal Situations	0.18	0.17	0.10	0.03	0.29	0.11	0.12						
7. Sales (Log MM Won)	10.58	1.43	0.18	0.38	0.07	0.02	0.05	-0.02					
8. Tangible Fixed Asset per Employee (Log MM Wons)	3.21	0.79	0.04	0.61	0.12	-0.01	-0.14	0.07	0.42				
9. Growth of Tangible Fixed Asset/Employee	0.11	0.15	0.21	-0.09	0.02	0.01	0.01	0.09	0.02	0.26			
10. Industry Concentration Ratio (CR3)	0.55	0.19	-0.06	0.23	0.12	-0.09	-0.02	0.00	0.33	0.20	-0.11		
11. Union (D)	0.69	0.46	0.10	0.03	-0.06	-0.02	0.04	-0.08	0.34	0.07	0.04	0.12	
12. Manual Tool	0.67	0.47	-0.06	-0.24	-0.03	0.08	0.03	-0.07	-0.32	-0.23	0.00	-0.04	-0.09

(Table Continued)

Variables	Mean	S.D.	1	2	3	4	5	6	7	8	9	10	11
13. Power-driven Tool	0.30	0.46	0.05	0.28	0.06	-0.12	-0.05	0.06	0.37	0.26	0.00	0.06	0.11
14. Semiautomatic Machine	0.16	0.15	-0.04	-0.07	0.09	-0.04	-0.05	0.01	-0.04	0.01	0.10	0.00	0.05
15. Automatic Machine	0.13	0.16	0.02	0.17	0.12	0.02	0.05	0.27	0.12	0.08	-0.04	0.04	0.20
16. Workers' Average Tenure	5.51	2.83	0.11	0.28	0.33	0.03	-0.04	0.00	0.34	0.31	0.07	0.12	0.19
17. Workers' Average Education	11.91	0.72	-0.06	0.10	0.16	-0.11	0.02	0.22	0.06	0.01	-0.04	0.22	0.01
18. Interactive Learning with Seniors/ Coworkers	0.94	0.08	0.01	0.00	0.19	-0.05	0.07	0.14	0.06	0.08	0.06	0.08	0.03
19. Interactive Learning with Junior Workers	0.69	0.14	0.08	0.14	0.33	0.06	0.06	0.24	0.14	0.27	0.12	0.10	0.02
20. Decision Making Authority (Team)	0.40	0.13	-0.01	0.06	0.28	0.01	0.04	0.27	-0.03	0.10	0.01	0.14	-0.04
21. Decision Making Authority (Individual)	0.35	0.13	-0.04	0.06	0.33	0.04	0.06	0.21	-0.01	0.13	0.01	0.09	-0.01
22. Group Incentive (D)	0.09	0.29	0.04	0.04	0.18	-0.02	-0.01	0.11	-0.04	0.07	0.16	0.12	-0.04
23. Intraworkshop Mobility (D)	0.44	0.50	-0.08	0.01	-0.11	-0.11	-0.10	-0.17	0.02	-0.02	-0.10	0.07	0.02
24. Interworkshop Mobility (D)	0.28	0.45	0.06	0.06	0.21	0.17	0.14	0.16	0.11	0.07	0.19	0.01	0.03

(Table Continued)

Variables	12	13	14	15	16	17	18	19	20	21	22	23
13. Power-driven Tool	-0.93											
14. Semiautomatic Machine	-0.01	0.01										
15. Automatic Machine	-0.17	0.19	-0.15									
16. Workers' Average Tenure	-0.09	0.11	0.09	-0.05								
17. Workers' Average Education	0.03	0.00	0.00	0.32	-0.20							
18. Interactive Learning with Seniors/ Coworkers	-0.08	0.09	0.03	0.07	-0.07	0.28						
19. Interactive Learning with Junior Workers	-0.16	0.10	0.00	0.03	0.21	0.09	0.49					
20. Decision Making Authority (Team)	0.02	-0.02	0.16	0.05	0.18	0.09	0.12	0.31				
21. Decision Making Authority (Individual)	0.05	-0.05	0.16	0.10	0.20	0.09	0.14	0.31	0.75			
22. Group Incentive (D)	-0.06	0.08	0.12	0.01	0.09	0.09	0.06	0.22	0.21	0.20		
23. Intraworkshop Mobility (D)	-0.13	0.11	-0.08	0.00	-0.10	0.06	0.00	-0.06	-0.10	-0.02	-0.01	
24. Interworkshop Mobility (D)	0.12	-0.09	0.06	0.01	0.05	-0.01	-0.02	0.06	0.18	0.17	0.03	-0.55

Notes: $p < 0.05$ if correlations are greater than 0.14; $p < 0.01$ if correlations are greater than 0.18.

