Career Experiences Replaced

Emergence of Japanese Internal Labor Markets*

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Abstract

Contemporary Japanese firms provide a rare example of the "ports of entry" policy. This microanalysis of a steel company in the 1930s-1960s however shows that 1) mid-career recruiting was active and industry-specific skills were valued by the end of the 1960s, while 2) the return on firm-specific skills gradually increased from the 1950s, and 3) the return on schooling surged and the return on previous careers decreased from the 1950s, indicating that extended schooling was replacing mid-career experiences. The Japanese model occasionally emerged at coincidence of expanding demand for better educated workers and build of systematic work organization.

Key words: Specific human capital; asymmetric learning; return on education; internal labor markets; Japan.

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1 Introduction

Internal labor markets characterized by long-term employment and a preference for internal promotion are widely observed in developed economies. Functional aspects of the practice have been focused in the literature as devices for induction of firm-specific human capital investment, insurance of risk-averse workers, and facility of current employers' learning about their employees' abilities (Waldman (2013) and Osterman (2011)).

Among those aspects, the feature to motivate human capital investment into a specific direction is apparent and accordingly has attracted attentions. In Germany, skill is highly standardized at an industry level by the apprenticeship system and hence the firm specificity of human capital is negligible.[1] In the case of the United States, while firm-specific human capital and therefore tenure have a positive impact on wage growth, the industry specificity has a larger impact.[2] Meanwhile, in Japan, tenure at a specific firm has a larger impact on wage growth than total experience does, indicating that firm-specific human capital contributes more than general human capital does.[3] In terms of the firm- and industry- specificity portfolio of human capital, the Japanese and German labor markets constitute a bipolar division, with the United States in the middle. These apparently heterogenous features of human capital acquisition are interdependent in depth to the extent of asymmetry of employer learning and job security.

The classic of comprehensive approach to such interconnected features of internal labor markets, Doeringer and Piore (1971), went further beyond descriptions of such general aspects of internal labor markets, and suggested the "ports of entry" hypothesis.[4] It assumed that only some of the lowest ranking jobs in the firm are open to new entrants and that any higher level job is exclusively filled via internal promotion. While this extreme conjecture of internal labor markets is well known, little supporting empirical evidence exists, and some empirical studies of Western labor markets such as Baker, Gibbs and Holmstrom (1994a, 1994b) provide evidence to the contrary.[5] As such an extremely internalized labor market is rarely observed in the Western economies, contemporary Japanese firms provide an exceptional example of the implementation of the "ports of entry" policy. For both blue-collar and white-collar jobs, major firms primarily recruit new graduates, commit to long-term employment, and predominantly promote from within.[6] With the large impact of tenure at a specific firm on wage growth, this recruitment practice constitutes a particular feature of the contemporary Japanese labor market, which emphasizes investment in firm-specific human capital.

Because this recruitment policy is dominant among the well-paying major firms, the practice affects the income distribution of the Japanese economy even at a macro level. If the "ports of entry" policy is implemented by all firms, the opportunity for a worker to match with a firm is essentially limited to the year of graduation; if a worker happens to graduate

[1] See Dustmann and Meghir (2005), pp. 90-96.

[2] See Neal (1995), pp. 660-669; Parent (2000), pp. 308-320; Weinberg (2001), pp.236-247; Poletaev and Robinson (2008), pp. 402-413; Altonji and Williams (2005), p. 393; and Shaw and Lazear (2008), pp. 717-720.

[3] See Altonji and Schakotko (1987), pp. 442-454; and Abe (2000), pp. 261-264.

[4] See Doeringer and Piore (1971), pp. 43-48.

[5] See Baker, Gibbs and Holmstrom (1994a), pp. 897-903.

[6] For the descriptive evidence, see Sugayama (2011), pp. 9-11.

during recession, when firms decrease recruitment, the probability of being hired by a major firm is lower than usual. Strict implementation of the "ports of entry" policy prevents workers from being employed by a larger firm later. Therefore, in an economy in which the "ports of entry" policy is strictly implemented, life-time income is significantly affected by when in the business cycle the worker graduates. The degree of this distortion depends on the prevalence of internal labor markets, and the distortion effect is captured by persistence of cohort effects in the labor market. The more inflexible the market for mid-career recruitment, the more the state of economy when a worker graduates affects her and his employment opportunities.

While such distortions are observed in the United States, Germany, Canada, those in Japanese are especially serious among less-educated workers. The state of the economy in the graduation year persistently affects workers' employment and income, and such effects are particularly long-lasting for less-educated workers.[7] Strict implementation of the "ports of entry" policy has realized a "dual" structure, under which the outside intermediate recruitment market is dysfunctional, not only to well-educated white-collar workers but also to less-educated service and blue-collar workers.[8] By contrast, the German labor market institutions, the apprentice system especially, encourage concentration in industry-specific human capital.[9] The U.S. labor market appreciates firm-specific human capital, but places more emphasis on industry-specificity than on firm-specificity, staying between the German and the Japanese markets but tending slightly toward the former.[10]

Particular features of Japanese internal labor markets including this aspect were considered a characteristic of innovative organizations in the 1980s. While items of the Japanese human resource management, to the extent recognized as useful, have been adopted by American companies and hence they are not unique to Japan anymore, it is still not clear how such organizations emerged.[11] This research addresses this question, by examining the formation based on an employee-level panel data set of a steel works in the 1930s to the 1960s.

Section 2 presents an underling work framework for analysis. We take the model of DeVaro and Waldman (2012), which captures general and firm-specific human capital acquisition and asymmetric employer learning, as a persuasive approach in a comprehensive way to understand internal labor markets. The section deducts predictions focusing on asymmetric employer learning and firm-specific human capital acquisition, which we presume are essential factors of internal labor markets, from DeVaro and Waldman (2012). Section 3 describes features of the case plant of the steel industry and the data set, verifies the existence of an internal labor market in the case establishment during the sample period, and tracks changes in this internal labor market throughout the period. The estimation result shows that the impact of human capital acquisition within the case establishment expanded throughout the period. The

[7] For the United States, see Kahn (2010); for Japan, Genda, Kondo and Ohta (2010) and Abe (2012); for Germany, see von Wachter and Bender (2006); and for Canada, see Oreopoulos, von Wachter and Heisz (2012).

[8] See Ujihara (1966), pp. 402-425; Ishikawa (2001), pp.241-282; and Odaka (2003), pp. 126-136.

[9] See Dustmann and Meghir (2005), pp. 90-96; Pischke and von Wachter (2008), pp. 596-598; Gathmann and Schönberg (2010), pp. 10-36.

[10] See Abe (2000), pp. 261-264; Topel (1991), pp. 166-172; Neal (1995), pp. 660-669; Parent (2000), pp. 308-320; Weinberg (2001), pp. 236-247; Poletaev and Robinson (2008), pp. 402-413; and Shaw and Lazear (2008), pp. 717-720.

[11] See Waldman (2013), pp. 540-558.

internal labor market has increasingly facilitated investment in firm-specific human capital.

Section 4 decomposes wage growth in the establishment into employees' physiological characteristics, schooling, previous career experiences, tenure at the establishment, and completion of in-house training programs at the establishment, and it then examines the effect of each. The principal results of sections 3 and 4 are that 1) return on previous career experiences, which capture the return on general or industry-specific human capital, were valued throughout the period, the mid-career recruitment market was still active, and employees' reproduction decision depended on general experience as well as tenure through the period from the 1930s to the 1960s, although 2) the impact of firm tenure that reflects return on firm-specific human capital continuously increased during the sample period, and, 2) the return on previous career experiences rapidly decreased from the 1950s and the return on schooling rapidly increased from the 1950s. These results suggest that previous experience served as an opportunity for general and industry-specific human capital investment as schooling did throughout the period but that their relative importance changed after the Second World War; schooling was replacing general work experience as the primary opportunity for general human capital investment. Mid-career experience appears to have been supplanted by schooling.

2 Underlining framework

2.1 Technology, skill, and organization

The desirable structure of an organization depends on the prevalence of relevant information. Meanwhile, the technological conditions shape the informational structure and so affect the organizational structure. This relationship is particularly observed in the work organization within a firm. Technological changes affect the type of necessary skill, and such changes could determine which entity, the employees or the firm, possesses more information about the skill. If the firm has more information about the skill, then direct control of the work organization could more efficiently provide employees with incentives. Given the technology, skill, and informational structures, a firm chooses the optimal organization to reduce the loss due to asymmetric information. The firm chooses an internal labor market when it has more information about the necessary skills and when the skills are complementary to each other and/or are firm-specific.[12]

Internal labor markets characterized by long-term employment and internal promotion are widely considered work organizations for highly skilled workers of large companies in developed economies. They have been thought to work as a monitoring and evaluation device to make the wages sensitive to employee performance and to give the employees incentives to invest in industry- and/or firm-specific human capital under asymmetric information between the employer and employees. Thus, the wages determined within internal labor markets are not expected to differ much, on average in the long term, from the marginal productivity, though they are somehow shielded from the competitive outside market and hence not necessarily

[12] See Doeringer and Piore (1971), pp. 1-7; Williamson, Wachter and Harris (1975); Rosen (1988); Aoki (1988), pp. 49-98; and Osterman (2011).

equalized to workers' marginal productivity on every-minute-basis.[13]

One component of internal labor markets that serves as an evaluation device is "employer learning." Employer learning is typically mentioned when discussing the effect of schooling on wages. Workers' abilities are generally private information at the time of recruitment. Thus, employers use proxies of workers' abilities during recruiting; schooling is often one such proxy. Because more educated people are presumed to be more able with positive probability, employers statistically discriminate applicants based on education. Once a worker is hired, however, employers gradually learn about the worker's true ability. Employers come to rely more on information about the ability of the worker observed after hiring, and less on educational background, to determine wages. Accordingly, the impact of educational backgrounds on wages decreases as workers acquire experience.[14] A wage curve is thus presumed to be a trajectory to the true value of the employee's latent ability. While the employer learning process occurs in the market market as a whole, a firm can accelerate the process with long-term employment.[15] Furthermore, such asymmetric employer learning makes internal labor markets self-sustainable. If the current employers better know their employees than do potential employers, the current employers can retain their employees capitalizing on the informational advantage.

2.2 Human capital acquisition and asymmetric learning

In the related literature, we consider that DeVaro and Waldman (2012) provides one of the most comprehensive and tractable insight over internal labor markets. Inherited from Gibbons and Waldman (1999) and Gibbons and Waldman (2006), the model captures both of work experience and schooling as channels of human capital acquisition. In addition, while Gibbons and Waldman (1999) and Gibbons and Waldman (2006) assumed an environment of symmetric learning, that is, an environment without internal labor markets, DeVaro and Waldman (2012) introduced essential parts of asymmetric learning and acquisition of firm-specific human capital, which are very key factors of internal labor market, from Waldman (1984).

Let us first summarize their two-period model. Hereafter θ_i denotes worker i's ability to learn on the job, $\exp_{i,t}$ denotes the worker i's labor-market experience until period t, $\eta_{i,t} = \theta_i f(\exp)$ denotes worker i's the "on-the-job human capital" in period t, where $f(1) > f(0) > 0$, and S_i denotes worker i's years of schooling. Then assume that $\theta_i = \phi_i + B(S_i)$, where $B(S) > B(S-1)$ for $S = 2, 3, \ldots, N$, where $\phi_i \in (\phi_L, \phi_H)$ is a random draw from the probability density function $g(\phi)$, where $g(\phi) > 0$ for $\phi \in (\phi_L, \phi_H)$ and $g(\phi) = 0$ outside of the interval. All firms are presumed to have homogenous production functions and firm consists of two jobs 1 and 2. Product of worker i assigned to job j in period t is given by

$$y_{i,j,t} = (1 + k_{i,t})[d_j + c_j \eta_{i,t}] + G(S_i), \tag{1}$$

[13]See Alexander (1974), pp. 74-83; Aoki (1988), pp. 54-60; Baker et al. (1994a), pp. 881-884; and Baker and Holmstrom (1995), pp. 256-257.

