Extended Schooling and Internalized Training

Skill Elements Evolution of Blue-collar Workers in an Internal Labor Market*

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Abstract

Long-term employment and internal promotion at major firms are common in developed economies. We examine the long-range changes in the returns on skill elements and training using a micro dataset of a Japanese ironworks. We show that, 1) the return on schooling rose from the late 1940s and that on tenure surged but that on previous experience became modest from the mid-1950s, 2) complementarity between schooling and experience strengthened from the mid-1950s, and 3) training programs focused on better-educated employees from the late 1940s, which formed an internal labor market in the flexible labor market in the 1960s.

Key words: specific skills; asymmetric employer learning; return on schooling; internal labor markets; Japan.
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1 Introduction

Major firms in developed economies, and particularly those regarded as excellent companies, tend to prefer long-term employment and internal promotion. Workers at the executive level are often more mobile, working for shorter length of time and at different firms. However, the firm organizations as a whole are usually dominated by middle management promoted from within, unless the firm is so young that it lacks sufficient internal skilled employees. This preference for long-term employment and internal promotion, a combination known as an internal labor market, is still widely observed in developed economies, even after labor market reforms and increasing international integration of labor markets (Ariga, Ohkusa and Brunello (1999, 2000); Altonji and Williams (2005); Pfeifer (2008); and Ben-Ner, Kong and Lluis (2012)). There are a few reasons for this practice: to encourage workers to acquire firm-specific skills, to provide risk-averse workers with job security as an insurance, and to enable employers to learn about their employees' abilities (Osterman (2011) and Waldman (2013)).

Major Japanese companies are well-known examples of the internal labor market practice. This study examines how the personnel practice for blue-collar workers in the manufacturing sector formed in early 20th-century Japan by analyzing a dataset newly built from the original wage records of a major ironworks. The performance of the Japanese economy until the 1980s, once admired, was based largely in the manufacturing, especially within efficient blue-collar organizations. At that stage, anecdotal descriptions of blue-collar workers in Japanese manufacturing were actively discussed (Aoki (1988)). However, the excitement disappeared before empirical analyses were conducted. Thus, examining the incentives used and the way skills of blue-collar workers developed is necessary to understand the history of the Japanese economy.

However, such an examination has meaning beyond the Japanese experience as well. Organizations of full-time blue-collar workers in other developed economies are extremely inflexible owing to historical industrial relations institutions. For example, in the United States and in Germany, the management of major firms cannot freely determine individual wages or promote blue-collar workers in the same way as they can for white-collar workers, being bound by trade union agreements. Thus, major Western manufacturing firms are unable to apply finely tuned incentive mechanisms to blue-collar workers, and instead have to apply much coarser or flatter wage schemes. As a natural result, blue-collar workers are expected to work in a routine way.

The aforementioned situation is common in American and European manufacturing firms. However, for most of the world, that type of institutional arrangement is neither relevant nor ideal. If there is a direction of sophistication for organizations in today's emerging economies, it is more likely be toward Japan than toward Europe or the United States. With regard to manufacturing, the dominant players are likely to be Asian countries, where Western unionism does not occur.

Work organization and personnel practices in contemporary Japanese firms can be summarized as follows. First, both white-collar workers and blue-collar workers work under a deliberately designed wage and promotion system with long-term employment. Every year, all blue-collar and white-collar employees are eligible for a possible substantial upgrade to their basic wage adding to a mere seniority based rise, based on merit. An employee's performance during the previous dictates whether he or she is upgraded and by how much. Thus, the so-called "seniority-based wage" system in Japan is a simply a myth because seniority-based rise counts quite a small portion in wage growth as a whole. While it is true that long-term employment is guaranteed, winners and losers are strictly differentiated every year. This pressure empowers employees, and dedicated effort is the norm in the workplace, for both blue-collar and white-collar employees (Aoki (1988) and Kike (1996)).

Second, because major firms predominantly stick to this strict internal meritocracy, workers with greater ability and longer service are more likely to earn higher wages. Thus, wage growth is highly responsive to tenure (Abe (2000)). Again, this does not mean there is an emphasis on seniority. "Losers" are more likely to quit their first employers. People in this category find it more difficult than new graduates do to find long-term employment at another major firm, because major firms tend to commit to an internal labor market practice. Thus, those who leave find it more difficult to re-enter a long-term employment at another major firm and their tenure tends to be shorter. This competition structure within the labor market further amplifies the return on tenure, on aggregate.

Third, employers' investments in employees' skills, typically from off-the-job training programs, concentrate on better-educated employees (Higuchi (1994)). Fourth, and lastly, major firms primarily hire new graduates (Genda, Kondo and Ohta (2010) and Sugayama (2014)).

As an approach to determine the origin of these practices, we analyze the wage dynamics and training programs at a major ironworks in Japan. To do so, we create and examine a new long-term employee-level panel dataset for the ironworks for the period 1930–1960.

Section 2 presents the underlying framework for the analysis. Here, we adopt the model of DeVaro and Waldman (2012). The model captures general and firm-specific skill acquisition, as well as asymmetric employer learning, which we assume are essential factors of internal labor markets. The predictions in this section are based on this model.

Section 3 describes the features of the case plant within the steel industry and the dataset. The dataset is created from the original wage records of individual employees of the ironworks. Then, we verify the existence of an internal labor market at the case plant during the sample period.

Section 4 decomposes the wage growth in the plant into human capital components, including physiological characteristics, schooling, previous career experience, tenure at the plant, and completion of in-house training programs at the plant. Then, we track the evolution of the returns on skill elements in cohorts. The principal findings are as follows. First, the return on firm tenure rose sharply from the late 1940s onwards. Second, the return on schooling surged from the late 1940s. Third, the growth in the return on previous career experience, which captures the return on general and/or industry-specific skills, became modest from the mid-1940s, before increasing again in the 1960s. Mid-career experience appears to have been supplanted by schooling from the late 1940s. However, at the same time, mid-career recruiting was active during the sample period until the end of the 1960s, with the return on previous career experience still being valued, albeit being modest.

Section 5 investigates the in-house off-the-job training policy. Here, we also find a discontinuous change in the late 1940s. Before and during the Second World War, regulations required major firms to complement the public education system by providing training programs to employees who had not completed their secondary education. Them, the postwar education reform, led by the United States, meant that junior high school became compulsory, and the regulations on in-house off-the-job training programs were abandoned. In response, off-the-job training programs focused on less-educated employees until the mid-1940s, and on better-educated employees from the late 1940s. At the same time, employees who had more previous experience were more likely to be accepted as trainees from the 1930s to the mid-1940s. They were then less likely to be accepted through the 1950s, but more likely to be accepted again in the 1960s. While the case firm continuously invested in better-educated employees from the 1940s, the value they ascribed to previous experience became modest from the late 1940s to the 1950s, before picking up again in the 1960s. This result is consistent with the aforementioned trends in the return on previous experience. With regard to customs specific to contemporary major Japanese firms, there was a preference for new graduates with better physiological characteristics in the 1960s. During this time, there was a shortage of labor in the Japanese labor market, as shown by the return on previous experience rising again, when the domestic migration of slack labor in the rural regions ended.[1] Thus, the case firm began to focus on new graduates with better physiological characteristics.

In summary, the emphasis on schooling and tenure became intangible in the late 1940s and in the mid-1950s, while a preference for new graduates endowed with better characteristics became prominent only in the 1960s. Furthermore, the case firm actively sought experienced workers. Complementarity between extended general education and enhanced internal labor markets has a long history, and hence is deeply rooted in the Japanese economy. Meanwhile, a strong preference for new graduates was barely observed before the 1970s, thus is a relatively new phenomenon, and might not be necessarily structurally entrenched.

2 Underlying framework

2.1 Technology, skill, and organization

The desirable structure of an organization depends on who possesses relevant information. At the same time, technological conditions shape the informational structure, which affects the organizational structure. This relationship is particularly evident in the work organization within a firm. Technological changes affect the types of skills required, which, in turn, determine whether employees or the firm possesses more information about the skill. If the firm has more information about the skill, then more centralized control within the work organization could more efficiently provide employees with incentives. The firm chooses an internal labor market, a centralized incentive mechanism, when it has more information about the necessary skills and when the skills are complementary and/or are firm-specific (Rosen (1988); Aoki (1988); Osterman (2011); and Waldman (2013)).

[1] Japan's rapid postwar growth in the 1950s and the 1960s relied considerably on internal migration of workers from rural regions.

Internal labor markets characterized by long-term employment and internal promotion have been thought to work as a monitoring and evaluation device to make wages sensitive to employee performance and to give employees incentives to acquire industry- and/or firm-specific skills. Thus, the wages determined within internal labor markets are not expected to differ much in the long term, on average, from marginal productivity. However, they are somewhat shielded from the competitive outside market and, hence, are not necessarily equal to workers' marginal productivity at any particular point in time (Baker, Gibbs and Holmstrom (1994a)).

Since workers' abilities are generally private information at the time of recruitment, employers use proxies for these abilities during recruiting. One such proxy is schooling. Since better-educated people are presumed to be more able, with a positive probability, employers discriminate between applicants statistically, based on education. However, once a worker is hired, employers gradually learn about the worker's innate ability. Then to determine wages, employers come to rely more on information observed after hiring, and less on educational background. Accordingly, the relative impact of educational background on wages decreases as workers acquire work experience, which is called the "employer learning" process (Farber and Gibbons (1996) and Altonji and Pierret (2001)). While the employer learning process occurs in the market as a whole, a firm can accelerate the process with long-term employment (Baker et al. (1994a, 1994b) and Pinkston (2009)). Furthermore, such asymmetric employer learning makes internal labor markets self-sustainable. If a current employer knows their employees better than potential employers do, the current employers can retain their employees by capitalizing on this informational advantage (Waldman (1984)).

2.2 Skill acquisition and asymmetric employer learning

Of models presented in related studies, the model of DeVaro and Waldman (2012) provides a comprehensive and tractable insight into internal labor markets. Based on the work of Gibbons and Waldman (1999) and Gibbons and Waldman (2006), the model captures work experience and schooling as channels of skill acquisition, as well as employers' learning processes. In addition, DeVaro and Waldman (2012) introduce asymmetric employer learning and the acquisition of firm-specific skills from Waldman (1984, 1996), which are essential factors of internal labor markets. A consistent theoretical description of employer learning and skill acquisition was requested by empirical works such as that of Ariga, Ohkusa and Brunello (1999). They showed the existence of a fast track, controlling for time-invariant factors, within Japanese internal labor markets, which could not be explained by pure learning of time-invariant innate abilities. The Gibbons and Waldman (1999) model, and subsequent models based on this model, captures how employers learn about workers' ability to acquire skills in the workplace, which is consistent with the findings of Ariga et al. (1999). Primary factors of internal labor market practice is long-term employment and internal promotion. DeVaro and Waldman (2012) justify the practice by assuming that asymmetry of employer learning and firm-specificity of skills are considerable.

Let us first summarize the two-period model of DeVaro and Waldman (2012). Hereafter, θ_i denotes worker i's ability to acquire skills on the job, $\mathrm{Experience}_{i,t}$ denotes worker i's labor-market experience until period t, $\eta_{i,t} = \theta_i f(\mathrm{Experience}_{i,t})$ denotes worker i's "on-the-job" skill in period t, where $f(1) > f(0) > 0$, and School_i denotes worker i's years of schooling. Then, assume $\theta_i = \phi_i + B(\mathrm{School}_i)$, where $B(\mathrm{School}) > B(\mathrm{School} - 1)$, for $\mathrm{School} = 2, 3, \ldots, N$ and $\phi_i \in (\phi_L, \phi_H)$ is a random draw from the probability density function $g(\phi)$, assuming that $g(\phi) > 0$, for $\phi \in (\phi_L, \phi_H)$ and $g(\phi) = 0$ lies outside the interval. All firms are presumed to have homogenous production functions and each firm comprises two jobs, 1 and 2. The product of worker i assigned to job j in period t is given by $y_{i,j,t} = (1 + k_{i,t})(d_j + c_j\eta_{i,t}) + G(\mathrm{School}_i)$, where $0 < d_2 < d_1$, $0 < c_1 < c_2$, G is increasing in School, and $k_{i,t} > 0$ if worker i was employed at the same firm in period $t - 1$. Here, $\mathrm{Experience}_{i,t}$, School_i, $f(\cdot)$, $B(\cdot)$, $G(\cdot)$, d_j, c_j, and $k_{i,t}$ all form public information, while $y_{i,j,t}$ is privately observed by the current employer, and ϕ_i is unknown to an employer in worker i's first period of employment. Employers learn about workers' abilities asymmetrically, such that ϕ_i is learned at the end of worker i's first period only by the current employer who privately observes worker i's product, $y_{i,j,t}$. Lastly, we assume no transaction costs and a common discount factor.

Define $\eta^{'} \equiv (d_1 - d_2)/(c_2 - c_1)$ that solves $d_1 + c_1\eta^{'} = d_2 + c_2\eta^{'}$ and assume that $(E[\phi \mid \mathrm{School}] + B(\mathrm{School}))\, f(0) \equiv \theta^E(\mathrm{School}) f(0) < \eta^{'}$ for any School. That is, any worker in her/his first period, when no employer learning has yet occurred, is efficiently assigned to job 1. Furthermore, assume $(\phi_L + B(\mathrm{School}))\, f(1) < \eta^{'} < (\phi_H + B(\mathrm{School}))\, f(1)$, which ensures that some workers in their second period are efficiently assigned to job 1, and the remainder are efficiently assigned to job 2. After worker i finishes her/his first period, the current employer either offers the worker a job assignment for her/his second period or fires her/him. This decision is publicly observed by other firms and wages are determined before each period by spot-market contracting. Observing the current employer's decision on worker i, other firms offer a wage, and the worker's employer in the first period offers a wage that is weakly greater than that offered by other firms. Consider $\eta^+(\mathrm{School})$ such that $y_{i,1,t} - w^N_{i,t} = y_{i,2,t} - w^P_{i,t}$ in worker i's second period if $\eta_{i,t} = \eta^+(\mathrm{School})$, where w^N denotes the wage paid to the worker assigned to job 1 and w^P is the wage paid to the worker assigned to job 2. That is, the profit is indifferent to promoting worker i to job 2 if $\eta_{i,t} = \eta^+$.

In this setting, there is a perfect Bayesian equilibrium that applies to worker i's second period of being employed by firm A. In this equilibrium, if $\eta_{i,t} < \eta^+(\mathrm{School}_i)$, then the worker remains at firm A, is assigned to job 2, and is paid $w^P_t(\mathrm{School}_i, \eta_{i,t}) = d_2 + c_2\eta^+(\mathrm{School}_i) + G(\mathrm{School}_i)$; and if $\eta_{i,t} \geq \eta^+(\mathrm{School}_i)$, then the worker remains at firm A, is assigned to job 1, and is paid $w^N_t(S_i, \eta_{i,t}) = d_1 + c_1\,(\phi_L + B(\mathrm{School}_i) f(1)) + G(\mathrm{School}_i)$. In summary, outside employers offer wages that comprise a return on the general skills acquired at school, $G(\mathrm{School}_i)$, and the least on-the-job skill possible, given the public information available about promotion at the current employer. Then, the current employer makes a counteroffer that is only weakly greater than the wage offered by other firms.[2]

We can immediately derive useful implications for the existence of internal labor markets as places of asymmetric employer learning and workers' acquisition of firm-specific skills, as well as places in which to evaluate schooling and work experience.