TABLE 2

DETERMINANTS OF MULTISKILLING RATIO (WITH SALES VARIATION OF MAJOR PRODUCTS) (N=206)

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Intercepts	-0.414	-0.617**	-0.856***	-0.743***	-0.662**	-0.649**	-0.588**	-0.615**	-0.579**
	(0.279)	(0.281)	(0.293)	(0.276)	(0.279)	(0.276)	(0.282)	(0.282)	(0.279)
Control Variables									
Sales (Log MM Wons)	-0.009	-0.010	-0.010	-0.010	-0.008	-0.007	-0.008	-0.010	-0.013
	(0.013)	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)
Tangible Fixed Asset	0.004	0.003	-0.001	-0.013	-0.002	-0.005	-0.001	0.001	0.001
(Log MM Wons)	(0.021)	(0.020)	(0.019)	(0.020)	(0.020)	(0.019)	(0.020)	(0.020)	(0.020)
Union (D)	-0.070**	-0.054*	-0.057*	-0.056*	-0.054*	-0.051	-0.052	-0.053	-0.054*
	(0.034)	(0.033)	(0.032)	(0.032)	(0.033)	(0.032)	(0.033)	(0.033)	(0.032)
Manual Tool	0.054	0.091	0.092	0.151*	0.089	0.084	0.085	0.088	0.065
	(0.087)	(0.083)	(0.082)	(0.083)	(0.082)	(0.081)	(0.083)	(0.084)	(0.083)
Power-driven Tool	0.062	0.113	0.109	0.171**	0.115	0.114	0.104	0.112	0.098
	(0.091)	(0.087)	(0.087)	(0.087)	(0.087)	(0.086)	(0.088)	(0.088)	(0.087)
Semiautomatic Machine	0.115	0.107	0.099	0.119	0.078	0.061	0.094	0.105	0.093
	(0.100)	(0.095)	(0.094)	(0.093)	(0.095)	(0.094)	(0.096)	(0.096)	(0.094)
Automatic Machine	0.156	0.057	0.074	0.085	0.057	0.033	0.061	0.056	0.058
	(0.102)	(0.100)	(0.099)	(0.098)	(0.100)	(0.099)	(0.100)	(0.101)	(0.099)
Workers' Average Tenure	0.032***	0.031***	0.032***	0.028***	0.029***	0.028***	0.030***	0.031***	0.031***
	(0.006)	(0.005)	(0.005)	(0.005)	(0.006)	(0.005)	(0.006)	(0.006)	(0.005)
Workers' Average Education	0.065***	0.063***	0.050***	0.054***	0.059***	0.059***	0.060***	0.063***	0.065***
	(0.022)	(0.021)	(0.022)	(0.021)	(0.021)	(0.021)	(0.022)	(0.022)	(0.021)

(Table Continued)

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Intercepts	-0.414	-0.617**	-0.856***	-0.743***	-0.662**	-0.649**	-0.588**	-0.615**	-0.579**
	(0.279)	(0.281)	(0.293)	(0.276)	(0.279)	(0.276)	(0.282)	(0.282)	(0.279)
Independent Variables									
Sales Variation		2.057***	2.092***	1.962***	2.075***	2.005***	2.051***	2.043***	1.838***
		(0.679)	(0.670)	(0.661)	(0.673)	(0.664)	(0.677)	(0.682)	(0.678)
Occurrence of Abnormal Situations		0.275***	0.255***	0.212***	0.228**	0.232***	0.267***	0.271***	0.241***
		(0.089)	(0.088)	(0.089)	(0.091)	(0.088)	(0.089)	(0.091)	(0.090)
Interactive Learning with Seniors/Coworkers			0.433**						
			(0.170)						
Interactive Learning with Junior Workers				0.366***					
				(0.105)					
Decision Making Authority (Team)					0.244**				
					(0.113)				
Decision Making Authority (Individual)						0.334***			
						(0.108)			
Group Incentive (D)							0.066		
							(0.048)		
Intraworkshop Mobility (D)								-0.008	
								(0.029)	
Interworkshop Mobility (D)									0.073**
									(0.032)
R-Square	0.20	0.28	0.30	0.32	0.29	0.31	0.28	0.28	0.29
F-value	5.48***	6.70***	6.86***	7.50***	6.64***	7.21***	6.32***	6.12***	6.71***

Note: *p<0.10, **p<0.05, ***p<0.01. Standard errors are in parentheses.

