School, Firm, and Family

Emergence of the Japanese Internal Labor market*

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Abstract

Contemporary Japanese firms recruit new graduates and promote from within, providing a rare example of the "ports of entry" policy. This microanalysis of the steel industry in the 1930-60s shows that 1) the internal labor market had been continuously enhanced after the 1930s, but 2) mid-career recruiting was active, previous experience served as signal of ability, and employees' fertility decision largely depended on previous experience as well as tenure until the 1960s, while 3) the return on education sharply increased after the 1950s. These facts indicate that extended schooling replaced mid-career experience after the 1970s alongside technology-education complementary development.

Key words: Internal labor market, return on schooling, tenure and wage, fertility decision.
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, however, 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 the internal labor market 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, the contemporary Japanese firm provides 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 flexible the market, the more luck with respect to the state of economy when a worker graduates affects employment would be mitigated. While such distortions are observed in the US, 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.[8]

This particular feature of the Japanese labor market implies that a study of the Japanese internal labor market could clarify some aspects in the most controversial component of the internal labor market hypothesis: the "ports of entry" policy. This research thus examines the formation of the Japanese internal labor market 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 the internal labor market 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 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 was used as a screening device as was schooling, and employees' fertility decision depended on previous experience which captures investment in general human capital as well as tenure, 2) return on human capital acquisition within the firm gradually increased throughout the period, 3) the return on schooling increased rapidly after the Second World War, and 4) selection for in-house training programs was affected by previous experience before the Second World War, but by schooling after the war. These results suggest that while previous experience served as a signal of general human capital as schooling did throughout the period, the relative importance

[7] For the US, see Kahn (2010); and Genda, Kondo and Ohta (2010); for Germany, see von Wachter and Bender (2006, 2008); 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.

of them changed after the Second World War; years of schooling was replacing the years of previous experience as the primary opportunity for general human capital investment and the screening device to calibrate the employees' hidden general human capital at the time of recruitment. Mid-career experience appears to have been supplanted by schooling, not directly absorbed by the internal labor market.

2 Supposed working of internal labor market

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 the 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 the internal labor market somehow separates wage dynamics from the performance or merit of employees. Instead, the internal labor market has 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 the internal labor market are not expected to differ much, on average in the long term, from the marginal productivity, though they might differ in the short term.[11]

One component of the internal labor market 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 supposed to be more able with positive probability, employers statistically discriminate applicants based on education. Once a worker is hired, however, employers gradually learn the worker's true ability. Employers come to rely

[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.

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 supposed 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 the internal labor market 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 the internal labor market 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 their human capital through work experience. Then some workers join a firm that commits to long-term employment and determines wages in some administrative manner, not by simply following the outside market pricing. Thus the wage determination within the firm is assumed to replace the market pricing, at least to some extent.

While such a firm is assumed to shield its wage determination from the outside market is beneficial, 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 via 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 an internal labor market even more elaborate than the one 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 feature is not owing to the unique culture of Japanese firms, though post-war Japanese firms

[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; Pinkston (2009), pp. 381-389; and Galindo-Rueda (2003).

[14] See Williamson et al. (1975); and Greenwald (1986).

[15] See Hall (1980, 1982).

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 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 the internal labor market in which workers' general cognitive skills are engaged in firm-specific human capital.[17] The postwar experience in Japan was similar; accelerated growth of the internal labor market after the Second World War was associated with education reform that led to a massive increase in secondary school graduates.

Except for the industries that emerged in the twentieth century, such as the petroleum refinery industries, the transition to internal labor markets for older major industries 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 skill ascribed to individual senior employees was transformed into a manualized skill 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.

This research focuses on the wage growth observed in the micro data of 1,544 blue-collar employees from 1929 to 1969 at the Kamaishi Iron Works, one of the leading iron works in Japan at the time, and addresses the formation of internal labor market.

3 Existence of an internal labor market in the case establishment

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

[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.

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.

Following this merger, Japan entered into a war against the United States, and the wartime isolation made the Japanese steel industry regress. Under the U.S. occupation after the war, as a part of antitrust policy imposed by the United States, Nippon Iron and Steel was dissolved into Fuji Steel and the Yawata Steel, with Kamaishi belonging to the former.

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 financing, which was 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.[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. This data set has both considerable disadvantages and advantages.

The disadvantage is due to selection and survival biases. 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.[23] However, this selection principle does not imply

[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.

[23] See Umezaki (2010), pp.47-49.

that the sample set is unbiased. First, the employees who willingly moved to Nagoya were those who believed that they would perform well at the most advanced plant: they were more ambitious and/or self-confident. Second, all of the sample employees were those who had worked until they moved to Nagoya in the 1960s. The "losers" at Kamaishi who had lost in the internal competition are not included.

However, the data set also has advantages, specifically with respect to this research. 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. This information includes records of previous work experience and not only educational details but also physiological features such as height, weight, and lung capacity, which were thought to be important data concerning blue-collar workers.

Each individual wage record includes:

1. Educational background (yos).

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

3. Panel data of training, promotion, wage and personal information:

   (1) 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).

   (2) Licenses the employee held.

   (3) Family composition.

   (4) Clinical history.

   (5) Basic wages.

   (6) Promotion and deployment: classes, division, and department assignment, and job assignment.

The panel data of the basic wage starts when the employee joined the firm and ends at the time when the employee moved to the Tokai Iron Works, varying from 1964 to 1969.

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 at mandatory 6-year elementary school and 2-year high 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 of elementary and junior high school and an additional 3 years of high school. High elementary school graduates comprised a majority before 1947,[24] and junior high school graduates were a majority after 1947.

3.3 Existence of the 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 the internal labor market that shields wage determination from the outside price mechanism.[25]

Table 2 contains regressions of real daily wages (rw) on experience in the labor market (exp), tenure (ten), the 2-year joined dummies such as $\mathrm{yj1928-1929}$, $\mathrm{yj1930-1931}$,

[24] 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.