[2]See DeVaro and Waldman (2012), pp. 96–101, 140–142.

Lemma 1. *Allow the difference in the fixed parts of the productivity of each job, $d_1 - d_2$, to change depending on the state of the world in each period. Then, if the return on firm-specific skills, k, is strictly positive, the threshold of promotion, η^+, changes in each period, provided that schooling and work experience are fixed at the same level.*

Proof. By the definition of η^+, we have

$$
\begin{aligned}
y_{i,1,t} - w_{i,t}^N &= (1+k)\big(d_1 + c_1\eta^+(\text{School}_i)\big) - [d_1 + c_1(\phi_L + B(\text{School}_i)f(1))] \\
&= (1+k)\big(d_2 + c_2\eta^+(\text{School}_i)\big) - \big(d_2 + c_2\eta^+(\text{School}_i)\big) = y_{i,2,t} - w_{i,t}^P.
\end{aligned} \tag{1}
$$

We can rearrange this equation to the threshold of promotion, $\eta^+(\text{School}_i)$, as follows:

$$
\eta^+(\text{School}_i) = -\frac{c_1 B(\text{School}_i)}{k(c_2 - c_1) - c_1} f(1) + \frac{k(d_1 - d_2) - c_1\phi_L f(1)}{k(c_2 - c_1) - c_1}, \tag{2}
$$

which increases in $d_1 - d_2$ only if $k > 0$. □

Lemma 1 states that wage profiles that depend on promotion can be different in different cohorts under different phases of business cycles. The point is that this phenomenon emerges only if $k > 0$, which means that the return on firm-specific skills is strictly positive. As an implication for empirical tests, this lemma predicts cohort effects in wage profiles if the return on firm-specific skills is strictly positive under asymmetric employer learning inside and outside internal labor markets. When verifying the existence of internal labor markets based on this lemma, we presume that essential elements of internal labor markets are asymmetric learning by employers and firm-specific skill acquisition by workers.

A caveat is that Gibbons and Waldman (2006), based on the same production technology, predict that allowing task-specificity generates cohort effects under symmetric employer learning. Therefore, to verify the existence of an internal labor market consisting of asymmetric employer learning and firm-specific skill acquisition, we need to control for the effect of industry-specific skill acquisition.

Another observation from prior literature is the potential insurance role of internal labor markets. As Beaudry and DiNardo (1991) clarify, internal labor markets, which somehow "shield" internal wage dynamics from the outside market, provide insurance for risk-averse employees against macroeconomic shocks and, hence, could also deliver cohort effects. Therefore, to prove the existence of an internal labor market that facilitates asymmetric employer learning and firm-specific skill acquisition, as well as insures employees, we need to control for macroeconomic shocks.

Lemma 2. *If the return on firm-specific skills, k, is sufficiently large, then an increase in schooling,* School, *alone decreases the threshold of promotion, η^+, or, allows a smaller return on work experience, $f(1)$, to sustain the same level of η^+.*

Proof.

$$
\eta^+(\text{School}) - \eta^+(\text{School} - 1) = -\frac{c_1\big(B(\text{School}) - B(\text{School} - 1)\big)}{k(c_2 - c_1) - c_1} f(1) < 0, \tag{3}
$$

if $k > c_1/(c_2 - c_1)$. □

Lemma 2 describes how schooling and work experience are substitutes for promotion if k is sufficiently large. Both schooling and work experience are observable to other employers and, thus, increase the wage they offer, irrespective of whether a worker is promoted. While the cost of promotion is to raise the wage offered by the other employers, because promotions are also observable, an increase in the product of schooling and work experience increases wages anyway, which lowers the threshold for promotion. This result predicts that when firm-specificity of skills becomes sufficiently large, schooling could replace work experience as a basis for worker promotion.

2.3 Transformation in the steel industry and the postwar reform

Japanese manufacturing, led by heavy industry, as in the United States, moved toward the formation of internal labor markets in the 1920s. Then, after the Second World War, internal labor market practices developed further (Hashimoto and Raisian (1985); Aoki (1988); and Moriguchi (2003)). While it is true that the contemporary Japanese labor market is more inflexible owing to the internal labor market practice of major firms, high-performing firms in the United States have also continued to manage long-term employment. As a result, the return on tenure has actually increased during the last few decades (Altonji and Williams (2005)). Thus, even if their scopes show different depths and levels of sophistication in terms of internal labor market practices, the postwar development of the internal labor market itself has been a common trend in both economies.

A significant difference, between the two economies was the development of unionization. Under postwar U.S. occupation, unions were legalized and rapidly prevailed. However, enterprise unions, rather than trade unions, became dominant. The management and the enterprise union of a firm shared the growth of the firm as their goal. Furthermore, unions negotiated job security and only average wages with the management of a firm. Individual incentives for blue-collar workers were under the perfect control of the management, as they were for white-collar workers. Therefore, internal distortion of individual incentives due to unionization is thought to have been negligible in Japan.

Meanwhile, the postwar reform profoundly changed the Japanese system. Before the 1947 reform led under the US occupation, secondary education from 7th grade or higher had not been mandate. Instead, major firms were required to offer training programs that covered secondary level education. Thus, the Japanese system was closer to the European system, under which students were separated into general education and vocational education after the primary education. Then, by the 1947 reform stipulated junior high school as mandate, and junior high school uniformly provided general education, instead of vocational training. The number of high school was drastically increased, and they were predominantly general high schools. Japanese secondary education came to provide mass workforce who received standardized secondary education focusing on general cognitive skills.

Industries that Doeringer and Piore (1971) describe as those in which internal labor markets were formed in the 20th twentieth century, such as the steel industry, are those that Goldin and Katz (2008) describe as having grown with technology-skill (education) complementarity. In the United States, since the early 20th century, high schools have supplied a large number of graduates with general skills. These better-educated workers were better suited to internal labor markets in which workers' general cognitive skills were engaged in firm-specific operations.[3] In postwar Japan, the accelerated prevalence of internal labor markets after the Second World War was associated with U.S.-led education reforms, which resulted in a massive increase in secondary school graduates.

For the Japanese steel industry, large technological transitions were observed in the 1920s and in the 1950s, as larger open-hearth furnaces were introduced, and in the 1960s, when converter furnaces were introduced. In the iron and steel industry prior to the Second World War, sophisticated production procedures were developed by employees. These procedures were then taught to younger employees by the senior employees of the company. Along with the technological transition, the traditional skills ascribed to individual senior employees were transformed into manualized skills and made known to the management.[4].

3 Existence of an internal labor market

3.1 Case plant

This study uses wage records of one of the oldest modern ironworks in Japan. From the 1950s to the 1960s, the government adopted an industrial policy that coordinated the long-term credit supply to induce steel and other important manufacturing companies to invest in new technology. For the steel industry, three phased modernization investments were coordinated from the 1950s to the 1960s.

As part of a company-wide investment plan, the firm in this case study decided to build a new state-of-the-art plant at another, distant city. The firm also decided to shrink the case ironworks' capacity and to relocate its skilled workers to the new plant. Consequently, 1,600 skilled workers moved from the case ironworks to the new ironworks in the late 1960s. Selection for relocation was handled in cooperation with the union and, in principle, anyone who was willing to move was relocated.[5]

3.2 Data

This study examines a panel dataset newly created from the preserved wage records for 1,558 relocated employees. The records track these workers from the late 1920s or later, depending on the employee's entry year, to the 1960s, when they left the ironworks. The total number of observations is 23,120. The original personnel documents contain all the important information about the employees' characteristics they reported when recruited such as education, previous work experience, licenses they had, physiological characteristics when hired, as well as job assignments, promotions, and basic wages. This enables us to recover employees' lives from when they were born to the 1960s, when they were relocated.

[3] See Goldin and Katz (2008), pp. 102–125, 176–181.
[4] See Nakamura (2010), pp. 8–25.
[5] See Umezaki (2010), pp. 33–38, 47–49.

Owing to the nature of the original documents, our dataset could potentially have two kinds of bias. The first is a selection bias owing to selection procedures for the relocation in the 1960s. The second is a selection bias. The descriptive evidence of the selection procedures indicates that the former might not be serious. However, the latter type could be significant. The case ironworks belonged to a large steel company in Japan. Thus, while leaving the ironworks for a company offering better pay was unlikely, movement in the other direction was likely. Our dataset does not include employees who joined the ironworks in the early period, lost out to the internal competition, and then left.

Thus, our dataset only include the employees who survived until the late 1960s.end of the sample period and does not include those who had dropped during the sample period. This means first that sample distribution might be more upward than the original population, and second that the sample is immune from a possible bias or distortion of distribution due to cross sections who dropped during the sample period, because they are excluded. Therefore, the sample bias contained in this dataset might affect, for instance, estimates of absolute level of wages but does not affect estimated growth in wages during the sample period, which would have been affected by including employees who had dropped during the sample period. Also, if our dataset includes employees who had dropped during the sample period, it would have made estimates of the increase in the return on tenure during the sample period higher than real, and higher than the returns on other skill elements, because employees who had dropped in early stages likely had lower productivity than survivors and hence including them overestimate the return on tenure. Our dataset is free from such contamination.

The aim of this research is to inquire the long-term changes in wage dynamics, particularly focusing on the return on tenure, instead of estimation of the absolute level of wages. Therefore, the specific structure of our dataset would not distort estimates we perform, but rather would help produce unbiased estimates.

Each individual wage record includes the following information: (1) educational background; (2) physiological characteristics when employed (height, weight, and lung capacity); (3) information on prior labor market experience; (4) panel data of wages; (4) panel data of ranks, jobs, department assignments, in-house training programs, and promotions; (5) licenses the employee held; (6) family composition; and (7) clinical history. The in-house training programs include the following: (a) 1927–1935: "Development Center for Youth," 3 days a week, 4 years, 800 hours total; (b) 1935–1948: "School for Youth," part-time, 3 days a week, 4 years; (c) 1939–1946: "Development Center for Technicians," full-time, 3 years, 6,453 hours total; and (d) 1946–1973: "Development Center," 3 days a week before 1950, 6 days a week from 1950, for 2 years; from 1963, only high school graduates were admitted. The firm also provided short-term programs, such as elementary calculus, which were also recorded.

INSERT **Table 1** HERE

The composition of the cohorts is shown in **Table 1**. While major contemporary Japanese firms predominantly hire new graduates, this did not hold for the case firm from the 1930s to the 1960s. Through the sample period, new graduates were not the primary source of the workforce. In some periods, such as the late 1940s or the 1960s, we see a higher portion of new graduates. In the late 1940s, the supply of the male workforce dropped owing to conscription.

Then, in the 1960s, the demand for labor surged following the rapid growth of the national economy. These occasions tentatively indicate that new graduates were hired when there was a shortage of experienced workers.

Entry volumes were not stable. Some cohorts, such as 1948 and 1949, when many male workers came back from the war, had much larger volumes. We control for potential biases from this unbalanced size of cohorts by inserting a two-year-joined dummy variable ($\mathrm{Yearjoined}^{19\mathrm{XX}-\mathrm{YY}}$) in later analyses whenever the case is cohort sensitive.

Compulsory education was extended from six years to nine years in 1947. Thus, the difference in educational backgrounds across employees who graduated before 1947 is primarily distributed between the six years spent completing mandatory elementary school and the eight years comprising the mandatory six years and additional two years at high elementary school. Similarly the difference across employees who graduated after 1947 is distributed mainly between the mandatory nine years, comprising six years of elementary school and three years of junior high school, and the twelve years comprising the mandatory nine years and an additional three years of high school. High elementary school graduates made up the majority of employees before 1947, and junior high school graduates made up the majority after 1947.

3.3 Existence of an internal labor market

This subsection empirically establishes the existence of an internal labor market practice in the case firm. The wage determination based on the practice is shielded because of asymmetric employer learning and the intention to motivate the acquisition of firm-specific skills. Persistent cohort effects indicate the firm-specificity of skills and asymmetric employer learning described by **Lemma 1**. To specify the firm-specificity of skill acquisition and the asymmetry of employer learning, we need to control for task-specificity of skill acquisition (Gibbons and Waldman (2006)) and the insurance effect against macroeconomic shocks (Beaudry and DiNardo (1991)).

Table 2 contains a regression of log real wages ($\log(w_{i,t})$) on age ($\mathrm{Age}_{i,t}$), years of schooling (School_i), labor market experience prior to joining the ironworks ($\mathrm{PreExperience}_i$), tenure at the ironworks ($\mathrm{Tenure}_{i,t}$), their square terms, and on the two-year-joined dummy variables (i.e, $\mathrm{Yearjoined}_\mathrm{i}^{1930-31}$, $\mathrm{Yearjoined}_\mathrm{i}^{1932-33}$, etc.), where ${\mathrm{Yearjoined}^{19\mathrm{XX}-\mathrm{YY}}}_i$ takes 1 if worker i joined the firm in 19XX–19YY and ${\mathrm{Yearjoined}^{1928-29}}_i = 1$ is the control group. Macroeconomic shocks are controlled for using the growth of the real gross national product ($\Delta\mathrm{GNP}$). We also include year dummy variables to control for the rapid growth in average productivity during the sample period. The result show that the cohort effects survive among most cohorts, which suggests that an internal labor market at the case ironworks seems to have formed in the 1930s. This statistical inference is consistent with the descriptive picture formed from documents and interviews.[6]

INSERT **Table 2** HERE

[6]See Umezaki (2010), pp. 42–51.