TABLE 3

DETERMINANTS OF MULTISKILLING RATIO (WITH SALES RATIO VARIATION OF MAJOR PRODUCTS) ($N=206$)

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Intercepts	-0.414	-1.719***	-1.847***	-1.754***	-1.719***	-1.657***	-1.684***	-1.708***	-1.567***
	(0.279)	(0.542)	(0.540)	(0.528)	(0.538)	(0.532)	(0.542)	(0.546)	(0.540)
Control Variables									
Sales (Log MM Wons)	-0.009	-0.012	-0.011	-0.012	-0.009	-0.008	-0.010	-0.012	-0.015
	(0.013)	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)
Tangible Fixed Asset	0.004	0.010	0.006	-0.004	0.007	0.003	0.009	0.010	0.008
(Log MM Wons)	(0.021)	(0.020)	(0.020)	(0.020)	(0.020)	(0.020)	(0.020)	(0.020)	(0.020)
Union (D)	-0.070**	-0.058*	-0.061*	-0.060*	-0.058*	-0.056*	-0.057*	-0.058*	-0.058*
	(0.034)	(0.033)	(0.033)	(0.032)	(0.033)	(0.032)	(0.033)	(0.033)	(0.033)
Manual Tool	0.054	0.084	0.085	0.144*	0.082	0.077	0.079	0.082	0.059
	(0.087)	(0.083)	(0.082)	(0.083)	(0.083)	(0.082)	(0.083)	(0.084)	(0.083)
Power-driven Tool	0.062	0.098	0.092	0.154*	0.098	0.098	0.088	0.096	0.084
	(0.091)	(0.087)	(0.086)	(0.086)	(0.086)	(0.085)	(0.087)	(0.087)	(0.087)
Semiautomatic Machine	0.115	0.108	0.101	0.119	0.081	0.064	0.095	0.107	0.093
	(0.100)	(0.095)	(0.094)	(0.093)	(0.096)	(0.095)	(0.096)	(0.096)	(0.094)
Automatic Machine	0.156	0.068	0.084	0.095	0.068	0.045	0.072	0.068	0.068
	(0.102)	(0.100)	(0.100)	(0.098)	(0.100)	(0.099)	(0.100)	(0.101)	(0.099)
Workers' Average Tenure	0.032***	0.031***	0.032***	0.028***	0.029***	0.028***	0.031***	0.031***	0.032***
	(0.006)	(0.006)	(0.005)	(0.005)	(0.006)	(0.006)	(0.006)	(0.006)	(0.005)
Workers' Average Education	0.065***	0.055**	0.042*	0.046**	0.051**	0.051**	0.052**	0.055**	0.058***
	(0.022)	(0.021)	(0.021)	(0.021)	(0.021)	(0.021)	(0.021)	(0.021)	(0.021)

(Table Continued)

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Intercepts	-0.414	-1.719***	-1.847***	-1.754***	-1.719***	-1.657***	-1.684***	-1.708***	-1.567***
	(0.279)	(0.542)	(0.540)	(0.528)	(0.538)	(0.532)	(0.542)	(0.546)	(0.540)
Independent Variables									
Sales Variation		1.178***	1.109***	1.091***	1.145***	1.094***	1.173***	1.170***	1.057**
		(0.405)	(0.402)	(0.395)	(0.402)	(0.398)	(0.404)	(0.408)	(0.404)
Occurrence of Abnormal Situations		0.276***	0.260***	0.215***	0.234***	0.236***	0.268***	0.273***	0.241***
		(0.089)	(0.089)	(0.089)	(0.091)	(0.089)	(0.090)	(0.091)	(0.090)
Interactive Learning with Seniors/Coworkers			0.386**						
			(0.171)						
Interactive Learning with Junior Workers				0.360***					
				(0.106)					
Decision Making Authority (Team)					0.226**				
					(0.114)				
Decision Making Authority (Individual)						0.338***			
						(0.108)			
Group Incentive (D)							0.066		
							(0.049)		
Intraworkshop Mobility (D)								-0.006	
								(0.029)	
Interworkshop Mobility (D)									0.075**
									(0.032)
R-Square	0.20	0.27	0.29	0.31	0.29	0.30	0.28	0.27	0.29
F-value	5.48***	6.62***	6.61***	7.36***	6.48***	7.04***	6.24***	6.04***	6.66***

Note: *p<0.10, **p<0.05, ***p<0.01. Standard errors are in parentheses.

