Education, Experience, and Tenure
Intra-Firm Wage Dynamics in the Japanese Steel Industry*

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Abstract

Contemporary major Japanese firms recruit new graduates and promote from within, providing a rare example of the "ports of entry" policy, and were once recognized as innovative organizations. This microanalysis of a steel company in the 1930-60s shows that 1) the internal labor market had been enhanced, but 2) mid-career recruiting was active and employees' fertility decision depended on previous experience as well as tenure by the 1960s, while 3) the return on education surged and in-house training was linked to educational background from the 1950s, indicating that extended schooling replaced mid-career experience after the 1970s under technology-education complementarity.

Key words: Internal labor markets, return on schooling, specific human capital, Japan.
JEL: J31, J24, N35.

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1 Introduction

Work organization diversity strongly depends on human capital specificity. Let us tentatively differentiate human capital into 1) the general, which is uniformly productive in various industries, such as knowledge taught at school, 2) the industry-specific, which is more productive in a specific industry than in other industries, and 3) the firm-specific, which is more productive at a specific firm than at other firms.

While the general human capital is the basis in every developed economy, relative importance of the industry specificity and the firm specificity is diverse. In Germany, the skill is highly standardized at an industry-level by the apprenticeship system, which is arguably supported by the macro-level inflexibility of the labor market, and hence the firm specificity of human capital is negligible.[1] In the case of the United States, while the firm-specific human capital and therefore tenure have a positive impact on wage growth, the industry specificity has a larger impact.[2] In Japan, meanwhile, tenure at a specific firm has a larger impact on the wage growth than the total experience does, indicating that the firm-specific human capital contributes more than the general human capital does.[3] In terms of the firm- and the industry-specificity portfolio of the human capital, the Japanese and the German labor markets constitute a bipolar division, with the United States in the middle.

Internal labor markets characterized by long-term employment and a preference for internal promotion, which at least partly focuses on investment in specific human capital, are widely observed in developed economies. The "ports of entry" hypothesis, suggested by Doeringer and Piore (1971),[4] assumes 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 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 the year when the worker graduates happens to be in a recession, when firms decrease recruitment, the probability of being hired

[1] See Dustmann and Meghir (2005), pp. 90-96; and Cunat and Melitz (2011).

[2] See 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.

[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.

by a major firm is smaller than usual. Strict implementation of the "ports of entry" policy prevents workers from being employed 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 less luck with respect to the state of economy when a worker graduates affects employment would be mitigated. While such distortions are observed in the United States, Germany, Canada, that in Japanese is especially serious among less-educated workers. State in the graduation year persistently affects workers' employment and income, and particularly lasting to less-educated workers.[7] Strict implementation of the "ports of entry" policy has realized a "dual" structure, under which the outside market of intermediate recruitment market is dysfunctional, not only to well-educated white-collar workers, but also to less-educated service and blue-collar workers.[8]

This particular feature of Japanese internal labor markets were believed as innovative organizations in the 1980s. While they are now often recognized as obsolete, it is still not clear how those particular organizations emerged; an endogenous innovation or an occasional equilibrium responding to some exogenous shocks? This research addressing this question and intends to study the most controversial component of internal labor markets hypothesis: the "ports of entry" policy, by examining the formation based on an employee-level panel data set of an establishment of a steel firm in the 1930s to the 1960s.

Section 2 reviews the potential functions of internal labor markets by surveying theoretical and empirical works. Among them, facilitation of both the specific human capital investment and the employer learning is carefully addressed by this research. Section 3 describes features of the case establishment and the data set, verifies the existence of an internal labor market in the establishment during period of the data set, and tracks changes in this internal labor market throughout the period. Wage curves show that wages of lower performers were disproportionately compressed, suggesting that the internal labor market served as a screening device that generated "predictable winners and losers."[9] The estimation result shows that the impact of the human capital acquisition within the establishment enlarged through the period. The internal labor market has increasingly facilitated investment in the firm-specific human capital.

Section 4 decomposes wage growth in the establishment into employees' physiological characteristics, schooling, previous work experience, 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 are, 1) previous experience was valued throughout the period, and employees' fertility decision depended on previous experience which captures investment in general human capital as well as tenure, 2) the return on schooling increased rapidly after the Second World War, and 3) selection for in-house training programs was affected by schooling

[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 Baker, Gibbs and Holmstrom (1994b), pp. 942-944.

after the Second World War. These results, with the result in section 3 that the return on human capital acquisition within the firm gradually increased throughout the period, suggest that previous experience served as an opportunity of general human capital investment as schooling did throughout the period, the relative importance of them changed after the Second World War; the years of schooling was replacing the years of previous experience as the primary opportunity for general human capital investment. Mid-career experience appears to have been supplanted by schooling, not directly absorbed by the internal labor market.

2 Supposed working of internal labor markets

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 structure, a firm chooses the optimal organization to reduce the loss due to asymmetric information. The firm chooses an internal labor market when the firm has more information about the necessary skills and when the skills are complementary to each other and/or are firm-specific.[10]

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. Meanwhile the empirical and descriptive works on the issue in the last two decades have generally rejected the classical conjecture that internal labor markets somehow separate wage dynamics from the performance or merit of employees. Instead, internal labor markets have been thought to work as a second-best 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.[11]

One component of internal labor markets that serve 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

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

[11] 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.

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.[12] 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 also occurs in the competitive market, a firm can accelerate the process with long-term employment.[13] Furthermore, employer learning accelerated by long-term employment makes internal labor markets self-sustainable. If the current employers better knows their employees than do potential employers, the current employers can limit the turnover of better workers. In an equilibrium of a homogeneous labor market in which all employers adopt the strategy of limiting the turnover of better workers, the mid-career recruitment market for qualified workers shrinks both because the quality of the pooled workforce is expected to be low and because wages after leaving a current employer are expected to be low.[14]

2.2 Schooling, previous work experience, and tenure

An important characteristic of internal labor markets suggested by Doeringer and Piore (1971) is that the wage determination within the firm is somehow "shielded" from the competitive labor market. This shielding is the very reason that a closed firm organization is called an internal labor "market." People invest in general human capital at schools, and they may also invest in general human capital through work experience. Then some workers may join a firm that commits to long-term employment and determines wages in some administrative manner, not by simply following the outside market pricing, and invest in more specific human capital. Thus the wage determination within the firm is assumed to replace the market pricing, at least to some extent.

While such a firm assumes it is beneficial to shield its wage determination from the outside market, it does not necessarily ignore general human capital accumulated from schooling and previous work experience. Depending on the relative importance of specific human capital recognized by the firm, the firm builds an incentive scheme that weighs schooling, previous experience, and tenure at its own mechanism. The more important a firm values investment within its own organization, the larger weight it should give to tenure.