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

$\mathrm{yj}1932-1933$, etc., and the interactions between the 2-year joined dummies and tenure such as $(\mathrm{yj}1928-1929)\times\mathrm{ten}$, $(\mathrm{yj}1930-1931)\times\mathrm{ten}$, $(\mathrm{yj}1932-1933)\times\mathrm{ten}$, 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.[26]

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.[27]

As Baker et al. (1994b) describes, the serial correlation of wage growth is another useful indicator of the internal labor market.[28] In the competitive market, in which wage increments are serially independent, the wage history should have a unit root and be random walk, or the coefficient of the first-lagged should be 1 in the auto-regression of wage. If the firm shields wage determination from the market by some wage policy, the result would be different.

Indeed, the common unit root of rw in the level term is rejected, and individual unit root of first difference of rw ($\Delta\mathrm{rw}$) is rejected.[29] Thus each of the differences of individual wage growth $\Delta\mathrm{rw}_{\mathrm{ten}}$ is a contraction mapping and tends to a unique fixed point.

Furthermore, the auto-regression of real wage with random effects ($\mathrm{rw}_{\mathrm{ten}}$), with the years of education (yos_i), and with the year dummies inserted as regressors yields a consistent result;[30]

$$(1)\qquad \log\mathrm{rw}_{\mathrm{ten}} = \underset{14.1903^{**}}{0.1843} - \underset{-8.2331^{**}}{0.0245}\log\mathrm{yos} + \underset{511.3296^{**}}{0.9168}\log\mathrm{rw}_{\mathrm{ten}-1}.$$

The coefficient of the first lag is smaller than 1, indicating that the level of rw is stationary after year dummies are controlled for.

In addition, the regression of real wage on the more lagged terms with random effects and

[26] 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.

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

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

[29] Common panel unit root test (Levin, Lin and Chu test) of rw: t statistic:-11.0441^{**}, cross sections included: $1,395$, total panel observations: $20,410$. Individual panel unit root test (Im, Pesaran and Chin test) of $\Delta\mathrm{rw}$: W statistic:-60.8254^{**}, cross sections included: $1,309$, observations: $18,419$. Optimal lag is determined by Akaike Information Criterion, $**$ denotes significance at the 1 percentage level.

[30] Estimation: Panel estimated generalized least squares with cross-section random effects. Year dummies: Yes. Sample periods: 40 (1930-1969). Cross-sections included: 1,481. Total panel observations: 20,369. The t statistics are within parentheses, where $**$ denotes significance less than 1 percent. Adjusted R^2: 0.9850. F-statistic: $33,488.3314^{**}$.

year dummies yields,[31]

$$
\begin{aligned}
\text{(2)} \qquad \log \mathrm{rw}_{\mathrm{ten}} = &\underset{(18.7069^{**})}{0.2246} - \underset{0.4976}{0.0014} \log \mathrm{yos} \\
&+ \underset{(70.4231^{**})}{0.6146} \log \mathrm{rw}_{\mathrm{ten}-1} + \underset{(7.8813^{**})}{0.0685} \log \mathrm{rw}_{\mathrm{ten}-2} \\
&+ \underset{(8.5806^{**})}{0.0689} \log \mathrm{rw}_{\mathrm{ten}-3} + \underset{(4.4246^{**})}{0.0341} \log \mathrm{rw}_{\mathrm{ten}-4} \\
&+ \underset{(5.6398^{**})}{0.0422} \log \mathrm{rw}_{\mathrm{ten}-5} + \underset{(5.0983^{**})}{0.0356} \log \mathrm{rw}_{\mathrm{ten}-6} \\
&+ \underset{(5.0263^{**})}{0.0325} \log \mathrm{rw}_{\mathrm{ten}-7} + \underset{(5.9691^{**})}{0.0295} \log \mathrm{rw}_{\mathrm{ten}-8}.
\end{aligned}
$$

The past wages have a significantly persistent impact on the current wage growth with the same sign, that is, toward the same direction. At the same time, the impact is decreasing, with each wage history going to some stationary state.

The periods of concern saw rapid growth of labor productivity in the industry, and hence, the average wage accordingly grew rapidly on average. For equations (1) and (2), however, the effect is controlled for by the year dummies. If employees are homogeneous, then, controlling for the firm-wide trend of productivity, the persistent effect of past wages toward the same direction must not appear. In other words, following the serial correlations observed in equations (1) and (2), the sample employees seem to have been heterogeneous in ability of human capital accumulation and there were "predictable winners and losers."[32]

In addition, it is reasonable to infer that the "predictable winners and losers" were found by the employer learning 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.[33]

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

Meanwhile, wage growth trajectory of a cohort differs from the others, as shown in **Figure 1**. **Table 3** regresses the real daily wage $\mathrm{rw}_{\mathrm{ten}}$ on the interaction terms of the 2-year joined

[31]Estimation: Panel estimated generalized least squares with cross-section random effects. Year dummies: Yes. Sample periods: 33 (1937-1969). Cross-sections included: 1,093. Total panel observations: 10,902. Adjusted R^2: 0.9811. F statistic: $13,833.6637^{**}$.

[32]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.).

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

dummy and the 1st and 2nd lagged terms of real daily wage such as $(\mathrm{yj}1928 - 1929) \times \log \mathrm{rw}_{\mathrm{ten}-1}$, $(\mathrm{yj}1930 - 1931) \times \log \mathrm{rw}_{\mathrm{ten}-1}$, $(\mathrm{yj}1932 - 1933) \times \log \mathrm{rw}_{\mathrm{ten}-1}$, etc., $(\mathrm{yj}1928 - 1929) \times \log \mathrm{rw}_{\mathrm{ten}-2}$, $(\mathrm{yj}1930 - 1931) \times \log \mathrm{rw}_{\mathrm{ten}-2}$, $(\mathrm{yj}1932 - 1933) \times \log \mathrm{rw}_{\mathrm{ten}-2}$, etc. Then significantly different wage curves are observed even between adjacent cohorts. These nonparallel wage curves generate the cohort effects observed in model 2-1 in **Table 2**.

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 significantly 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 shown in the coefficient of interaction term between 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 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 specific increase of return on 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 return on human capital investment is larger for younger workers.

4 Wage growth in the internal labor market

4.1 Human capital investment, wage growth, and reproduction

Table 4 provides the results of the random effect estimation regressing real daily wage (rw) on the height when employed by the firm (hgt),[34] 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 interaction of the previous work experience and tenure ($\mathrm{pre} \times \mathrm{ten}$), the dummy variables of

[34]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)."