A. Demand Variability and Multiskilling (Hypothesis 1)

In Table 2 and Table 3, the results of regression analyses to test Hypothesis 1 and 2 are presented. Model (1) in Table 2 and Table 3 included only the control variables to estimate multiskilling. More specifically, model (1) of Table 2 shows that firms with unions slow the multiskill formation ($p<0.05$). This result is consistent with Black and Lynch's (1997) empirical finding that the existence of union negatively affects labor productivity. In model (1), workers' average tenure was positively associated with multiskilling ($p<0.01$). This result shows that multiskilling is progressed with workers' longevity of service with the firm. Also, workers' average education was positively associated with multiskilling ($p<0.01$). On the other hand, sales, tangible fixed asset per employee, and characteristics of machines and tools were not significant. Model (1) in Table 3 shows the similar results as in Table 2. Model (2) in Table 2 includes control variables and two major independent variables: sales variation and the occurrence of abnormal situations. These two independent variables show significant positive associations with multiskilling ($p<0.01$). Model (2) in Table 3 shows that both sales proportion variation and the occurrence of abnormal situations have significantly positive coefficients ($p<0.01$). These results show that all three measures of demand uncertainty (2 measures of demand variability and one measure of the occurrence of abnormal situations) were significantly positively associated with multiskill formation. Therefore, Hypothesis 1 that "variability in product demand will be positively associated with multiskilling" is supported.

B. HRM Practices and Multiskilling (Hypothesis 2)

Model (3)–(9) in Table 2 and Table 3 present the results of regression analyses testing the relationship between various HRM practices and multiskilling. Model (3) and (4) in Table 2 and Table 3 show that both interactive learning with senior workers/coworkers and with junior workers are significantly positively associated with multiskilling ($p<0.01$). This result indicates that multiskilling is fostered by active mutual learning among workers. In model (5) and (6) in Table 2 and Table 3, it is shown that decision making authority at the team level ($p<0.05$) and at the individual level ($p<0.01$) are both important in fostering multiskilling. The delegation of decision authority to workers at the

workplace is deemed crucial in multiskill formation. In model (7) in Table 2 and Table 3, group incentive is not significantly positively associated with multiskilling (p=*n.s.*). It seems likely that since only a few firms, 9% of the sample firms, adopt group incentives, there is not enough variance of the variable to test the effects.

In model (8) in Table 2 and Table 3, intraworkshop mobility is not significantly associated with multiskill formation. The insignificance of intraworkshop mobility indicates that the sample firms do not provide enough opportunity for workers to learn diverse tasks by moving within a workshop. On the contrary, model (9) in Table 2 and Table 3 shows that interworkshop mobility is significantly positively associated with multiskill formation ($p<0.05$). This result is consistent with Koike's (1988) observation that job rotation across workshop fosters multiskilling in Japanese firms.

Hypothesis 2 that "HRM practices promoting interaction among workers (interactive learning with senior workers/coworkers and with junior workers, group incentives, intraworkshop mobility, interworkshop mobility, and delegation of decision making authority) will be positively associated with multiskill formation" is supported in the analyses except in the case of group incentives and intraworkshop mobility.

C. Multiskilling and Firm Growth (Hypothesis 3-a, 3-b, 3-c)

Table 4 and Table 5 present the results of regression analyses testing hypothesis 3-a, 3-b, and 3-c. Model (1) in Table 4 shows the relationship between the control variables and labor productivity growth. Among the control variables, sales ($p<0.05$) and tangible fixed asset per employee ($p<0.01$) are significantly positively associated with labor productivity growth. The significance of sales is an interesting result that traditional economics cannot easily explain. One possible explanation would be that interactions among people increase with the size of the firm (Lucas 1988; Backus, Kehoe, and Kehoe 1992; and Grossman and Helpman 1994). Concentration ratio (CR3) is not significant but the sign was negative as expected. Although not significant, it shows that labor productivity growth is slower in monopolistic industries than in more competitive industries. In addition, union, workers' average tenure and workers' average education are not significantly associated with labor productivity growth (p=*n.s.*).