[14]See Farber and Gibbons (1996), pp. 1010-1018; and Altonji and Pierret (2001), pp. 316-323.

[15]See Baker et al. (1994a), p. 901; Baker, Gibbs and Holmstrom (1994b), pp. 952-953; and Pinkston (2009), pp. 381-389.

where $0 < d_2 < d_1$, $0 < c_1 < c_2$ and $k_{i,t} \geq 0$ if worker i was employed at the same firm in the period $t-1$. All of $x_{i,t}$, S_i, $f(\cdot)$, $B(S)$, $G(S)$, d_j, c_j and $k_{i,t}$ are public information, $y_{i,j,t}$ is privately observed by the current employer, and ϕ_i is privately known to worker i. Learning about workers' abilities are assumed to be asymmetric such that θ_i is learned at the end of worker i's first period only by the current employer, who privately observes worker i's product. For simplicity, no transaction cost and a common discount factor are assumed.

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 $\theta^E(N)f(0) < (d_1 - d_2)/(c_2 - c_1)$, where $\theta^E(S)$ denotes the expected value of θ for workers with years of schooling S, that is, that any worker in her/his first period when no learning has been occurred is assigned to job 1. Further assume $[\phi_L + B(S)]\, f(1) < \eta^{'} < [\phi_H + B(S)]\, f(1)$, which ensures thats some workers in their second period are efficiently assigned to job 1 and the others to job 2. After worker i finishes her/his first period, the firm that employs her/him offers a job assignment for her/his second period or fire her/him. This decision is publicly observed by other firms and wages are determined before each period by spot-market contracting. Observing the decision on worker i, other firms offer a wage, and the worker's first period employer offers a wage weakly greater than the wage offered by others. Consider $\eta^+(S)$ such that $w^N_{i,t} - y_{i,1,t} = w^P_{i,t} - y_{i,2,t}$ in worker i's second period if $\eta_{i,t} = \eta^+(S)$, where w^N denotes wage paid to worker assigned to job 1 and w^P wage paid to worker assigned to job 2, that is, profit is indifferent whether promoting worker i to job 2 or to 1. Under this setting, in worker i's second period who was employed by firm A, if $\eta_{i,t} \geq \eta^+(S_i)$, then the worker remains at firm A, assigned to job 2, and is paid $w^P_t(S_i, \eta_{i,t}) = d_2 + c_2\eta^+(S_i) + G(S_i)$, and if $\eta_{i,t} \leq \eta^+(S_i)$, then the worker remains at firm A, assigned to job 1, and is paid $w^N_t(S_i, \eta_{i,t}) = d_1 + c_1\left[\phi_L + B(S_i)f(1)\right] + G(S_i)$. In short, outside employers offer wages consisting of return on general human capital acquired at school $G(S_i)$ and the least on-the-job human capital possible given the public information about promotion at the current employer, and the current employer counteroffers a wage only weakly greater than the wage offered by the others.[16]

Then we can immediately derive useful implications for existence of internal labor markets as a place of asymmetric learning and investment in firm-specific human capital and for evaluation of schooling and work experience inside of internal labor markets.

Lemma 1. *Allow the difference in fixed parts of 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 human capital k is strictly positive, the threshold of promotion η^+ changes in each period, with fixing schooling and work experience at the same level.*

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

$$\begin{aligned} y_{i,1,t} - w^N_{i,t} &= (1+k)\left[d_1 + c_1\eta^+(S_i)\right] - \left[d_1 + c_1\left[\phi_L + B(S_i)f(1)\right]\right] \\ &= (1+k)\left[d_2 + c_2\eta^+(S_i)\right] - \left[d_2 + c_2\eta^+(S_i)\right] = y_{i,2,t} - w^P_{i,t}. \end{aligned} \tag{2}$$

It is rearranged to the threshold of promotion, $\eta^+(S_i)$,

$$\eta^+(S_i) = -\frac{c_1 B(S_i)}{k(c_2 - c_1) - c_1} f(1) + \frac{k(d_1 - d_2) - c_1\phi_L f(1)}{k(c_2 - c_1) - c_1}, \tag{3}$$

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

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

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

Proof.

$$\eta^+(S) - \eta^+(S-1) = -\frac{c_1\big(B(S) - B(S-1)\big)}{k(c_2 - c_1) - c_1} f(1) < 0, \tag{4}$$

if

$$k > \frac{c_1}{c_2 - c_1} \tag{5}$$

□

Lemma 1 states that wage profiles depending 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 the return on firm-specific skill is strictly positive. As an implication for empirical test, it predicts cohort effects in wage profiles if the return on firm-specific human capital is strictly positive under employer learning asymmetric inside and outside internal labor markets. When verifying 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 human capital accumulation by workers.

An immediate caveat is that Gibbons and Waldman (2006), based on the same production technology, predicted that allowing task-specificity generates cohort effects under symmetric learning. Therefore, in order to verify an internal labor market consisting of asymmetric learning and investment in firm-specific human capital, we need to control for the effect of investment in industry-specific human capital. Under symmetric learning environment, Gibbons and Waldman (2006) assumed that d_2 disproportionately increases, or, $d_1 - d_2$ decreases, under the "good" state of the economy. Within internal labor markets, however, $d_1 - d_2$ might either decrease under the "bad" state of the economy. In a short-term downturn of the economy, for instance, a firm would naturally decrease production, but might preserve the managerial structure. With the managerial structure being kept and the production decreased, fixed portion of marginal return on rank and file worker d_1 might decrease but d_2 might not change. Then, in a thinner cohort hired in a "bad" period, $\eta^+(S_i)$ decreases and hence promotion becomes easier than usual within an internal labor market. Therefore, as long as focusing on inside of an internal labor market, all the lemma above could mention is potential survival of cohort effect and does not indicate a direction of changes in $\eta^+(S_i)$ depending on states of the economy.

Another remark from the literature is a potential role of insurance with internal labor markets. As Beaudry and DiNardo (1991) clarified, a role of internal labor markets, which somehow intends to "shield" internal wage dynamics from the market, is provision of insurance to risk-averse employees against macroeconomic shocks, and it could deliver cohort effects, too. Therefore, in order to prove the existence of an internal labor market that does not only insure employers but also facilitates asymmetric learning and firm-specific human capital acquisition, we need to control for macroeconomic shocks.

Lemma 2 describes that schooling and experience are substitutes for promotion if k is sufficiently large. This is the case in the environment defined by the model because both schooling and experience are observable to other employers and thus increase wage offered from them whether the worker is promoted or not. At the same time, the cost of promotion is in that it raises wage offered from other employers because promotion is observable too. Thus, increase in product of schooling and experience results in increase in wage anyway, and this lowers threshold for promotion. This result predicts that exactly when firm-specificity of skill is strengthened, work experience could be replaced by schooling for a worker to be promoted.

2.3 Transformation in the steel industry

Japanese manufacturing, led by heavy industry as in the United States, moved toward the formation of internal labor markets in the 1920s, and after the Second World War, it developed internal labor markets even more elaborate than the ones in the United States. Then, "lifetime employment" became known as a feature of Japanese manufacturing. As well-performing firms in the United States have also continuously managed long-term employment and the return on tenure has rather increased in the last few decades (Hall (1980, 1982) and Altonji and Williams (2005)), this feature is not due to the unique culture of Japanese firms, though post-war Japanese firms have more strongly tended toward policies of long-term employment and wage growth with tenure.[17] Post-war Japan experienced a faster and deeper transition in the same direction as the other developed economies.

Meanwhile, the industries that Doeringer and Piore (1971) mentioned as the ones for which internal labor markets were formed in the early twentieth century are the industries that Goldin and Katz (1998) asserted have grown with technology-skill/education complementarity since the early twentieth century. In the United States, since the early twentieth century, high schools have supplied a large number of graduates with general human capital, and these better-educated workers were better suited to internal labor markets in which workers' general cognitive skills are engaged in firm-specific human capital.[18] The postwar experience in Japan was similar; the accelerated prevalence of internal labor markets after the Second World War was associated with education reform that led to a massive increase in secondary school graduates.

In the case of old major industries dating back to the nineteenth century, the transition to internal labor markets was accompanied by the dissolution of an autonomous intermediary work organization into a work organization systematically planned and directly controlled by firms.[19] Such a transition proceeded with a technological transformation that provided firms with informational advantages in the acquisition of relevant human capital, making direct control by the firm relatively efficient.

[17] See Hashimoto and Raisian (1985); Aoki (1988), pp. 59-69; Mincer and Higuchi (1988); and Moriguchi (2003).

[18] See Goldin and Katz (2008), pp. 102-125, 176-181.

[19] See Williamson (1985), pp. 206-239.

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. Before the Second World War, in the iron and steel industry, sophisticated production procedures were developed by employees, and these procedures were taught to the younger employees by the senior employees of the company. Along with the technological transition, however, the traditional skills ascribed to individual senior employees were transformed into manualized skills and made known to the management.[20] As was the case with the U.S. steel industry, framing a work organization with a systematic wage and promotion scheme was the core of the transition.

3 Existence of an internal labor market

3.1 Case plant

This research uses wage records of a Japanese iron works, which is one of the oldest modern iron works in Japan. From the 1950s to the 1960s, the government adopted an industrial policy that induced steel and other important manufacturing companies to invest in new technology with coordination of long-term credit coordinated. For the steel industry, three phased modernization investments were coordinated from the 1950s to the 1960s. These plans emphasized efficiency improvements in iron and steel production and the expansion of fine steel production for the case iron works, but the replacement of old blast furnaces was not planned.

As part of a company-wide investment plan, the case company that operated the case iron works decided to build a new state-of-the-art plant at another distant city. The firm also decided to shrink the case iron works' capacity and to relocate to the new plants the skilled workers of the case iron works. Consequently, 1,600 strong skilled workers moved from the case iron works to the new iron works in the late 1960s. Selection for relocation was handled in cooperation with the union, and in principle, anyone who was willing to move was allowed to be relocated. Thus, the measure used to select the employees for relocation was the willingness of the employees.[21]

3.2 Data

This research examines the preserved panel data of wages for 1,490 employees relocated from the case iron works, tracking these workers from the late 1920s or later, depending on the employee's entry year, to the 1960s, when they left the case iron works. The number of total observations is 22,050.

The original personnel documents studied here contain all the important information about employees from when they were recruited and about promotion and wage growth. This information enables us to recover employees' entire lives from the time when they were born to the 1960s, when they were relocated.

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[20] See Nakamura (2010), pp. 8-25.
[21] See Umezaki (2010), pp. 33-38, 47-49.

Each individual wage record includes:

1. Educational background (S).
2. Physiological characteristics when employed: height (hgt), weight, and lung capacity.
3. Panel data of previous career experiences, ranks, jobs and department assignments, wages, training programs sponsored by the firm, promotion, wage and personal information:
   (1) Work experience prior to entry to the firm.
   (2) Promotion and deployment: rank, division, department, and job.
   (3) Basic wage.
   (4) The record of in-house training completed, if any.
      ▷ Systematic programs for selected employees.
         1927-1935: “Youth Development Center” (ydc); three days a week, 4 years, 800 hours total.
         1935-1948: “School for Youth” (sy); half time, three days a week, 4 years.
         1939-1946: “Development Center for Technicians” (dct); full time, 3 years, 6,453 hours total.
         1946-1973: “Development Center” (dc); three days a week, (by 1950), 6 days a week (from 1950) 2 years; from 1963, only high school graduates were admitted.
      ▷ Short term programs (for example, elementary calculus).
   (5) Licenses the employee held.
   (6) Family composition.
   (7) Clinical history.

