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# Does *examination hell* pay off ? A cost–benefit analysis of "*ronin*" and college education in Japan

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**Abstract**

College-bound students in Japan undergo a process of intense preparation known as *examination hell*. An extreme manifestation of *examination hell* is the *ronin* phenomenon. Typically 30% of students choose the *ronin* option under which they spend years in addition to high school preparing for the next year's college entrance examinations. Using the mean scores of the entrance examinations as a measure of college quality, I find that college quality significantly improves the internal rate of return (*IRR*) to college education among the sample of male graduates in Japan. *Ronin* increases earnings indirectly by improving the quality of the college attended. I also show that the *IRR* with respect to *ronin* is one of diminishing returns. On average, the number of *ronin* years which maximizes the *IRR* is found to be somewhere between 1 and 2 years.


*JEL classification:* I22; J24; J31

*Keywords:* Costs; Human capital; Educational economics; Rate of return

## 1. Introduction

In Japan, the high value placed on college prestige leads to intense competition among high-school students to enter top colleges. These students undergo a phase termed *examination hell* in which they cram to prepare for the annual college entrance examinations. An extreme manifestation of *examination hell* is the *ronin* phenomenon. When students are not accepted into the college of choice, they may repeat the process under *ronin* status. *Ronin* students spend an additional year, or as many years as it may take to enter the college of their choice, and often attend specialized college entrance preparatory schools. The proportion of students entering college with *ronin* experience averages about 30%, and may even exceed 60% among the top colleges.

The incentives of *examination hell* can only be explained under a system that rewards individuals as a function of college quality. Certain institutions are more preferred than others because they are judged to be of higher quality and improve the economic advancement of their graduates. If college quality did not matter, then students would be indifferent about which colleges to attend. Competition to enter colleges would equalize across colleges to the point where *examination hell* would cease to exist, *ronin* would be considered irrational behavior, and the supplementary education business would go bust. But such scenarios depart from reality. *Examination hell* intensified and

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the supplementary education business flourished in the postwar period, and substantial household resources continue to be allocated towards the pursuit of college prestige in Japan.

The considerable investment undertaken in *examination hell* warrants a cost–benefit investigation to evaluate the investment criteria of college education in Japan. While previous studies have focused primarily on the benefits side (e.g. Ono, 2004a), the costs associated with *examination hell* are often overlooked in the literature. As suggested by Prest and Turvey (1965), the advantage of cost–benefit analysis is "that it forces those responsible to quantify costs and benefits as far as possible rather than rest content with vague qualitative judgments or personal hunches… (and) that it has the very valuable by-product of causing questions to be asked … which would otherwise not have been raised" (p. 730). The reality is that *examination hell* is a fact of life and an institutionalized process in Japan. But the obvious question—*does examination hell pay off?*—remains unanswered. The paucity of empirical research requires an estimation method that quantifies the costs and benefits of *examination hell* in a unifying framework.

In this paper, I conduct a cost–benefit analysis of college education in Japan using a 1995 representative sample of Japanese male college graduates. I estimate the returns to *ronin* investments because *ronin* is a definitive feature of *examination hell*, and because the costs and benefits associated with *ronin* can be assessed with relative accuracy with regards to both time and money units. College quality is measured by the mean scores on entrance examinations administered by each college. Central to the analysis is understanding the causal structure underlying *ronin*, college quality and earnings. If the motive of *ronin* is to be admitted to a college of higher quality, and an improvement in college quality raises earnings, then the process in which *ronin* affects earnings must be modeled as a two-stage process. On the other hand, if *ronin* affects earnings regardless of college quality, then the process can be examined using standard OLS. This paper will examine both possibilities.