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,[15] this fea-

[12] See Farber and Gibbons (1996), pp. 1010-1018; and Altonji and Pierret (2001), pp. 316-323.
[13] See Baker et al. (1994a), p. 901; Baker et al. (1994b), pp. 952-953; and Pinkston (2009), pp. 381-389.
[14] See Williamson et al. (1975); and Greenwald (1986).
[15] See Hall (1980, 1982).

ture is not owing 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.[16] 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 20th 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 20th 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.[17] The postwar experience in Japan was similar; 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.[18] 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.

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. Along with the technological transition, the traditional skills ascribed to individual senior employees were transformed into manualized skills and made known to the management.[19] 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 Kamaishi Iron Works: Historical context

The Kamaishi Iron Works, opened by the Nambu Domain in 1857, is the oldest modern iron works in Japan. After being nationalized in 1873 and re-privatized in 1884, new blast furnaces were built and integrated production of pig iron and steel began in 1903. After being purchased by Mitsui Holdings, then the largest conglomerate, in 1924, it was merged with other major iron works to form the Nippon Iron and Steel Corporation in 1934. The merger was coordinated by the government for technological improvements. After the Second Wolrd War, as a part of antitrust policy under the U.S. occupation, Nippon Iron and Steel was dissolved into Fuji Steel and the Yawata Steel, with Kamaishi belonging to the former.

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

[17] See Goldin and Katz (1998), pp. 707-716; and Goldin and Katz (2008), pp. 102-125, 176-181.

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

[19] See Nakamura (2010), pp. 24-25.

After the 1950s, the government adopted an industrial policy that induced steel and other important manufacturing companies to invest in new technology with long-term finance coordinated by the government. For the steel industry, three phased coordinated 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 Kamaishi Iron Works, but the replacement of old blast furnaces was not planned.

A large change during the modernization of the production lines from the 1950s was the standardization, or manualization, of the production procedures. Before the Second World War, in the iron and steel industry, sophisticated procedures of production were developed by employees, and these procedures were taught to the younger employees by the senior employees of the company. After the 1950s, however, the production line procedures became manualized by better-educated employees, and the best practices at the shop floor became known to the firm.[20]

As part of a company-wide investment plan, Fuji Iron and Steel decided to build a new state-of-the-art plant then named Tokai in Nagoya.[21] The firm also decided to decrease Kamaishi's capacity, to increase the capacity of other new plants such as Tokai, and to relocate to Tokai the skilled workers of Kamaishi and of other old iron works. Consequently, 1,678 skilled workers moved from Kamaishi to Tokai in 1964, 1967, 1968, and 1969. 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 simply the willingness of the employees.[22]

3.2 Data

This research examines the preserved panel data of wages for 1,544 relocated Kamaishi employees, tracking these workers from the late 1920s or later, depending on the employee's entry year, to the 1960s, when they left Kamaishi. The number of total observations is 24,022.

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.

Each individual wage record includes:

1. Educational background (yos).

2. Physiological characteristics when employed: height (hgt), weight, and lung capacity.

3. Panel data of previous work experience, rank, job and department assignments, wage, training, promotion, wage and personal information:

[20] See Nakamura (2010), pp. 8-21.

[21] Since Fuji and Yawata merged into the Nippon Steel in 1970, both Kamaishi and Tokai, which was renamed as Nagoya, have belonged to Nippon.

[22] In addition to the 1,678 workers from Kamaishi, 908 workers moved from Muroran, 972 workers moved from Hirohata, and 127 workers moved from Kawasaki. See Umezaki (2010), pp. 33-38, 47-49.

(1) Work experience previous 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 (*Seinen Kunrenjo*)" (ydc); three days a week, 4 years, 800 hours total.

1935-1948: "School for Youth (*Seinen Gakko*)" (sy); half time, three days a week, 4 years.

1939-1946: "Development Center for Technicians (*Ginosha Yoseijo*)" (dct); full time, 3 years, 6,453 hours total.

1946-1973: "Development Center (*Kyoshujo*)" (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**. An important 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 gaining experience at several workplaces to acquire the relevant skills and then either gaining employment with a large firm on a long-term basis or starting one's own workshop became typical for male skilled workers. **Table 1** indicates that the "port of entry" practice of a typical "Japanese firm," for which almost exclusively new graduates are recruited, did not dominate for blue-collar workers even at the leading firm in the steel industry, then the core industry, from 1929 to 1969.

Compulsory education was extended from 6 years to 9 years in 1947, as reflected in the minimum years of schooling in **Table 1**. 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 spent as mandatory 6 years and additional 2 years at elementary school, and the difference in the employees who graduated after 1947 is distributed mainly between the mandatory 9 years comprising 6-year elementary school and 3-year 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,[23] 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, which somehow shields wage determination from the outside market, is to be empirically established. We follow the strategy presented by Baker et al. (1994b).

If a firm offers competitive wages with respect to observable characteristics such as the educational background in the market when the firm recruits workers, and if the firm adopts the internal labor market policy under which wages are determined based on the internal rules or evaluation that more or less shield the internal wage dynamics from the market price, then the wage growth of each cohort preserves the trace of the outside market pricing only at the point of recruitment and is shielded from the market price thereafter and thus could preserve a common legacy. Thus, the survival of the cohort effect is a useful indicator of the existence of an internal labor market that shields wage determination from the outside price mechanism.[24]

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. To control for the effect of educational background, the years of schooling (yos) is also inserted as a regressor. The period saw a rapid growth in average productivity, which is controlled for by year dummies.[25]

The cohort effects in model 2-1 survive among the employees of all cohorts. The internal labor market at the Kamaishi Iron Works seems to have been formed in the 1930s. This statistical inference is consistent with the descriptive picture based on documents and hearings.[26]

As Baker et al. (1994b) describes, the serial correlation of wage residuals is another useful indicator of an internal labor market.[27] In the competitive market, assuming that the observable variables provide an unbiased forecast of wage, the residuals of the estimated wages subtracted the observed wages should be serially independent, the history of residual should have a unit

[23] 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.

[24] See Baker et al. (1994b), pp. 923, 933-940; and Baker and Holmstrom (1995), pp. 258-259.

[25] Our approach differs from that of Baker et al. (1994b) in some important aspects. To avoid the identification difficulty and still extract the cohort effect, Baker et al. (1994b) assumes that the tenure effect on wage growth is linear, estimates the coefficient of the linear regression of wages on tenure, deducts the estimated tenure effect from the cohort average wage, and regresses this adjusted cohort average wage on the cohort dummies. However, in this data set, as the decreasing impact of past wages on the current wage in equation (2) below shows, the tenure effect is not linear. Furthermore, the two-staged estimation seems to make the cohort effect appear larger than they actually are. Hence, to deal with the identification problem, we simply bind the adjacent two cohorts together into one group and then regress the wages on dummies of the two-cohort groups.

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

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

root and be random walk. If the firm shields wage determination from the market by some wage policy, the result would be different.