TABLE 4

MULTISKILLING AND LABOR PRODUCTIVITY GROWTH ($N=206$)

Variables	(1)	(2)	(3)	(4)
Intercept	0.001	0.047	0.032	0.159
	(0.123)	(0.121)	(0.128)	(0.255)
Control Variables				
Industry Concentration Ratio (CR3)	-0.050	-0.057	-0.056	-0.057
	(0.038)	(0.037)	(0.038)	(0.038)
Sales (Log MM Won)	0.013**	0.014**	0.013**	0.014**
	(0.005)	(0.005)	(0.005)	(0.005)
Tangible Fixed Asset Growth (Per Employee)	0.127***	0.125***	0.125***	0.122***
	(0.046)	(0.045)	(0.045)	(0.045)
Union (D)	0.008	0.014	0.014	0.015
	(0.015)	(0.015)	(0.015)	(0.015)
Workers' Average Tenure	0.001	-0.002	-0.002	-0.002
	(0.003)	(0.003)	(0.003)	(0.003)
Workers' Average Education	-0.004	-0.018	-0.011	0.014
	(0.010)	(0.010)	(0.010)	(0.010)
Independent Variables				
Multiskilling Ratio		0.102***	0.093***	0.098***
		(0.032)	(0.034)	(0.034)
Sales (MM Won)			0.101	
			(0.325)	
Sales Ratio Variation of Major Products				-0.085
				(0.192)
Occurrence of Abnormal Situations			0.033	0.035
			(0.034)	(0.043)
R-Square	0.08	0.13	0.13	0.13
F-value	3.11***	4.23***	3.35***	3.36***

Note: *p<0.10, **p<0.05, ***p<0.01, Standard errors are in parentheses.

Model (2) in Table 4 shows that multiskilling is significantly positively associated with labor productivity growth ($p<0.01$). Therefore, the hypothesis 3-a that "multiskilling will be positively associated with labor productivity growth" is supported.

Model (3) and (4) in Table 4 show that uncertainty, external and internal, is not significantly associated with labor productivity growth when multiskilling is included in the regression equations ($p=n.s.$). This result indicates that uncertainty influences labor productivity growth only through multiskill formation. That is, there

TABLE 5

MULTISKILLING AND LEVEL OF LABOR PRODUCTIVITY ($N=206$)

Variables	(1)	(2)	(3)	(4)
Intercept	-256.92**	-256.92**	-358.82***	-243.13
	(117.95)	(117.80)	(124.38)	(251.91)
Control Variables				
Industry Concentration Ratio (CR3)	36.33	36.33	42.75	35.38
	(36.09)	(36.09)	(35.93)	(36.35)
Sales (Log MM Won)	10.38*	10.38*	9.40*	10.39*
	(5.51)	(5.51)	(5.47)	(5.59)
Tangible Fixed Asset Growth (Per Employee)	75.32***	75.32***	76.12***	75.41***
	(9.12)	(9.12)	(9.05)	(9.33)
Union (D)	-17.62	-17.62	-17.96	-17.82
	(14.82)	(14.82)	(14.69)	(14.92)
Workers' Average Tenure	5.22*	5.11*	5.59**	5.04*
	(2.70)	(2.70)	(2.68)	(2.73)
Workers' Average Education	9.45	9.45	13.88	10.05
	(9.60)	(9.60)	(9.79)	(9.82)
Independent Variables				
Multiskilling Ratio		-6.65	-19.63	-3.00
		(31.13)	(32.59)	(33.02)
Sales (MM Won)			737.24	
			(509.89)	
Sales Ratio Variation of Major Products				-16.83
				(190.11)
Occurrence of Abnormal Situations			-23.07	-14.83
			(40.71)	(41.31)
R-Square	0.41	0.41	0.42	0.41
F-value	23.16***	19.77***	14.35***	15.24***

Note: *p<0.10, **p<0.05, ***p<0.01, Standard errors are in parentheses.

is no direct effect of uncertainty on labor productivity growth without the mediating effect of multiskilling. Therefore, the hypothesis 3-b that "the firm's uncertainty (sales variations, sales proportion variations, and frequency of unusual situation occurrence) does not have a direct relationship with its labor productivity growth" is supported.