## 2. *Examination hell* and the pursuit of college quality in Japan

### 2.1. The examination

In Japan, admission into college requires students to successfully pass the entrance examinations administered by each institution. *Examination hell*, which refers to students' cramming and preparing in order to pass these examinations, is an expression common to all households with college-bound children. Unlike in Western societies where factors such as high-school performance and extracurricular activities are considered in the admission process, college admission in Japan is determined almost entirely by performance in entrance examinations.[1] Hence, there is enormous pressure for students to successfully pass the examinations. Although the oft-cited correlation between *examination hell* and youth suicide is unfounded (Tsukada, 1991), cramming and other extreme measures are common features of the preparation stage, and continues to attract considerable attention among Western scholars. For example, Rohlen (1983) writes:

> The extent to which some will go in order to prepare is awesome. And the extent to which some parents will encourage or permit the sacrifice of time and money to this undertaking is truly frightening. What Americans regard as the lunatic fringe—students memorizing whole English dictionaries or doing seven hours of preparation a night for a year—actually sets the pace in this sort of competition. (p. 106)

The investments undertaken in *examination hell* are substantial. Many students do not get accepted to the school of their choice on their first attempt. Some 30% of these students will continue under *ronin* status. These *ronin* students spend additional years preparing for the entrance examinations after high-school graduation, often attending specialized college preparatory schools.[2] The supplementary

[1] In recent years, Japanese universities have increased the proportion of students admitted through recommendations (*suisen nyugaku*) and have started to introduce admissions procedures similar to the US where applicants are evaluated on the basis of their high-school performance and activities. However, these proportions are still small. For example, according to the 1997 *Obunsha* publication, the proportion of applicants accepted through recommendation at Waseda University and Keio University were 8% and 3%, respectively. For the 1945–1991 cohort of applicants covered in the current study, these proportions are even smaller. Hence, I assume in this study that the majority of the students entered universities through the entrance examinations.

[2] *Ronin* originally refers to a masterless samurai in feudal Japan. In contemporary terms, *ronin* refers to students who aspire to universities but do not have an affiliation, i.e. they belong to neither high schools nor universities.

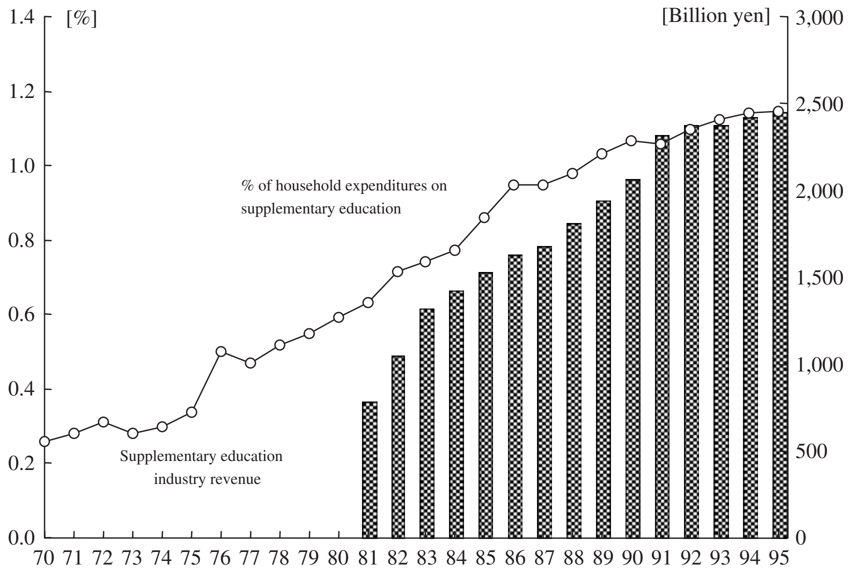


Fig. 1. Growth of the supplementary education industry [Source: Statistics Bureau, Management and Coordination Agency; Ministry of Education].

education industry in Japan expanded gradually in the postwar period reaching a market volume of 2.5 trillion yen in 1995, or approximately 1% of GDP (Fig. 1). The top firms in the industry are now listed in the Tokyo Stock Exchange. Secular trends show that the proportion of household expenditures spent on supplementary education has grown steadily in the postwar period (Fig. 1). This increase can be explained partly by the second baby boom, and the rise in household income which increased demand for educational services (Blumenthal, 1992).

The motivations underlying *examination hell* can only be explained under a labor market that rewards workers depending on the quality of the college that they attended: If all workers were rewarded equally regardless of college quality, then there would be no incentive to invest in college quality. Hence, there is good reason to expect that graduation from the prestigious colleges is linked to higher labor market rewards.