For the ith employee in the tenth tenure, consider $\mathrm{rwrsd01}_{i,ten} = \log(\mathrm{rw}_{i,\mathrm{ten}}) - [\mathrm{rw}_{i,\mathrm{ten}}]$ where $[\mathrm{rw}_{i,\mathrm{ten}}]$ is the estimated value by model 3-1 in **Table 3** below, and also consider $\mathrm{rwrsd02}_{i,ten} = \log(\mathrm{rw}_{i,\mathrm{ten}}) - [\mathrm{rw}_{i,\mathrm{ten}}]$, where $[\mathrm{rw}_{i,ten}]$ is the estimated value by model 3-2 in **Table 3**. Difference between models 3-1 and 3-2 is in that the latter contains the ith employee's relative height. Then, both of $\mathrm{rwrsd01}_{i,ten}$ and $\mathrm{rwrsd02}_{i,ten}$ reject the common and individual unit root hypotheses.[28]

If employees are homogeneous, then, with the firm-wide trend of productivity controlled for by the year dummies, 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 accumulation and there were "predictable winners and losers."[29]

In addition, it is reasonable to infer that the "predictable winners and losers" were found by the employer learning about the "latent" ability of the employees. If only firm-specific human capital matters and the effect of employer learning is negligible for the wage growth of each employee, then employees more quickly promoted in the current year, who have smaller firm-specific human capital than the more slowly promoted employees who had accordingly longer time to invest in firm-specific human capital, would be promoted more slowly in the next year, and hence serial correlation would be weakened. However, if the effect of employer learning is overwhelming, for example, in the case of using the accumulated information for the assignment of employees, then the employees promoted in the current year would likely be promoted in the next year, and a regularly serial correlation would be observed.[30]

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 "predictable winners and losers" were generated by compressing wage increase of slow-track groups.

The existence of an internal labor market at this firm has been verified. 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-

[28](1) For $\mathrm{rwrs01}$. Common panel unit root test (Levin, Lin and Chu test): t statistic:-113.3332^{***}, cross sections included: $1,395$, total panel observations: $19,371$. Individual panel unit root test (Im, Pesaran and Chin test): W statistic:-52.0774^{***}, cross sections included: $1,357$, total panel observations: $19,257$. (2) For $\mathrm{rwrs02}$. Common panel unit root test (Levin, Lin and Chu test): t statistic: -122.7191^{***}, cross sections included: $1,102$, total panel observations: $14,284$. Individual panel unit root test (Im, Pesaran and Chin test): W statistic:-52.4568^{***}, cross sections included: $1,067$, observations: $14,179$.Optimal lags are determined by Akaike Information Criterion, $***$ denotes significance at the 1 percentage level.

[29]See Baker et al. (1994b), p. 947; and Baker and Holmstrom (1995), p. 257. Such a result is theoretically predicted by symmetric learning between the employer and the employee (Gibbons and Waldman (1999), pp. 1333-1341.).

[30]See Baker et al. (1994a), pp. 901, 916; and Baker et al. (1994b), pp. 924, 926-927, 952-954.

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 shown in the coefficient of interaction term between the 2-year cohort dummy and tenure ($\mathrm{yj} \times \mathrm{ten}$) increases as the cohorts decrease. 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. Model 2-3 checks for robustness. After controlling for the cohort effect, the coefficient of interaction term between the 2-year cohort dummy and tenure ($\mathrm{yj} \times \mathrm{ten}$) is stable, supporting our interpretation of model 2-2.

Although the latest cohorts in model 2-2 show an exceptionally large coefficient of ($\mathrm{yj} \times \mathrm{ten}$), this value does not imply that the return on investment in human capital spiked in the late 1960s. Even after the cohort effect is controlled for in model 2-3, ($\mathrm{yj} \times \mathrm{ten}$) has an exceptionally large coefficient in the cohorts of the late 1960s. Thus the exceptionally large coefficient of ($\mathrm{yj} \times \mathrm{ten}$) in the late 1960s does not indicate a particular increase of the return on firm-specific human capital investment at that time; rather, it captures the marginally decreasing aspect of investment in human capital shown in equation (2). The particularly large coefficient of ($\mathrm{yj} \times \mathrm{ten}$) of the late 1960s just indicates that the return on human capital investment is larger for younger workers.

4 Wage growth in an internal labor market

4.1 Human capital investment, wage growth, and reproduction

Table 3 provides the results of the random effect estimation regressing real wage (rw) on the height when employed by the firm (hgt), the years of schooling (yos), previous work experience before he joined the firm (pre), tenure at the firm (ten), the interaction of height and tenure ($\mathrm{hgt} \times \mathrm{ten}$), the interaction of the years of schooling and tenure ($\mathrm{yos} \times \mathrm{ten}$), 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 ($\mathrm{dcy} \times \mathrm{ten}$, $\mathrm{sy} \times \mathrm{ten}$, $\mathrm{dct} \times \mathrm{ten}$, $\mathrm{dc} \times \mathrm{ten}$).[31] 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,[32] the years of schooling is separated by the prewar education dummy (prw) and the postwar education generation dummy (psw). Assuming that

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

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

the individual productivity function can be approximated by a Cobb-Douglas function, we apply logarithmic expression on regressors as well as the dependent variable, the rear wage. The years of schooling (yos) has a positive coefficient. Schooling raised productivity and real wage earning. Previous work experience (pre) also has a positive coefficient, indicating that longer previous experience led to larger productivity. In model 4-2, height (hgt) has a positive coefficient. Physical strength did matter in the steel industry.

Human capital acquisition also affected workers' fertility decision. When fertility is endogenous, human capital accumulation is presumed to affect fertility decision. **Table 4** regresses the number of dependent children to components of human capital. While the job security within the internal labor market, represented by ten, has a positive coefficient, the previous experience pre has also a positive coefficient. Public education (yos) also has a positive impact, as Omori (2009) and Azarnert (2010) predicted. While insecurity of job is generally destructive to workers' family and fertility,[33] workers who joined Kamaishi had not necessarily postpone fertility decision until getting job security at this firm. They made children given the portfolio of human capital accumulation composed of physiological characteristics (hgt), public education (yos), general experience (pre), and tenure at this firm (ten). In the portfolio, tenure has a relatively larger impact, but does not dominate others. Furthermore, with human capital components being controlled for, the real wage (rw) does not increase the number of children. Employees insured themselves by assembling human capital acquisitions, and cash flow did not independently affect their fertility decision.

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

Table 4 also indicates that the role of training programs changed over the sample period. By the middle 1940s, while the training program completion dummies, dcy, sy, dct, have negative coefficients, interactions with work experience, dcy $\times$ pre, dcy $\times$ ten, sy $\times$ pre, dct $\times$ pre, dct $\times$ ten, dc $\times$ ten, have positive coefficients, indicating that less productive employees were selected for training and that training programs and work experience were complements.