The composition of the cohorts is shown in **Table 1**. A feature shown in **Table 1** is that new graduates were never dominant until the 1960s, in clear contrast with contemporary Japanese firms. The recruitment practice of employing new graduates became prevalent for blue-collar workers only in the late 1960s and was not typical before then. Indeed, the mean value of previous experience, years after graduating from school and before being employed by the firm, pre, is not even monotonically decreasing.

After the late nineteenth century, when heavy manufacturing from the Western world was introduced, the career pattern of acquiring experience at several workplaces to acquire the relevant skills and then either gaining long-term employment with a large firm or starting one's own workshop became typical for male skilled workers. Although the picture described in **Table 1** is contrary to that of contemporary Japanese firms, it had been the tradition until the end of the 1960s.

Entry volumes were not stable and some cohorts such as 1948 and 1949, when many male workers came back from the war, had much larger volume. Potential biases from this unbalanced size of cohorts are controlled for by inserting the year joined dummies ($\mathrm{yj19XX}$) in later analyses whenever the case is cohort sensitive.

Compulsory education was extended from 6 years to 9 years in 1947. Thus the difference in educational backgrounds across the employees who graduated before 1947 is primarily distributed between the 6 years spent completing mandatory elementary school and the 8 years comprising the mandatory 6 years and additional 2 years at high elementary school, and the difference across the employees who graduated after 1947 is distributed mainly between the mandatory 9 years comprising 6 years of elementary school and 3 years of junior high school and the 12 years comprising the mandatory 9 years and an additional 3 years of high school. High elementary school graduates comprised a majority before 1947,[22] and junior high school graduates were a majority after 1947.

3.3 Existence of an internal labor market and its change

The existence of the internal labor market policy, whose wage determination is shielded due to asymmetric learning and intention to motivate investment in firm-specific human capital, is to be empirically established. An indicator described by **Lemma 1** above is persistent cohort effects. To extract firm-specificity of human capital acquisition and asymmetry of learning, we need to control for task-specificity of human capital acquisition (Gibbons and Waldman (2006)) and insurance effect against macroeconomic shocks (Beaudry and DiNardo (1991)).

Table 2 contains regressions of real wages (rw) on total experience in the labor market (exp), tenure at the firm (ten), the 2-year joined dummies such as $\mathrm{yj1928}-1929$, $\mathrm{yj1930}-1931$, $\mathrm{yj1932}-1933$, etc., and the interactions between the 2-year joined dummies and tenure such as $(\mathrm{yj1928}-1929)\times\mathrm{ten}$, $(\mathrm{yj1930}-1931)\times\mathrm{ten}$, $(\mathrm{yj1932}-1933)\times\mathrm{ten}$, etc. The years of schooling (S) to control for the effect of educational background (S) and previous work experience (pre) are also inserted as regressors. Furthermore, to control for potential impact of the return on industry-/task- specific skills on cohort effects suggested by Gibbons and Waldman (2006), interaction terms of previous employment experience with the same previous industry dummy ($\mathrm{pem}\times\mathrm{ibs}$) to control for the industry-specificity, and with the same previous job dummy ($\mathrm{pem}\times\mathrm{jbs}$) to control for the the task-specificity are inserted as regressors. Macroeconomic shocks are controlled for by the growth of real gross national expenditure ($\Delta\mathrm{rgne}$). The period saw a rapid growth in average productivity, which is controlled for by year dummies.

Then, the cohort effects survive among the employees of all cohorts with controlling for industry- and/ro task-specific skills ($\mathrm{pre}\times\mathrm{ibs}$, $\mathrm{pre}\times\mathrm{jbs}$) and exogenous shocks (year dummies and $\Delta\mathrm{rgne}$) in models 2-1 and 2-2 in **Table 2**. The internal labor market at the case iron works seems to have been formed in the 1930s. This statistical inference is consistent with the descriptive picture based on documents and hearings.[23]

As Baker et al. (1994b) describes, the serial correlation of wage residuals is another useful

[22] By the 1920s, major heavy industry factories had already developed a preference for the graduates of high elementary schools over those of elementary schools, especially for candidates applying to be foremen. See Sugayama (2011), p. 37.

[23] See Umezaki (2010), pp. 42-51.

indicator of an internal labor market.[24] In the competitive market, assuming that the observable variables provide an unbiased forecast of wage, the residuals of the wages estimated by observable variables subtracted from the observed wages should be serially independent, and the history of residual should have a unit root and be a random walk. If the firm more or less shields wage determination from the market by some wage policy, the result would be different.

For the ith employee in the tenth tenure, consider $\mathrm{rwrsd01}_{i,\mathrm{ten}} = \log(\mathrm{rw}_{i,\mathrm{ten}}) - \mathrm{E}[\mathrm{rw}_{i,\mathrm{ten}}]$ where $\mathrm{E}[\mathrm{rw}_{i,\mathrm{ten}}]$ is the value estimated by model 3-1 in **Table 3** below, and also consider $\mathrm{rwrsd02}_{i,\mathrm{ten}} = \log(\mathrm{rw}_{i,\mathrm{ten}}) - \mathrm{E}[\mathrm{rw}_{i,\mathrm{ten}}]$, where $\mathrm{E}[\mathrm{rw}_{i,\mathrm{ten}}]$ is the value estimated by model 3-3 in **Table 3**. The difference between models 3-1 and 3-3 is in that the latter contains the ith employee's relative height. Then, both $\mathrm{rwrsd01}_{i,\mathrm{ten}}$ and $\mathrm{rwrsd02}_{i,\mathrm{ten}}$ reject the common and individual unit root hypotheses.[25] This result is consistent with the inference that each wage history had a unique fixed point that was presumably the true value of the employee, which was being learned by the employer. If employees are homogeneous, the persistent effect of past wages toward the same direction must not appear. In other words, from the serial correlations observed in wage residuals, the sample employees seem to have been heterogeneous in ability of human capital acquisition and the employer learned about it.[26] Note that serial correlations of wage per se can be predicted under symmetric learning environments (Gibbons and Waldman (1999, 2006)). What we emphasize here is that wage residuals verged on some fixed point, which indicates that the firm accumulated some information about employees' abilities during tenure.

Figure 1, **Figure 2**, and **Figure 3** show the mean, maximum, and minimum wage curves of two consecutive cohorts in each calendar year from 1928 to 1967. **Figure 3**, in comparison with **Figure 1** and **Figure 2**, indicates that the firms learning about workers' latent abilities resulted in compressed wage growth of workers whose abilities were predicted to be inferior to others.

In **Table 2**, we also observe, with total experience (exp) inserted as a regressor, that the positive coefficient of tenure at the firm (ten) in model 2-1 captures the specific effect of experience within the firm independent of total experience, arguably because of acquisition of human capital within the firm. The experience within the firm significantly contributed to wage growth, a contribution consistent with the assumption that the internal labor market did work for investment in firm-specific human capital within the firm.

Model 2-2 suggests that the impact of human capital acquisition within the firm had gradually increased throughout the period, as shown by the coefficient of the interaction term between the 2-year cohort dummy and tenure ($\mathrm{yj} \times \mathrm{ten}$), which increases as the cohorts de-

[24] See Baker et al. (1994b), pp. 943-953.

[25] (1) For $\mathrm{rwrsd01}$. Common panel unit root test (Levin, Lin and Chu test): t statistic:-7.3196^{***}, cross sections included: 946, total panel observations: $9,991$. Individual panel unit root test (Im, Pesaran and Chin test): W statistic:-310.4427^{***}, cross sections included: 900, total panel observations: $9,853$. (2) For $\mathrm{rwrsd02}$. Common panel unit root test (Levin, Lin and Chu test): t statistic: 16.2350^{***}, cross sections included: 899, total panel observations: $9,917$. Individual panel unit root test (Im, Pesaran and Chin test): W statistic:-283.5373^{***}, cross sections included: 856, total panel observations: $9,068$. Optimal lags are determined by Akaike Information Criterion, *** denotes significance at the 1 percentage level.

[26] See Baker et al. (1994b), p. 947.

crease. Because the firm-wide increase in productivity throughout the period is controlled for by the inserted year dummies, it indicates that the return on human capital investment within the firm gradually increased throughout the period.

4 Wage growth in an internal labor market

4.1 Human capital investment, wage growth, and reproduction

To estimate wage regression, we assume that workers' production function can be approximated by a Cobb-Douglas form, where return on each human capital item is marginally decreasing, and take logarithmic terms of both sides of wage=production equation. Logarithmic terms of independent variables allow decreasing return on input and thus largely reproduce similar results of Mincer forms in Mincer (1974). An important different point is in that a Mincer wage regression allows negative, not only marginally decreasing, impact of age and experience by quadratic forms of these variables. If we deal with data set including over 55 year-old workers when their wage begin to decrease with aging, this aspect might be critical. However, in this data set, as well as many other data set, returns on age and experience are marginally decreasing but do not have negative impact because old workers over their late 50s are not included. Thus, we do not have a specific reason to take a Mincer form regression instead of a Cobb-Douglas form at the expense of tractability of results.

Table 3 provides the results of the random effect estimation regressing real wage (rw) on the height when employed by the firm (hgt), age (age), the years of schooling (S), previous work experience before he joined the firm (pre), previous employment experience other than self-employed or family-operated businesses before he joined the firm (pem), interaction terms of previous employment experience with the same previous industry dummy ($\mathrm{pem}\times\mathrm{ibs}$) and with the same previous job dummy ($\mathrm{pem}\times\mathrm{jbs}$), tenure at the firm ($\mathrm{ten}$), the interaction of height and tenure ($\mathrm{hgt}\times\mathrm{ten}$), the interaction of the years of schooling and tenure ($S\times\mathrm{ten}$), the dummy variables of completing in-house training programs, the Development Center for Youth (dcy, operated in 1927-1935), School of Youth (sy, operated in 1935-1948), Development Center for Technicians (dct, operated in 1939-1946), and Development Center (dc, operated in 1946-1973), the interaction of these dummy variables and the previous work experience ($\mathrm{dcy}\times\mathrm{pre}$, $\mathrm{sy}\times\mathrm{pre}$, $\mathrm{dct}\times\mathrm{pre}$, $\mathrm{dc}\times\mathrm{pre}$), and the interaction of these dummy variables and tenure ($\mathrm{dcy}\times\mathrm{ten}$, $\mathrm{sy}\times\mathrm{ten}$, $\mathrm{dct}\times\mathrm{ten}$, $\mathrm{dc}\times\mathrm{ten}$).[27] Note that to control for the improved nutrition throughout the period, we use relative height compared with average height in the state statistics for estimation. Thus (observed height)/(average height at his age in the year in the Ministry of Education statistics) is used as "height (hgt)." In addition, the compulsory schooling was extended from 6 years to 9 years in 1947. Because extension of compulsory schooling may have an impact on productivity and wages,[28] the interaction dummy between the years of schooling and the post-education generation dummy ($S\times\mathrm{psw}$) is inserted. Assuming that the

[27]The records of the employees who had joined the firm before 1939 lack the information on physiological characteristics.

[28]See Oreopoulos (2005), pp. 158-170.

individual productivity function can be approximated by a Cobb-Douglas function, we apply logarithmic expression on regressors as well as the dependent variable, the real wage.

The years of schooling (S) has a positive coefficient. Schooling raised productivity and real wage earning. In models 3-2 and 3-4, height (hgt) has a positive coefficient. Physical strength did matter in the steel industry. The positive coefficient of previous employment experience (pem) and the negative one of previous work experience (pre) with controlling for (pem) indicate that employment experience instead of self-employment significantly increased productivity. In particular, the larger positive coefficient of the interaction between previous employment experience and the same industry dummy ($\mathrm{pem} \times \mathrm{ibs}$) shows that investment in industry-specific human capital was the primary source of productivity increase from previous experience.