### 2.2. The rankings

In Japan, the issue of who graduated from where is a national obsession. Articles that feature personnel moves among important persons—whether they be in politics, government or the private sector—will be sure to report which schools they graduated from. As Dore (1973) explains, "it is not so much important to get into a university as important to get to the right university" (p. 294). There are numerous publications that rank universities along dimensions of difficulty in admission and successful outcome of their graduates. With respect to the former, the most famous is the annual publication by *Obunsha*, which ranks Japanese universities by the mean scores of their entrance examination scores. The first column of Table 1 shows the ranking of the top 10 Japanese universities according to this scale. The *ronin* rate is the proportion of incoming students who have at least 1 year of *ronin* experience. Because these are the most prestigious and desirable universities in Japan, it is not surprising that the *ronin* rate among the top schools is significantly higher than the national average of 30%.

In addition, there are various publications that tabulate the number of executives, politicians and bureaucrats by their graduating institutions on an annual basis. The right two columns of Table 1 show a snapshot of such rankings commonly reported in the media: The number of chief executive officers (CEOs) among companies listed in the Tokyo Stock Exchange, and the number of politicians and high-level bureaucrats.

Although not shown here, what is striking about the CEO ranking is that 49% are graduates from the top five, and 63% are graduates from the top 10 universities. Given that there are more than 600 universities in Japan, the fact that half of all CEOs

Table 1
Top 10 ranking of Japanese universities, various categories

| Rank | Ranking based on mean score of entrance examinations[a] | *Ronin* rate (%) | CEOs among companies listed in Tokyo Stock Exchange[b] | Politicians and high-level bureaucrats[c] |
|---|---|---|---|---|
| 1 | Tokyo | 51 | Tokyo | Tokyo |
| 2 | Kyoto | 53 | Keio (p) | Kyoto |
| 3 | Hitotsubashi | — | Waseda (p) | Chuo (p) |
| 3 | Keio (p) | 68 | Kyoto | Waseda (p) |
| 5 | Tokyo University of Foreign Studies | — | Hitotsubashi | Tohoku |
| 6 | Ochanomizu | — | Nihon (p) | Hokkaido |
| 7 | Osaka | 44 | Doshisha (p) | Keio (p) |
| 8 | Nagoya | 33 | Tohoku | Nihon (p) |
| 9 | Tokyo Institute of Technology | — | Kansai Gakuin (p) | Kyushu |
| 10 | Waseda (p) | — | Chuo (p) | Hitotsubashi |

p: private universities.
[a]*Source:* Obunsha (1986).
[b]*Source:* Diamond (1998).
[c]*Source:* Toyo Keizai data, reprinted from Kawaijuku (1996).

are graduates of only the top five universities is compelling evidence that university credentials matter greatly in Japanese society. Undoubtedly, educational credentials are key determinants of success in other societies, but to a lesser extent. For example, comparable estimates suggest that the graduates of the top five universities comprise just 16.7% of managers and directors among US corporations.[3] A study of Fortune 100 companies by Cappelli and Hamori (2004) shows that the proportion of executives who graduated from an Ivy League institution (as their first degree institution) was 10% in 2001.

Empirical studies have also documented the benefits of educational prestige in the Japanese labor market. Graduates of higher-ranking colleges achieve higher earnings (Ono, 2004a); they are also more likely to be selected from the labor queue for primary (versus secondary) employment (Sakamoto & Powers, 1995), to be employed by prestigious firms (Abe, 1997; Higuchi, 1994), and to reach upper management positions (Ishida, Spilerman, & Su, 1997).

In sum, college prestige is highly valued in Japan. Clearly, the labor market is structured to reward individuals according to college quality. The benefits from graduating prestigious universities are generous enough to motivate students to invest in *examination hell*. These investments in time and money terms are substantial. The central question that motivates my empirical analysis becomes the following: Does *examination hell* pay off in the end, after all the costs and benefits are accounted for?