From the late 1940s, while the training program completion dummy, dc, has a positive coefficient, interactions with work experience, dc $\times$ pre, dc $\times$ ten, have negative coefficients, which mentions that more productive employees were selected for training and that training program and experience became less complementary and/or 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 probit estimation. The pre-war program, Development Center for Technicians (dcy), more likely accepted less-educated employees, obliged by the governmental ordinance,[34] while the post-war program, Development Center (dc), more likely accepted better-educated employees. When choosing

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

[34] 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. Thus, positive coefficients of sy and dct are at least partly induced by the governmental policy. This requirement was abandoned when junior high school became compulsory in 1947.

employees for training programs, the firm statistically discriminated better-educated employees by the middle 1940s, and less-educated employees from the late 1940s.

As to previous experience, the Development Center for Technicians and Development Center (dct, dc) more likely accepted those who had less experience. During wartime, the firm came to invest in employees who had less previous experience, and after the war, invested in those who had more the years of schooling and less previous experience.

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 "port of entry" policy after the war.

4.3 Increase in the return on schooling

The larger coefficient of the interaction between the postwar education dummy and the years of schooling (psw$\times$yos) than that of the interaction between the prewar education dummy and the years of schooling (prw$\times$yos) 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 (yj $\times$ yos) in model 6-1, and in models 6-2 and 6-3, controlling for the effect of employer learning (yos $\times$ ten). Although model 6-1 shows a negative return on education in early cohorts, this result is because the employer learning effect is not controlled for and thus the decreasing value of schooling record as "sheepskin"[35] 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 surged after the war. Because the signaling effect of schooling is controlled for, the return on education reflects the return on 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 (dy$\times$yos). 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. The postwar growth took the direction of technology-education complementary development.

[35] See Hungerford and Solon (1987), pp. 175-177; Belman and Heywood (1991), pp. 721-723; and Jaeger and Page (1996), pp. 734-738.

5 Discussion: Implication of the empirical results

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 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.[36] The postwar junior high schools and most high schools have focused on general education and not vocational education that teaches specific and inflexible skills.

Despite the rapid increase in the number of better-educated workers, the larger coefficient of the interaction between the postwar education dummy and the years of schooling ($\mathrm{psw} \times \mathrm{yos}$) than that of the interaction between the prewar education dummy and the years of schooling ($\mathrm{prw} \times \mathrm{yos}$) in **Table 4** and the increasing coefficient of interaction term between the 2-year cohort dummy and the years of schooling ($\mathrm{yj} \times \mathrm{yos}$) in cohorts decreasing, notably since the 1950s, in model 6-2 in **Table 6**, imply that the return on schooling increased after the Second World War.[37]

This larger coefficient of $\mathrm{psw} \times \mathrm{yos}$ indicates that, responding to the increased supply of a better-educated workforce, the technology-skill/education complementarity was augmented along with the manualization of the production line, and the transition actually increased the demand for more educated workers and increased the return on education, as occurred in the United States from the 1920s to the 1940s.[38] The Kamaishi Iron Works rode the trend and invested more in better-educated workers after the Second World War, as **Table 6** shows.

While the "port 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.[39] In our case, the practice was never dominant up to the end of the 1960s, although an internal labor market was already formed in the 1930s. Employees' fertility decision marking was also on the balance between previous experience and tenure at the firm. Employees' fertility decision only relatively dependent of the internal labor market indicates that the establishment was not a modern "manor," and 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, the in-house training program changed after the Second World War. After the Second World War, employees with less previous experience and with more education were

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

[37] 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 institutional factors had a significant role in the United States (Goldin and Margo (1992), pp. 17-32; and Goldin (1999), pp. s80-s92.).

[38] See Goldin and Katz (1998), pp. 726-727.

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

more likely to be accepted after the war as shown in **Table 5**.

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, extended secondary schooling, instead of on-the-job training, replaced the role of previous experience before joining an internal labor market under technology-education complementary development; and third, the extreme style of internal labor markets in Japan, the "port of entry" policy, was thus occasionally implemented while catching up with the United States after the war-time self-isolation. While it is not exceptional among developed economies after the Second World War in the long-term that education has replaced tenure within internal labor markets,[40] 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 management of major firms not only for white-collar employees but also for blue-collar employees in the 1960s among Japanese manufacturing firms;[41] since then, on-the-job training closely linked to employees' educational backgrounds to has become a persistent personnel policy in Japanese firms.[42]

Let us get back to the question; whether the transition of Japanese firm organizations was an endogenous innovation or not. An inference based on the results in this research is that it was an adjustment to rapid increase in the return on education, which overwhelmed work experience on short-term basis in early stages of workers' careers, under technology-skill/innovation complementary development, and to explosive expansion of secondary education influenced by the United States, instead of unique invention. Rather, the "uniquely-American invention"[43] of extended secondary school in the early twentieth century was introduced to Japan under the U.S. occupation. The critical change of in-house training at Kamaishi, more focus on better-educated employees indeed occurred from the late 1940s.

Meanwhile, Japan capitalized on an advantage of backwardness. Japanese manufacturing followed the U.S. manufacturing to build internal human capital investment well linked to expanded secondary education, and went ahead beyond the American ascendants. Extreme focus on firm-specific human capital investment on better educated workers arrived at the top of sophistication once, and left an inflexible labor market in the society. In addition, the Japanese case is quite different from the German case. Germany renovated its apprenticeship system and transformed it seamlessly linked to compulsory secondary education. As a result, surprisingly, the return on compulsory schooling independent of the effect from apprenticeship is not observed in Germany.[44] Catching up with the United States, Japan and Germany reached at contrasting extreme equilibria. The choice between the opposite directions was definitely endogenous and path-dependent.

Then, a possible question is whether the Japanese system is sustainable or not. Our results indicate that a strict "port of entry" policy was not a principle, at least up to the 1960s.

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

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

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

[43] See Goldin (1998), p. 350.

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

Such a policy appears to have prevailed since the 1970s and does not have so long history. Furthermore, the practice is thought to have become less prevalent since the 1990s, when the mobility of younger generations has increased again while long-term employment is still prominent among older employees in major Japanese firms.[45] The "dual structure" of the labor market also has been relaxed.[46] The strict "port of entry" policy is probably shorter-lived than was assumed. Japanese firms have recently conducted mid-career recruitment more, and this change is not unprecedented, but rather reflects the 1960s norm. This change also would shake inflexible "dual" labor market in the near future.