As described by Baker, Gibbs and Holmstrom (1994b), the serial correlation of wage residuals is another useful indicator of an internal labor market.[7] In a competitive market, we assume that the observable variables provide an unbiased forecast of wages. Then, the wage residuals calculated by subtracting the wages estimated using the observable variables from the observed wages should be serially independent. If the firm more or less shields wage determination from the market using some wage policy, this result would be different. Here, we use the following benchmark Mincerian specification in 3-1 in **Table 3** to run a pooled regression of log real wage ($\log(w_t)$) for $\text{Tenure}_t \geq 1$.

$$
\begin{aligned}
\log(w_t) = & \text{Constant} + \alpha_1 \text{School}_i + \alpha_2 \text{School}_i^2 + \alpha_3 \text{Postwar} \cdot \text{School}_i \\
& + \alpha_4 \text{PreExperience} + \alpha_5 \text{PreExperience}^2 \\
& + \alpha_6 \text{PreEmployment} + \alpha_7 \text{PreEmployment}^2 \\
& + \alpha_8 \text{Tenure}_t + \alpha_9 \text{Tenure}^2 \\
& + \alpha_{10} \text{Training}^{1927-35} + \alpha_{11} \text{Training}^{1927-35} \text{Tenure}_t \\
& + \alpha_{12} \text{Training}^{1935-48} + \alpha_{12} \text{Training}^{1935-48} \cdot \text{Tenure}_t \\
& + \alpha_{13} \text{Training}^{1939-46} + \alpha_{14} \text{Training}^{1939-46} \cdot \text{Tenure}_t \\
& + \alpha_{15} \text{Training}^{1946-73} + \alpha_{16} \text{Training}^{1946-73} \cdot \text{Tenure}_t + \epsilon
\end{aligned} \tag{4}
$$

where Postwar denotes the postwar education generation dummy variable that takes 1 if the worker graduated in or after 1947; PreExperience denotes labor market experience before joining the case firm, PreEmployment denotes employment experience before joining the case firm, which does not include self-employment and working for a family-run business such as farming; $\text{Training}^{1927-1935}$ is a dummy variable for completing the firm-sponsored program, Development Center for Youth (1927–1935); $\text{Training}^{1935-1948}$ denotes completing the School for Youth program (1935–1948); $\text{Training}^{1939-1946}$ denotes the Development Center for Technician program (1939–1946); and $\text{Training}^{1946-1973}$ denotes the Development Center program (1946–1973). Then, we regress $\hat{w}_{\text{Tenure}_t}$, estimated by equation (4), for $\text{Tenure}_t \geq 1$, on the independent variables in equation (4) and $\hat{w}_{t-1}$. Here, the coefficient of $\hat{w}_{t-1}$ is significant, which indicates a serial correlation of wage residuals.[8] The result is consistent with the assumption that the way the firm determined wages shielded the internal wage dynamics from the market.

4 Evolution of skill elements

4.1 Skill acquisition and wage growth

Table 3 provides the results after regressions after controlling for the random effect of log real wage ($\log(w_{i,t})$) on the constant (Constant), the relative height when employed by the com-

[7] See Baker et al. (1994b), pp. 943–953.

[8] The coefficient of $\hat{w}_{t-1}$, 1.7109, has a t-statistic of 27.3944^{***}, adjusted R^2 of 0.7389, and F-statistic of 3389.2152^{***}.

pany (height divided by the national average height for that age in the year joined, Height_i),[9] age ($\mathrm{Age}_{i,t}$), years of schooling (School_i), years of previous labor market experience before joining the company ($\mathrm{PreExperience}_i$), years of previous employment experience (other than being self-employed or working in a family-operated business) ($\mathrm{PreEmployment}_i$), their squared terms, the interaction terms of previous employment experience with the equivalent previous industry dummy variable ($\mathrm{EqIndustry}_i \cdot \mathrm{PreEmployment}_i$) and with the equivalent previous job dummy variable ($\mathrm{EqJob}_i \cdot \mathrm{PreEmployment}_i$), tenure at the company ($\mathrm{Tenure}_{i,t}$), its squared term, the dummy variables for completing in-house training programs, (i.e., the Development Center for Youth ($\mathrm{Training}_{i,t}^{1927-35}$), School for Youth ($\mathrm{Training}_{i,t}^{1935-48}$), Development Center for Technicians ($\mathrm{Training}_{i,t}^{1939-46}$), and Development Center ($\mathrm{Training}_{i,t}^{1946-73}$) programs), and the interaction of these dummy variables with tenure ($\mathrm{Training}_{i,t}^{1927-35} \cdot \mathrm{Tenure}_{i,t}$, $\mathrm{Training}_{i,t}^{1935-48} \cdot \mathrm{Tenure}_{i,t}$, $\mathrm{Training}_{i,t}^{1939-46} \cdot \mathrm{Tenure}_{i,t}$, $\mathrm{Training}_{i,t}^{1946-73} \cdot \mathrm{Tenure}_{i,t}$).[10] In addition, compulsory schooling was extended from six years to nine years in 1947. Since this extension may have had an impact on productivity and wages (Oreopoulos (2005)), we include the interaction between the postwar education generation dummy variable and years of schooling ($\mathrm{Postwar}_i \cdot \mathrm{School}_i$). Then, our estimation model is as follows.

$$
\begin{aligned}
\log(w_{i,t}) =& \mathrm{Constant} + \beta_1 \mathrm{Height}_i + \beta_2 \mathrm{Height}_i^2 + \beta_3 \mathrm{Age}_{i,t} + \beta_4 \mathrm{Age}_{i,t}^2 \\
& + \beta_5 \mathrm{School}_i + \beta_6 \mathrm{School}_i^2 + \beta_7 \mathrm{Postwar}_i \cdot \mathrm{School}_i \\
& + \beta_8 \mathrm{PreExperience}_i + \beta_9 \mathrm{PreExperience}_i^2 \\
& + \beta_{10} \mathrm{PreEmployment}_i + \beta_{11} \mathrm{PreEmployment}_i^2 \\
& + \beta_{12} \mathrm{EqIndustry}_i \cdot \mathrm{PreEmployment}_i + \beta_{13} \mathrm{EqJob}_i \cdot \mathrm{PreEmployment}_i \\
& + \beta_{14} \mathrm{Tenure}_{i,t} + \beta_{15} \mathrm{Tenure}_{i,t}^2 \\
& + \beta_{16} \mathrm{Training}_{i,t}^{1927-35} + \beta_{17} \mathrm{Training}_{i,t}^{1927-35} \cdot \mathrm{Tenure}_{i,t} \\
& + \beta_{18} \mathrm{Training}_{i,t}^{1935-48} + \beta_{19} \mathrm{Training}_{i,t}^{1935-48} \cdot \mathrm{Tenure}_{i,t} \\
& + \beta_{20} \mathrm{Training}_{i,t}^{1939-46} + \beta_{21} \mathrm{Training}_{i,t}^{1939-46} \cdot \mathrm{Tenure}_{i,t} \\
& + \beta_{22} \mathrm{Training}_{i,t}^{1946-73} + \beta_{23} \mathrm{Training}_{i,t}^{1946-73} \cdot \mathrm{Tenure}_{i,t} + \mu_i + \nu_{i,t}
\end{aligned}
\tag{5}
$$

INSERT **Table 3** HERE

Years of schooling (School_i) has a positive coefficient, indicating that it raised productivity and real wages. In specifications 3–2 and 3–4, relative height (Height_i) has a positive coefficient, showing that physical strength mattered in the steel industry. The positive coefficient of previous labor market experience ($\mathrm{PreExperience}_i$) indicates that work experience raised productivity and was rewarded. In particular, the positive coefficient of the interaction between the equivalent industry dummy variable and previous employment experience

[9]To control for improved nutrition throughout the period, we use height relative to the national average height. Thus, we use (observed height)/(average height for a person's age in that year, according to the Ministry of Education statistics) as "height (Height_i)."

[10]Note that the records of employees who joined the firm before 1939 lack information on physiological characteristics.

$(\mathrm{EqIndustry}_i \cdot \mathrm{PreEmployment}_i)$ shows that acquiring industry-specific skills from previous labor market experience significantly increased productivity.

4.2 Evolution of returns on skill elements

Since the time window of aforementioned benchmark results is the entire sample period, the evolution of the emphasis on skill elements is not differentiated. To focus on intra-firm changes in the returns on acquiring different skill elements, we need to control for highly likely complementarity between the skill elements. To estimate the evolution of each skill element while factoring in potential complementarity between them, we assume a Translog work function of workers as an approximation whose restriction on the substitutability between skill elements is smaller than other specifications. We also reasonably assume that wages largely reflect marginal labor productivity. Hence, using a logarithmic specification, we estimate a logarithmic wage formula as follows:

$$
\begin{aligned}
\log\left(w_{i,t}\right) = & \mathrm{Constant} + \beta_1 x_{1,i,t}^2 \cdot \log^2\left(x_{1,i,t}\right) \\
& + \beta_2 x_{2,i,t} \cdot \log\left(x_{2,i,t}\right) + \beta_3 x_{2,i,t}^2 \cdot \log^2\left(x_{2,i,t}\right) \\
& + \beta_4 x_{3,i,t} \cdot \log\left(x_{3,i,t}\right) + \beta_5 x_{3,i,t}^2 \cdot \log^2\left(x_{3,i,t}\right) \\
& + \beta_6 x_{1,i,t} \cdot x_{2,i,t} \cdot \log\left(x_{1,i,t}\right) \cdot \log\left(x_{2,i,t}\right) \\
& + \beta_7 x_{1,i,t} \cdot x_{3,i,t} \cdot \log\left(x_{1,i,t}\right) \cdot \log\left(x_{3,i,t}\right) \\
& + \beta_8 x_{2,i,t} \cdot x_{3,i,t} \cdot \log\left(x_{2,i,t}\right) \cdot \log\left(x_{3,i,t}\right) \\
& + \gamma_1 \mathrm{Yearjoined}^{1930-31}{}_i \cdot x_{1,i,t} \cdot \log\left(x_{1,i,t}\right) \\
& + \gamma_2 \mathrm{Yearjoined}^{1932-33}{}_i \cdot x_{1,i,t} \cdot \log\left(x_{1,i,t}\right) \\
& + \cdots \\
& + \gamma_{19} \mathrm{Yearjoined}^{1966-67}{}_i \cdot x_{1,i,t} \cdot \log\left(x_{1,i,t}\right) + \mu_i + \nu_{i,t},
\end{aligned}
\tag{6}
$$

where x_1 is the element in interest of three elements, years of schooling (School_i), previous experience ($\mathrm{PreExperience}_i$), and tenure ($\mathrm{Tenure}_{i,t}$); x_2 and x_3 denote the other two; $\mathrm{Yearjoined}^{19\mathrm{XX}-\mathrm{YY}}{}_i$ denotes a two-year-joined dummy variable, which takes the value 1 if worker i joined the case company in 19XX–19YY, with the cohort who joined the firm in 1928–1929 as the control group. While this specification differs from the standard Mincerian type and, hence, its estimates cannot be directly compared with those in prior studies, it is straightforward to track the intra-firm evolution along for cohorts by observing changes in the coefficients of the interactions, $\gamma_1, \ldots, \gamma_{19}$.

Table 4 shows the results by a standard Translog formula in specification 4-1, and the two-year-joined dummy variables are inserted in specification 4-2. As the coefficients of two-year-joined dummy variables of specification 4-2 show, a rapid rise in wage, and hence, a rapid increase in productivity over cohort is observed. We then decompose the increase over cohort.

INSERT **Table 4** HERE

First, for the return on schooling, the results are reported in **Table 5**.

INSERT **Table 5** HERE

The coefficients of the terms $\text{Yearjoined}^{\text{19XX}-\text{YY}}{}_i \cdot \text{School}_i \cdot \log\left(School_i\right)$ in specification 5-1 indicate that the return on schooling slowly grew in the 1930s, then the growth accelerated the 1948–1849 cohort. From 1947, compulsory schooling was extended from six years to nine years, and the supply of workers with more years of schooling increased exogenously. Thus, the surging return on schooling from the late 1940s cannot be attributed to supply-side constraints. Rather, the demand for better-educated labor increased.

Second, for the return on previous labor market experience, the results are reported in **Table 6**.

INSERT **Table 6** HERE

Specification 6-1 shows that the return on previous labor market experience gradually increased from the mid-1930s, and hit the peak in the mid-1950s, while it gained a little again in the late 1960s. The result is consistent with the fact that the firm continuously recruited experienced workers (**Table 1**)

Third, **Table 7** shows the results for the return on tenure. The coefficients of the interactions of the two-year-joined dummy variable with tenure ($\text{Yearjoined}^{\text{19XX}-\text{YY}}{}_i \cdot \log\left(\text{Tenure}_{i,t}+1\right)$) in specification 7–1 show an aggregate growth of the return on tenure during the period. This growth began in the mid-1930s, which indicates that an internal labor market practice was forme and the gain surged from the late 1950s-cohort. The surge disappears once we control for the year dummy variables in specification 7–2. Thus the surge was plant-wide, including both technological and organizational achievements.

INSERT **Table 7** HERE

INSERT **Figure 1** HERE

Figure 1 summarizes the results shown in **Tables 5–7**. In 1938, just after the invasion of China and before the attack on Pearl Harbor, the National General Mobilization Act, Act 55 of 1938, came into force, suspending the market economy. The act was repealed in 1946 after Japan's defeat. Thus, between 1938 and 1945, Japan was a state-controlled economy in which wages were strictly regulated. Indeed, the returns on skill elements, measured by the contributions to the growth in the real wage, were stable during the period as shown in **Figure 1**. A comparison of the periods before 1938 and after 1946 shows that the return on previous work experience in the early stages of workers' careers was surpassed by that on extended schooling from the 1948–1949 cohort onwards. The return on schooling elevated from the 1948-1949 cohort nd that on tenure surged from the late 1950s cohorts.

These returns capture each year's promotion in terms of basic wages. Assuming that the increase in the return on tenure captures an increase in the firm-specificity of skills internally acquired, we can conclude that the surge in the return on longer tenure combined with better education is consistent with our prediction. **Lemma 1** predicts that an increase in the firm-specificity of skill, k, is accompanied by a larger impact of schooling on wage promotion. Also, **Lemma 2** predicts that when the return on firm tenure increased, previous work experience was replaced by extended schooling as k increases. An increase in wage of worker i in year t reflect in a major Japanese firm worker i' promotion in wage notch in year t. **Figure 1** show that as firm specific skills ($tenure$) was more rewarded, impact of schooling on promotion was more rewarded from the 1948-1949 cohort, being consistent with the predictions.

Next, we track evolution of complement of complementarity between skill elements. To inquire the evolution of complementarity, we estimate the formula,

$$\begin{aligned}
\log\left(w_{i,t}\right) =& \text{Constant} + \beta_1 x_{1,i,t}^2 \cdot \log^2\left(x_{1,i,t}\right) + \beta_2 x_{1,i,t}^2 \cdot \log^2\left(x_{1,i,t}\right) \\
&+ \beta_3 x_{2,i,t} \cdot \log\left(x_{2,i,t}\right) + \beta_4 x_{2,i,t}^2 \cdot \log^2\left(x_{2,i,t}\right) \\
&+ \beta_5 x_{3,i,t} \cdot \log\left(x_{3,i,t}\right) + \beta_6 x_{3,i,t}^2 \cdot \log^2\left(x_{3,i,t}\right) \\
&+ \beta_7 x_{1,i,t} \cdot x_{3,i,t} \cdot \log\left(x_{1,i,t}\right) \cdot \log\left(x_{3,i,t}\right) \\
&+ \beta_8 x_{2,i,t} \cdot x_{3,i,t} \cdot \log\left(x_{2,i,t}\right) \cdot \log\left(x_{3,i,t}\right) \\
&+ \gamma_1 \text{Yearjoined}^{1930-31}{}_i \cdot x_{1,i,t} \cdot x_{2,i,t} \cdot \log\left(x_{1,i,t}\right) \cdot \log\left(x_{2,i,t}\right) \\
&+ \gamma_2 \text{Yearjoined}^{1932-33}{}_i \cdot x_{1,i,t} \cdot x_{2,i,t} \cdot \log\left(x_{1,i,t}\right) \cdot \log\left(x_{2,i,t}\right) \\
&+ \cdots \\
&+ \gamma_{19} \text{Yearjoined}^{1966-67}{}_i \cdot x_{1,i,t} \cdot x_{2,i,t} \cdot \log\left(x_{1,i,t}\right) \cdot \log\left(x_{2,i,t}\right) + \mu_i + \nu_{i,t},
\end{aligned} \tag{7}$$

where complementarity between skill elements x_1 and x_2 are in our interest and we focus on evolution of coefficients of their interactions with two-year-cohort dummy variables, $\gamma_1 \cdots \gamma_{19}$.