Human capital acquisition also affected workers' reproduction decisions. When reproduction is endogenous, human capital accumulation is presumed to affect reproduction decisions. **Table 4** regresses the number of dependent children to components of human capital. While the job security within the internal labor market, represented by tenure (ten), has a positive coefficient, the previous experience (pre) also has a positive coefficient. While job insecurity is generally destructive to a worker's family and reproduction,[29] workers who joined the case iron works did not necessarily postpone their reproduction decisions until obtaining job security with the firm. They made their reproduction decisions given the portfolio of human capital accumulation composed of physiological characteristics (hgt), public education (S), general or industry-specific skills (pre), and tenure at this firm (ten). In the portfolio, tenure has a relatively larger impact, but does not dominate others.

4.2 Schooling, previous experience, and in-house training programs

Table 3 also indicates that the role of training programs changed over the sample period. Before the war, from 1939, the government required major firms to have the Development Center for Youth or School for Youth (sy, dct) for employees who had not graduated junior high school. This requirement was abandoned when junior high school became compulsory in 1947. By the mid-1940s, while the training program completion dummies (dcy, sy, dct) have negative coefficients, interactions with work experience ($\mathrm{dcy} \times \mathrm{pre}$, $\mathrm{dcy} \times \mathrm{ten}$, $\mathrm{sy} \times \mathrm{pre}$, $\mathrm{dct} \times \mathrm{pre}$, $\mathrm{dct} \times \mathrm{ten}$, $\mathrm{dc} \times \mathrm{ten}$) have positive coefficients, indicating that less productive employees were selected for training due to the government ordinance and that training programs and work experience were complements.

From the late 1940s, with the ordinance being abandoned, while the training program completion dummy (dc), has a positive coefficient, interactions with work experience, $\mathrm{dc} \times \mathrm{pre}$, $\mathrm{dc} \times \mathrm{ten}$, have negative coefficients, which indicates that more productive employees were selected for training and that training programs and experience became less complementary and/or that statistical discrimination in selection for training was strengthened.

Furthermore, the firm's selection policy itself changed over time. **Table 5** decomposes the probability of acceptance to in-house training programs (dcy, sy, dct, dc) by logit estimation.

[29]See Doiron and Mendolia (2011), pp. 385-395.

The pre-war program, Development Center for Technicians (dcy), more likely accepted less-educated employees, as required by the ordinance. A further contrast is shown in the previous employment experience (pem). While the pre-war programs (sy, dct) more likely accepted employees with more previous employment experience, the post-war program, Development Center (dc) more likely accepted employees wit less previous experience. General or industry-specific skills came to be recognized as substitute of the internal training program. In addition, from the late 1940s, height ($mathrmhgt$) has a significantly positive coefficient, which indicates that height was used as a selection device that captured innate ability of employees

Roughly speaking, the firm concentrated investment in human capital on new graduates instead of on more experienced workers from the 1940s. In these terms, it may be said that the firm slowly moved toward the "ports of entry" policy after the war.

4.3 Increasing return on schooling and decreasing return on experience

The positive coefficient of the interaction between the postwar education dummy and the years of schooling ($\mathrm{psw} \times S$) in **Tables 3** suggests that the return on schooling increased after the Second World War. **Table 6** attempts to track changes in the return on schooling along with cohorts by regressing real wage (rw) on interaction terms between the 2-year cohort dummy and the years of schooling ($\mathrm{yj} \times S$) in model 6-1, and in models 6-2 and 6-3, controlling for the effect of employer learning ($S \times \mathrm{ten}$). Although model 6-1 shows a negative return on education in early cohorts, this result is observed because the employer learning effect is not controlled for and thus the decreasing value of schooling record as "sheepskin"[30] is captured. With the employer learning effect controlled for, the coefficient of the interaction terms in model 6-2 indicates that the return on education had been stable until the end of the Second World War and then surged after the war. Because the signaling effect of schooling is controlled for, the return on education reflects the increase in productivity due to human capital investment at school. Model 6-3 is a robustness check of the estimation in model 6-2, controlling for changes in the return on education during the period by inserting interaction terms between year dummy and the years of schooling ($\mathrm{dy} \times S$). Then, in contrast to the result from model 6-2, the return on schooling maintains a high level throughout the period, and hence, changes in the return on schooling in model 6-2 come mainly from variation with time, as we have interpreted the results of model 6-2.

After the Second World War, mandatory education was extended from 6 years to 9 years, and the supply of workers with the more years of schooling was exogenously increased. Thus, the surging return on schooling from the 1950s cannot be attributed to the supply side constraints. Rather, the demand for better-educated labor increased with the increasing supply of better-educated workers.

Behind the increase in return on schooling, return on previous work experience decreased. Model 7-1 on **Table 7** looks as if return on previous experience grew after the Second World War, but, with controlling for the increasing return on schooling by interactions of year dummies and the years of schooling ($\mathrm{dy} \times S$), result turns out to be opposite in model 7-2. From the

[30] See Hungerford and Solon (1987); Belman and Heywood (1991); Jaeger and Page (1996); and Farber and Gibbons (1996).

1950s, return on previous experience relative to the one of schooling continuously fell. This fall is consistent with the change in selection of systematic trainees from the 1950s on **Table 5**. Previous work experience was being replaced by extended secondary schooling. Therefore, as predicted by **Lemma 2**, from the 1950s, when the return on firm-specific human capital increased, which is captured by coefficients of interaction terms between the cohort dummy and tenure (model 2-2 in **Table 2**), work experience was replaced by extended schooling.

Meanwhile, the result of model 7-1 implies that pervious work experience was valued for better educated workers even after the 1940s because in general aging is not correlated with years of secondary schooling. While general skill acquisition in early career experiences was being replaced from the 1950s, general or industry-specific skill acquisition beyond secondary education till worked, and thus, "ports of entry" did not become dominant by the end of the 1960s and average precious experience did not decrease (**Table 1**).

5 Discussion

The secondary school system in prewar Japan, introduced from Europe, focused on training a small group of elites. The system was completely transformed into one focused on making a massive investment in the human capital of a majority of the people, the American system of secondary education; this transformation was accompanied by a convergence to the U.S.-led technology-skill complementary development.[31] The postwar junior high schools and most high schools have focused on general education and not vocational education that teaches specific and inflexible skills.

Two observations imply that the return on schooling increased after the Second World War despite of the rapid increase in the number of better educated workers. First, the coefficient of the interaction between the postwar education dummy and the years of schooling ($\mathrm{psw} \times S$) has a positive coefficient (**Table 3**), which indicates that the return on schooling increased under the postwar education system. Second, the coefficient of the interaction between the 2-year cohort dummy and the years of schooling ($\mathrm{yj} \times S$) increases as cohorts decrease, notably since the 1950s, as shown in model 6-2 in **Table 6**.[32] Enhanced role of schooling replaced the value of early career experience before employed by the case plant as shown by model 7-2 in **Table 7**.

While the "ports of entry" of internal labor markets, in which only young workers are employed and are assigned to the lowest ranking jobs, is a symbolic characterization of internal labor markets suggested by Doeringer and Piore (1971), it is not always empirically supported.[33] In our case, the practice was never dominant up to the end of the 1960s, although

[31] See Goldin (2001), pp. 269-275; and Ueshima, Funaba and Inoki (2006), pp. 72-73.

[32] We need to mention that our analysis is limited to until the 1960s. An empirical study on the manufacturing sector as a whole indicates that the wage premium with high school graduation or more peaked in the mid-1960s and has gradually declined since then (Ohkusa and Ohta (1994), p. 180-181). The educational wage differential was squeezed by the rapidly increased supply of high-school graduates (Ueshima (2003), pp. 47-48.), as it was in the United States in the mid-twentieth century, although regulations played a significant role in the United States (Goldin and Margo (1992), pp. 17-32; and Goldin (1999), pp. s80-s92.).

[33] See Doeringer and Piore (1971), pp. 43-48; and Baker and Holmstrom (1995), p. 256.

an internal labor market was already formed in the 1930s. Not only firm-specific human skills that were acquired during tenure, but also industry-specific skills that had been acquired before employed by the case firm contributed and were valued as seen in **Table 3**. **Table 4** shows that employees' reproduction decisions depended on both previous experience and firm tenure. That employees' reproduction decision was only relatively dependent on the internal labor market indicates that the flexible labor market was socially stable.

At the same time, the return on human capital investment within the firm continuously increased from the 1930s to the 1960s, as shown in model 2-2 in **Table 2**. Also, the return on schooling increased especially after the Second World War, as shown in model 6-2 in **Table 6**. Furthermore, while the in-house training program until the mid-1940s accommodated employees with more previous work experience, the program from the late 1940s focused on employees with less previous work experience as described in **Table 5**. In addition, After the Second World War, return on previous work experience as a whole continuously decreased from the 1950s, with controlling for the return on schooling in model 7-2 of **Table 7**.

Summarizing our empirical results, we could reasonably conjecture that first, the coexistence of internal labor markets and the outside labor market was normal until the 1960s as it is in Western countries; second, the return on investment in firm-specific human capital increased through the period; and third, extended secondary schooling replaced the role of previous work experience before joining an internal labor market. Extended role of schooling that replaced general work experience under enhanced impact of firm-specific human capital is exactly what **Lemma 2** predicts. While it is not exceptional among developed economies after the Second World War in the long-term that education has replaced work experience,[34] in the case of post-war Japanese manufacturing, this trend appears to have reached further, with rapid technology transfer after the wartime isolation and explosive expansion of secondary school. Then the "ports of entry" policy has been thought to have become a common practice for the human recourse management of major firms not only for white-collar employees but also for blue-collar employees among Japanese manufacturing firms;[35] since then, on-the-job training closely linked to employees' educational backgrounds has become a persistent personnel policy in Japanese firms.[36]

Japanese manufacturing followed U.S. manufacturing to build internal human capital investment well linked to expanded secondary education and went ahead beyond its American predecessors toward "ports of entry" policy. Extreme focus on firm-specific human capital investment in better educated workers was once considered the height of organizational sophistication, and it left an inflexible labor market in the society. In this sense, we might be able to say that the Japanese model was an extreme adjustment to the U.S. model rather than something innovative. This course of the Japanese catch-up was quite different from the German case. Germany renovated its apprenticeship system and transformed it into a system seamlessly linked with compulsory secondary education. As a result, surprisingly, the return on compulsory schooling independent of the effect of apprenticeship is not observed in Ger-

[34]See Dohmen, Kriechel and Phann (2004), pp. 218-219.

[35]See Gordon (1985), pp. 386-411; and Sugayama (2011), pp. 338-443.

[36]See Higuchi (1994), pp. 172-174.

many.[37] Catching up with the United States, Japan and Germany reached contrasting extreme equilibria.

Then, a possible question is whether the Japanese system is sustainable or not. Our results indicate that a strict "ports of entry" policy was not a principle, at least up to the 1960s. Such a policy appears to have prevailed since the 1970s and does not have so long a history. Furthermore, the practice is thought to have become less prevalent since the 1990s, when the mobility of younger generations increased again while long-term employment was still prominent among older employees in major Japanese firms.[38] The "dual structure" of the labor market also has been relaxed.[39] The strict "ports of entry" policy in Japan is probably shorter-lived than was assumed. Japanese firms have recently conducted more mid-career recruitment, and this change is not unprecedented, but rather reflects the 1960s norm. This change also would shake the inflexible "dual" labor market in the near future.

References

Abe, Yukiko, "A comparison of wage structures in the United States and Japan: Results from cell mean regressions," *The Japanese Economic Review*, Jun 2000, *51* (2), 252–267.

____ , "A cohort analysis of male labor supply in Japan," *Journal of Japanese and International Economies*, Mar 2012, *26* (1), 23–43.

Alexander, Arthur J., "Income, experience, and the structure of internal labor markets," *The Quarterly Journal of Economics*, Feb 1974, *88* (1), 63–85.