## 3. *Ronin*, college quality and earnings

I undertake cost–benefit analysis of college education in Japan by estimating the internal rate of return (*IRR*). The *IRR* to college education is derived by equating the net present value of the costs and benefits over the lifetime. I first calculate the total annual cost of college education by summing its direct costs ($d$) and indirect costs, where the latter are estimated by the earnings of high-school graduates ($Y_{\rm h}$) who have been in the labor force for $s$ years. The total annual cost of college education in year $s$ of college is expressed as $(Y_{\rm h}+d)_s$. The benefit from college education in any given year of work experience ($x$) is the difference in earnings between college and high-school graduates of the same age expressed as $(Y-Y_{\rm h})_x$. Total costs and benefits are discounted to the year in which the college graduate enters the labor market at $x=0$. The net present value ($NPV$) of investments in

[3]This proportion was estimated from an unpublished draft of Useem and Karabel (1986), cited in Ishida (1993). The proportion of managers and directors from the top 11 institutions is 22.5% according to Useem and Karabel's data.

college education is

$$NPV = \sum_{x=0}^{n}(Y - Y_{\mathrm{h}})_x(1+a)^{-x} - \sum_{x=-s}^{-1}(Y_{\mathrm{h}} + d)_x(1+a)^{-x}, \quad (1)$$

where $n$ is the year of work experience when individuals retire. Two interpretations can be derived from the $NPV$. First, we can estimate $NPV$ using the predetermined market discount rate in place of $a$ in the equation. In this case, the so-called "decision rule" (Willis & Rosen, 1979) maintains that college investment is deemed worthwhile if the estimated $NPV$ is positive. And second, we can derive the $IRR$ by setting $NPV=0$. Under this formulation, the $IRR$ is the discount rate which sets $NPV=0$.[4]

*Ronin* is a special case in which the timing of labor market entry is delayed by the number of years spent under *ronin* status. Consequently, this has the effect of prolonging the period in which costs are incurred, and shortening the duration in which benefits can be accrued, which therefore depresses the $IRR$, ceteris paribus. The benefits and costs of *ronin* can be expressed by the following equation:

$$\sum_{x=r}^{n}(Y^* - Y_{\mathrm{h}})_x(1+a)^{-x} \geqslant \sum_{x=-s}^{r-1}(Y_{\mathrm{h}} + d)_x(1+a)^{-x}, \quad (2)$$

where $r$ is the number of years spent under *ronin* status and $Y^*$ is the earnings of *ronin*.[5] In order for the *ronin* individual to have the same $IRR$ as their non-*ronin* counterparts, the following condition must hold:[6]

$$\sum_{x=r}^{n}(Y^* - Y)_x(1+a)^{-x} \geqslant \sum_{x=0}^{r-1}(Y + d)_x(1+a)^{-x}. \quad (3)$$

The "premium" from *ronin* experience ($Y^* - Y$) is the benefit in earnings obtained from *ronin* experience in addition to what the individual would have earned had he not experienced *ronin*. Since the total cost of *ronin* is always greater than zero, Eq. (3) implies that *ronin* individuals must not only earn more ($Y^* > Y$) but that the sum of the discounted "premium" from *ronin* experience must be greater than or equal to the sum of its discounted costs to be deemed a worthwhile investment. Note that the indirect cost of *ronin* is now the earnings of college graduates (and not high-school graduates). Thus, Eq. (3) points to two important implications: (i) The marginal cost of *ronin* increases at an increasing rate because foregone earnings become more expensive, and (ii) The *pure* effect (and not the *total* effect; see discussion below) of *ronin* on $IRR$ is negative ceteris paribus, because the cost of *ronin* is always higher than the cost of no *ronin*.

[4]From Eq. (1), it is clear that $IRR$ will vary depending on the value of $n$, while the costs associated with college are sunk costs incurred over $s$ years and independent of $n$. However, some individuals may choose to work longer than others (i.e. choose different values of $n$) so that they can recoup the benefits over a longer time span, thereby offsetting the proportion of benefits over costs. Individuals choose to retire at different ages for various reasons, but it is difficult to account for such individual variations in $IRR$ estimations. Following convention, I assume that n is fixed for all individuals.

[5]For simplicity, equation (2) assumes that the annual direct cost associated with *ronin* is equivalent to college tuition. In reality, the direct cost of *ronin* such as *yobiko* (or preparatory school) expenditures are likely to be smaller than tuition. I account for the differences in costs in the internal rate of return estimations (see following section).