Table 8 reports complementarity between tenure and schooling and **Table 9** reports that between tenure and previous labor market experience. In either case, complementarity gained rapidly from the late 1940s cohorts. As specifications 8-2 and 9-2 in which year dummy variables are controlled for show further modest increases, the increases complementarity between tenure and schooling and tenure and previous labor market experience were company-wide phenomenon. Given massive investment in new technologies in the 1950s and 1960s, the complementarity seems to be strengthened by technological changes through the period.

INSERT **Table 8** HERE

INSERT **Table 9** HERE

The summary is depicted in **Figure 2**. Thus, while own return on previous labor market experience was largely dominated by that on schooling from the late 1940s cohorts, complementarity between previous labor market experience and tenure was not by that between schooling and tenure.

As a result, the firm still actively poached skilled workers in terms of mid-career recruiting until the end of 1960s, as shown in **Table 1**. Unless the first year of tenure strictly overwhelms that of general work experience as a preparation for entry-level training, an employer does not exclusively seek new graduates. Presuming that a real intention to provide entry-level training should appear in offers of in-house training programs to employees, we next focus on trainee selection for in-house off-the-job training programs.

5 Changes in selection policy of training programs

5.1 Impact of education reform in 1947

Wage determination was not the only aspect to change over time, as the role of in-house training programs changed as well. Specifications 3–1 and 3–2 **Table 3** show that the dummy variables for completing the pre-war and wartime training programs, namely the Development Center for Youth ($\mathrm{Training}^{1927-35}$), School for Youth ($\mathrm{Training}^{1935-48}$) and Development Center for Technicians ($\mathrm{Training}^{1939-46}$), have a negative coefficient. However, the dummy variable for the postwar program, the Development Center ($\mathrm{Training}^{1946-73}$), has a positive coefficient.

Between the two periods, governmental regulations changed. The Cabinet Order on Training Programs for Youth in 1926 and the Cabinet Order on School for Youth in 1939 required that major firms provide training programs, namely the Development Center for Youth ($\mathrm{Training}^{1927-35}$) or School for Youth programs ($\mathrm{Training}^{1935-48}$). These programs included second-level education for employees who had not graduated from a junior high school in order to complement the public education system. This requirement was repealed in 1946 as compulsory education was extended from six years to nine years including three years at a junior high school, in 1947.

By the mid-1940s, while the training program completion dummies ($\mathrm{Training}^{1927-35}$, $\mathrm{Training}^{1935-48}$, $\mathrm{Training}^{1939-46}$) have negative coefficients, interactions with tenure ($\mathrm{Training}^{1927-35} \cdot \mathrm{Tenure}_{i,t}$, $\mathrm{Training}^{1935-1948} \cdot \mathrm{Tenure}_{i,t}$, $\mathrm{Training}^{1946-73} \cdot \mathrm{Tenure}_{i,t}$) have positive coefficients. This indicates that employees who were selected for training first compensated for the cost of training by accepting reduced wages, and then earned the return on those skills during their tenure. This scheme was reasonable given that the mid-career market was so flexible that the cost paid by the firm in advance might have resulted in a rather higher turnover.

From the late 1940s, with the ordinances being repealed, the training program completion dummy variable ($\mathrm{Training}^{1946-73}$) has a positive coefficient, while the interaction with tenure ($\mathrm{Training}^{1946-73} \cdot \mathrm{Tenure}_{i,t}$) has a negative coefficient. This indicates that the selected employees no longer compensated for the cost of training. Given that junior high school became compulsory and was provided free by the state, this change makes sense.

Therefore, we can tentatively infer that the in-house training programs until the mid-1940s were expected to complement the public education system under the governmental regulations, and that employees at least partly compensated for the cost themselves. However, any program from the mid-1940s onwards, after the regulation was abandoned, was provided as a firm's own program, and the cost was paid by the firm.

When relative contribution of skill elements to productivity change, this should be reflected in training policies, the exact investment in employees' skills, as well as wage in formulation, which is a hedonic compensation to acquired skills.

Thus, it is likely that changes in the role of training were accompanied by changes in trainee selection. The latter changes would have reflected the management's decisions on those employees in which they chose to invest. Owing to the number of observations, we restrict our analysis the to the School for Youth ($\mathrm{Training}^{1935-48}$) and Development Center ($\mathrm{Training}^{1946-73}$) programs. These two programs ran the longest, providing the most observations.

5.2 Pre-reform program

Tables 10 decomposes the probability of acceptance to the pre-reform in-house training program, School for Youth ($\mathrm{Training}^{1935-48}$, from 1935 to 1948, into relative height (Height_i), age (Age), years of schooling (School), previous labor market experience ($\mathrm{PreExperience}$), and previous employment experience ($\mathrm{Employment}_{\mathrm{pervious}}$), their squared terms, the dummy variable for new graduate (New), which takes 1 if the employee was hired by the case firm immediately after graduation ($\mathrm{PreExperience} = 0$) and 0 otherwise,[11] and its interaction terms with years of schooling and relative height ($\mathrm{New} \cdot \mathrm{School}$, $\mathrm{New} \cdot \mathrm{Height}_i$). Thus,

$$\begin{aligned}\mathrm{Training} =& \mathrm{Constant} + \alpha_1 \mathrm{Height}_i + \alpha_2 \mathrm{Height}^2 + \alpha_3 \mathrm{Age} + \alpha_4 \mathrm{Age}^2 \\ & + \alpha_5 \mathrm{School} + \alpha_6 \mathrm{School}^2 + \alpha_7 \mathrm{New} + \alpha_8 \mathrm{New} \cdot \mathrm{School} + \alpha_9 \mathrm{New} \cdot \mathrm{Height}_i \\ & + \alpha_{10} \mathrm{PreExperience} + \alpha_{11} \mathrm{PreExperience}^2 \\ & + \alpha_{12} \mathrm{PreEmployment} + \alpha_{13} \mathrm{PreEmployment}^2 + \epsilon,\end{aligned} \tag{8}$$

using a probit estimation. Assuming that selected employees joined the firm within three years before the program began in 1935, or later, until the program ended, we include employees who joined the firm between 1933 and 1948.

INSERT **Table 10** HERE

Then, in all specifications (10–1, 10–2, and 10–3), years of schooling (School) has a negative coefficient, which is consistent with the regulatory constraint that the program provide a substitute for public education for less educated employees. Further, in all specifications, relatively shorter employees (i.e., with smaller relative height, (Height)) were more likely to be accepted as trainees. If both educational achievement and height can be assumed to be a proxy of ability, the pre-reform program regulated invested in less-educated and hence less able employees, being regulated by the government ordinance.

At the same time, longer previous employment ($\mathrm{PreEmployment}$) consistently has a positive coefficient. The pre-war and wartime program tended to invest in more experienced, though less-educated and shorter employees. Thus, the firm tried to invest in better-skilled employees within the allowance of regulation that required investment in less-educated employees.

[11] Thus, $\mathrm{NEW}_i = 1$ does not mean that worker i was new graduate when accepted as a trainee, but mean that worker i was immediately hired after graduation and thus $\mathrm{PreExperience} = 0$ and $\mathrm{PreEmployment} = 0$

Thus, the trainee selection policy was mainly inclusive and supportive of less advantaged employees. In other words, it chose less educated employees and less physiologically advantaged employees. Among the employees who satisfied the regulatory constraints, those with more previous work experience were preferred, as they were expected to have acquired general or industry-specific skills, were preferred.

Related to pervious experience, we now consider the new graduate dummy variable (New). Contemporary major Japanese firms predominantly hire new graduates and less appreciate previous experience. In the case of the School for Youth program ($\mathrm{Training}^{1935-48}$), it seems as if new graduates (New) were preferred in specification 7–2 in **Table 7**. However, consistently positive coefficients of previous employment experience ($\mathrm{PreEmployment}$) in all specifications 7–1, 7–2, and 7–3 show that previous experience, particularly in factories, was strongly appreciated.

This apparently paradox is solved in **Table 1**. The entry of new graduates in the period from 1935 to 1948 concentrated on the early 1940s as the war against China and the United States escalated, and males with better physiological characteristics were drafted. A possible inference is that, to fill places, new graduates were hired, but experienced workers were preferred, if available. Further, to supplement the shortage of human capital in the new graduates, the new graduates were more likely accepted as trainees.

Tables 11 presents the results of the equivalent specifications for the postwar program, Development Center ($\mathrm{Training}^{1946-73}$) between 1946 and 1962. Here, we include cohorts from year joined 1943 to year joined 1962. Since the program explicitly required a educational level from 1963, namely, a high school graduate or higher (12 years or longer), we separate the sample period at 1963. Then, in all specifications (i.e., 11–1, 11–2, and 11–3), years of schooling (School) has a positive coefficient. Further, when relative height (Height_i) has a significant coefficient in specifications 11–1 and 11–3, it is positive. In contrast to the School for Youth program ($\mathrm{Training}^{1935-48}$) in **Table 10**, the postwar program, which was free from regulatory requirements, was more likely to invest in employees who possessed better human capital before entering the labor market, such as physiological characteristics and education. With regard to previous experience, both previous labor market experience ($\mathrm{PreExperience}$) and previous employment experience ($\mathrm{PreEmployment}$) have negative coefficients. The firm began to invest more in the better-educated when the complementarity between schooling and tenure was enhanced and the regulatory restriction to do so was abandoned.

For new graduates (New), between 1946 and 1962, the interaction terms of the new graduate dummy variable with relative height and years of schooling ($\mathrm{New} \cdot \mathrm{Height}_i$, $\mathrm{New} \cdot \mathrm{School}$) have a negative coefficient in specification 11–3 in **Table 11**. This indicates that the program invested in new graduates whose physiological and schooling backgrounds were relatively inferior. Only with controlling for these aspects, new graduates were generally preferred, as shown in specification 11–2.

INSERT **Table 11** HERE

Tables 12 presents the results of the specifications from which years of schooling (School) are dropped for the Development Center program ($\mathrm{Training}^{1946-73}$) between 1963 and 1969. Here, the cohorts form year joined 1960 to year joined 1967 are included. From 1963, a high school graduate education level was a formal requirement to be accepted as a trainee. Specification 6-1 in **Table 6** (**Figure 1**) shows that the return on previous labor market experience gained from the 1962-1963 cohort. Indeed, previous labor market experience ($\mathrm{PreExperience}$) turns out to have positive coefficients in all specifications, in contrast to the results shown in **Table 11**. Here, the preference for experienced workers recovered slightly.

INSERT **Table 12** HERE

Between 1963 and 1969, new graduates came to be preferred, in general, as shown in specification in 12–2 in **Table 12**. Moreover, the interaction term between the new graduate dummy variable and relative height ($\mathrm{New} \cdot \mathrm{Height}_i$) has a positive coefficient in specification 9–3. Thus, new graduates with an advantage in physiological characteristics, provided that they were high school graduates, were preferred as trainees for the first time.

Therefore, while an obvious preference for experienced employees disappeared from 1946, a preference for new graduates with better physical endowments became prominent in the 1960s for the first time. At the same time, a positive coefficient of previous labor market experience ($\mathrm{PreExpeirence}$) in all specifications (12–1, 12–2, and 12–3) in **Table 12** shows that, in contrast to the results for the late 1940s to the 1950s in **Table 11**, experienced workers became more sought after. Given that the labor shortage due to the rapid growth of the Japanese economy had become inexorable in the 1960s, it is possible that new graduates with good physical and educational endowments were a second choice, with experienced workers being preferred, if available.

At the same time, specification 12-3 shows that, when controlling for the interaction with relative height, the new graduate dummy variable itself negatively affected the probability of acceptance as a trainee. With the return on previous experience ticking up after hitting the bottom in the 1960s (**Figure 1**), if employees were better-educated but relatively shorter, those with more previously experience were preferred as trainees. In that sense, the preference for new graduates over those with experience was still limited, mainly to workers who were better-educated and who were physiologically better endowed.

6 Discussion

The secondary school system in pre-war Japan, introduced from Europe, focused on training a small group of elites. The system was then subsequently transformed, making a massive investment in the human capital of the majority of the people (Ueshima, Funaba and Inoki (2006), pp. 72–73). The postwar junior high schools and most high schools provided general education that teaches general cognitive skills, as opposed to vocational education, which teaches specific skills.

The coefficient of the interaction between the postwar education dummy and years of schooling ($\mathrm{Postwar} \cdot \mathrm{School}$) is positive (**Table 3**), which indicates that the return on schooling increased under the postwar education system, despite the rapid increase in the number of better-educated workers. Indeed, the return on schooling continuously increases from the

1948-1949 cohort. The enhanced role of schooling largely dominated the value of early career experience before being employed by the plant in this case study (**Figure 1**).

The return on schooling rose from the late 1940s and the return on skill acquisition within the company rapidly increased from the mid-1950s (**Figure 1**). Accompanying this trend, the firm-sponsored training program from the late 1940s to the 1950s focused on employees who were expected to have more talent, but who had less previous work experience. In particular, the program selected those who were better-educated new graduates, as described in **Table 11**.

If the returns on skill elements estimated by observed wages reflect the productivity of each element, and if the training program is a complement to those skill elements, the shift in the trainee selection policy should track that of the relative return on skill elements. The positive impact of schooling and the negative impact of previous experience on the probability of being accepted as a trainee from the late 1940s to the 1950s (**Table 11**) dovetail with the rinsing return on schooling overwhelming that on previous experience during the same period (**Figure 1**). This indicates that the firm altered its trainee selection policy in the most productive way it was able to predict.

Furthermore, new graduates endowed with better physiological characteristics came to be preferred as trainees, as the eligibility for trainees was limited to high school graduates from 1963 (**Table 12**). The firm began to focus on physiologically advantaged new graduates equipped with better education. However, as shown by results in **Tables 10-12**, the preference only emerged in the 1960s in a contained manner for better-educated and employees endowed with better physiological characteristics. It means that, as for a phenomenon specific for contemporary Japanese major firms, the preference for new graduates never appeared only in the 1960s. Thus, adhesion of contemporary major Japanese firms to new graduates was not common until the end of the 1960s, and if it came to be, it should not be earlier than the 1970s.

The fact that the return on schooling rose from the late 1940s and that on tenure rose from the mid-1950s as the return on previous experience became relatively behind suggests that general cognitive skills taught at school and specific skills acquired at the workplace were complements. It was relatively commmon among developed economies after the Second World War that education replaced work experience.[12] Our case might also be placed in a broader context of skill-biased growth in a "race between education and technology" (Goldin and Katz (2008)) in developed economies, where a complementarity between education and experience with advanced technology was observed. Such complementarity between schooling and experience has been widely observed in the postwar developed world.