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 ($\mathrm{dcy} \times \mathrm{ten}$, $\mathrm{sy} \times \mathrm{ten}$, $\mathrm{dct} \times \mathrm{ten}$, $\mathrm{dc} \times \mathrm{ten}$).[35] 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,[36] the postwar education generation dummy (psw) is inserted.

The years of schooling (yos) has a significantly positive coefficient. Schooling raised productivity and real wage earning. Previous work experience (pre) also has a significantly positive coefficient, indicating that longer previous experience led to larger productivity and was appreciated by the firm. In models 4-3 and 4-4, height (hgt) has a significantly positive coefficient. Physical strength did matter in the steel industry.

Interaction terms of tenure with height, the years of schooling, and previous experience ($\mathrm{hgt} \times \mathrm{ten}$, $\mathrm{yos} \times \mathrm{ten}$, and $\mathrm{pre} \times \mathrm{ten}$) indicate the effect of "employer learning." The effect of employer learning is typically observed as a non-positive coefficient of the interaction term between schooling and experience in a wage regression of raw level data, or a negative coefficient in a wage regression of the logarithmic expression because the effect of statistical discrimination based on schooling decreases as experience is acquired.[37] The negative coefficient of $\mathrm{yos} \times \mathrm{ten}$ captures that effect of employer learning in models 4-1 to 4-4.

Along with the years of schooling, other proxies of ability that are observable to the employer when recruited are physical characteristics such as height. Height sometimes affects wages,[38] and, especially in the case of blue-collar workers in the steel industry, then a male-dominated industry, physical strength was definitely critical especially in the departments of flatting and pig iron production, where workers were required to cope with high temperature and still make sensitive decisions about how to manage the flatting process and the blast-furnace that determined the quality of product. Height is a good proxy of such physical strength. With regard to height, the employer learning hypothesis holds. The interaction term of height with tenure ($\mathrm{hgt} \times \mathrm{ten}$) has a significantly negative coefficient in models 4-3 and 4-4.

Previous experience also appears to indicate the effect of employer learning, though to a lesser extent. In models 4-1 to 4-4, the interaction term between previous work experience and tenure ($\mathrm{pre} \times \mathrm{ten}$) has a significantly negative coefficient with a small absolute value, indicating that the firm recognized previous work experience as a proxy of workers' ability and that the statistical discrimination based on previous experience was corrected after the workers joined the firm.

The labor market environment also affected workers' fertility decision. When fertility is endogenous, human capital accumulation is supposed to affect fertility decision. **Table 5** regresses the number of dependent children to components of human capital. While the

[35] Some samples lack the information on height, weight, and lung capacity.

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

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

[38] See Hersch (2008), pp. 369-375.

job security within the internal labor market, represented by ten, has a significantly positive coefficient, the previous experience pre has also a significantly positive coefficient with considerable positivity. 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,[39] 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. The interaction of the postwar program with tenure $(\mathrm{dc} \times \mathrm{ten})$ has a significantly negative coefficient while the interaction terms of the prewar programs with tenure $(\mathrm{dcy} \times \mathrm{ten}, \mathrm{sy} \times \mathrm{ten}, \mathrm{dct} \times \mathrm{ten})$ have significantly positive coefficients in models 4-1, 4-2, 4-3, and 4-4.

The interaction term between the training programs and tenure captures the complementarity of the training programs with tenure. When other effects such as employer learning are controlled for, the sign of the coefficient of their interaction term would depend on whether the training program and acquisition of experience within the firm are complements. Thus, a possible interpretation of the change from the positive sign of the interaction terms with tenure of the prewar programs, Development Center for Youth, School of Youth, and Development Center for Technicians $(\mathrm{dcy} \times \mathrm{ten}$, $\mathrm{sy} \times \mathrm{ten}$, $\mathrm{dct} \times \mathrm{ten})$ to the negative sign of the postwar program, Development Center $(\mathrm{dc} \times \mathrm{ten})$ seems to be the change in content of the programs in terms of complementarity with experience within the firm. The negative coefficient of $(\mathrm{dc} \times \mathrm{ten})$ indicates that the Development Center focused on general human capital, which was a substitute for schooling.

With this change, the relation between previous experience and in-house training also changed after the Second World War. Before the war, interaction terms between the completion of in-house training programs and previous experience $(\mathrm{dcy} \times \mathrm{pre}$, $\mathrm{sy} \times \mathrm{pre}$, $\mathrm{dct} \times \mathrm{pre})$ have significantly positive coefficients, indicating that previous experience and completion of in-house training program $(\mathrm{dcy}$, sy, $\mathrm{dct})$ were complements, and thus workers who had more previous experience likely earned more after completing in-house training program than did those who had less previous experience. After the war, the interaction term $(\mathrm{dc} \times \mathrm{pre})$ has a significantly negative coefficient, which suggests that previous experience and the in-house training program (dc) were substitutes and new graduates likely earned more after completing the program than those who had more previous experience.

Furthermore, the firm's selection policy itself changed over time. **Table 6** decomposes the probability of acceptance to in-house training programs $(\mathrm{dcy}$, sy, dct, $\mathrm{dc})$ by probit estima-

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

tion. The pre-war program, Development Center for Technicians (dcy), more likely accepted less-educated employees, while the post-war program, Development Center (dc), more likely accepted better-educated employees.[40] As to previous experience, the School for Youth (sy) more likely accepted employees who had more previous experience, and the Development Center for Technicians and Development Center (dct, dc) more likely accepted those who had less experience. During wartime, the firm invested in employees who had less previous experience, and after the war, invested in those who had more years of schooling and less previous experience.

Table 7 inserted the estimated probabilities of dcy, sy, dct, and dc by **Table 6** as regressors in wage regressions. A noteworthy result is that the interaction term between total experience and years of schooling ($\exp \times \mathrm{yos}$) is positive, and hence, the effect of employer learning disappears. Bias due to lack of information about employees' abilities in the early stage is reflected by an acceptance policy for in-house training programs; thus, by controlling for the probability of acceptance to in-house training programs, the positive coefficient of $\exp \times \mathrm{yos}$ in models 7-1 and 7-2 captures the complementary effect between schooling and work experience.