[6]From Eqs. (1) and (2), we obtain the following equality:

$$\sum_{x=r}^{n}(Y^* - Y_{\mathrm{h}})_x(1+a)^{-x} - \sum_{x=0}^{n}(Y - Y_{\mathrm{h}})_x(1+a)^{-x} = \sum_{x=-s}^{r-1}(Y_{\mathrm{h}} + d)_x(1+a)^{-x} - \sum_{x=-s}^{-1}(Y_{\mathrm{h}} + d)_x(1+a)^{-x} \quad (A.1)$$

Since

$$\sum_{x=0}^{n}(Y - Y_{\mathrm{h}})_x(1+a)^{-x} = \sum_{x=r}^{n}(Y - Y_{\mathrm{h}})_x(1+a)^{-x} + \sum_{x=0}^{r-1}(Y - Y_{\mathrm{h}})_x(1+a)^{-x}$$

and

$$\sum_{x=-s}^{r-1}(Y_{\mathrm{h}} + d)_x(1+a)^{-x} = \sum_{x=-s}^{-1}(Y_{\mathrm{h}} + d)_x(1+a)^{-x} + \sum_{x=0}^{r-1}(Y_{\mathrm{h}} + d)_x(1+a)^{-x}$$

Eq. (A.1) becomes:

$$\sum_{x=r}^{n}(Y^* - Y)_x(1+a)^{-x} = \sum_{x=0}^{r-1}(Y - Y_{\mathrm{h}})_x(1+a)^{-x} + \sum_{x=0}^{r-1}(Y_{\mathrm{h}} + d)_x(1+a)^{-x}$$

from which we obtain Eq. (3) by combining the two terms on the right-hand side (note that $Y_{\mathrm{h}}$ drops out of the equation).

The motivations underlying *ronin* behavior can be summarized as follows:

(i) Individuals invest in *ronin* because they believe it will improve the quality of the college that they attend.
(ii) The improvement in college quality will subsequently lead to higher payoffs.
The effect of *ronin* ($r$) on earnings ($Y$) is therefore a two-stage process which is mediated through college quality ($Q$). There is also a third possibility, the direct (or pure) effect of *ronin*, in which:
(iii) *ronin* affects earnings independent of college quality.

The two-stage process can be expressed in functional form as

$$Y = f(r, Q), \tag{4a}$$

$$Q = g(r). \tag{4b}$$

The total effect of *ronin* on earnings is therefore

$$\frac{dY}{dr} = \frac{\partial Y}{\partial Q}\frac{dQ}{dr} + \frac{\partial Y}{\partial r}. \tag{5}$$

The total effect of *ronin* on earnings is the sum of the direct effect of *ronin* on earnings ([$=\partial Y/\partial r$] corresponding to (iii)) plus the indirect effect, which is the product of the *ronin* effect on college quality ([$=dQ/dr$] corresponding to (i)) times the effect of college quality on earnings ([$=\partial Y/\partial Q$] corresponding to (ii)). Capturing the *ronin* effects on earnings therefore requires specifying a system of structural equations. The empirical strategy will be discussed in the methods section.

In Eq. (5), $\partial Y/\partial Q$ is always positive. This has been established by previous studies (see earlier discussion) and I take this as given. From this, it follows that $dQ/dr$ must also be positive. This is the essence of the incentive structure underlying *examination hell. Ronin* improves the probability of getting accepted into colleges of higher $Q$, and higher $Q$ leads to higher earnings.[7] To further illustrate this point, suppose that $dQ/dr=0$. Then the benefits of *ronin* are reduced to its pure effect ($\partial Y/\partial r$). This does not imply that the pure effect of *ronin* must be zero. However, this scenario departs from reality, because it implies that individuals invest in *ronin* regardless of the quality of the college that they attend.