Then a striking difference between the United States and Japan in the 1980s was that employers in Japan strongly preferred new graduates, which indicates that the complementarity between schooling and firm-specific experience dominated that between schooling general or industry experience. However, as shown in **Figure 4**, complementarity between schooling and tenure and that between schooling and previous labor market experience never showed a distinctive gap until the end of the 1960s. In particular, previous experience in the same industry was strongly rewarded as shown in **Table 3**. The characteristics and complementarity of skill elements earned at school and workplace in Japan by the end of the 1960s seems to show little difference from those in the United States. While general or industry experience

[12] See Dohmen, Kriechel and Phann (2004), pp. 218–219.

had been continuously complements of schooling, the relative return of tenure gained more from the mid-1950s than general or industry experience. This seems to be the primary reason why Japanese firms tilted toward longer-term employment.

Over the last two decades, the Japanese labor market has become more flexible. This is widely recognized, but there is some debate about the scope of the transformation. Some emphasize that long-term employment is still robustly prevalent, mainly focusing on existing tenured workers. (Kato (2001); Shimizutani and Yokoyama (2009); and Ono (2010)) Others believe that the change is structural, largely considering younger workers (Kawaguchi and Ueno (2013)). The greater mobility of younger workers seems to support the latter observation. Our case study suggests that the coexistence of high mobility of younger workers and stable internal labor markets for experienced employees in major firms was the norm in Japan until the end of the 1960s, as it was in the United States. Rising income inequality, widening wage differentials between secondary education graduates and tertiary education graduates, and even greater mobility in the labor market as a whole have consistently increasing returns on tenure for workers who have gained stable employment in the United States (Altonji and Williams (2005)). Indeed, Speltzer (2015) shows that considerable chunk of wage inequality in the United States has been generated by employees who work for large firms. This suggests that Japan, and probably the United States, are returning to the situation that prevailed prior to the 1970s.

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Appendix I: Data sources

Wages and workers' characteristics Original wage records of the case firm in Japan.

Series of national data Consumer prices (to deflate nominal wages): Nippon Tokei Kyokai (Japan Statistical Association), ed (1988), p.362. National average height: the School Health Statistics surveyed by the Ministry of Education, Science, Sports and Culture (http://www.e-stat.go.jp/). Real gross national product: Ohkawa, Takamatsu and Yamamoto (1974), pp. 232 (1885-1929) – 233 (1930–70); to connect series before and after 1955, when governmental statistics are not continuous, a deflator from Ohkawa, Noda, Takamatsu, Yamada, Kumazaki, Shinomiya and Minami (1967), p. 134, is used.

Appendix II Definition and descriptive statistics of variables.

Variable	Definition	Mean	Median	Maximum	Minimum	Standard deviation	Skewness	Kurtosis	Number of observations
$w_{i,t}$	Real daily wage of worker i in year t: yen per day.	3.5782	3.3700	72.0600	0.3400	1.9650	2.4475	66.7437	23,120
Height_i	Relative height of worker i when employed by the firm: (observed height)/(national average height at his age in the year).	0.9957	1.0000	1.1000	0.8000	0.0406	-0.4750	6.6180	16,637
$\text{Age}_{i,t}$	Age of worker i in year t.	30.5638	30.0000	55.0000	13.0000	8.1126	0.3644	2.5497	23,120
School_i	Years of schooling of worker i.	8.7093	8.0000	15.0000	5.0000	1.6194	1.1881	4.3356	23,120
Postwar_i	Postwar education generation dummy variable: =1 if 12 years old or younger in 1947, and 0 otherwise.	0.1805	0.0000	1.0000	0.0000	0.3846	1.6615	3.7606	23,120
PreExperience_i	Years of previous labor market experience of worker i prior joining the firm: $\text{Age}_i-(6+\text{School}_i+\text{Tenure}_{i,t})$. Every sample employee had worked at the firm until the last year of his record.	6.3631	6.0000	35.0000	0.0000	5.1436	0.7689	3.4393	23,120
PreEmployment_i	Years of previous employment experience of worker i with another employer prior joining the firm. Does not include self-employment or employed by family business such as farming.	2.7015	1.0000	25.0000	0.0000	3.5578	1.6194	6.1774	23,120
EqIndustry_i	=1 if worker i had engaged in an equivalent industry as the steel making prior joining the firm, and 0 otherwise.	0.2311	0.0000	1.0000	0.0000	0.4215	1.2758	2.6277	23,120
EqJob_i	=1 if worker i had engaged in an equivalent job before joining the firm as the one after joining the firm, and 0 otherwise.	0.1412	0.0000	1.0000	0.0000	0.3482	2.0610	5.2477	23,120
New_i	= 1 if PreExperience_i =0 (employed by the case firm immediately after graduation).	0.1733	0.0000	1.0000	0.0000	0.3785	1.7265	3.9809	23,120
$\text{Tenure}_{i,t}$	Tenure of worker i in year t: (years after employed by the firm).	10.0591	9.0000	37.7500	0.0000	6.9391	0.6156	2.7515	23,120
$\text{Training}_{i,t}^{1927-35}$	=1 if worker i had completed Development Center for Youth (operated from 1927 to 1935), and 0 otherwise.	0.0010	0.0000	1.0000	0.0000	0.0308	32.3714	1,048.9100	23,120
$\text{Training}_{i,t}^{1935-48}$	=1 if completed School for Youth (operated from 1935 to 1948), and 0 otherwise.	0.0419	0.0000	1.0000	0.0000	0.2004	4.5720	21.9034	23,120
$\text{Training}_{i,t}^{1939-46}$	=1 if completed Development Center for Technician (operated from 1939 to 1946), and 0 otherwise.	0.0513	0.0000	1.0000	0.0000	0.2205	4.0700	17.5646	23,120
$\text{Training}_{i,t}^{1946-73}$	=1 if completed Development Center (operated from 1946 to 1973), and 0 otherwise.	0.1257	0.0000	1.0000	0.0000	0.3316	2.2577	6.0970	23,120
$\text{Yearjoined}_i^{19XX-YY}$	2-year-joined dummy variable: =1 if worker i joined the firm from 19XX to 19YY(=19XX+1), and 0 otherwise.								
Year_t^{19XX}	Year dummy variable: =1 if t is 19XX, and 0 otherwise.								
GNP_t	Real gross national product in year t.								

Sources : See **Appendix I**.

Table 1 Employee numbers, years of schooling, and previous labor market experience across cohorts.

Year joined (Yearjoined^{19XX})	Number of employees who joined	Number of observations	Years of schooling (School)				Years of previous experience (PreExperience)				Number of employees who joined without previous experience (PreExperience=0)		Nationwide events
			mean	median	max	min	mean	median	max	min	number	percentage	
1928	1	24	11.00	11	11	11	4.00	4	4	4	0	0.00%	
1929	1	38	8.00	8	8	8	0.00	0	0	0	1	100.00%	
1930	1	28	8.00	8	8	8	2.00	2	2	2	0	0.00%	
1931	0	na	na	na	na	na	na	na	na	na	na	na	na
1932	0	na	na	na	na	na	na	na	na	na	na	na	na
1933	4	102	8.00	8	8	8	1.45	1	3	1	0	0.00%	
1934	2	54	6.85	6	8	6	7.56	5	11	5	0	0.00%	
1935	5	141	8.82	8	12	8	2.95	1	7	0	2	40.00%	
1936	7	152	8.00	8	8	8	5.97	6	9	0	1	14.29%	
1937	7	191	8.00	8	8	8	6.22	7	13	0	1	14.29%	Engaged in a war with China from 1937 and with US from 1941
1938	18	494	7.63	8	8	6	4.85	5	12	0	5	27.78%	
1939	41	1,030	7.94	8	9	6	4.95	5	12	0	7	17.07%	
1940	40	1,001	7.95	8	13	6	5.02	5	13	0	10	25.00%	
1941	47	1,094	8.30	8	14	6	4.63	5	13	0	15	31.91%	
1942	29	652	8.04	8	13	6	3.86	1	16	0	13	44.83%	
1943	27	611	8.25	8	13	6	3.38	0	17	0	14	51.85%	
1944	22	493	7.97	8	13	6	3.24	1	14	0	11	50.00%	
1945	17	379	8.25	8	11	6	0.00	0	0	0	17	100.00%	
1946	17	342	8.00	8	8	8	1.52	0	23	0	14	82.35%	
1947	12	225	8.00	8	8	8	0.08	0	1	0	11	91.67%	Compulsory education extended to 9 years in 1947
1948	291	5,548	8.79	8	14	5	9.04	8	23	0	10	3.44%	
1949	271	4,845	8.94	8	14	6	7.96	8	21	0	16	5.90%	
1950	37	619	9.00	9	13	6	4.49	0	18	0	19	51.35%	
1951	53	873	8.44	8	13	6	8.34	8	14	3	0	0.00%	
1952	7	105	8.16	8	9	8	5.85	6	7	4	0	0.00%	
1953	13	154	9.00	9	9	9	2.00	2	2	2	0	0.00%	
1954	20	239	9.79	9	12	9	1.47	2	2	0	5	25.00%	
1955	13	144	9.00	9	9	9	2.25	2	10	2	0	0.00%	
1956	96	1,014	8.87	9	12	7	7.47	7	20	1	0	0.00%	
1957	72	662	9.06	9	12	6	6.32	6	17	0	6	8.33%	Rapid growth began
1958	29	223	9.00	9	9	9	2.52	2	8	1	0	0.00%	
1959	90	616	10.25	9	13	8	3.52	2	15	0	9	10.00%	
1960	47	274	10.20	9	12	8	3.79	2	25	0	16	34.04%	
1961	41	173	9.56	9	15	9	3.40	2	13	0	4	9.76%	
1962	87	299	10.66	12	12	9	1.30	2	11	0	46	52.87%	
1963	47	121	8.98	9	15	7	7.50	2	35	0	5	10.64%	
1964	17	87	8.78	8	12	8	19.34	20	34	2	0	0.00%	
1965	11	34	12.00	12	12	12	0.12	0	1	0	10	90.91%	
1966	9	20	12.00	12	12	12	0.40	0	1	0	6	66.67%	
1967	9	19	10.63	11	12	9	5.37	5	10	0	3	33.33%	
total	1,558	23,120									277	17.78%	

Notes : Previous labor market experience: Years after graduating school, before employed by the firm.

Table 2 Effect of cohort and tenure.

	2–1		
Estimation method	panel least squares		
Dependent variable	log(w)		
Cross-section	pooled		
Period (year)	fixed		
Independent variables	coefficient	t-statistic	
Constant	0.4015	12.6557	***
Age	0.0265	38.4943	***
Age^2	-0.0003	-28.1745	***
School	0.0077	2.4334	***
School^2	-0.0001	-0.8124	
PreExperience	0.0079	18.3520	***
PreExperience^2	-0.0001	-6.8631	***
EqInduistry・PreExperience	0.0006	4.2582	***
EqJob・PreExperience	0.0026	15.7884	***
Tenure	0.0270	31.4127	***
Tenure^2	-0.0003	-24.0801	***
Yearjoined$^{1930-1931}$	-0.0409	-2.1629	**
Yearjoined$^{1932-1933}$	-0.0122	-0.8738	
Yearjoined$^{1934-1935}$	-0.0337	-2.5582	***
Yearjoined$^{1936-1937}$	-0.0249	-1.8765	***
Yearjoined$^{1938-1939}$	-0.0031	-0.2297	
Yearjoined$^{1940-1941}$	-0.0374	-2.5985	***
Yearjoined$^{1942-1943}$	-0.0676	-4.3799	***
Yearjoined$^{1944-1945}$	-0.1064	-6.4599	***
Yearjoined$^{1946-1947}$	-0.0987	-5.5509	***
Yearjoined$^{1948-1949}$	-0.1237	-6.6356	***
Yearjoined$^{1950-1951}$	-0.1656	-8.2573	***
Yearjoined$^{1952-1953}$	-0.1702	-7.8270	***
Yearjoined$^{1954-1955}$	-0.1783	-7.8401	***
Yearjoined$^{1956-1957}$	-0.2778	-11.6143	***
Yearjoined$^{1958-1959}$	-0.3129	-12.2271	***
Yearjoined$^{1960-1961}$	-0.3449	-12.8475	***
Yearjoined$^{1962-1963}$	-0.3685	-13.0792	***
Yearjoined$^{1964-1965}$	-0.2886	-9.4658	***
Yearjoined$^{1966-1967}$	-0.3244	-9.1470	***
ΔGNP	yes		
cross-sections included		15,555	
periods included (years)		41 (1929-1969)	
included observations		21,562	
adjusted R^2		0.9809	
F statistic		16,059.0766	***

Notes : Base year joined dummy is Yearjoined$^{1928-1929}$. ***, ** and * respectively denote significance at the 1, 5 and 10 percentage levels. Definitions of variables are in the **Appendix II**.

Table 3 Wage regression on skill elements.

	3–1			3–2			3–3			3-4		
Estimation method	panel extended generalized least squares											
Dependent variable	log(w)			log(w)			log(w)			log(w)		
Cross-section	random effect			random effect			random effect			random effect		
Period (year)	pooled			pooled			pooled			pooled		
Independent variables	coefficient	t-statistic		coefficient	t-statistic		coefficient	t-statistic		coefficient	t-statistic	
Constant	-1.1086	-15.2919	***	-1.5083	-20.6046	***	-5.8535	-8.2002	***	-5.8634	-8.2384	***
Height							8.7897	6.1427	***	8.8814	6.2251	***
Height^2							-4.1843	-5.7989	***	-4.2335	-5.8843	***
Age				0.0483	20.1647	***	0.0434	17.7904	***	0.0428	17.5626	***
Age^2				-0.0003	-10.1117	***	-0.0003	-10.8816	***	-0.0003	-10.6185	***
School	0.1575	10.4665	***	0.1044	7.4003	***	0.0686	4.1045	***	0.0635	3.8064	***
School^2	-0.0066	-8.5994	***	-0.0043	-6.0954	***	-0.0034	-4.0343	***	-0.0031	-3.6720	***
Postwar・School	0.0518	63.6035	***	0.0473	60.0136	***	0.0566	68.9749	***	0.0559	67.9409	***
PreExperience	0.0445	27.7912	***	0.0171	8.9288	***	0.0246	9.6814	***	0.0243	9.6052	***
PreExperience^2	-0.0006	-7.8483	***	-0.0006	-7.1253	***	-0.0012	-10.5445	***	-0.0012	-10.5231	***
PreEmployment	0.0118	6.2975	***	0.0099	5.5158	***	-0.0023	-1.0863		-0.0050	-2.3281	**
PreEmployment^2	-0.0005	-3.2176	***	-0.0006	-3.9732	***	0.0004	2.4653	**	0.0004	2.1151	**
EqIndustry・PreEmployment				0.0098	8.6664	***				0.0088	6.9875	***
EqJob・PreEmployment				-0.0100	-8.7973	***				-0.0051	-3.8458	***
Tenure	0.1249	146.6286	***	0.0921	55.9905	***	0.1335	69.3851	***	0.1338	69.6463	***
Tenure^2	-0.0016	-49.0251	***	-0.0014	-35.3995	***	-0.0028	-51.0070	***	-0.0028	-51.1972	***
Training$^{1927-35}$	-0.8003	-4.7392	***	-0.5415	-3.2635	***						
Training$^{1927-35}$・Tenure	0.0177	1.9966	**	0.0164	1.8474	*						
Training$^{1935-48}$	-0.1668	-7.6702	***	-0.1603	-7.5813	***						
Training$^{1935-48}$・Tenure	0.0086	6.4654	***	0.0074	5.5960	***						
Training$^{1939-46}$	-0.2406	-11.8359	***	-0.2086	-10.5107	***						
Training$^{1939-46}$・Tenure	0.0130	10.5580	***	0.0113	9.1412	***						
Training$^{1946-73}$	0.1619	14.1057	***	0.2203	19.1373	***						
Training$^{1946-73}$・Tenure	-0.0038	-3.6088	**	-0.0081	-7.5189	***						
cross-sections included		1,558			1,558			1,246			1,246	
periods included (years)		41(1929-1969)			41(1929-1969)			31(1939-1969)			31(1939-1969)	
included observations		23,120			23,120			16,637			16,637	
adjusted R^2		0.7773			0.7773			0.8648			0.8651	
F statistic		4,747.3652	***		3,842.8808	***		8,188.6402	***		7,114.6473	***

Notes : ***, ** and * respectively denote significance at the 1, 5, and 10 percentage levels. The records of the employees who had joined the firm before 1939 lack the information about somatic characteristics. Definitions of variables are in the **Appendix II**.