Roughly speaking, the firm concentrated investment in human capital on new graduates instead of on more experienced workers after the Second World War. 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 return on schooling

The significantly positive coefficient of the postwar education dummy (psw) in **Tables 4, 6, 7** suggests that the return on education increased after the Second World War. **Table 8** attempts to track changes in the return on schooling along with cohorts by regressing real wage (rw) on interaction terms between the cohort dummy and the years of schooling ($\mathrm{yj} \times \mathrm{yos}$) in model 8-1, and in models 8-2 and 8-3, controlling for the effect of employer learning ($\mathrm{yos} \times \mathrm{ten}$). Although model 8-1 gives a result consistent with a negative return on education in early cohorts, this result can be explained by an employer learning effect that is not controlled for and decreasing value of schooling record as "sheepskin"[41] is captured. With the employer learning effect controlled for, the coefficient of the interaction terms in model 8-2 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 8-3 is a robust check of the estimation in model 8-2, which controls for changes in the return on education during the period by inserting interaction terms between year dummy and the years of schooling ($\mathrm{dy} \times \mathrm{yos}$). Then, in contrast to the result from model 8-2, the return on schooling maintains a high level throughout the period, and hence, changes in return on schooling in model 8-2

[40] 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, significantly positive coefficients of sy and dct are at least partly induced by the governmental policy.

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

come mainly from variation with time, as we have interpreted the results of model 8-2.

After the Second World War, mandatory education was extended from 6 years to 9 years, and the supply of workers with more years of schooling was exogenously increased. Thus, the surging return on schooling after the War did not come from 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.

5 Discussion: Implication of the empirical result

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.[42] The postwar junior high schools and most high schools have focused on general education and not vocational education that teaches specific and inflexible skills. The "uniquely-American invention"[43] of extended secondary school in the early twentieth century was introduced to Japan after the Second World War.

Despite the rapid increase in the number of better-educated workers, the significantly positive coefficient of the postwar education dummy (psw) in **Table 4** and the increasing coefficient of interaction term between cohort dummy and years of schooling ($\mathrm{yj} \times \mathrm{yos}$) in cohorts decreasing, notably since the 1950s, in model 8-2 in **Table 8**, imply that the return on schooling increased after the Second World War.[44]

In particular, the post-war education generation dummy psw reflects the result of exogenous extension of mandatory education, that is, it does not contain the effect of statistical discrimination of using schooling as a screening device. The effect of statistical discrimination, based on educational background, if it even exists, is captured by years of schooling (yos). When yos is controlled for, the positive coefficient of psw contains the genuine effect of human capital investment at school that was compulsorily extended by 3 years.

This positive coefficient of psw 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.[45] The Kamaishi Iron Works rode the trend and

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

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

[44] 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.).

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

invested more in better-educated workers after the Second World War, as **Table 6** shows.

While the "port of entry" of the internal labor market, in which only young workers are employed and are assigned to the lowest ranking jobs, is a symbolic characterization of the internal labor market suggested by Doeringer and Piore (1971), it is not always empirically supported.[46] In our case, the practice was never dominant up to the end of the 1960s, although the 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 relatively independent 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 8-2 in **Table 8**. Furthermore, the in-house training program changed after the Second World War. While before the war employees with more previous experience were more likely to be accepted by the program, employees with less previous experience were more likely to be accepted after the war as shown in **Table 6**.

Summarizing our empirical results, we could reasonably conjecture that first, the coexistence of internal labor market and 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 the internal labor market 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 a internal labor market,[47] in the case of post-war Japanese manufacturing, this trend appears to have reached further, with rapid technology transfer after isolation and explosive expansion of secondary school.

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;[48] since then, on-the-job training closely linked to one's educational background to has become a persistent personnel policy in Japanese firms.[49] Our results, however, require us to have some reservations about such a stereotype of Japanese firms. It is true that human capital investment at Kamaishi Iron Works favored new graduates after the Second World War, but a strict "port of entry" policy was not a principle, at least up to the 1960s. Such a policy appears to have prevailed since the 1970s. Furthermore, the practice is supposed 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 large Japanese firms.[50] The strict "port of entry" pol-

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

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

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

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

[50] See Ono (2010), pp. 13-22.

icy is probably shorter-lived than is usually 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.

References

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

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

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

____ **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.

Azarnert, Leonid V., "Free education, fertility and human capital accumulation," *Journal of Population Economics*, March 2010, *23* (2), 449–468.

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

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

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

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*, November 1991, *73* (4), 720–724.

Cunat, Alejandro and Marc J. Melitz, "Volatility, labor market felixiblity, and the pattern of comparative advantage," *Journal of the European Economic Association*, 2011, *in press.*

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*, June 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*, November 1996, *111* (4), 1007–1047.

Galindo-Rueda, Fernando, "Employer learning and schooling-related statistical discrimination in Britain," May 2003. Institute for the Study of Labor, Germany, IZA Discussion Paper series, No. 778.

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*, November 1999, *114* (4), 1321–1358.

Goldin, Claudia, "America's graduation from high school: The evolution and spread of secondary schooling in the twentieth century," *The Journal of Economic History*, June 1998, *58* (2), 345–374.

——, "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*, June 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 Havard 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*, February 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.

Greenwald, Bruce C., "Adverse selection in the labour market," *The Review of Economic Studies*, July 1986, *53* (3), 325–347.

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

——, "The importance of lifetime jobs in the US economy," *The American Economic Review*, September 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*, September 1985, *75* (4), 721–735.

Hersch, Joni, "Profiling the new immigrant worker: The effects of skin color and height," *Journal of Labor Economics*, April 2008, *26* (2), 345–386.

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*, February 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*, November 1996, *78* (4), 733–740.

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

Mincer, Jacob and Yoshio Higuchi, "Wage structure and labor turnover in the United States and Japan," *Journal of the Japanese and International Economies*, June 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*, September 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)*, March 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*, October 1995, *13* (4), 653–677.

Odaka, Konosuke, "The dual strucutre 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 strucutre*, 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*, June 1994, *8* (2), 173–203.

Omori, Tatsuya, "Effects of public education and social security on fertility," *Journal of Population Economics*, July 2009, *23* (3), 585–601.