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

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

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

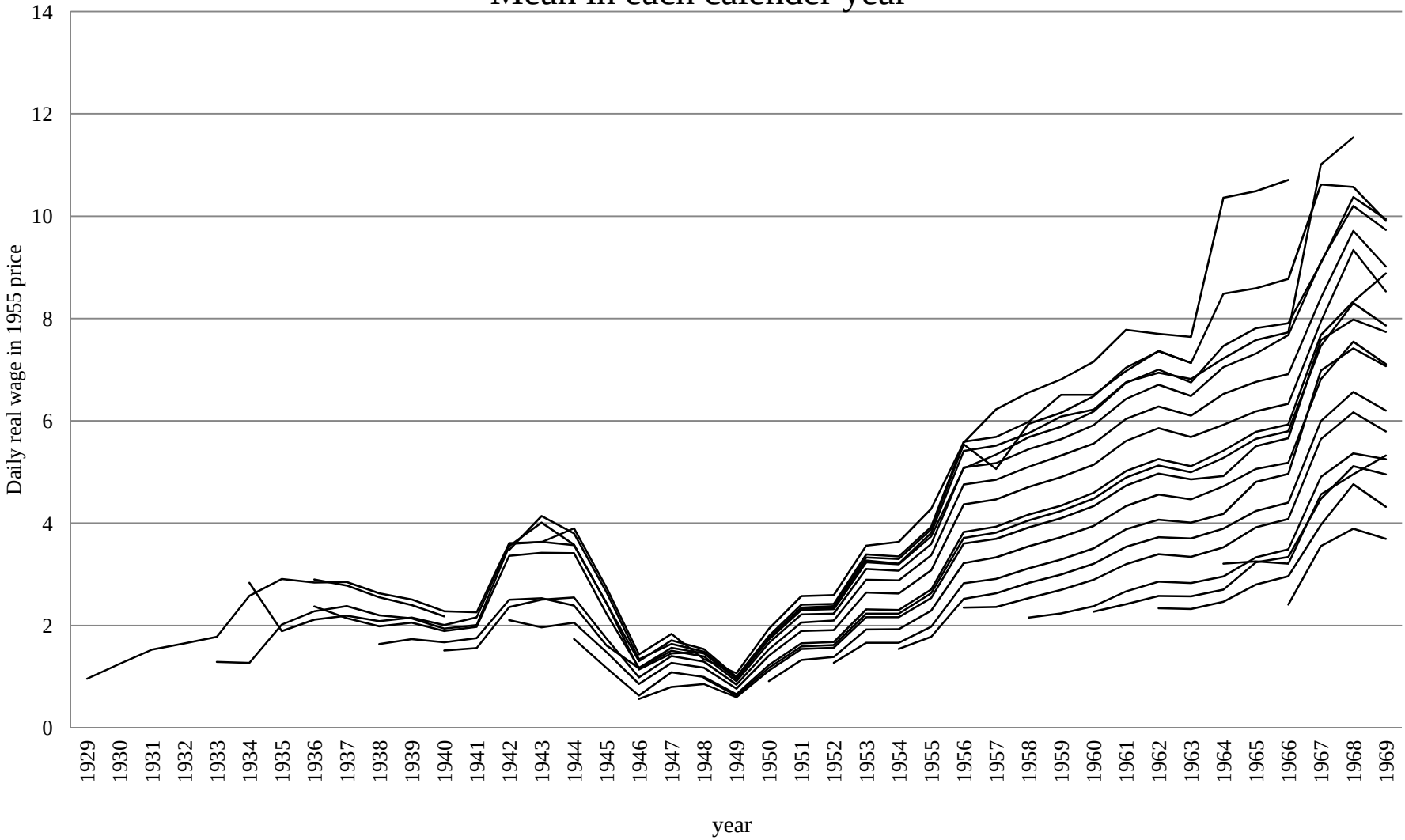

Figure 2 Wage curves of two consecutive cohort year groups:
Maximum in each calender yeaar

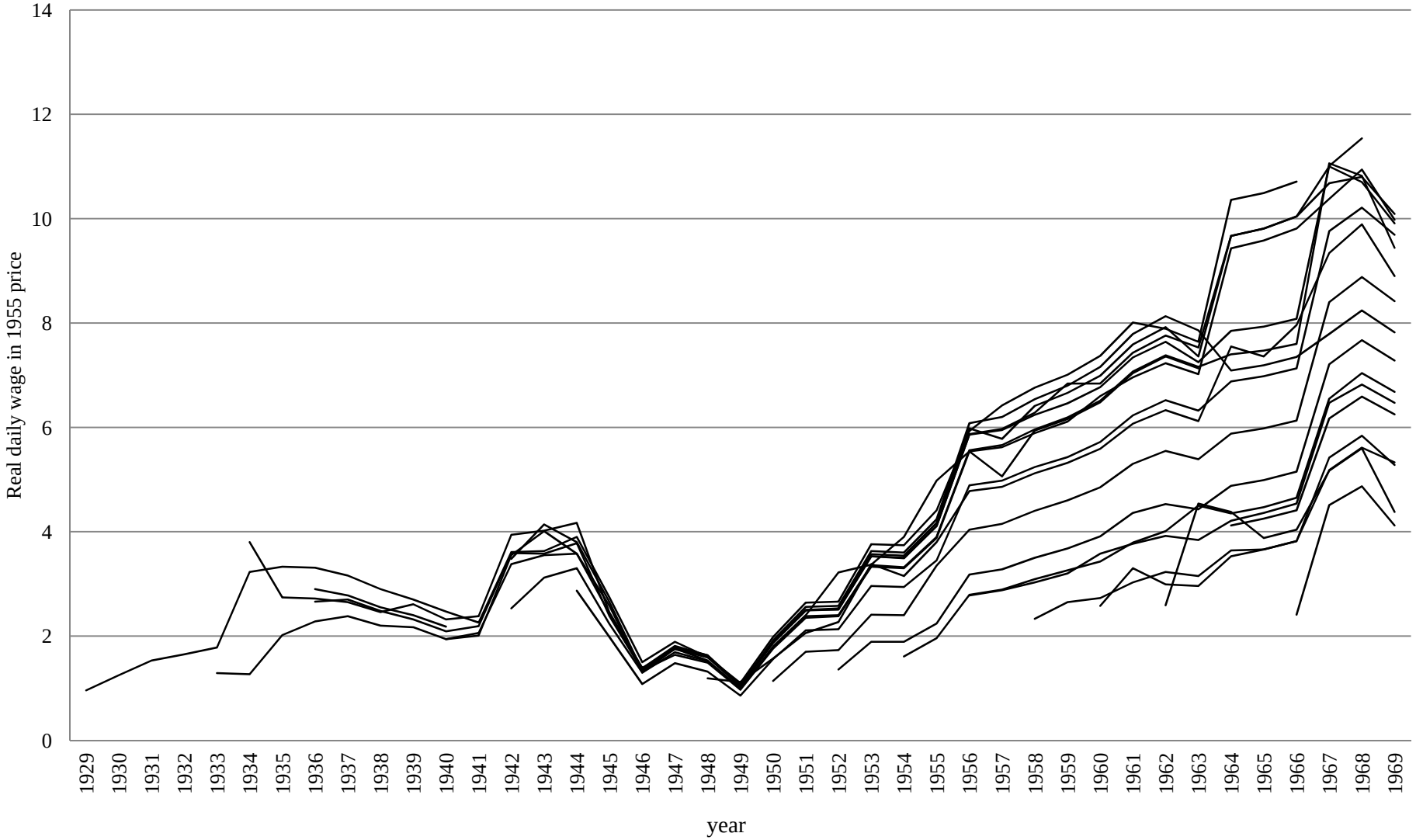

Figure 3 Wage curves of two consecutive cohort year groups:
Minimum in each calender year