Table 4 Increase in productivity orver cohorts.

	4–1			4–2		
Estimation method	panel extended generalized least squares					
Dependent variable	log(w)			log(w)		
Cross-section	random effect			random effect		
Period (year)	pooled			pooled		
Independent variables	coefficient	t-statistic		coefficient	t-statistic	
Constant	-3.3287	-21.1050	***	-2.0365	-9.1847	***
School·log(School)	0.3588	27.2024	***	0.0150	1.3354	
$School^2$·log^2(School)	-0.0061	-22.3191	***	-0.0003	-1.2980	
(PreExperience+1)·log(PreExperience+1)	0.0509	18.1989	***	0.0149	7.0923	***
$(PreExperience+1)^2$·log^2(PreExperience+1)	0.0000	0.4088		-0.0001	-3.1363	***
(Tenure+1)·log(Tenure+1)	0.0695	49.2151	***	0.0737	52.7715	***
$(Tenure+1)^2$·log^2(Tenure+1)	0.0000	0.0230		0.0000	-1.8274	*
School·(PreExperience+1)·log(School)·log(PreExperience+1)	-0.0020	-17.9749	***	-0.0001	-3.0843	***
School·(Tenure+1)·log(School)·log(Tenure+1)	0.0002	4.2058	***	0.0005	8.9775	***
(PreExperience+1)·(Tenure+1)·log(PreExperience+1)·log(Tenure+1)	0.0005	25.7559	***	0.0003	19.9373	***
$Yearjoined^{1930–1931}$				0.0603	0.1968	
$Yearjoined^{1932–1933}$				0.4558	2.0965	**
$Yearjoined^{1934–1935}$				0.9590	4.7957	***
$Yearjoined^{1936–1937}$				1.1732	6.1946	***
$Yearjoined^{1938–1939}$				1.6138	8.9934	***
$Yearjoined^{1940–1941}$				1.7424	9.7599	***
$Yearjoined^{1942–1943}$				1.9724	10.9626	***
$Yearjoined^{1944–1945}$				2.1436	11.8052	***
$Yearjoined^{1946–1947}$				2.5588	13.9164	***
$Yearjoined^{1948–1949}$				2.9337	16.5406	***
$Yearjoined^{1950–1951}$				3.2240	17.9733	***
$Yearjoined^{1952–1953}$				3.5214	18.5996	***
$Yearjoined^{1954–1955}$				3.7767	20.3943	***
$Yearjoined^{1956–1957}$				3.8308	21.4202	***
$Yearjoined^{1958–1959}$				3.9172	21.7057	***
$Yearjoined^{1960–1961}$				3.9598	21.6052	***
$Yearjoined^{1962–1963}$				4.0060	21.7260	***
$Yearjoined^{1964–1965}$				5.1423	25.4822	***
$Yearjoined^{1966–1967}$				5.3113	21.0628	***
ΔGNP	Yes			Yes		
cross-sections included		1,555			1,555	
periods included (years)	40 (1930–1969)			40 (1930–1969)		
included observations		21,562			21,562	
adjusted R^2		0.7925			0.8291	
F statistic		8,237.9679	***		3,607.4663	***

Notes : Base year joined dummy variable is $Yearjoined^{1928–1929}$. *** and ** respectively denote significance at the 1 percentage level and at 5 percentage levels. Definitions of variables are in the **Appendix II**.

Table 5 Increase in return on schooling over cohort: : Relative to the 1928–1929 cohort.

	5–1			5–2		
Estimation method	panel extended generalized least squares					
Dependent variable	log(w)			log(w)		
Cross-section	random effect			random effect		
Period (year)	pooled			pooled		
Independent variables	coefficient	t-statistic		coefficient	t-statistic	
Constant	-0.2401	-2.9088	***	-0.1235	-1.6539	*
$School^2 \cdot log^2(School)$	-0.0024	-16.9816	***	-0.0005	-3.5263	***
(PreExperience+1)·log(PreExperience+1)	0.0220	11.0916	***	0.0241	16.1812	***
$(PreExperience+1)^2 \cdot log^2(PreExperience+1)$	-0.0001	-2.6905	***	-0.0001	-4.7853	***
(Tenure+1)·log(Tenure+1)	0.0689	50.4746	***	0.0327	20.4203	***
$(Tenure+1)^2 \cdot log^2(Tenure+1)$	0.0000	-1.6327		0.0001	16.8872	***
School·(PreExperience+1)·log(School)·log(PreExperience+1)	-0.0002	-6.5166	***	-0.0002	-8.8189	***
School·(Tenure+1)·log(School)·log(Tenure+1)	0.0007	14.2406	***	0.0000	0.8736	
(PreExperience+1)·(Tenure+1)·log(PreExperience+1)·log(Tenure+1)	0.0003	18.3477	***	0.0002	14.9905	***
$Yearjoined^{1930-1931} \cdot School \cdot log(School)$	-0.0534	-3.2581	***	-0.0190	-1.4184	
$Yearjoined^{1932-1933} \cdot School \cdot log(School)$	-0.0294	-2.8982	***	0.0014	0.1681	
$Yearjoined^{1934-1935} \cdot School \cdot log(School)$	0.0149	1.7823	*	0.0122	1.8125	*
$Yearjoined^{1936-1937} \cdot School \cdot log(School)$	0.0119	1.5278		0.0211	3.3607	***
$Yearjoined^{1938-1939} \cdot School \cdot log(School)$	0.0382	5.5141	***	0.0377	6.6904	***
$Yearjoined^{1940-1941} \cdot School \cdot log(School)$	0.0527	7.7349	***	0.0379	6.7068	***
$Yearjoined^{1942-1943} \cdot School \cdot log(School)$	0.0639	9.2312	***	0.0383	6.5602	***
$Yearjoined^{1944-1945} \cdot School \cdot log(School)$	0.0755	10.6078	***	0.0380	6.2153	***
$Yearjoined^{1946-1947} \cdot School \cdot log(School)$	0.0960	13.0380	***	0.0478	7.4441	***
$Yearjoined^{1948-1949} \cdot School \cdot log(School)$	0.1150	17.4984	***	0.0483	7.9915	***
$Yearjoined^{1950-1951} \cdot School \cdot log(School)$	0.1290	19.3338	***	0.0445	7.0694	***
$Yearjoined^{1952-1953} \cdot School \cdot log(School)$	0.1457	19.7443	***	0.0436	6.2701	***
$Yearjoined^{1954-1955} \cdot School \cdot log(School)$	0.1525	22.0998	***	0.0394	5.8039	***
$Yearjoined^{1956-1957} \cdot School \cdot log(School)$	0.1577	24.2151	***	0.0259	3.7844	***
$Yearjoined^{1958-1959} \cdot School \cdot log(School)$	0.1567	23.7414	***	0.0211	2.9940	***
$Yearjoined^{1960-1961} \cdot School \cdot log(School)$	0.1581	23.3407	***	0.0165	2.2639	***
$Yearjoined^{1962-1963} \cdot School \cdot log(School)$	0.1578	23.2891	***	0.0139	1.8806	*
$Yearjoined^{1964-1965} \cdot School \cdot log(School)$	0.2035	26.6981	***	0.0185	2.3182	***
$Yearjoined^{1966-1967} \cdot School \cdot log(School)$	0.1998	21.8890	***	-0.0009	-0.1132	
$Year^{19XX}$	No			Yes		
ΔGNP	Yes			No		
cross-sections included		1,555			1,558	
periods included (years)	40 (1930–1969)			41 (1929–1969)		
included observations		21,562			23,120	
adjusted R^2		0.8275			0.9170	
F statistic		3,693.8861	***		3,815.1013	***

Notes : Base year joined dummy variable is $Yearjoined^{1928-1929}$ and base year dummy variable is $Year^{1930}$. *** and ** respectively denote significance at the 1 percentage level and at 5 percentage levels. Definitions of variables are in the **Appendix II**.

Table 6 Increase in return on previous labor market experience over cohort: Relative to the 1928−1929 cohort.

	6−1			6−2		
Estimation method	panel extended generalized least squares					
Dependent variable	log(w)			log(w)		
Cross-section	random effect			random effect		
Period (year)	pooled			pooled		
Independent variables	coefficient	t-statistic		coefficient	t-statistic	
Constant	-1.9224	-12.9003	***	-0.2209	-2.1397	**
School·log(School)	0.2282	18.0711	***	0.0462	5.4110	***
$School^2 \cdot log^2(School)$	-0.0034	-12.9612	***	-0.0008	-4.4186	***
$(PreExperience+1)^2 \cdot log^2(PreExperience+1)$	-0.0005	-16.3725	***	-0.0002	-13.1286	***
(Tenure+1)·log(Tenure+1)	0.0721	79.5556	***	0.0420	57.2992	***
$(Tenure+1)^2 \cdot log^2(Tenure+1)$	0.0000	1.3144		0.0001	12.4780	***
School·(PreExperience+1)·log(School)·log(PreExperience+1)	-0.0021	-20.1363	***	-0.0003	-4.4156	***
School·(Tenure+1)·log(School)·log(Tenure+1)	0.0000	1.7600	*	0.0000	2.9284	***
(PreExperience+1)·(Tenure+1)·log(PreExperience+1)·log(Tenure+1)	0.0006	34.0277	***	0.0002	14.6292	***
$Yearjoined^{1930-1931}$·(PreExperience+1)·log(PreExperience+1)	-0.6645	-7.1871	***	-0.3565	-5.8954	***
$Yearjoined^{1932-1933}$·(PreExperience+1)·log(PreExperience+1)	-0.5375	-10.3200	***	-0.2346	-6.8671	***
$Yearjoined^{1934-1935}$·(PreExperience+1)·log(PreExperience+1)	-0.0331	-3.8923	***	-0.0109	-1.9632	**
$Yearjoined^{1936-1937}$·(PreExperience+1)·log(PreExperience+1)	-0.0211	-3.8496	***	0.0008	0.2165	
$Yearjoined^{1938-1939}$·(PreExperience+1)·log(PreExperience+1)	0.0025	0.6884		0.0165	6.9015	***
$Yearjoined^{1940-1941}$·(PreExperience+1)·log(PreExperience+1)	0.0119	3.5602	***	0.0190	8.7837	***
$Yearjoined^{1942-1943}$·(PreExperience+1)·log(PreExperience+1)	0.0355	9.5307	***	0.0287	11.8595	***
$Yearjoined^{1944-1945}$·(PreExperience+1)·log(PreExperience+1)	0.0399	7.6444	***	0.0282	8.3177	***
$Yearjoined^{1946-1947}$·(PreExperience+1)·log(PreExperience+1)	0.0772	14.5460	***	0.0451	12.9826	***
$Yearjoined^{1948-1949}$·(PreExperience+1)·log(PreExperience+1)	0.0669	23.6323	***	0.0362	19.1608	***
$Yearjoined^{1950-1951}$·(PreExperience+1)·log(PreExperience+1)	0.0785	25.4947	***	0.0366	17.6176	***
$Yearjoined^{1952-1953}$·(PreExperience+1)·log(PreExperience+1)	0.1177	12.4495	***	0.0479	7.7020	***
$Yearjoined^{1954-1955}$·(PreExperience+1)·log(PreExperience+1)	0.1871	12.1548	***	0.0545	5.2811	***
$Yearjoined^{1956-1957}$·(PreExperience+1)·log(PreExperience+1)	0.0937	31.8980	***	0.0265	12.8000	***
$Yearjoined^{1958-1959}$·(PreExperience+1)·log(PreExperience+1)	0.1095	24.7037	***	0.0171	5.5738	***
$Yearjoined^{1960-1961}$·(PreExperience+1)·log(PreExperience+1)	0.0950	23.5733	***	0.0220	8.0193	***
$Yearjoined^{1962-1963}$·(PreExperience+1)·log(PreExperience+1)	0.1032	24.1525	***	0.0294	10.5724	***
$Yearjoined^{1964-1965}$·(PreExperience+1)·log(PreExperience+1)	0.1136	28.9626	***	0.0407	15.2521	***
$Yearjoined^{1966-1967}$·(PreExperience+1)·log(PreExperience+1)	0.1921	11.7046	***	0.0113	1.2384	
$Year^{19XX}$	No			Yes		
ΔGNP	Yes			No		
cross-sections included		1,555			1,558	
periods included (years)	40 (1930−1969)			41 (1929−1969)		
included observations		21,562			23,120	
adjusted R^2		0.8116			0.9155	
F statistic		3,318.9535	***		3,738.3985	***

Notes: Base year joined dummy variable is $Yearjoined^{1928-1929}$ and base year dummy variable is $Year^{1930}$. *** and ** respectively denote significance at the 1 percentage level and at 5 percentage levels. Definitions of variables are in the **Appendix II**.

Table 7 Increase in return on tenure over cohort: Relative to the 1928−1929 cohort.