Altonji, Joseph G. and Charles R. Pierret, "Learning and statistical discrimination," *The Quarterly Journal of Economics*, Feb 2001, *116* (1), 313–350.

____ **and Nicolas Williams**, "Do wages rise with job seniority? A reassessment," *Industrial and Labor Relations Review*, Apr 2005, *58* (3), 370–397.

____ **and Robert A. Schakotko**, "Do wages rise with job seniority?," *The Review of Economic Studies*, January 1987, *54* (3), 437–459.

Aoki, Masahiko, *Information, Incentives, and Bargaining in the Japanese Economy*, Cambridge: Cambridge University Press, 1988.

Ariga, Kenn, Giorgio Brunello, and Yasushi Ohkusa, *Internal Labor Markets in Japan*, Cambridge: Cambridge University Press, 2000.

Baker, George and Bengt Holmstrom, "Internal labor markets: Too many theories, too few facts," *The American Economic Review*, May 1995, *85* (2), 255–259.

[37] See Pischke and von Wachter (2008).

[38] See Kato (2001); Shimizutani and Yokoyama (2009); and Ono (2010).

[39] Ariga, Brunello and Ohkusa (2000), pp. 207-225.

———, Michael Gibbs, and Bengt Holmstrom, "The internal economics of the firm: Evidence from personnel data," *The Quarterly Journal of Economics*, Nov 1994a, *109* (4), 881–919.

———, ———, and ———, "The wage policy of a firm," *The Quarterly Journal of Economics*, Nov 1994b, *109* (4), 921–955.

Beaudry, Paul and John DiNardo, "The effect of implicit contracts on the movement of wages over the business cycle: Evidence from micro data," *The Journal of Political Economy*, August 1991, *99* (4), 665–688.

Belman, Dale and John S. Heywood, "Sheepskin effects in the returns to education: An examination of women and minorities," *The Review of Economics and Statistics*, Nov 1991, *73* (4), 720–724.

DeVaro, Jed and Michael Waldman, "The signaling role of promotions: Further theory and empirical evidence," *Journal of Labor Economics*, Jan 2012, *30* (1), 91–147.

Doeringer, Peter B. and Michael J. Piore, *Internal Labor Markets and Manpower Analysis*, Lexington, MA: Heath Lexington Books, 1971.

Dohmen, Thomas J., Ben Kriechel, and Gerard A. Phann, "Monkey bars and ladders: The importance of lateral and vertical job mobility in internal labor market careers," *Journal of Population Economics*, Jun 2004, *17* (2), 193–228.

Doiron, Denise and Silvia Mendolia, "The impact of job loss on family dissolution," *Journal of Population Economics*, December 2011, *25* (1), 367–398.

Dustmann, Christian and Costas Meghir, "Wages, experience and seniority," *The Review of Economic Studies*, January 2005, *72* (1), 77–108.

Farber, Henry S. and Robert Gibbons, "Learning and wage dynamics," *The Quarterly Journal of Economics*, Nov 1996, *111* (4), 1007–1047.

Gathmann, Christina and Uta Schönberg, "How general is human capital?: A task-based approach," *Journal of Labor Economics*, January 2010, *28* (1), 1–49.

Genda, Yuji, Ayako Kondo, and Souichi Ohta, "Long-term effects of a recession at labor market entry in Japan and the United States," *Journal of Human Resources*, Winter 2010, *45* (1), 157–196.

Gibbons, Robert and Michael Waldman, "A theory of wage and promotion dynamics inside firms," *The Quarterly Journal of Economics*, Nov 1999, *114* (4), 1321–1358.

——— and ———, "Enriching a theory of wage and promotion dynamics inside firms," *Journal of Labor Economics*, January 2006, *24* (1), 59–107.

Goldin, Claudia, "Egalitarianism and the returns to education during the Great Transformation of American education," *The Journal of Political Economy*, December 1999, *107* (s6), S65–S94.

——, "The human-capital century and American leadership: Virtues of the past," *The Journal of Economic History*, Jun 2001, *61* (2), 263–292.

—— **and Lawrence F. Katz**, "The origins of technology-skill complementarity," *The Quarterly Journal of Economics*, August 1998, *113* (3), 693–732.

—— **and** ——, *The Race Between Education and Technology*, Cambridge, MA: The Belknap Press of Harvard University Press, 2008.

—— **and Robert A. Margo**, "The Great Compression: The wage structure in the United States at mid-century," *The Quarterly Journal of Economics*, Feb 1992, *107* (1), 1–34.

Gordon, Andrew, *The Evolution of Labor Relations in Japan: Heavy Industry, 1853-1955*, Cambridge, MA: Council on East Asian Studies, Harvard University, 1985.

Hall, Robert E., "Employment fluctuations and wage rigidity," *The Brookings Papers on Economic Activity*, Sep 1980, (2), 91–124.

——, "The importance of lifetime jobs in the US economy," *The American Economic Review*, Sep 1982, *72* (4), 716–724.

Hashimoto, Masanori and John Raisian, "Employment tenure and earnings profiles in Japan and the United States," *The American Economic Review*, Sep 1985, *75* (4), 721–735.

Higuchi, Yoshio, "Effects of job training and productivity growth on retention of male and female workers in Japan," in Toshiaki Tachibanaki, ed., *Labour Market and Economic Performance: Europe, Japan and the USA*, St. Martin's Press New York 1994, pp. 155–182.

Hungerford, Thomas and Gary Solon, "Sheepskin effects in the returns to education," *The Review of Economics and Statistics*, Feb 1987, *69* (1), 175–177.

Ishikawa, Tsuneo, *Income and Wealth*, Oxford: Oxford University Press, 2001.

Jaeger, David A. and Marianne E. Page, "Degrees matter: New evidence on sheepskin effects in the returns to education," *The Review of Economics and Statistics*, Nov 1996, *78* (4), 733–740.

Kahn, Lisa B., "The long-term labor market consequences of graduating from college in a bad economy," *Labour Economics*, Apr 2010, *17* (2), 303–316.

Kato, Takao, "The end of lifetime employment in Japan?: Evidence from national surveys and field research," *Journal of the Japanese and International Economies*, December 2001, *15* (4), 489–514.

Mincer, Jacob, *Schooling, Experience, and Earnings*, New York: National Bureau of Economic Research, 1974.

___ **and Yoshio Higuchi**, "Wage structure and labor turnover in the United States and Japan," *Journal of the Japanese and International Economies*, Jun 1988, *2* (2), 97–133.

Moriguchi, Chiaki, "Implicit contracts, the Great Depression, and institutional change: A comparative analysis of U.S. and Japanese employment relations, 1920-1940," *The Journal of Economic History*, Sep 2003, *63* (3), 625–665.

Nakamura, Naofumi, "Sengo Kamaishi seitetsujo ni okeru jukuren no saihen: hozen shokuba no jirei (From apprenticeships to firm-specific skills: a case of the maintenance workshop in the post-war Kamaishi Steel Works)," *Shakai Kagaku Kenkyu (The Journal of Social Science)*, Mar 2010, *61* (5-6), 3–26. Institute of Social Science, The University of Tokyo.

Neal, Derek, "Industry-specific human capital: Evidence from displaced workers," *Journal of Labor Economics*, Oct 1995, *13* (4), 653–677.

Odaka, Konosuke, "The dual structure of the Japanese economy," in Takafusa Nakamura and Konosuke Odaka, eds., *The Economic History of Japan: 1600-1990, volume 3: Economic History of Japan 1914-1955: A Dual Structure*, Oxford University Press New York 2003, pp. 111–136.

Ohkusa, Yasushi and Souichi Ohta, "An empricial study of the wage-tenure profile in Japanese manufacturing," *Journal of the Japanese and International Economies*, Jun 1994, *8* (2), 173–203.

Ono, Hiroshi, "Lifetime employment in Japan: Concepts and measurements," *Journal of the Japanese and International Economies*, Mar 2010, *24* (1), 1–27.

Oreopoulos, Philip, "Estimating average and local average treatment effects of education when compulsory schooling laws really matter," *The American Economic Review*, Mar 2005, *96* (1), 152–175.

___ **, Till von Wachter, and Andrew Heisz**, "The short- and long- term career effects of graduating in a recession," *American Economic Journal: Applied Economics*, January 2012, *4* (1), 1–29.

Osterman, Paul, "Institutional labor economics, the new personnel economics, and internal labor markets: A reconsideration," *Industrial and Labor Relations Review*, Jul 2011, *64* (4), 637–653.

Parent, Daniel, "Industry-specific capital and the wage profile: Evidence from the National Longitudinal Survey of Youth and the Panel Study of Income Dynamics," *Journal of Labor Economics*, Apr 2000, *18* (2), 306–323.

Pinkston, Joshua C., "A model of asymmetric employer learning with testable implications," *The Review of Economic Studies*, 2009, *76* (1), 367–394.

Pischke, Jörn-Steffen and Till von Wachter, "Zero returns to compulsory schooling in Germany: Evidence and interpretation," *The Review of Economics and Statistics*, August 2008, *90* (3), 592–598.

Poletaev, Maxim and Chris Robinson, "Human capital specificity: Evidence from the Dictionary of Occupational Titles and displaced worker survey, 1984-2000," *Journal of Labor Economics*, Jul 2008, *26* (3), 387–420.

Rosen, Sherwin, "Transaction costs and internal labor markets," *The Journal of Law, Economics, & Organization*, Spring 1988, *4* (1), 49–64.

Shaw, Kathryn and Edward P. Lazear, "Tenure and output," *Labour Economics*, August 2008, *15* (4), 705–724.

Shimizutani, Satoshi and Izumi Yokoyama, "Has Japan's long-term employment practice survived? Development since the 1990s," *Industrial and Labor Relations Review*, Apr 2009, *62* (3), 313–326.

Sugayama, Shinji, *"Shusha" Shakai no Tanjo: Blue Collar kara White Collar he (Birth of the Corporate Society: From Blue collar to White collar)*, Nagoya: Nagoya University Press, 2011.

Topel, Robert, "Specific capital, mobility, and wages: Wages rise with job seniority," *The Journal of Political Economy*, Feb 1991, *99* (1), 145–176.

Ueshima, Yasuhiro, "Why wages equalized in the high-speed growth era: Japanese manufacturing, 1961-1969," *Journal of the Japanese and International Economies*, Mar 2003, *17* (1), 33–54.

____, Takuji Funaba, and Takenori Inoki, "New technology and demand for educated workers: The experience of Japanese manufacturing in the ear of high-speed growth," *Journal of the Japanese and International Economies*, Mar 2006, *20* (1), 50–76.

Ujihara, Shojiro, *Nihon Rodo Mondai Kenkyu (Research on Industrial Relations in Japan)*, Tokyo: The University of Tokyo Press, 1966.

Umezaki, Osamu, "Keiei gorika to tokai tenshutsu: 1960 nendai ni okeru naibu rodo shijo keisei no ichi sokumen (Restructuring of Kamaishi Iron and Steel Works and the transfer of emoloyees to Tokai Iron and Steel Works: an analysis of the internal labour market formation in the 1960s)," *Shakai Kagaku Kenkyu (The Journal of Social Science)*, Mar 2010, *61* (5-6), 27–54. Institute of Social Science, The University of Tokyo.

von Wachter, Till and Stefan Bender, "In the right place at the wrong time: The role of firms and luck in young workers," *The American Economic Review*, Dec 2006, *96* (5), 1679–1705.

Waldman, Michael, "Job assignments, signalling, and efficiency," *Rand Journal of Economics*, Summer 1984, *15* (2), 255–267.

——, "Theory and evidence in internal labor markets," in Robert Gibbons and John Roberts, eds., *The Handbook of Organizational Economics*, Princeton University Press Princeton, NJ 2013, pp. 520–569.

Weinberg, Bruce A., "Long-term wage fluctuations with industry-specific human capital," *Journal of Labor Economics*, Jan 2001, *19* (1), 231–264.