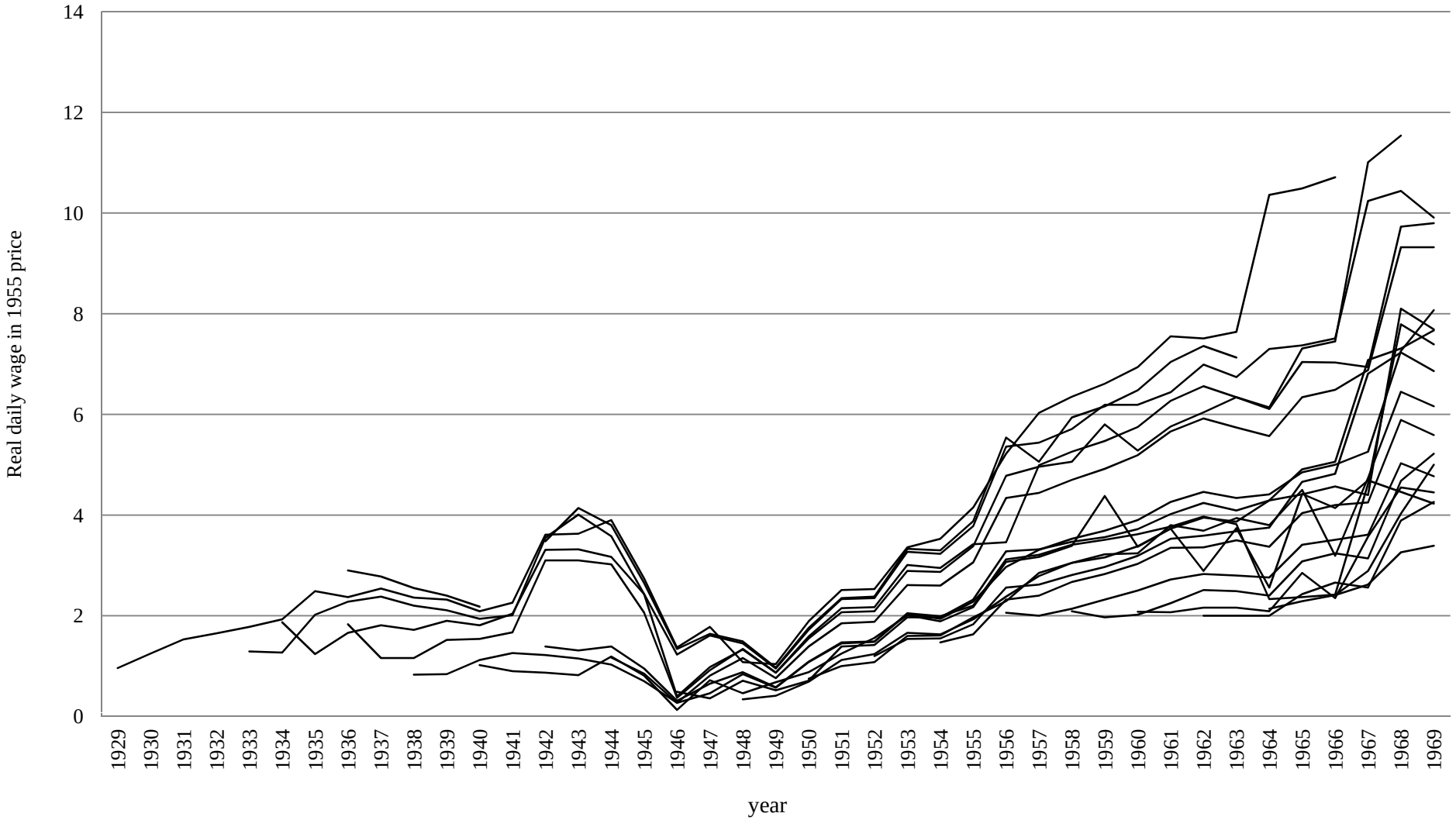

Table 1 Emplyee numbers, years of schooling, and previous experience across cohorts.

Year joined	Number of employees who joined	Number of observations	Years of schooling (yos)				Years of previous experience (pre)				Nationwide events
			max	min	median	mean	max	min	median	mean	
yj1928	1	35	9	9	9	9.00	3	3	3	3.00	
yj1929	1	38	8	8	8	8.00	1	1	1	1.00	
yj1930	1	34	8	8	8	8.00	2	2	2	2.00	
yj1931	0	0	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	
yj1932	0	0	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	
yj1933	3	92	8	8	8	8.00	5	2	2	2.75	
yj1934	2	62	8	6	6	6.94	11	5	5	7.81	
yj1935	5	158	8	8	8	8.00	9	1	1	3.94	
yj1936	7	220	8	8	8	8.00	9	1	6	5.77	
yj1937	7	214	8	6	8	7.74	12	1	8	6.51	
yj1938	18	534	8	6	8	7.54	13	0	6	5.30	
yj1939	41	1,175	8	6	8	7.91	13	0	5	5.15	War effort
yj1940	43	1,196	8	6	8	7.81	12	0	6	5.29	
yj1941	44	1,162	9	6	8	7.88	13	0	4	4.70	
yj1942	31	788	9	6	8	7.71	16	0	2	4.33	
yj1943	25	605	9	0	8	7.61	14	0	3	4.39	
yj1944	27	626	8	0	8	7.42	16	0	2	4.44	
yj1945	18	399	8	6	8	7.78	3	0	1	0.85	
yj1946	19	388	8	6	8	7.78	22	0	1	3.37	
yj1947	12	226	8	6	8	7.84	3	0	1	0.89	
yj1948	293	5,664	12	6	8	8.01	23	0	9	9.64	
yj1949	266	4,795	12	6	8	8.05	21	0	8	8.64	Reconstructior
yj1950	38	634	12	6	9	8.38	26	0	6	5.83	
yj1951	54	889	9	6	8	7.66	21	5	9	9.41	
yj1952	7	105	9	6	8	7.82	10	5	7	7.31	
yj1953	13	154	12	9	9	9.16	4	0	3	2.77	
yj1954	19	238	12	9	9	9.79	3	0	3	2.31	
yj1955	11	124	9	9	9	9.00	3	2	3	2.88	
yj1956	93	973	12	7	9	8.81	20	1	7	7.43	
yj1957	71	657	12	6	9	8.90	18	0	6	7.03	Rapid growth began
yj1958	26	199	9	9	9	9.00	9	2	3	3.10	
yj1959	89	610	14	8	9	10.08	15	0	3	3.84	
yj1960	46	265	12	8	9	10.19	26	0	3	4.85	
yj1961	37	161	12	9	9	9.15	12	1	3	4.07	
yj1962	89	312	12	8	12	10.73	9	0	2	2.08	
yj1963	43	117	12	0	9	7.60	36	2	12	10.30	
yj1964	17	88	9	6	8	8.13	35	2	20	20.63	
yj1965	9	35	12	8	12	11.09	5	1	1	1.91	
yj1966	10	31	12	12	12	12.00	13	0	1	2.06	
yj1967	8	19	12	9	9	10.42	14	1	5	6.47	
total	1,544	24,022									