	7−1			7−2		
Estimation method	panel extended generalized least squares					
Dependent variable	log(w)			log(w)		
Cross-section	random effect			random effect		
Period (year)	pooled			pooled		
Independent variables	coefficient	t-statistic		coefficient	t-statistic	
Constant	-0.7400	-5.5678	***	0.1229	1.2069	
School·log(School)	0.1470	13.0185	***	0.0253	2.9772	***
School^2·log^2(School)	-0.0024	-10.1083	***	-0.0003	-1.5563	
(PreExperience+1)·log(PreExperience+1)	0.0353	14.6048	***	0.0221	12.6917	***
(PreExperience+1)^2·log^2(PreExperience+1)	-0.0001	-3.1366	***	-0.0001	-4.8324	***
(Tenure+1)^2·log^2(Tenure+1)	0.0004	48.0423	***	0.0003	33.8665	***
School·(PreExperience+1)·log(School)·log(PreExperience+1)	-0.0010	-10.2214	***	-0.0002	-3.3884	***
School·(Tenure+1)·log(School)·log(Tenure+1)	0.0006	2.8760	***	0.0005	3.5333	***
(PreExperience+1)·(Tenure+1)·log(PreExperience+1)·log(Tenure+1)	0.0001	3.9486	***	0.0001	5.4598	***
Yearjoined$^{1930-1931}$·(Tenure+1)·log(Tenure+1)	-0.0023	-0.7210		0.0037	1.5795	
Yearjoined$^{1932-1933}$·(Tenure+1)·log(Tenure+1)	0.0134	7.6279	***	0.0152	11.1974	***
Yearjoined$^{1934-1935}$·(Tenure+1)·log(Tenure+1)	0.0130	8.5243	***	0.0156	13.2135	***
Yearjoined$^{1936-1937}$·(Tenure+1)·log(Tenure+1)	0.0208	16.0177	***	0.0199	19.7499	***
Yearjoined$^{1938-1939}$·(Tenure+1)·log(Tenure+1)	0.0314	31.7209	***	0.0264	34.0617	***
Yearjoined$^{1940-1941}$·(Tenure+1)·log(Tenure+1)	0.0359	38.5000	***	0.0277	38.7364	***
Yearjoined$^{1942-1943}$·(Tenure+1)·log(Tenure+1)	0.0426	43.5999	***	0.0306	41.4980	***
Yearjoined$^{1944-1945}$·(Tenure+1)·log(Tenure+1)	0.0473	43.5208	***	0.0305	37.3040	***
Yearjoined$^{1946-1947}$·(Tenure+1)·log(Tenure+1)	0.0576	41.2480	***	0.0355	34.0143	***
Yearjoined$^{1948-1949}$·(Tenure+1)·log(Tenure+1)	0.0647	78.9103	***	0.0398	59.0901	***
Yearjoined$^{1950-1951}$·(Tenure+1)·log(Tenure+1)	0.0712	61.7984	***	0.0420	44.1548	***
Yearjoined$^{1952-1953}$·(Tenure+1)·log(Tenure+1)	0.0827	28.3621	***	0.0471	21.4295	***
Yearjoined$^{1954-1955}$·(Tenure+1)·log(Tenure+1)	0.0905	34.5982	***	0.0516	25.4118	***
Yearjoined$^{1956-1957}$·(Tenure+1)·log(Tenure+1)	0.1028	59.6157	***	0.0496	29.3460	***
Yearjoined$^{1958-1959}$·(Tenure+1)·log(Tenure+1)	0.1294	39.0920	***	0.0512	17.3555	***
Yearjoined$^{1960-1961}$·(Tenure+1)·log(Tenure+1)	0.1557	27.0473	***	0.0503	10.3875	***
Yearjoined$^{1962-1963}$·(Tenure+1)·log(Tenure+1)	0.2101	24.0535	***	0.0448	5.9517	***
Yearjoined$^{1964-1965}$·(Tenure+1)·log(Tenure+1)	0.3382	25.1313	***	0.0840	7.6871	***
Yearjoined$^{1966-1967}$·(Tenure+1)·log(Tenure+1)	0.5066	12.1183	***	-0.0115	-0.3763	
Year^{19XX}	No			Yes		
ΔGNP	Yes			No		
cross-sections included		1,555			1,558	
periods included (years)	40 (1930−1969)			41 (1929−1969)		
included observations		21,562			23,120	
adjusted R^2		0.8317			0.9149	
F statistic		3,807.3085	***		3,710.5758	***

Notes : Base year joined dummy variable is Yearjoined$^{1928-1929}$ and base year dummy variable is Year^{1930}. *** and ** respectively denote significance at the 1 percentage level and at 5 percentage levels. Definitions of variables are in the **Appendix II**.

Table 8 Increase in complementarity between schooling and tenure over cohort: Relative to the 1928−1929 cohort.

	8–1			8–2		
Estimation method	panel extended generalized least squares					
Dependent variable	$\log(w)$			$\log(w)$		
Cross-section	random effect			random effect		
Period (year)	pooled			pooled		
Independent variables	coefficient	t-statistic		coefficient	t-statistic	
Constant	-0.7147	-5.3718	***	0.1841	1.7644	
School·log(School)	0.1570	14.1547	***	0.0180	2.0957	**
$\text{School}^2\cdot\log^2(\text{School})$	-0.0030	-13.1874	***	-0.0003	-1.4749	
(PreExperience+1)·log(PreExperience+1)	0.0416	17.6357	***	0.0257	14.7527	***
$(\text{PreExperience}+1)^2\cdot\log^2(\text{PreExperience}+1)$	-0.0001	-4.2056	***	-0.0001	-7.8192	***
(Tenure+1)·log(Tenure+1)	0.0442	33.2653	***	0.0329	32.2761	***
$(\text{Tenure}+1)^2\cdot\log^2(\text{Tenure}+1)$	0.0003	34.4519	***	0.0002	16.3585	***
School·(PreExperience+1)·log(School)·log(PreExperience+1)	-0.0013	-13.4006	***	-0.0003	-4.2532	***
(PreExperience+1)·(Tenure+1)·log(PreExperience+1)·log(Tenure+1)	0.0002	12.9293	***	0.0002	13.5716	***
$\text{Yearjoined}^{1930-1931}$·School·(Tenure+1)·log(School)·log(Tenure+1)	-0.0023	-12.7262	***	-0.0009	-6.6037	***
$\text{Yearjoined}^{1932-1933}$·School·(Tenure+1)·log(School)·log(Tenure+1)	-0.0014	-14.1534	***	-0.0003	-3.8211	***
$\text{Yearjoined}^{1934-1935}$·School·(Tenure+1)·log(School)·log(Tenure+1)	-0.0013	-16.1102	***	-0.0003	-4.6720	***
$\text{Yearjoined}^{1936-1937}$·School·(Tenure+1)·log(School)·log(Tenure+1)	-0.0011	-14.4269	***	-0.0002	-2.8314	***
$\text{Yearjoined}^{1938-1939}$·School·(Tenure+1)·log(School)·log(Tenure+1)	-0.0005	-7.8952	***	0.0001	3.3303	***
$\text{Yearjoined}^{1940-1941}$·School·(Tenure+1)·log(School)·log(Tenure+1)	-0.0002	-3.3392	***	0.0002	3.9402	***
$\text{Yearjoined}^{1942-1943}$·School·(Tenure+1)·log(School)·log(Tenure+1)	0.0001	1.6180		0.0002	4.2362	***
$\text{Yearjoined}^{1944-1945}$·School·(Tenure+1)·log(School)·log(Tenure+1)	0.0004	5.4824	***	0.0001	2.7841	***
$\text{Yearjoined}^{1946-1947}$·School·(Tenure+1)·log(School)·log(Tenure+1)	0.0010	10.5859	***	0.0003	4.9687	***
$\text{Yearjoined}^{1948-1949}$·School·(Tenure+1)·log(School)·log(Tenure+1)	0.0012	24.2901	***	0.0004	11.7657	***
$\text{Yearjoined}^{1950-1951}$·School·(Tenure+1)·log(School)·log(Tenure+1)	0.0015	22.4592	***	0.0004	8.4595	***
$\text{Yearjoined}^{1952-1953}$·School·(Tenure+1)·log(School)·log(Tenure+1)	0.0023	14.2097	***	0.0007	5.7786	***
$\text{Yearjoined}^{1954-1955}$·School·(Tenure+1)·log(School)·log(Tenure+1)	0.0023	18.7990	***	0.0007	7.3932	***
$\text{Yearjoined}^{1956-1957}$·School·(Tenure+1)·log(School)·log(Tenure+1)	0.0031	33.5910	***	0.0005	5.3737	***
$\text{Yearjoined}^{1958-1959}$·School·(Tenure+1)·log(School)·log(Tenure+1)	0.0042	27.4714	***	0.0003	2.3007	**
$\text{Yearjoined}^{1960-1961}$·School·(Tenure+1)·log(School)·log(Tenure+1)	0.0049	20.5819	***	0.0000	0.1727	
$\text{Yearjoined}^{1962-1963}$·School·(Tenure+1)·log(School)·log(Tenure+1)	0.0079	20.5453	***	-0.0008	-2.4320	**
$\text{Yearjoined}^{1964-1965}$·School·(Tenure+1)·log(School)·log(Tenure+1)	0.0140	22.9747	***	0.0000	-0.0708	
$\text{Yearjoined}^{1966-1967}$·School·(Tenure+1)·log(School)·log(Tenure+1)	0.0172	11.7515	***	-0.0049	-4.6319	***
Year^{19XX}	No			Yes		
ΔGNP	Yes			No		
cross-sections included		1,555			1,558	
periods included (years)	40 (1930–1969)			41 (1929–1969)		
included observations		21,562			23,120	
adjusted R^2		0.8239			0.9147	
F statistic		3,603.9462	***		3,701.8498	***

Notes : Base year joined dummy variable is $\text{Yearjoined}^{1928-1929}$ and base year dummy variable is Year^{1930}. *** and ** respectively denote significance at the 1 percentage level and at 5 percentage levels. Definitions of variables are in the **Appendix II**.

Table 9 Increase in complementarity between previous experience and tenure over cohort: Relative to the 1929–1930 cohort.

	9–1			9–2		
Estimation method	panel extended generalized least squares					
Dependent variable	log(w)			log(w)		
Cross-section	random effect			random effect		
Period (year)	pooled			pooled		
Independent variables	coefficient	t-statistic		coefficient	t-statistic	
Constant	-2.4988	-16.7853	***	0.0023	0.0215	
School·log(School)	0.2897	23.2657	***	0.0298	3.4155	***
School^2·log^2(School)	-0.0046	-18.0405	***	-0.0005	-2.7879	***
(PreExperience+1)·log(PreExperience+1)	0.0554	20.6679	***	0.0272	15.3142	***
(PreExperience+1)^2·log^2(PreExperience+1)	-0.0003	-11.1455	***	-0.0002	-11.8419	***
(Tenure+1)·log(Tenure+1)	0.0629	45.0056	***	0.0369	35.8491	***
(Tenure+1)^2·log^2(Tenure+1)	0.0002	18.9520	***	0.0001	15.5880	***
School·(PreExperience+1)·log(School)·log(PreExperience+1)	-0.0020	-18.9012	***	-0.0002	-2.3014	**
School·(Tenure+1)·log(School)·log(Tenure+1)	-0.0001	-1.0828		0.0002	4.6112	***
Yearjoined$^{1930–1931}$·(PreExperience+1)·(Tenure+1)·log(PreExperience+1)·log(Tenure+1)	-0.0119	-12.0854	***	-0.0050	-7.4148	***
Yearjoined$^{1932–1933}$·(PreExperience+1)·(Tenure+1)·log(PreExperience+1)·log(Tenure+1)	-0.0059	-11.0985	***	-0.0020	-5.5210	***
Yearjoined$^{1934–1935}$·(PreExperience+1)·(Tenure+1)·log(PreExperience+1)·log(Tenure+1)	-0.0013	-12.8839	***	-0.0004	-5.5485	***
Yearjoined$^{1936–1937}$·(PreExperience+1)·(Tenure+1)·log(PreExperience+1)·log(Tenure+1)	-0.0008	-13.1055	***	-0.0002	-4.0925	***
Yearjoined$^{1938–1939}$·(PreExperience+1)·(Tenure+1)·log(PreExperience+1)·log(Tenure+1)	-0.0003	-8.0321	***	0.0001	2.5163	**
Yearjoined$^{1940–1941}$·(PreExperience+1)·(Tenure+1)·log(PreExperience+1)·log(Tenure+1)	-0.0001	-2.7406	***	0.0001	3.2341	***
Yearjoined$^{1942–1943}$·(PreExperience+1)·(Tenure+1)·log(PreExperience+1)·log(Tenure+1)	0.0003	6.2565	***	0.0002	6.8971	***
Yearjoined$^{1944–1945}$·(PreExperience+1)·(Tenure+1)·log(PreExperience+1)·log(Tenure+1)	0.0004	5.1956	***	0.0002	3.2278	***
Yearjoined$^{1946–1947}$·(PreExperience+1)·(Tenure+1)·log(PreExperience+1)·log(Tenure+1)	0.0009	8.3173	***	0.0006	8.4580	***
Yearjoined$^{1948–1949}$·(PreExperience+1)·(Tenure+1)·log(PreExperience+1)·log(Tenure+1)	0.0007	38.1278	***	0.0002	17.7132	***
Yearjoined$^{1950–1951}$·(PreExperience+1)·(Tenure+1)·log(PreExperience+1)·log(Tenure+1)	0.0011	21.1810	***	0.0003	7.6011	***
Yearjoined$^{1952–1953}$·(PreExperience+1)·(Tenure+1)·log(PreExperience+1)·log(Tenure+1)	0.0024	8.2233	***	0.0006	3.1040	***
Yearjoined$^{1954–1955}$·(PreExperience+1)·(Tenure+1)·log(PreExperience+1)·log(Tenure+1)	0.0051	7.8316	***	0.0010	2.2133	**
Yearjoined$^{1956–1957}$·(PreExperience+1)·(Tenure+1)·log(PreExperience+1)·log(Tenure+1)	0.0017	24.2455	***	0.0001	1.4485	
Yearjoined$^{1958–1959}$·(PreExperience+1)·(Tenure+1)·log(PreExperience+1)·log(Tenure+1)	0.0044	13.5121	***	-0.0005	-2.1913	**
Yearjoined$^{1960–1961}$·(PreExperience+1)·(Tenure+1)·log(PreExperience+1)·log(Tenure+1)	0.0029	9.5495	***	-0.0006	-2.9520	***
Yearjoined$^{1962–1963}$·(PreExperience+1)·(Tenure+1)·log(PreExperience+1)·log(Tenure+1)	0.0075	12.4232	***	-0.0004	-1.0094	
Yearjoined$^{1964–1965}$·(PreExperience+1)·(Tenure+1)·log(PreExperience+1)·log(Tenure+1)	0.0055	21.6052	***	0.0007	3.9762	***
Yearjoined$^{1966–1967}$·(PreExperience+1)·(Tenure+1)·log(PreExperience+1)·log(Tenure+1)	0.0404	7.4237	***	-0.0082	-2.1410	**
Year^{19XX}	No			Yes		
ΔGNP	Yes			No		
cross-sections included		1,555			1,558	
periods included (years)	40 (1930–1969)			41 (1929–1969)		
included observations		21,562			23,120	
adjusted R^2		0.8100			0.9144	
F statistic		3,284.2079	***		3,687.0667	***

Notes : Base year joined dummy variable is Yearjoined$^{1928–1929}$ and base year dummy variable is Year^{1930}. *** and ** respectively denote significance at the 1 percentage level and at 5 percentage levels. Definitions of variables are in the **Appendix II**.

Table 10 Probability of acceptance as a trainee for in-house training program School for Youth operated from 1935 to 1948.