Model (1)–(4) in Table 5 test the relationship between multiskilling and the level of labor productivity. In any of the models, there is no significant association between multiskilling and

labor productivity (n=n.s.). Therefore, the hypothesis 3-c that "multiskilling will not have a significant positive association with the level of labor productivity" is supported.[2]

VI. Discussion and Conclusion

Our empirical study contributes to the literature of labor economics and human resource management in the following manner.

First, we examined the determinants of multiskilling for a key mechanism of human capital accumulation. It was shown that two uncertainty factors, the product-demand variability in the industry and the occurrence of abnormal situations at the workplace, were positively associated with multiskill formation in the sample firms. The theoretical relationship between uncertainty and multiskill formation proposed by Aoki (1988) and modeled by Park (1996) was empirically confirmed in this study.

Second, various human resource management practices employed by the firm were shown to affect multiskill formation of the workforce. Interactive learning with senior workers/coworkers and with junior workers, delegation of decision making authority to the production teams, and interworkshop mobility were positively associated with multiskilling. Except in the case of group incentive and intraworkshop mobility, all of the HRM practice variables in this study showed positive relationships with multiskilling. This result indicates that the firm should establish effective HRM practices to foster multiskilled workforce as a firm's core competencies to cope with environmental uncertainty characterized by demand and technology change (Becker and Gerhart 1996; Pfeffer 1994; and Youndt *et al.* 1996). Also the results of our study imply that multiskill formation is influenced by the development of

[2]We also conducted additional regression analyses to investigate the possible relationships between multiskilling and firm performance. We used *ROA* (return of assets) and *ROS* (return on sales) as the measures of dependent variable, firm performance. We obtained very similar results as in Table 5. Neither of multiskilling or uncertainty was significantly positively associated with two measures of firm performance.

internal labor markets. We can make this argument based on our finding that time for skill formation measured by workers' average tenure was important in promoting multiskilling. Therefore, human capital is accumulated more effectively in internal labor markets than external labor markets.

Third, uncertainty had an indirect impact on labor productivity growth only through multiskill formation. When both uncertainty and multiskilling were included in the regression models, uncertainty had no impact on labor productivity growth. This result suggests that labor productivity is enhanced only when firms successfully respond to uncertainty with multiskilled workforce.

Fourth, the degree of multiskilling was not significantly associated with the level of labor productivity. We found growth effect of multiskilling but no level effect after controlling other factors. This result indicates that the firm with highly multiskilled workforce has the potential to grow although the current productivity of its workers is low.

Fifth, our study tried to overcome the limitations of generalization of the existing empirical works. While existing works on *HRM* practices concentrated one or two industries, we examined 206 firms in 22 industries (in 3-digit *KSICs*). We discovered empirically the causal connections between uncertainty, multiskilling, and labor productivity growth over a wide range of industries.

We suggest the following future research directions. First, as mentioned above, more thorough analyses of the processes through which the characteristics of internal labor market affect human capital accumulation. It can be said that U.S. firms have different ways of coping with environmental uncertainty than Japanese firms. If the differences in coping exist, they should be sought in the differences of the internal labor markets of the firms in both countries. One important task is to uncover the contingencies under which *HRM* practices of U.S. firms perform better than those of Japanese firms, or vise versa.

Second, another research stream is to classify the type of a firm's HRM practices and examine its effects on performance. In

our study, we dealt with HRM practices and multiskilling separately. However, the current studies investigating *HRM* practices tend to take configurational approach (Ichniowski *et al.* 1997; Huselid 1995; Husedlid *et al.* 1997; Kandel and Lazear 1993; and Milgrom and Roberts, 1995). In particular, Milgrom and Roberts (1995) argued that the bundle of *HRM* practices have greater effects than the individual practices. They called this effect as the complementarity of a firm's HRM practices. More thorough analyses are needed to test whether individual or complementarity effect is greater.

Third, future research needs to look at the congruence between management strategy and *HRM* practices (Huselid 1995; Delery and Doty 1995; and Youndt *et al.* 1996). Congruence perspective is based on the contingency theory in management (Dewar and Werbel 1979; and Van de Ven and Drazin 1985). According to Delery and Doty (1995), if HRM systems are aligned with management strategy, firm performance improves. But if HRM systems are not congruent with management strategy, firm performance deteriorates. So far, empirical research investigating what constitutes the congruence and what part of the congruence drives performance has been rare. Further theory building and empirical examination in this topical area is needed.

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