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		2-3	
Estimation method	panel least squares					
Dependent variable	log(rw)					
Cross-section	pooled (no cross-section dummy)					
Period (year)	fixed (year dummies inserted)					
Indepedent variables	coefficient	*t* statistic	coefficient	*t* statistic	coefficient	*t* statistic
c	0.4680	25.0154 ***	-0.1154	-10.1009 ***	-0.2692	-5.3959 ***
log(yos)	0.1396	31.7046 ***	0.1400	32.4459 ***	0.1372	31.6735 ***
log(exp)	0.2116	112.8607 ***	0.2111	119.8044 ***	0.2087	111.7480 ***
log(ten)	0.0349	17.2919 ***				
yj1930-1931	-0.0331	-1.5826			0.1614	3.0335 ***
yj1932-1933	-0.0488	-3.1105 ***			0.0275	0.7193
yj1934-1935	-0.0752	-5.4992 ***			0.0937	2.7562 ***
yj1936-1937	-0.0924	-7.0411 ***			0.0986	2.8601 ***
yj1938-1939	-0.1171	-9.3742 ***			0.0786	2.2733 **
yj1940-1941	-0.1575	-12.6004 ***			0.1100	3.0945 ***
yj1942-1943	-0.1990	-15.6638 ***			0.1298	3.5129 ***
yj1944-1945	-0.2690	-20.8844 ***			0.0929	2.4309 **
yj1946-1947	-0.3049	-23.0515 ***			0.0810	2.0336 **
yj1948-1949	-0.3176	-24.9450 ***			0.1468	3.6206 ***
yj1950-1951	-0.3907	-29.8522 ***			0.1254	2.9612 ***
yj1952-1953	-0.4265	-29.9381 ***			0.1681	3.7131 ***
yj1954-1955	-0.4467	-31.5828 ***			0.2185	4.7186 ***
yj1956-1957	-0.5752	-42.2726 ***			0.1104	2.3354 **
yj1958-1959	-0.6238	-43.9963 ***			0.1559	3.1455 ***
yj1960-1961	-0.6643	-44.8111 ***			0.1656	3.2143 ***
yj1962-1963	-0.6663	-43.5349 ***			0.2260	4.2484 ***
yj1964-1965	-0.6600	-38.8257 ***			0.2381	4.0795 ***
yj1966-1967	-0.6611	-30.2358 ***			0.3515	4.6687 ***
yj1928-1929×log(ten)			0.0233	45.1015 ***	0.0293	16.2214 ***
yj1930-1931×log(ten)			0.0218	27.7769 ***	0.0214	8.9992 ***
yj1932-1933×log(ten)			0.0258	54.0805 ***	0.0314	18.7486 ***
yj1934-1935×log(ten)			0.0258	69.3462 ***	0.0289	19.9306 ***
yj1936-1937×log(ten)			0.0275	88.0729 ***	0.0307	22.6879 ***
yj1938-1939×log(ten)			0.0294	122.2468 ***	0.0339	26.6975 ***
yj1940-1941×log(ten)			0.0295	119.2301 ***	0.0328	25.8876 ***
yj1942-1943×log(ten)			0.0300	104.3127 ***	0.0325	25.1261 ***
yj1944-1945×log(ten)			0.0292	88.9540 ***	0.0343	25.9873 ***
yj1946-1947×log(ten)			0.0310	73.4937 ***	0.0376	26.7625 ***
yj1948-1949×log(ten)			0.0341	97.1136 ***	0.0364	29.2215 ***
yj1950-1951×log(ten)			0.0334	73.8378 ***	0.0381	28.4383 ***
yj1952-1953×log(ten)			0.0351	43.3464 ***	0.0362	19.5862 ***
yj1954-1955×log(ten)			0.0382	47.2044 ***	0.0339	18.7833 ***
yj1956-1957×log(ten)			0.0315	42.9422 ***	0.0416	28.5900 ***
yj1958-1959×log(ten)			0.0324	30.2860 ***	0.0377	19.9354 ***
yj1960-1961×log(ten)			0.0324	19.8505 ***	0.0372	13.5988 ***
yj1962-1963×log(ten)			0.0456	19.8849 ***	0.0337	9.3925 ***
yj1964-1965×log(ten)			0.0704	21.4546 ***	0.0591	8.9090 ***
yj1966-1967×log(ten)			0.1116	14.3929 ***	0.0443	1.9670 **
year dummies	yes		yes		yes	
cross-sections included	1,489		1,489		1,489	
periods included (years)	41 (1929-1969)		41 (1929-1969)		41 (1929-1969)	
included observations	22,038		22,038		22,038	
adjusted R^2	0.9785		0.9790		0.9793	
F statistic	16,194.9638 ***		16,562.1144 ***		12,870.9100 ***	

Notes : Base year joined dummy for models 2-1 and 2-3 is yj1928-1929. *** and ** respectively denote signifnicance at the 1 percentage level and at 5 percatage level.

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

	3-1			3-2		
Estimation method	panel generalized least squares					
Dependent variable	log(rw)					
Cross-section	random effect					
Period (year)	pooled (no year dummies inserted)					
Indepedent variables	coefficient	*t* statistic		coefficient	*t* statistic	
c	-1.4150	-33.3763	***	-1.2511	-23.4425	***
log(hgt)				0.1959	2.7416	***
log(yos)×prw	0.3239	17.9316	***	0.3239	14.8020	***
log(yos)×psw	0.5247	30.7698	***	0.5057	24.4005	***
log(pre)	0.1982	49.8839	***	0.1519	29.7626	***
log(ten)	0.6168	202.7651	***	0.6701	239.6783	***
dcy	-0.4263	-3.5817	***	-0.2457	-2.5355	**
dcy×log(ten)	0.1509	3.0560	***	0.0710	1.7535	*
sy	-0.3514	-18.9729	***	-0.2926	-18.3034	***
sy×log(ten)	0.1486	19.1903	***	0.1090	16.5757	***
dct	-0.5035	-15.1202	***	-0.2059	-5.8450	***
dct×log(ten)	0.2002	15.1929	***	0.0901	6.1847	***
dc	0.1788	10.5755	***	0.3096	21.9491	***
dc×log(ten)	-0.0635	-7.8730	***	-0.1672	-24.3744	***
cross-sections included	1,537			1,219		
periods included (years)	41(1929-1969)			31(1939-1969)		
included observations	23,172			16,486		
adjusted R^2	0.7023			0.8206		
F statistic	4,555.8741	***		5,799.7845	***	

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.