Ono, Hiroshi, "Lifetime employment in Japan: Concepts and measurements," *Journal of the Japanese and International Economies*, March 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*, March 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*, July 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*, April 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.

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*, July 2008, *26* (3), 387–420.

Rosen, Sherwin, "Transaction costs and internal labor markets," *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.

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.

Ueshima, Yasuhiro, "Why wages equalized in the high-speed growth era: Japanese manufacturing, 1961-1969," *Journal of the Japanese and International Economies*, March 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*, March 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)*, March 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*, December 2006, *96* (5), 1679–1705.

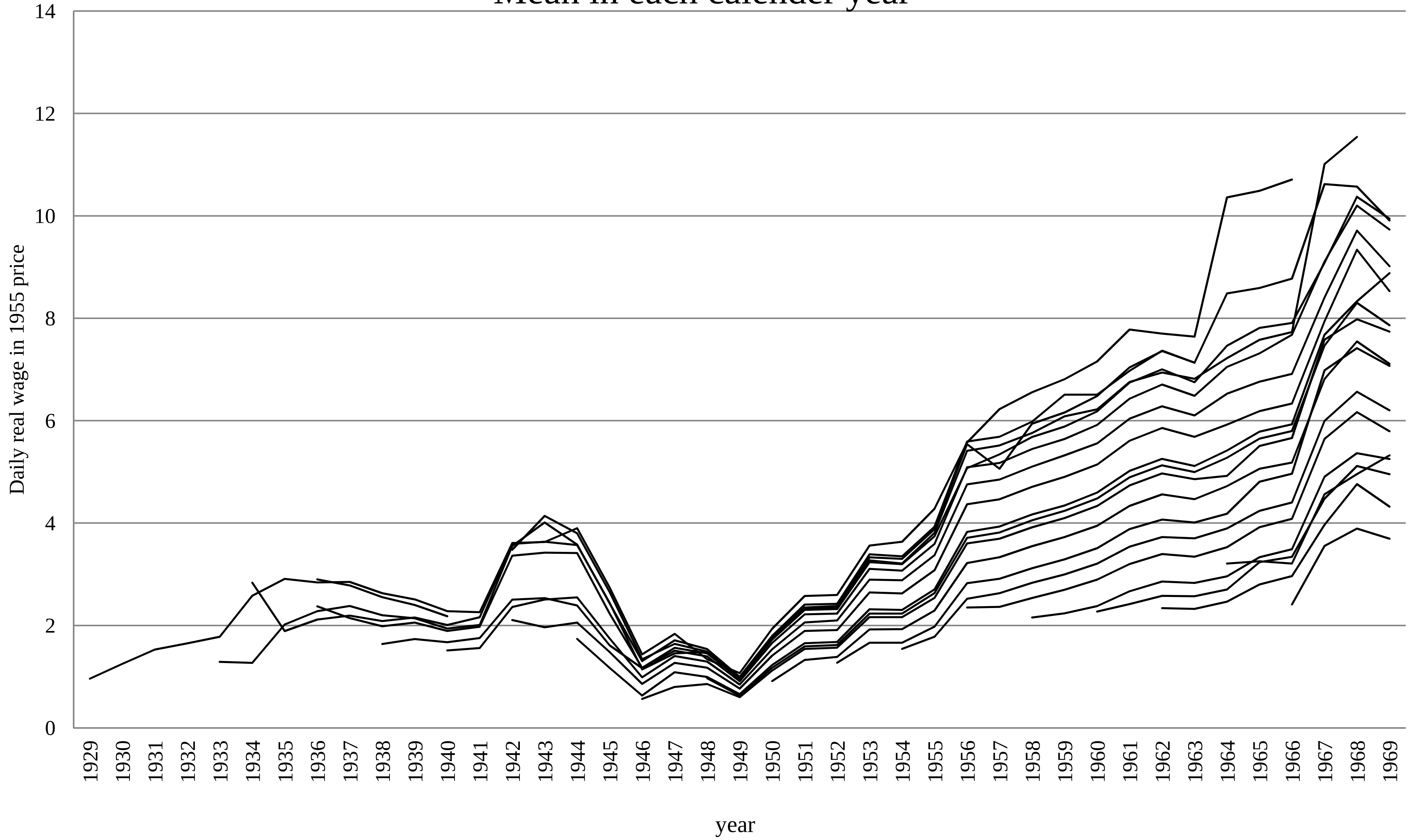
—— **and** ——, "Do initial conditions persist between firms?: An analysis of firm-entry cohort effects and job losers using matched employer-employee data," in Stefan Bender, Julia Lane, Kathryn Shaw, Fredrik Andersson, and Till von Wachter, eds., *The analysis of firms and employees: Quantitative and qualitative approaches*, Chicago University Press Chicago 2008, pp. 135–162.

Weinberg, Bruce A., "Long-term wage fluctuations with industry-specific human capital," *Journal of Labor Economics*, January 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