Williamson, Oliver, *The Economic Institutions of Capitalism: Firms, Markets, Relational Contracting*, New York: The Free Press, 1985.

——**, Michael Wachter, and Jeffrey Harris**, "Understanding the employment relation: the analysis of idiosyncratic exchange," *The Bell Journal of Economics*, Spring 1975, *6* (1), 250–278.

Figure 1 Wage curves of two consectuve cohort year groups: Mean in each calender year

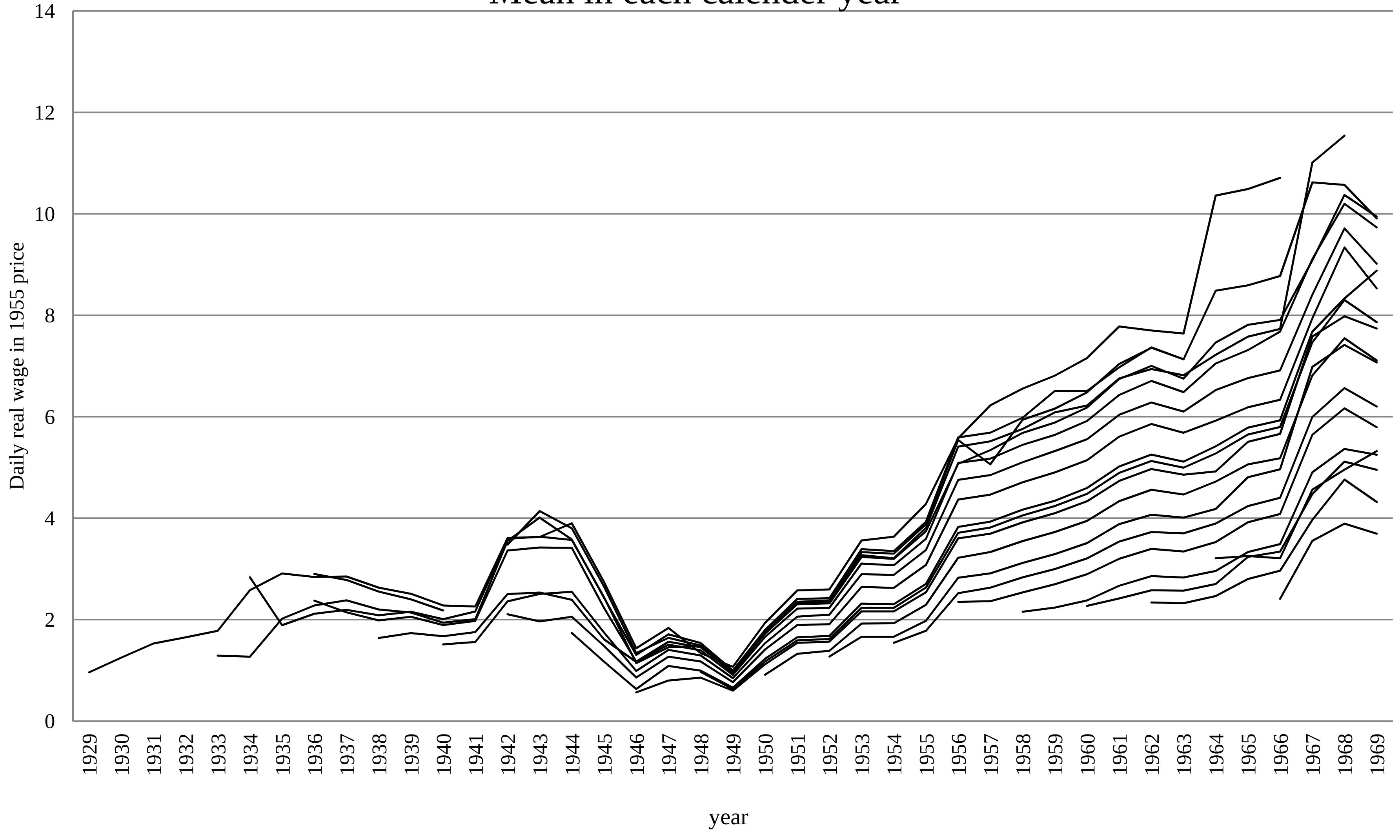

Figure 2 Wage curves of two consecutive cohort year groups: Maximum in each calender yeaar

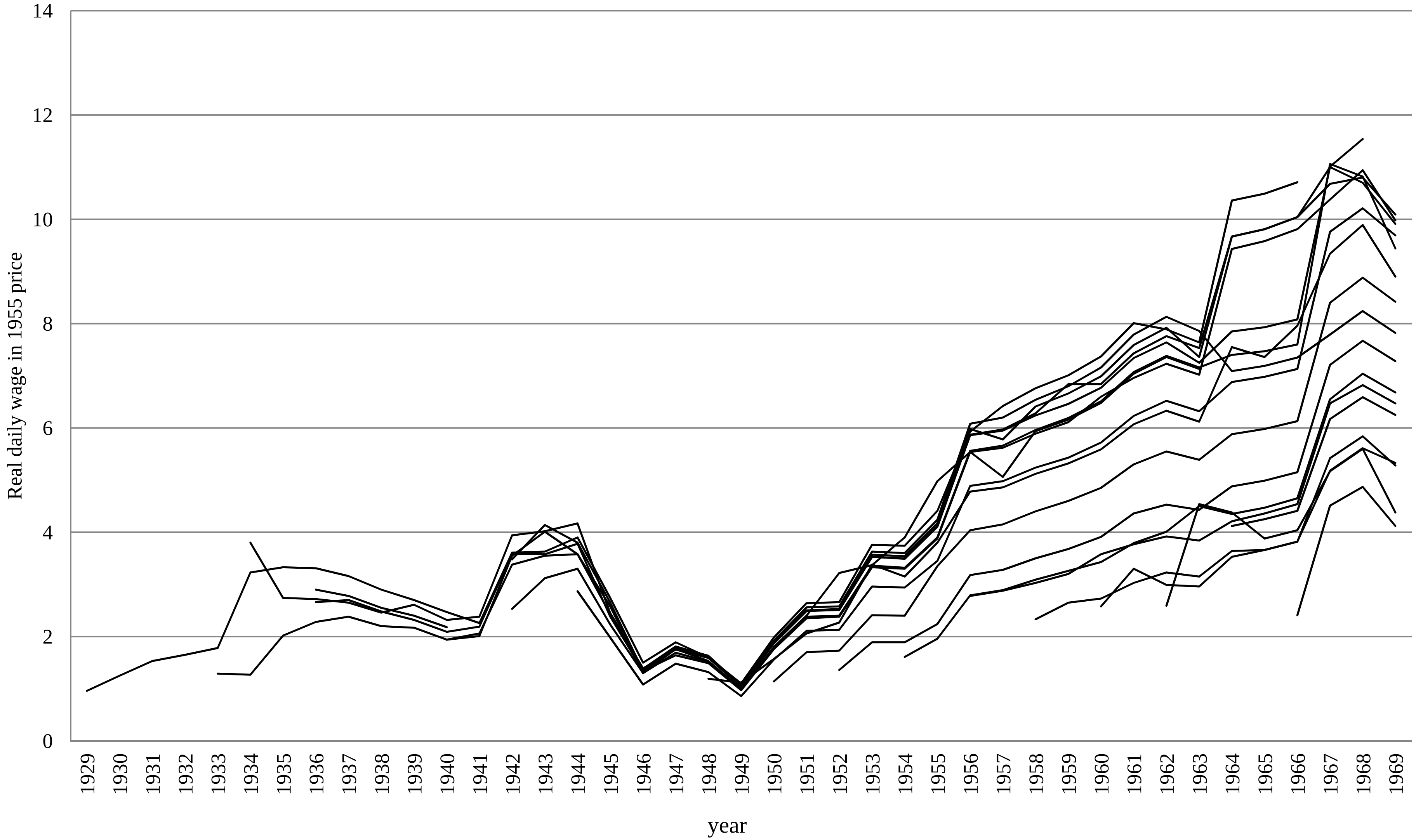

Figure 3 Wage curves of two consecutive cohort year groups: Minimum in each calender year

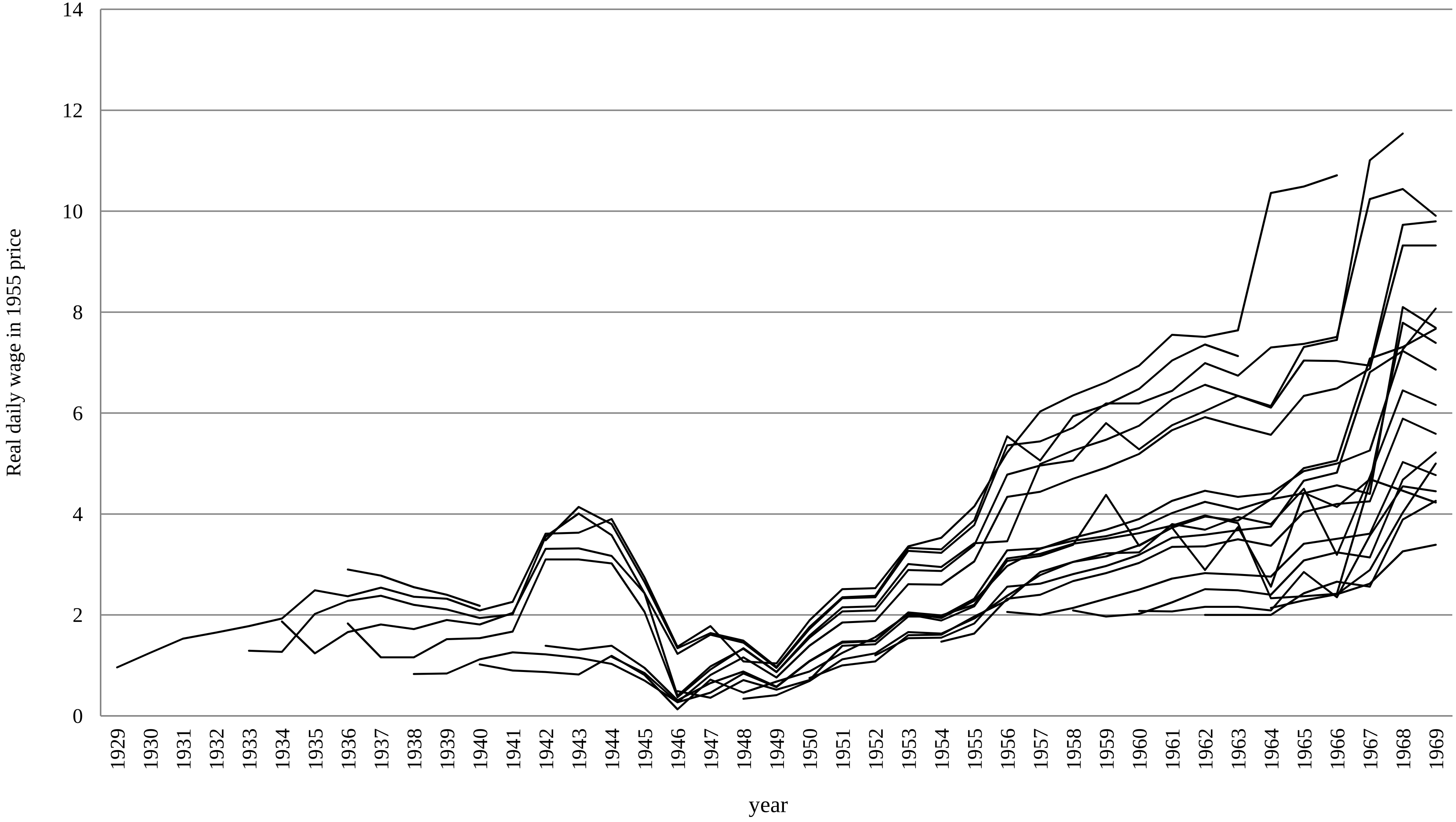

Table 1 Emplyee numbers, years of schooling, and previous experience across cohorts.