Table 4 Fertility decision by employees.

	4-1			4-2		
Estimation method	panel generalized least squares					
Dependent variable	noc					
Cross-section	pooled (no cross-section dummy)			random effect		
Period (year)	fixed (year dummies inserted)			pooled (no year dummies inserted)		
Indepedent variables	coefficient	*t* statistic		coefficient	*t* statistic	
c	-1.5839	-8.7938	***	-1.3633	-2.8619	***
hgt	0.7071	4.1444	***	0.4995	1.0622	
yos	0.0539	7.7797	***	0.0643	4.4188	***
pre	0.1085	56.1927	***	0.1118	25.8689	***
ten	0.1434	30.7769	***	0.1419	40.5368	***
rw	-0.0903	-4.0150	***	-0.1229	-11.3524	***
cross-sections included	1,219			1,219		
periods included (years)	31(1939-1969)			31(1939-1969)		
included observations	16,486			16,486		
adjusted R^2	0.4954			0.4251		
F statistic	463.4078	***		2,439.2969	***	

Notes: *** denotes signifnicance at the 1 percentage level.

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

	5-1		5-2		5-3		5-4	
Estimation method	binary probit		binary probit		binary probit		binary probit	
Dependent variable	dcy		sy		dct		dc	
Indepedent variables	coefficient	*z* statistic	coefficient	*z* statistic	coefficient	*z* statistic	coefficient	*z* statistic
c	-2.3755	-4.1691 ***	-1.5296	-7.9923 ***	-1.2867	-5.2966 ***	3.9721	17.3353 ***
log(age)	0.2112	1.3151	0.4258	9.8796 ***	0.6343	11.2544 ***	-1.3778	-27.5898 ***
log(yos)	-0.4539	-3.2520 ***	-0.4283	-7.1412 ***	-0.6750	-9.3723 ***	0.1473	2.0745 **
log(pre)	-0.0422	-0.7758	-0.0121	-0.8233	-0.6091	-33.4652 ***	-0.6199	-37.0405 ***
included observations	24,019		24,019		24,019		24,019	
McFadden R^2	0.0085		0.0091		0.1134		0.2334	
LR statistic	8.8582 **		183.4853 ***		1,174.6527 ***		4,229.2074 ***	

Notes : *** and ** respectively denote signifnicance at the 1 percentage level and at 5 percatage level.

Table 6 Change in return on education.

	6-1			6-2			6-3		
Estimation method	panel generalized least squares								
Dependent variable	log(rw)								
Cross-section	random effect								
Period (year)	pooled (no year dummies inserted)								
Indepedent variables	coefficient	*t* statistic		coefficient	*t* statistic		coefficient	*t* statistic	
c	-0.7957	-21.0819	***	-1.2037	-20.5126	***	-0.5010	-17.1849	***
pre	0.1128	30.4635	***	0.1079	29.0354	***	0.1142	46.3404	***
ten	0.6597	205.3089	***	0.8064	48.7065	***	0.6116	60.2288	***
yos×ten				-0.0162	-9.0301	***	-0.2399	-52.7048	***
yj1928-1929×yos	-0.0013	-0.0523		0.1900	5.9436	***	1.1834	54.2457	***
yj1930-1931×yos	-0.0344	-1.0794		0.1520	4.0259	***	1.1547	41.4584	***
yj1932-1933×yos	0.0200	0.8800		0.2070	6.7563	***	1.1243	56.7416	***
yj1934-1935×yos	0.0219	1.1348		0.2074	7.3841	***	1.1005	65.0508	***
yj1936-1937×yos	0.0413	2.3418	*	0.2288	8.4260	***	1.0850	70.2387	***
yj1938-1939×yos	0.0508	3.0891	***	0.2370	9.0145	***	1.0662	73.8429	***
yj1940-1941×yos	0.0453	2.7842	***	0.2320	8.8455	***	1.0408	72.7698	***
yj1942-1943×yos	0.0493	2.9595	***	0.2356	8.9109	***	1.0145	69.7782	***
yj1944-1945×yos	0.0596	3.4807	***	0.2446	9.1907	***	0.9846	66.5906	***
yj1946-1947×yos	0.0869	4.9759	***	0.2717	10.1326	***	0.9393	63.5183	***
yj1948-1949×yos	0.1371	8.8269	***	0.3274	12.5412	***	0.9356	67.8077	***
yj1950-1951×yos	0.1972	12.2704	***	0.3865	14.6738	***	0.8968	63.8825	***
yj1952-1953×yos	0.2409	13.7486	***	0.4318	15.7756	***	0.8544	58.8512	***
yj1954-1955×yos	0.2847	17.2557	***	0.4780	17.7367	***	0.8346	59.6398	***
yj1956-1957×yos	0.3113	20.2812	***	0.5025	19.2681	***	0.7873	58.0144	***
yj1958-1959×yos	0.3452	22.4902	***	0.5348	20.6186	***	0.7400	55.2108	***
yj1960-1961×yos	0.3866	24.0849	***	0.5747	21.9209	***	0.7114	52.8506	***
yj1962-1963×yos	0.4535	28.2613	***	0.6354	24.7503	***	0.6892	51.9205	***
yj1964-1965×yos	0.5180	25.5829	***	0.7078	24.3444	***	0.7236	50.9200	***
yj1966-1967×yos	0.5926	22.5316	***	0.7738	23.5076	***	0.6588	44.8916	***
sy	-0.2571	-14.1732	***	-0.2530	-14.0538	***	0.0201	3.2330	***
sy×ten	0.1178	15.0567	***	0.1154	14.8587	***	-0.0011	-0.5172	
dct	-0.3785	-11.7884	***	-0.3768	-11.8309	***	0.0327	3.1137	***
dct×ten	0.1597	12.1994	***	0.1590	12.2395	***	0.0234	6.7526	***
dc	0.1217	7.4678	***	0.1152	7.1157	***	-0.0071	-1.2267	
dc×ten	-0.0587	-7.2986	***	-0.0551	-6.8950	***	0.0417	17.5407	***
dy×yos	No			No			Yes		
cross-sections included	1,489			1,489			1,489		
periods included (years)	41(1929-1969)			41(1929-1969)			41(1929-1969)		
included observations	22,038			22,038			22,038		
adjusted R^2	0.7366			0.7376			0.9820		
F statistic	2,202.3825	***		2,137.0081	***		17,423.6840	***	

Notes : *** and ** respectively denote signifnicance at the 1 percentage level and 5 percantage level.

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).	
yos	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: age–(6+yos)+1.	
pre	previous experience: age–(6+yos+ten)+1. Note that every sample emolyee had worked at the firm until the last year of his record.	
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.	

Notes : The source of average height is the School Health Statistics surveyed by the Ministory of Education, Science, Sports and Culture (http://www.e-stat.go.jp/).