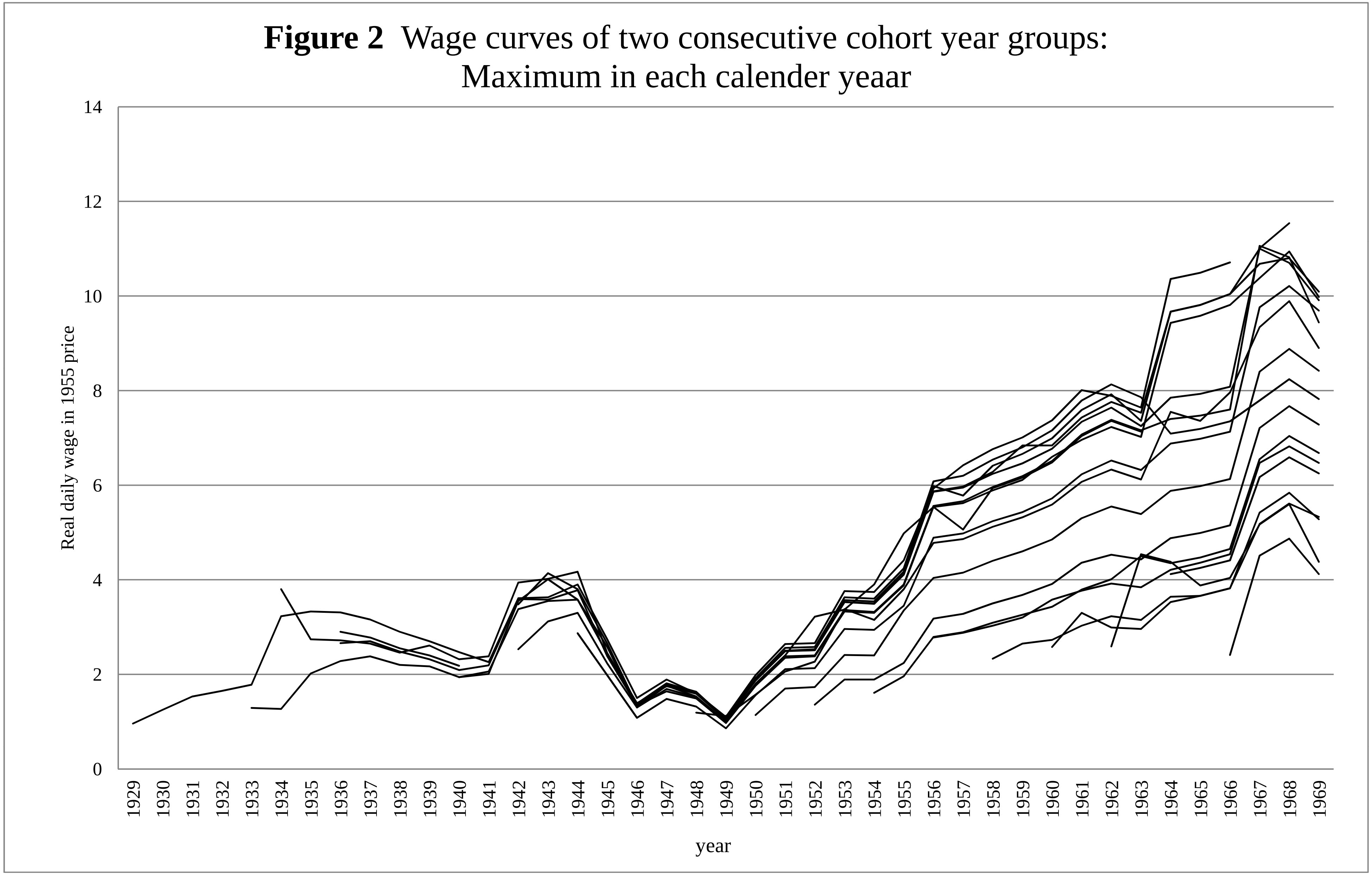


Figure 2 Wage curves of two consecutive cohort year groups:
Maximum in each calender yeaar
Real daily wage in 1955 price
0
2
4
6
8
10
12
14
1929 1930 1931 1932 1933 1934 1935 1936 1937 1938 1939 1940 1941 1942 1943 1944 1945 1946 1947 1948 1949 1950 1951 1952 1953 1954 1955 1956 1957 1958 1959 1960 1961 1962 1963 1964 1965 1966 1967 1968 1969
year