Year joined	Number of employees who joined	Number of observations	Years of schooling (S)				Years of previous experience (pre)				Nationwide events
			mean	median	max	min	mean	median	max	min	
yj1928	1	24	11.00	11	11	11	4.00	4	4	4	
yj1929	1	38	8.00	8	8	8	0.00	0	0	0	
yj1930	1	28	8.00	8	8	8	2.00	2	2	2	
yj1931	0	na	na	na	na	na	na	na	na	na	na
yj1932	0	na	na	na	na	na	na	na	na	na	na
yj1933	3	81	8.00	8	8	8	1.57	1	3	1	
yj1934	2	56	6.82	6	8	6	7.46	5	11	5	
yj1935	5	141	8.82	8	12	8	2.95	1	7	0	
yj1936	7	152	8.00	8	8	8	5.97	6	9	0	
yj1937	7	193	8.00	8	8	8	6.27	7	13	0	
yj1938	18	495	7.64	8	8	6	4.79	5	12	0	War effort
yj1939	39	1,010	7.93	8	9	6	5.20	5	12	0	
yj1940	41	1,053	7.96	8	13	6	5.13	6	13	0	
yj1941	44	998	8.22	8	14	6	4.61	4	13	0	
yj1942	29	651	8.08	8	13	6	3.93	1	16	0	
yj1943	23	522	8.38	8	13	6	3.58	2	17	0	
yj1944	26	564	8.17	8	13	6	2.75	0	14	0	
yj1945	17	376	8.25	8	11	6	0.00	0	0	0	
yj1946	17	344	8.00	8	8	8	1.38	0	23	0	
yj1947	11	203	8.00	8	8	8	0.09	0	1	0	
yj1948	282	5,298	8.78	8	14	5	9.06	8	23	0	Reconstructior
yj1949	257	4,532	8.97	8	14	6	7.92	7	21	0	
yj1950	37	609	8.99	9	13	6	4.43	0	18	0	
yj1951	53	856	8.44	8	13	6	8.34	8	14	3	
yj1952	7	104	8.16	8	9	8	5.86	6	7	4	
yj1953	13	154	9.00	9	9	9	2.00	2	2	2	
yj1954	19	220	9.83	9	12	9	1.45	2	2	0	
yj1955	11	122	9.00	9	9	9	2.30	2	10	2	
yj1956	90	910	8.88	9	13	7	7.39	7	20	1	Rapid growth began
yj1957	69	620	9.04	9	12	6	6.24	6	17	0	
yj1958	25	189	9.00	9	9	9	2.23	2	8	1	
yj1959	87	586	10.25	9	13	8	3.47	2	15	0	
yj1960	46	250	10.09	9	12	8	3.94	2	25	0	
yj1961	35	148	9.47	9	15	9	3.50	2	13	0	
yj1962	84	279	10.74	12	12	9	1.19	0	9	0	
yj1963	41	109	9.02	9	15	7	8.13	2	35	0	
yj1964	15	71	8.38	8	9	8	19.38	19	34	2	
yj1965	9	29	12.00	12	12	12	0.14	0	10	0	
yj1966	10	20	12.00	12	12	12	0.35	0	1	0	
yj1967	8	15	10.47	11	12	9	6.13	5	10	0	
total	1,490	22,050									

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

Table 2 Effect of cohort and tenure in panel estimations.

	2-1			2-2		
Estimation method	panel least squares					
Dependent variable	log(rw)					
Cross-section	pooled (no control)					
Period (year)	fixed (year dummies inserted)					
Independent variables	coefficient	*t* statistic		coefficient	*t* statistic	
c	1.0259	58.5498	***	1.2552	58.1633	***
log(*S*)	0.0793	20.2840	***	0.0793	20.8082	***
log(pre)	0.0783	87.8428	***	0.0787	90.4507	***
log(pre)×ibs	0.0113	12.4031	***	0.0112	12.6312	***
log(pre)×jbs	0.0192	18.4178	***	0.0188	18.5190	***
log(ten)	0.1068	48.8122	***	0.0292	6.5046	***
yj1930-1931	-0.0664	-3.1110	***	-0.0131	-0.2629	
yj1932-1933	-0.0688	-4.2581	***	-0.2040	-6.4404	***
yj1934-1935	-0.1416	-10.1613	***	-0.2472	-11.3152	***
yj1936-1937	-0.1701	-12.6437	***	-0.3064	-15.4784	***
yj1938-1939	-0.1824	-14.2604	***	-0.3575	-20.5543	***
yj1940-1941	-0.2369	-18.5503	***	-0.4360	-25.3715	***
yj1942-1943	-0.3011	-23.2736	***	-0.5640	-31.8966	***
yj1944-1945	-0.3656	-27.9614	***	-0.6877	-38.5697	***
yj1946-1947	-0.4000	-29.8086	***	-0.7592	-41.3079	***
yj1948-1949	-0.4677	-35.9202	***	-0.6918	-39.5150	***
yj1950-1951	-0.5401	-40.4203	***	-0.7948	-42.4627	***
yj1952-1953	-0.6091	-42.1070	***	-0.8623	-39.1903	***
yj1954-1955	-0.6373	-44.5672	***	-0.9062	-42.4827	***
yj1956-1957	-0.7695	-55.2790	***	-1.0103	-51.0522	***
yj1958-1959	-0.8536	-59.3754	***	-1.0991	-52.8219	***
yj1960-1961	-0.9041	-60.3538	***	-1.1657	-51.8778	***
yj1962-1963	-0.9470	-61.7582	***	-1.1572	-50.0551	***
yj1964-1965	-0.8564	-49.7182	***	-1.0801	-32.0611	***
yj1966-1967	-0.9392	-43.0552	***	-1.0815	-20.6270	***
yj1930-1931×log(ten)				-0.0031	-1.4496	
yj1932-1933×log(ten)				0.0060	4.6278	***
yj1934-1935×log(ten)				0.0044	4.5885	***
yj1936-1937×log(ten)				0.0062	7.2346	***
yj1938-1939×log(ten)				0.0084	11.2656	***
yj1940-1941×log(ten)				0.0101	13.4014	***
yj1942-1943×log(ten)				0.0149	17.9592	***
yj1944-1945×log(ten)				0.0200	23.1121	***
yj1946-1947×log(ten)				0.0249	26.4728	***
yj1948-1949×log(ten)				0.0151	16.8488	***
yj1950-1951×log(ten)				0.0197	17.9671	***
yj1952-1953×log(ten)				0.0216	12.4854	***
yj1954-1955×log(ten)				0.0259	15.1794	***
yj1956-1957×log(ten)				0.0259	17.3393	***
yj1958-1959×log(ten)				0.0320	16.1331	***
yj1960-1961×log(ten)				0.0415	14.1824	***
yj1962-1963×log(ten)				0.0342	9.1698	***
yj1964-1965×log(ten)				0.0439	6.4691	***
yj1966-1967×log(ten)				0.0295	1.7782	*
year dummies	yes			yes		
Δrgnp	yes			yes		
cross-sections included	1,489			1,489		
periods included (years)	41 (1929-1969)			41 (1929-1969)		
included observations	21,876			21,876		
adjusted R^2	0.9776			0.9788		
F statistic	14,717.8051		***	12,039.5438		***

Notes: Base year joined dummy is yj1928-1929. *** and ** respectively denote signifnicance at the 1 percentage level and at 5 percatage level. Definitions of

Table 3 Wage regression on physiological characteristics, schooling, and experiences.

	3-1			3-2			3-3			3-4		
Estimation method	panel extended generalized least squares											
Dependent variable	log(rw)											
Cross-section	random effect											
Period (year)	pooled (no control)											
Independent variables	coefficient	*t* statistic		coefficient	*t* statistic		coefficient	*t* statistic		coefficient	*t* statistic	
c	-1.3922	-35.0477	***	-5.1849	-90.5617	***	-4.9152	-79.9421	***	-4.9043	-80.1085	***
log(hgt)							0.5825	8.2301	***	0.5631	8.0003	***
log(age)				1.5866	82.8477	***	1.5772	75.9297	***	1.5690	75.4308	***
log(*S*)	0.2751	15.7629	***	0.1353	8.7012	***	0.0015	0.0897		0.0087	0.5040	
log(*S*)×psw	0.1947	50.1049	***	0.1868	54.2152	***	0.2294	67.6927	***	0.2248	65.9329	***
log(pre)	0.1667	37.9957	***	-0.0658	-13.8355	***	-0.0787	-13.5901	***	-0.0787	-13.6572	***
log(pem)	0.0385	9.5931	***	0.0084	1.9813	***	-0.0196	-4.8360	***	-0.0249	-5.2098	***
log(pem)×ibs				0.0316	7.8710	***				0.0319	7.3004	***
log(pem)×jbs				-0.0432	-9.9478	***				-0.0381	-7.9866	***
log(ten)	0.7054	222.1954	***	0.3051	54.4364	***	0.3807	68.7515	***	0.3831	69.0893	***
dcy	-2.3831	-5.0375	***	-1.1462	-2.7821	***						
dcy×log(ten)	0.6822	4.1008	***	0.3934	2.7177	***						
sy	-0.6645	-14.5021	***	-0.3457	-8.6061	***						
sy×log(ten)	0.2479	14.2179	***	0.1052	6.8851	***						
dct	-0.6858	-16.4175	***	-0.3581	-9.7508	***						
dct×log(ten)	0.2650	16.7119	***	0.1141	8.1829	***						
dc	0.1675	7.8815	***	0.4412	23.4141	***						
dc×log(ten)	-0.0466	-4.7122	***	-0.1539	-17.6580	***						
cross-sections included	1,557	1,557		1,557			1,246			1,245		
periods included (years)	41(1929-1969)			41(1929-1969)			31(1939-1969)			31(1939-1969)		
included observations	23,099			23,099			16,637			16,616		
adjusted R^2	0.6943			0.7569			0.8413			0.8417		
F statistic	4,037.0125 ***			4,494.6646 ***			12,587.6862			9,815.2451 ***		

Notes : ***, ** and * respectively denote signifnicance 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.

Table 4 Reproduction decision of employees.

	4-1			4-2		
Estimation method	panel extended generalized least squares					
Dependent variable	log(noc)			log(noc)		
Cross-section	pooled (no control)			random effect		
Period (year)	fixed (year dummies inserted)			pooled (no control)		
Independent variables	coefficient	*t* statistic		coefficient	*t* statistic	
c	-3.9310	-41.0856	***	-3.3146	-22.7870	***
log(hgt)	0.2125	2.9278	***	-0.0794	-0.4104	
log(age)	1.2704	34.8650	***	1.1175	28.0919	***
log(*S*)	-0.0861	-5.0113	***	-0.1065	-2.2885	**
log(pre)	0.0354	5.6221	***	0.0960	8.2808	***
log(ten)	0.0366	3.5823	***	0.0693	7.1136	***
log(rw)	0.3200	9.6514	***	0.0912	8.8631	***
cross-sections included	1,246			1,246		
periods included (years)	31(1939-1969)			31(1939-1969)		
included observations	16,637			16,637		
adjusted R^2	0.5718			0.5234		
F statistic	617.9844 ***			3,046.3080 ***		

Notes : ***, and ** respectively denote signifnicance at 1 and 5 percent levels. Definitions of variables are in the Appendix.