	10–1				10–2				10–3			
Estimation method	binary probit				binary probit				binary probit			
Dependent variable	$Training^{1935–48}$				$Training^{1935–48}$				$Training^{1935–48}$			
Independent variables	coefficient	*z* -statistic		marginal effect	coefficient	*z* -statistic		marginal effect	coefficient	*z* -statistic		marginal effect
Constant	54.4974	1.8714	*		48.8714	1.3020			54.6225	1.4524		
Height	-152.8145	-2.7186	***	0.0000	-216.0014	-3.0201	***	0.0000	-232.7837	-3.2121	***	0.0000
$Height^2$	77.1701	2.6980	***		108.8846	3.0061	***		116.2232	3.1844	***	
Age	2.3430	3.0105	***	0.0000	4.7747	3.4795	***	0.0000	5.0191	3.5010	***	0.0000
Age^2	-0.0481	-2.7576	***		-0.0953	-3.2607	***		-0.1003	-3.2881	***	
School	-1.4325	-2.3921	**	0.0000	-2.2741	-2.8979	***	0.0000	-2.2264	-2.7590	***	0.0000
$School^2$	0.0710	2.3256	**		0.1124	2.8565	***		0.1101	2.7287	***	
New					13.3524	3.4498	***	0.0000	9.4774	1.3058		0.0000
New･Height									5.9065	1.0706		
New･School									-0.1457	-0.3484		
PreExperience	-0.6688	-3.3064	***	0.0000	1.3710	1.9179	*	0.0000	1.4897	2.0225	**	0.0000
$PreExperience^2$	0.0274	2.2734	**		-0.0929	-2.1609	**		-0.0995	-2.2518	**	
PreEmployment	0.5052	2.5301	**	0.0000	1.3885	1.8026	*	0.0000	1.3598	1.8194	*	0.0000
$PreEmployment^2$	-0.0324	-1.7852	*		-0.1140	-1.6963	*		-0.1112	-1.7096	*	
total observations		493				493				493		
period	1935–48				1935–48				1935–48			
cohort (Year joined)	1932–48				1932–48				1932–48			
observations with dependent variable =1		25				25				25		
log likelihood		-70.8110				-51.2832				-50.5876		
McFadden R^2		0.2840				0.4814				0.4885		
LR statistic		56.1700	***			95.2255	***			96.6167	***	

Notes : Marginal effects are calculated by mean values of independent variables. ***, ** and * respectively denote significance at the 1, 5 and 10 percentage levels. Note that Height is the relative height to the national average. Definitions of variables are in the **Appendix II**.

Table 11 Probability of acceptance as a trainee for in-house training program School for Youth operated from 1946 to 1962.

	11–1				11–2				11–3			
Estimation method	binary probit				binary probit				binary probit			
Dependent variable	$Training^{1946–73}$				$Training^{1946–73}$				$Training^{1946–73}$			
Independent variables	coefficient	*z*-statistic		marginal effect	coefficient	*z*-statistic		marginal effect	coefficient	*z*-statistic		marginal effect
Constant	-35.7230	-7.3387	***		-13.5221	-2.7373	***		-35.7220	-5.5084	***	
Height	32.0055	3.3086	***	1.0414	-0.4086	-0.0418		-0.0080	36.9066	2.9943	***	1.5780
$Height^2$	-14.0605	-2.8660	***		1.4951	0.3011			-15.4298	-2.5559	**	
Age	0.0733	2.2888	**	0.0024	0.1345	3.9795	***	0.0026	0.1360	3.9746	***	0.0058
Age^2	-0.0025	-3.8743	***		-0.0035	-5.1041	***		-0.0035	-5.1126	***	
School	4.0505	19.6932	***	0.1318	3.0802	15.3184	***	0.0600	3.3796	14.7371	***	0.1445
$School^2$	-0.2254	-21.1101	***		-0.1801	-17.2033	***		-0.1916	-16.5875	***	
New					-1.6810	-19.3132	***	-0.0151	6.3652	4.9452	***	0.0005
New･Height									-6.3390	-5.3334	***	
New･School									-0.1905	-3.2918	***	
PreExperience	-0.4218	-25.8720	***	-0.0137	-0.8173	-29.3032	***	-0.0159	-0.7933	-27.4783	***	-0.0339
$PreExperience^2$	0.0196	17.3620	***		0.0371	26.7257	***		0.0364	25.4694	***	
PreEmployment	-0.2299	-11.2626	***	-0.0075	-0.1635	-7.1300	***	-0.0032	-0.1619	-7.0128	***	-0.0074
$PreEmployment^2$	0.0115	8.4030	***		0.0055	3.9647	***		0.0054	3.9023	***	
total observations		12,077				12,077				12,077		
period	1946–62				1946–62				1946–62			
cohort (Year joined)	1943–62				1943–62				1943–62			
observations with dependent variable =1		1649				1649				1649		
log likelihood		-2,352.9986				-2,153.8561				-2,131.9518		
McFadden R^2		0.5112				0.5526				0.5572		
LR statistic		4,922.5964	***			5,320.8813	***			5,364.6898	***	

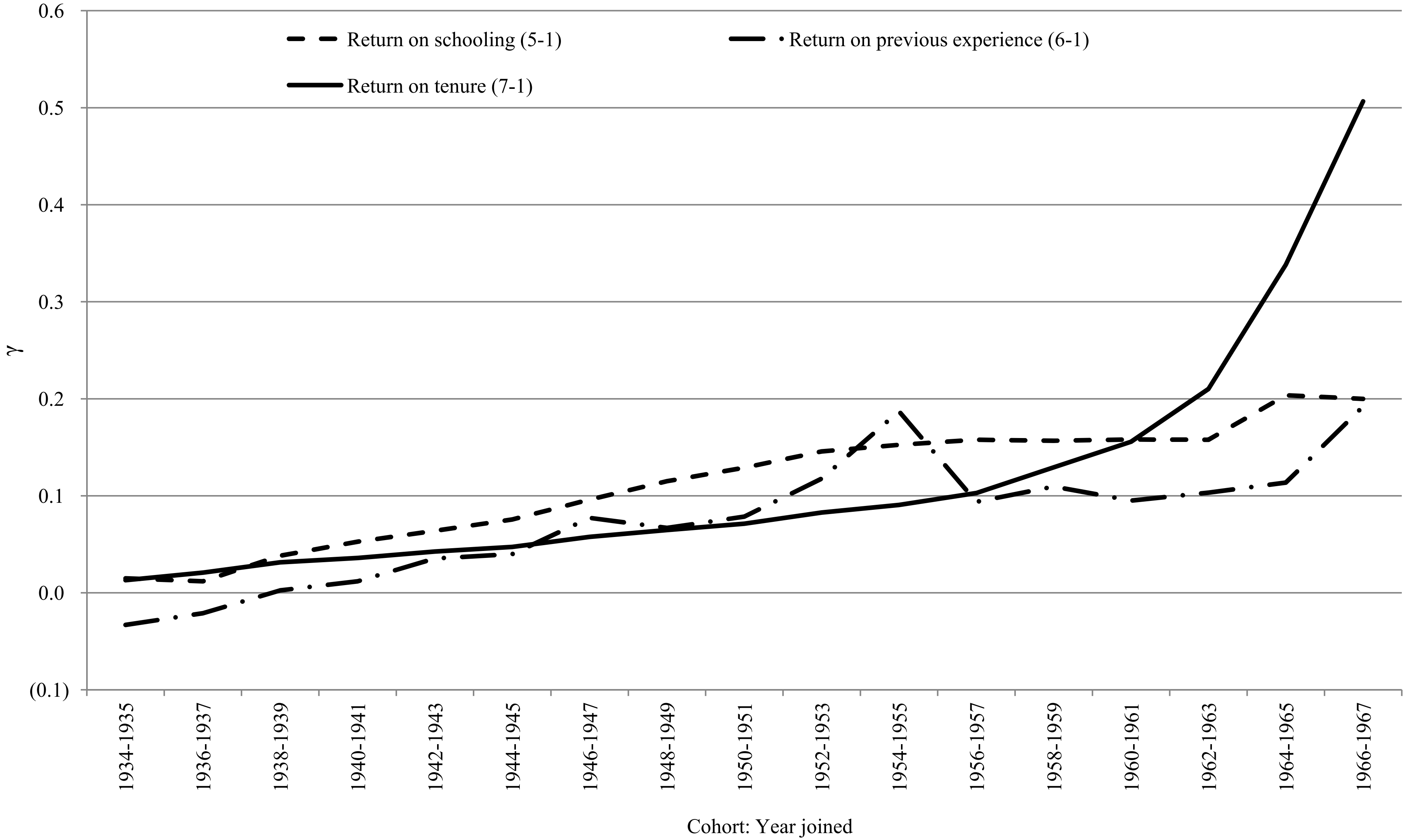
Notes : Marginal effects are calculated by mean values of independent variables. ***, ** and * respectively denote significance at the 1, 5 and 10 percentage levels. Note that Height is the relative height to the national average. Definitions of variables are in the **Appendix II**.

Table 12 Probability of acceptance as a trainee for in-house training program School for Youth operated from 1963 to 1969.

	12–1				12–2				12–3			
Estimation method	binary probit				binary probit				binary probit			
Dependent variable	$Training^{1946–73}$				$Training^{1946–73}$				$Training^{1946–73}$			
Independent variables	coefficient	*z*-statistic		marginal effect	coefficient	*z*-statistic		marginal effect	coefficient	*z*-statistic		marginal effect
Constant	20.7083	0.5032			15.1367	0.3634			76.5089	1.6463	*	
Height	-45.4600	-0.5911		0.0000	-48.1758	-0.6222		0.0000	-151.1421	-1.7898	*	0.0000
$Height^2$	20.1208	0.5403			21.6305	0.5767			65.0476	1.6211		
Age	0.5945	0.6082		0.0000	0.8995	0.8563		0.0000	0.7452	0.6492		0.0000
Age^2	-0.0193	-0.8340			-0.0266	-1.0631			-0.0236	-0.8601		
New					3.5972	2.1557	**	0.0000	-16.2044	-2.4917	**	0.0000
New･Height									19.8444	3.0817	***	
PreExperience	3.1758	8.8440	***	0.0000	6.8434	3.4471	***	0.0000	7.6158	3.3360	***	0.0000
$PreExperience^2$	-0.8512	-5.6465	***		-1.7346	-3.0501	***		-1.9644	-3.0041	***	
PreEmployment	-0.4173	-0.1653		0.0000	0.9397	0.0117		0.0000	0.9643	0.0020		0.0000
$PreEmployment^2$	-0.3000	-0.2494			-0.9272	-0.0231			-1.0338	-0.0044		
total observations		581				581				581		
period	1963–1969				1963–1969				1963–1969			
cohort (Year joined)	1960–1967				1960–1967				1960–1967			
observations with dependent variable =1		328				328				328		
log likelihood		-132.0007				-129.2931				-124.2776		
McFadden R^2		0.6682				0.6750				0.6876		
LR statistic		531.7270	***			537.1421	***			547.1732	***	

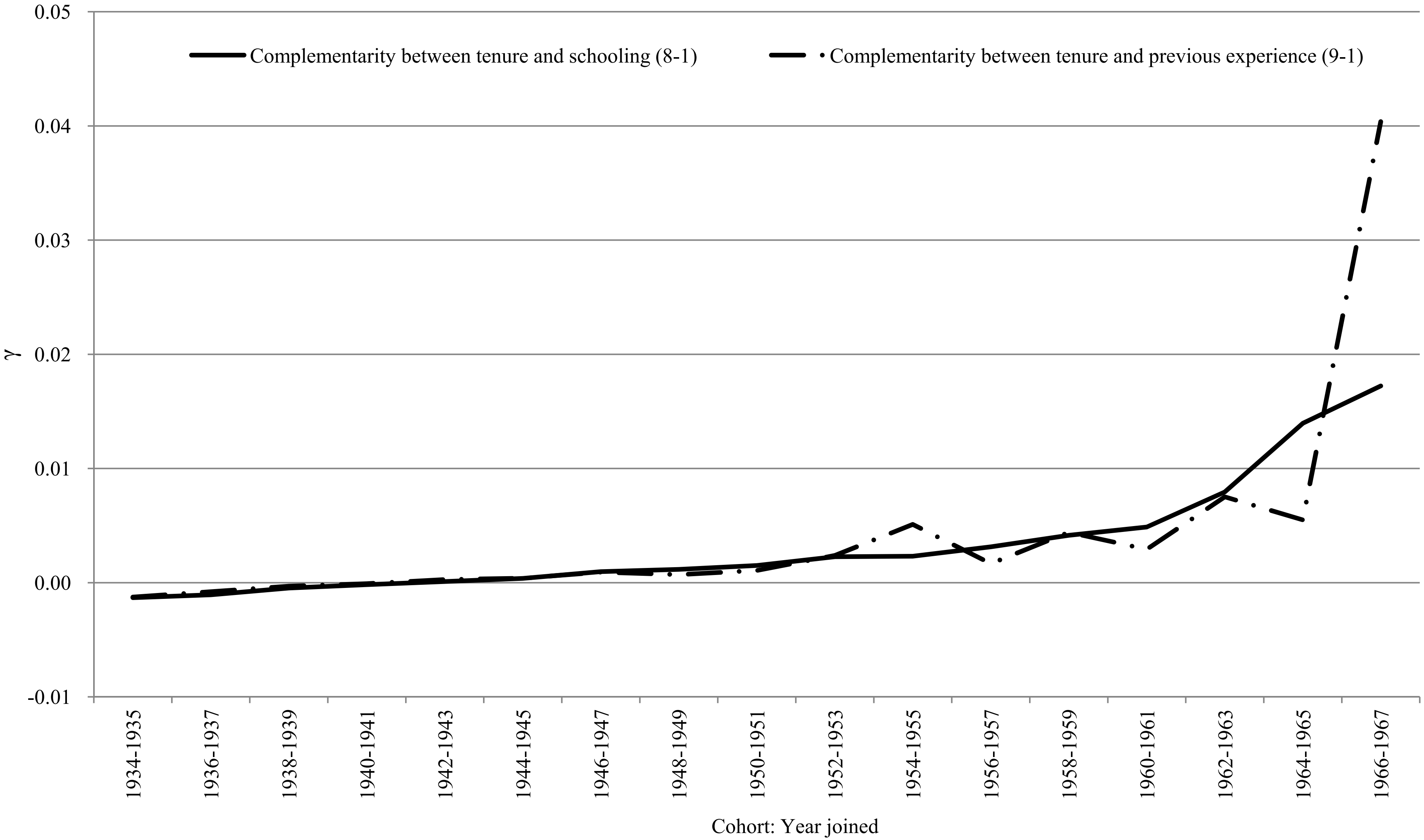
Notes: Marginal effects are calculated by mean values of independent variables. ***, ** and * respectively denote significance at the 1, 5 and 10 percentage levels. Note that Height is the relative height to the national average. Definitions of variables are in the **Appendix II**.

Figure 1 Return on schooling, previous experience, and tenure.



Note: Control cohort: joined in 1928-1929.

Figure 2 Complementarity of schooling with previous experience and tenure.



Note: Control cohort: joined in 1928-1929.