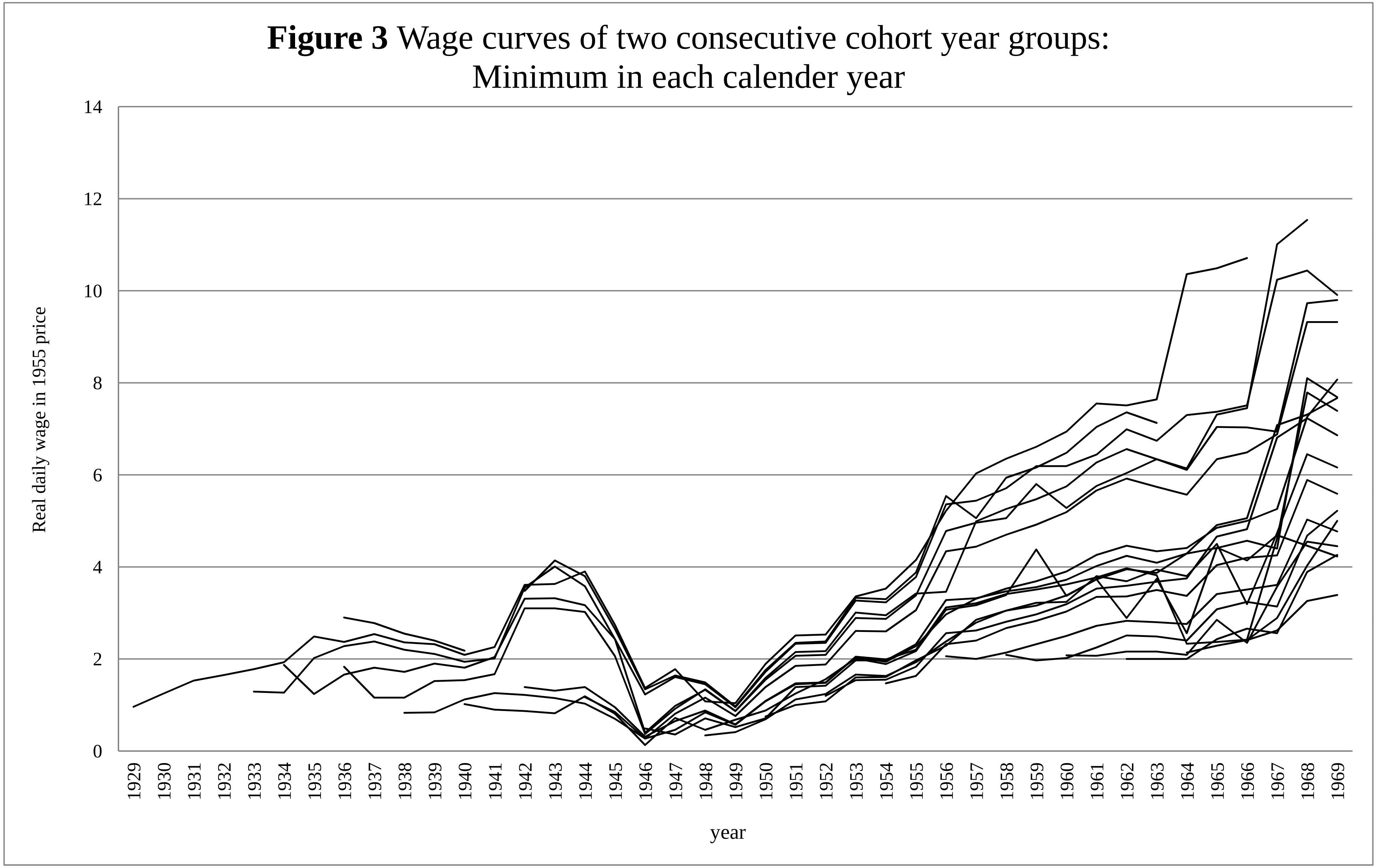


Figure 3 Wage curves of two consecutive cohort year groups:
Minimum in each calender year
Real daily wage in 1955 price
0
2
4
6
8
10
12
14
1929
1930
1931
1932
1933
1934
1935
1936
1937
1938
1939
1940
1941
1942
1943
1944
1945
1946
1947
1948
1949
1950
1951
1952
1953
1954
1955
1956
1957
1958
1959
1960
1961
1962
1963
1964
1965
1966
1967
1968
1969
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	
yj1940	43	1,196	8	6	8	7.81	12	0	6	5.29	War effort
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	
yj1950	38	634	12	6	9	8.38	26	0	6	5.83	Reconstructior
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	
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	Rapid growth began
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 the models 2-1 and 2-3 is yj1928-1929. ** and * respectively denote signifnicance at 1 percentage level and at 5 percatage level respectively.

Table 3 Cohort effect on wage curves

		3-1		
Estimation method		panel generalized least squares		
Dependent variable		$\log(rw_{ten})$		
Cross-section		random effect		
Period (year)		pooled (no year dummies inserted)		
Indepedent variables		coefficient	*t* statistic	
	c	0.2768	33.7436	**
	log(yos)	-0.0058	-0.9670	
1st lagged	yj1928-1929×$\log(rw_{ten-1})$	0.6591	17.8795	**
	yj1930-1931×$\log(rw_{ten-1})$	0.7896	16.1036	**
	yj1932-1933×$\log(rw_{ten-1})$	0.7523	23.6394	**
	yj1934-1935×$\log(rw_{ten-1})$	0.7800	43.1213	**
	yj1936-1937×$\log(rw_{ten-1})$	0.7588	48.3209	**
	yj1938-1939×$\log(rw_{ten-1})$	0.6790	70.5484	**
	yj1940-1941×$\log(rw_{ten-1})$	0.6975	89.0630	**
	yj1942-1943×$\log(rw_{ten-1})$	0.6963	68.9359	**
	yj1944-1945×$\log(rw_{ten-1})$	0.6504	66.6299	**
	yj1946-1947×$\log(rw_{ten-1})$	0.6890	58.7092	**
	yj1948-1949×$\log(rw_{ten-1})$	0.6510	79.5999	**
	yj1950-1951×$\log(rw_{ten-1})$	0.6307	43.2827	**
	yj1952-1953×$\log(rw_{ten-1})$	0.5976	17.6353	**
	yj1954-1955×$\log(rw_{ten-1})$	0.5719	17.5231	**
	yj1956-1957×$\log(rw_{ten-1})$	0.6604	21.4470	**
	yj1958-1959×$\log(rw_{ten-1})$	0.7144	17.9427	**
	yj1960-1961×$\log(rw_{ten-1})$	0.6696	13.7528	**
	yj1962-1963×$\log(rw_{ten-1})$	0.8186	16.7073	**
	yj1964-1965×$\log(rw_{ten-1})$	0.5956	12.3413	**
	yj1966-1967×$\log(rw_{ten-1})$	0.6237	3.2366	**
2nd lagged	yj1928-1929×$\log(rw_{ten-2})$	0.2417	6.2659	**
	yj1930-1931×$\log(rw_{ten-2})$	0.0905	1.7982	†
	yj1932-1933×$\log(rw_{ten-2})$	0.1367	4.0860	**
	yj1934-1935×$\log(rw_{ten-2})$	0.0974	5.1763	**
	yj1936-1937×$\log(rw_{ten-2})$	0.1196	7.3772	**
	yj1938-1939×$\log(rw_{ten-2})$	0.2021	20.6744	**
	yj1940-1941×$\log(rw_{ten-2})$	0.1755	22.6940	**
	yj1942-1943×$\log(rw_{ten-2})$	0.1735	17.1059	**
	yj1944-1945×$\log(rw_{ten-2})$	0.2133	22.0184	**
	yj1946-1947×$\log(rw_{ten-2})$	0.1680	14.5816	**
	yj1948-1949×$\log(rw_{ten-2})$	0.2124	27.8185	**
	yj1950-1951×$\log(rw_{ten-2})$	0.2254	15.3842	**
	yj1952-1953×$\log(rw_{ten-2})$	0.2485	6.9029	**
	yj1954-1955×$\log(rw_{ten-2})$	0.2702	7.7968	**
	yj1956-1957×$\log(rw_{ten-2})$	0.1670	5.1291	**
	yj1958-1959×$\log(rw_{ten-2})$	0.0862	2.0206	*
	yj1960-1961×$\log(rw_{ten-2})$	0.1212	2.3170	*
	yj1962-1963×$\log(rw_{ten-2})$	-0.0564	-1.0533	
	yj1964-1965×$\log(rw_{ten-2})$	0.2478	4.5225	**
	yj1966-1967×$\log(rw_{ten-2})$	0.1691	0.7385	
	interaction of year dummy and yos: dy×yos	yes		
	cross-sections included	1,433		
	periods included (years)	39 (1931-1969)		
	included observations	18,786		
	adjusted R^2	0.9853		
	F statistic	15,966.5019	**	

Notes : **, *, and † respectively denote signifnicance at 1 percentage level , at 5 percatage level and at 10 percentage level respectively.

Table 4 Wage regression on somatic characteristics, schooling, and experiences.