Table 5 Probability of acceptance as a trainee for in-house training programs

	5-1			5-2			5-3			5-4		
Estimation method	binary logit			binary logit			binary logit			binary logit		
Dependent variable	dcy			sy			dct			dc		
Independent variables	coefficient	*z* statistic		coefficient	*z* statistic		coefficient	*z* statistic		coefficient	*z* statistic	
c	2.3746	0.6086		-8.8777	-9.5963	***	2.9806	2.5088	**	16.7397	24.8991	***
log(hgt)				-5.0770	-5.2063	***	-0.9344	-0.6923		6.3238	9.9823	***
log(age)	-3.5316	-3.4444	***	1.6106	7.3966	***	-0.0497	-0.1808		-2.6587	-20.1175	***
log(*S*)	-1.2195	-1.0438		0.3655	1.4109		-3.4230	-9.3482	***	-3.4935	-17.0443	***
log(pre)	2.4420	4.4549	***	-1.1127	-12.3857	***	-0.4552	-3.4648	***	-1.0546	-25.3514	***
log(pem)				0.9264	10.5333	***	1.1091	10.5331	***	-1.8567	-23.6954	***
included observations	24,068			16,809			16,808			16,809		
McFadden R^2	0.0910			0.0602			0.0933			0.4174		
LR statistic	33.3034 ***			279.3557 ***			320.9954			5,990.2243 ***		

Notes : *** and ** respectively denote signifnicance at the 1 percentage level and at 5 percent level. No sufficient samples of height (hgt) and previous employment experience (pem) for dcy. Definitions of variables are in the Appendix.

Table 6 Change in return on education.

	6-1			6-2			6-3		
Estimation method	panel extended generalized least squares								
Dependent variable	log(rw)			log(rw)			log(rw)		
Cross-section	random effect			random effect			random effect		
Period (year)	pooled (no control)			pooled (no control)			pooled (no control)		
Independent variables	coefficient	*t* statistic		coefficient	*t* statistic		coefficient	*t* statistic	
c	-0.9826	-34.7064	***	-1.0913	-27.4007	***	-0.9943	-35.1979	***
log(pre)	0.1198	35.5105	***	0.1181	34.7707	***	0.1088	51.9371	***
log(ten)	0.7398	221.7444	***	0.7741	82.0526	***	0.7903	85.6815	***
log(*S*)×log(ten)				-0.0039	-3.8809	***	-0.3265	-77.0755	***
yj1930-1931×log(*S*)	-0.0836	-2.4515	**	-0.0347	-0.9563		0.0138	0.4656	
yj1932-1933×log(*S*)	-0.0119	-0.5221		0.0369	1.4218		0.0165	0.7792	
yj1934-1935×log(*S*)	0.0004	0.0226		0.0510	2.3683	**	-0.0183	-1.0144	
yj1936-1937×log(*S*)	0.0145	0.9529		0.0642	3.2286	***	-0.0372	-2.2082	**
yj1938-1939×log(*S*)	0.0297	2.2539	**	0.0794	4.3204	***	-0.0524	-3.3172	***
yj1940-1941×log(*S*)	0.0204	1.5904		0.0709	3.8779	***	-0.0778	-4.9609	***
yj1942-1943×log(*S*)	0.0275	2.0734	**	0.0782	4.2016	***	-0.1125	-7.0928	***
yj1944-1945×log(*S*)	0.0385	2.8024	***	0.0888	4.7023	***	-0.1248	-7.8059	***
yj1946-1947×log(*S*)	0.0608	4.1497	***	0.1108	5.6798	***	-0.1682	-10.3068	***
yj1948-1949×log(*S*)	0.1120	9.5726	***	0.1644	9.2028	***	-0.1864	-12.0325	***
yj1950-1951×log(*S*)	0.1809	14.5197	***	0.2328	12.7433	***	-0.2221	-14.1319	***
yj1952-1953×log(*S*)	0.2211	14.5233	***	0.2727	13.4930	***	-0.2703	-16.3457	***
yj1954-1955×log(*S*)	0.2752	19.6006	***	0.3275	16.8233	***	-0.2912	-17.9801	***
yj1956-1957×log(*S*)	0.3186	26.0797	***	0.3704	20.4785	***	-0.3378	-21.5183	***
yj1958-1959×log(*S*)	0.3544	28.7238	***	0.4058	22.4233	***	-0.3934	-24.9609	***
yj1960-1961×log(*S*)	0.3955	29.5031	***	0.4469	23.7188	***	-0.4170	-26.1997	***
yj1962-1963×log(*S*)	0.4445	33.3611	***	0.4948	26.6102	***	-0.4404	-27.7495	***
yj1964-1965×log(*S*)	0.4865	26.5974	***	0.5384	23.7596	***	-0.4066	-24.3892	***
yj1966-1967×log(*S*)	0.6178	25.0225	***	0.6679	23.9780	***	-0.4757	-27.5336	***
dcy	-2.3750	-4.8698	***	-2.3687	-4.8570	***	-0.2129	-1.7608	*
dcy×log(ten)	0.7238	4.1440	***	0.7221	4.1347	***	0.0237	0.5826	
sy	-0.5665	-12.5166	***	-0.5646	-12.4729	***	0.0317	2.4166	**
sy×log(ten)	0.2237	12.7276	***	0.2229	12.6867	***	0.0094	2.1171	**
dct	-0.5445	-13.5534	***	-0.5431	-13.5190	***	0.0717	6.0781	***
dct×log(ten)	0.2244	14.3493	***	0.2230	14.2572	***	0.0235	5.9259	***
dc	-0.0747	-3.5195	***	-0.0750	-3.5313	***	-0.0304	-4.5765	***
dc×log(ten)	0.0387	3.8408	***	0.0377	3.7402	***	0.0591	21.1030	***
dy×log(*S*)	No			No			Yes		
cross-sections included	1,490			1,490			1,490		
periods included (years)	41(1929-1969)			41(1929-1969)			41(1929-1969)		
included observations	21,902			21,902			21,902		
adjusted R^2	0.7254			0.7256			0.9841		
F statistic	1,995.9100 ***			1,930.9966 ***			19,376.8188 ***		

Notes : ***, ** and * respectively denote signifnicance at the 1 percentage level, 5 percantage level and 10 percantage level. Control group is yj1928-1929. Definitions of variables are in the Appendix.

Table 7 Change in return on previous experience

	7-1			7-2		
Estimation method	panel extended generalized least squares					
Dependent variable	log(rw)			log(rw)		
Cross-section	random effect			random effect		
Period (year)	pooled (no control)			pooled (no control)		
Independent variables	coefficient	*t* statistic		coefficient	*t* statistic	
c	-1.5040	-38.5382	***	0.7721	31.3067	***
log(*S*)	0.3817	22.8836	***	-0.6680	-15.8473	***
log(ten)	0.7272	217.0572	***	0.1594	77.5090	***
yj1930-1931×log(pre)	-0.2524	-3.2224	***	0.4138	7.5492	***
yj1932-1933×log(pre)	-0.1702	-3.2218	***	0.4394	12.2587	***
yj1934-1935×log(pre)	0.0047	0.2282		0.2264	15.6921	***
yj1936-1937×log(pre)	0.0124	0.9361		0.2323	25.8521	***
yj1938-1939×log(pre)	0.0282	3.6060	***	0.2260	43.4484	***
yj1940-1941×log(pre)	0.0202	2.8682	***	0.1929	41.9910	***
yj1942-1943×log(pre)	0.0437	4.6432	***	0.1793	28.9781	***
yj1944-1945×log(pre)	0.0386	2.5344	**	0.1679	16.4962	***
yj1946-1947×log(pre)	0.0641	2.3179	**	0.2087	11.9011	***
yj1948-1949×log(pre)	0.1086	29.7683	***	0.1211	55.8757	***
yj1950-1951×log(pre)	0.1802	29.0458	***	0.0885	23.4763	***
yj1952-1953×log(pre)	0.2040	12.0810	***	0.0598	6.0022	***
yj1954-1955×log(pre)	0.2693	12.6736	***	0.0115	0.9917	
yj1956-1957×log(pre)	0.3053	52.5736	***	0.0060	1.8108	*
yj1958-1959×log(pre)	0.3889	37.9170	***	-0.0700	-13.3223	***
yj1960-1961×log(pre)	0.4021	31.5316	***	-0.0710	-11.7570	***
yj1962-1963×log(pre)	0.4687	32.8774	***	-0.0685	-11.4832	***
yj1964-1965×log(pre)	0.3787	26.9705	***	0.0306	4.8372	***
yj1966-1967×log(pre)	0.7771	18.0706	***	-0.0502	-3.1390	***
dcy	-2.2793	-4.6437	***	-0.3814	-2.7739	***
dcy×log(ten)	0.7435	4.2562	***	0.0658	1.4233	
sy	-0.6544	-13.9240	***	0.0373	2.5054	**
sy×log(ten)	0.2271	12.6021	***	0.0213	4.2161	***
dct	-0.6437	-15.4032	***	0.0712	5.3172	***
dct×log(ten)	0.2172	13.5392	***	0.0491	10.9157	***
dc	0.2689	12.5150	***	-0.1401	-18.7466	***
dc×log(ten)	-0.0809	-7.9525	***	0.0760	24.0301	***
dy×log(*S*)	No			Yes		
cross-sections included	1,490			1,490		
periods included (years)	41(1929-1969)			41(1929-1969)		
included observations	21,902			21,902		
adjusted R^2	0.7036			0.9769		
F statistic	1,794.0461 ***			13,400.8465 ***		

Notes : ***, ** and * respectively denote signifnicance at the 1 percentage level, 5 percantage level and 10 percantage level. The control group for yj is yj1928-1929 and that for dy×log(*S*) is dy1929×log(*S*). Definitions of variables are in the Appendix.

Appendix List of variables.

variable	definition	
rw	real daily wage.	
age	age.	
hgt	relative height when employed by the firm: (observed hight)/(average hight at his age in the year).	
S	years of schooling: (years of schooling)+1.	
prw	postwar education generation (13 years old or elder in 1947).	dummy variable
psw	postwar education generation (12 years old or younger in 1947).	dummy variable
exp	experience in the labor market: years after graduation.	
pre	previous experience: years after graduation. Note that every sample emolyee had worked at the firm until the last year of his record.	
pem	perious employment experience: experience of employment other than self-employed or family-operated business.	
ibs	dummy of the same industry before employed by the firm: =1 if worked in the steel industry before employed by the firm.	dummy variable
jbs	dummy of the same job before employed by the firm: =1 if worked being assigned to the same job before employed by the firm (ex. heavy machine operator) as the one to which he was assigned after employed by the firm.	dummy variable
yj19XX	dummy of year joined: =1 if joined the firm in 19XX.	dummy variable
yj19XX-19YY	dummy of year joined: =1 ifjoined the firm from 19XX to 19YY.	dummy variable
dy19XX	year dammy.	dummy variable
ten	tenure: (years after employed by the firm)+1.	
dcy	1 if completed Development Center for Youth (from 1927 to 1935).	dummy variable
sy	1 if completed School for Youth (from 1935 to 1948).	dummy variable
dct	1 if completed Development Center for Technician (from 1939 to 1946).	dummy variable
dc	1 if completed Development Center (from 1946 to 1973).	dummy variable
noc	number of dependent children.	
rgne	Real gross national expenditure.	

Source : National average height: the School Health Statistics surveyed by the Ministory of Education, Science, Sports and Culture (http://www.e-stat.go.jp/). Real gross national expenditure: Kazushi Ohkawa, Nobukiyo, Takamatsu, and Yuzo Yamamoto, eds, *Estimates of Long-Term Economic Statistics of Japan since 1868, volume 1, National Income* , Tokyo: Toyo Keizai Shinposha, 1974, pp. 232 (1885-1929)-233 (1930-1970); to connect series before and after 1955, when governmental statistis are not continuous, a deflator from Kazushi Ohkawa, Tsutomu Noda, Nobukiyo Takamatsu, Saburo Yamada, Minoru Kumazaki, Yuichi Shionoya, and Ryoshin Minami, *Estimates of Long-Term Economic Statistics of Japan since 1868, 8 Prices*, Tokyo: Toyo Keizai Shinposha, 1967, p. 134 is used. Other items: Wage records of the case firm.