	4-1		4-2		4-3		4-4	
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	coefficient	*t* statistic
c	-2.6682	-33.3357 **	-2.6175	-32.6045 **	-2.5881	-33.6805 **	-2.5738	-33.3085 **
log(hgt)					1.3470	10.8687 **	1.3159	10.6321 **
log(yos)	0.8863	26.8400 **	0.8648	25.9864 **	0.8960	29.4501 **	0.8939	28.9999 **
psw	0.4580	48.1153 **	0.4633	47.2539 **	0.4254	46.7450 **	0.4220	44.6884 **
log(pre)	0.2670	32.0726 **	0.2653	31.5040 **	0.1861	22.0858 **	0.1813	21.2535 **
log(ten)	1.2797	35.2846 **	1.2762	35.1055 **	1.5253	36.0952 **	1.5338	36.0647 **
log(hgt)×log(ten)					-0.5957	-10.9257 **	-0.6038	-11.0554 **
log(yos)×log(ten)	-0.2724	-17.7946 **	-0.2676	-17.4387 **	-0.3692	-21.2573 **	-0.3708	-21.2524 **
log(pre)×log(ten)	-0.0325	-9.0683 **	-0.0368	-10.1481 **	-0.0197	-5.2166 **	-0.0220	-5.7583 **
dcy	-0.3998	-3.3897 **	-0.7623	-3.7885 **	-0.2055	-2.1629 *	-2.0061	-0.7438
dcy×log(pre)			0.1503	2.2566 *			0.7712	0.6686
dcy×log(ten)	0.1404	2.8668 **	0.1773	3.4235 **	0.0475	1.2047	0.0492	1.2464
sy	-0.3459	-18.8170 **	-0.4811	-16.7479 **	-0.2784	-17.6890 **	-0.4707	-11.9669 **
sy×log(pre)			0.0612	6.1429 **			0.0864	5.3268 **
sy×log(ten)	0.1460	18.9884 **	0.1548	19.8686 **	0.1013	15.7197 **	0.1023	15.8745 **
dct	-0.4616	-13.8858 **	-0.5505	-13.4670 **	-0.1975	-5.7145 **	-0.2427	-2.6771 **
dct×log(pre)			0.0576	4.2202 **			0.0214	0.5534
dct×log(ten)	0.1786	13.4554 **	0.1941	14.3209 **	0.0850	5.9841 **	0.0850	5.9840 **
dc	0.2040	11.6985 **	0.2586	10.7175 **	0.3065	21.2376 **	0.2991	13.7759 **
dc×log(pre)			-0.0433	-3.2899 **			0.0061	0.4492
dc×log(ten)	-0.0771	-9.1169 **	-0.0877	-10.1677 **	-0.1697	-23.0058 **	-0.1730	-23.3274 **
cross-sections included	1,537		1,537		1,219		1,219	
periods included (years)	41(1929-1969)		41(1929-1969)		31(1939-1969)		31(1939-1969)	
included observations	23,172		23,172		16,486		16,486	
adjusted R^2	0.7060		0.7064		0.8279		0.8278	
F statistic	3,974.6318 **		3,098.8648 **		4,955.9359 **		3,962.9911 **	

Notes : ** and * respectively denote signifnicance at 1 percentage level and at 5 percatage level. Some samples lack the information about somatic characteristics.

Table 5 Fertility decision by employees.

	5-1			5-2		
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	-2.8538	-5.0752	**	-1.4776	-1.3367	
hgt	0.0121	3.5047	**	0.0039	0.5449	
yos	0.0540	7.7955	**	0.0629	4.0582	**
pre	0.1072	53.7013	**	0.1118	25.6606	**
ten	0.1484	29.5923	**	0.1422	39.3113	**
rw	-0.0922	-4.0928	**	-0.1238	-11.1116	**
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	0.4952			0.4251		
F statistic	463.1304 **			2,438.7378 **		

Notes : ** denotes signifnicance at 1 percentage level.

Table 6 Probability of acceptance as a trainee for in-house training programs

	6-1			6-2			6-3			6-4		
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	-1.7697	-5.4185	**	-0.2369	-1.7329	*	0.6983	4.3908	**	-0.5215	-3.0493	**
log(yos)	-0.4314	-3.1559	**	-0.4181	-7.0980	**	-0.6697	-9.7323	**	0.2514	3.4096	**
log(pre)	-0.0080	-0.1636		0.0591	4.5555	**	-0.5237	-31.4753	**	-0.7825	-51.8727	**
included observations	24,019			24,019			24,019			24,109		
McFadden R^2	0.0069			0.0043			0.1010			0.1886		
LR statistic	9.0000 *			85.5154 **			1,046.1102 **			3,416.1457 **		

Notes : ** and * stand for signifnicance at 1 percentage level and at 5 percatage level respectively.

Table 7 Wage regression on tenure and estimated probability of completing training prgorams.

	7-1			7-2		
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	1.2537	8.0660	**	2.3221	19.4957	**
psw	0.6906	83.6095	**	0.6906	83.6095	**
log(ten)	1.5595	24.7569	**	0.1267	2.7953	**
log(exp)×log(yos)	0.6741	72.4515	**	0.6741	72.4515	**
[dcy]+[sy]	0.2635	7.1593	**			
([dcy]+[sy])×log(ten)	0.6626	40.5142	**			
[dcy]+[sy]+[dct]				0.6103	25.2732	**
([dcy]+[sy]+[dct])×log(ten)				0.1976	23.5449	**
[dct]+[dc]	0.9550	55.1855	**			
([dct]+[dc])×log(ten)	-0.2646	-55.5876	**			
[dc]				1.2083	60.5321	**
[dc]×log(ten)				-0.6044	-66.8669	**
cross-sections included	1,537			1,537		
periods included (years)	41(1929-1969)			41(1929-1969)		
included observations	23,172			23,172		
adjusted R^2	0.7491			0.7491		
F statistic	9,883.2971 **			9,883.2971 **		

Notes : [dcy], [sy], [dct], and [dc] are calculated by the equations 5-1 to 5-4 in **Table 5**. ** denotes signifnicance at 1 percentage level.

Table 8 Change in return on education.

	8-1			8-2			8-3		
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 1 percentage level and 5 percantage level.

Appendix List of variables.

variable	definition	
rw	real daily wage.	
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.	
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	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 Ministry of Education, Science, Sports and Culture (http://www.e-stat.go.jp/).