The *IRR* can likewise be expressed as a function of $Q$ and $r$ where the total change in *IRR* with respect to $r$ is

$$\frac{dIRR}{dr} = \underset{(+)}{\frac{\partial IRR}{\partial Q}}\underset{(+)}{\frac{dQ}{dr}} + \underset{(-)}{\frac{\partial IRR}{\partial r}}, \tag{6}$$

$\partial IRR/\partial r$ is the direct (or pure) effect of *ronin* on *IRR* (or the effect of $r$ on *IRR* controlling for $Q$) which is always negative, because the cost of *ronin* is always larger than the cost of no *ronin*.[8] $\partial IRR/\partial Q$ is the pure effect of $Q$ on *IRR* (or the effect of $Q$ on *IRR* controlling for $r$) which is always positive because we know that $\partial Y/\partial Q>0$. So the indirect effect of $r$ on *IRR* is $(\partial IRR/\partial Q)(dQ/dr)$ which must be positive as long as $dQ/dr>0$. This is another way of saying that the benefits of *ronin* are manifested as an indirect effect vis-à-vis improvements in $Q$.

Several important implications can be drawn from Eq. (6). First, if $dQ/dr=0$ then $(dIRR/dr) = (\partial IRR/\partial r)<0$: If $r$ had no impact on $Q$, then the total effect of $r$ on *IRR* is simply equal to its pure effect which is always negative. Under this scenario, no individual would have the incentive to invest in *ronin*. Second, if for some unlikely reason $\partial IRR/\partial r>0$, then all individuals will have the incentive to invest in *ronin* even if $dQ/dr=0$. And third, Eq. (6) can be rewritten in the form of a decision rule which stipulates that *ronin* is a good investment as long as its benefit outweighs its costs:

$$\frac{\partial IRR}{\partial Q}\frac{dQ}{dr} > \frac{\partial IRR}{\partial r}. \tag{6'}$$

## 4. Data and methods

The dataset used for the analysis is the 1995 Social Stratification and Mobility National Survey (hereafter SSM) which consists of men and women between the ages of 20 and 70 residing in Japan in 1995. My analysis is restricted to men. Given the intermittent career mobility patterns of Japanese women, it is difficult to obtain reliable rate of return estimations for women. An accurate analysis of women's returns to college education would require

[7] Another way to see this is simply that $r$ and $Q$ are positively correlated, which is consistent with the evidence presented in Table 1—higher quality colleges have a higher proportion of *ronin* students.

[8] $\partial IRR/\partial r<0$ does not imply that there are no pure benefits of *ronin*, but that the costs of *ronin* outweigh its benefits, if *ronin* had no effect on $Q$.

that they be analyzed separately. College graduates consist of graduates of 4-year universities. Graduates of junior college and graduate school were excluded because these educational institutions do not have comparable college quality scores as the 4-year institutions. The resulting sample size is 697, consisting of 475 high-school graduates and 222 college graduates. Descriptive statistics are reported in the Appendix A.

SSM is particularly suited for the purpose of my research because it reports the name of the college for respondents who attended college. College quality is measured by the mean scores on entrance examinations administered by each college as reported by *Obunsha's* annual publications.[9] The advantage of treating college quality as a continuous variable is that it allows us to estimate marginal effects or elasticities, which widens the implications of my findings and facilitates post-regression estimations and simulations. A majority of earlier studies have used discrete categories of colleges due mainly to data limitations. Given our full range of college quality scores, any attempt to collapse colleges into prespecified categories would be arbitrary. Moreover, I would lose valuable information in the process, and I avoid doing this.

The reliability of the SSM earnings data as a representative sample of Japanese male workers has been documented by Yano (1998), who compared the SSM data with actual earnings reported in the Ministry of Labor's publication, *Basic Wage Survey*. Based on Mincerian estimation results, Yano shows that the SSM earnings data provide estimates that conform very closely to those obtained from the *Basic Wage Survey* and suggests that the SSM earnings data are indeed ''useful''. My estimation results should therefore not be a misrepresentation of the Japanese labor force.

*Ronin* is not directly reported in the SSM, so the following coding procedure was employed. I assume that college students attend college for 4 years, and begin working immediately after college graduation. These are not unreasonable assumptions given that repeating a grade in college and taking time off after college graduation are rare occurrences in Japan. Unlike the college system in the US and other Western countries, all college students in Japan must remain in school for at least 4 years regardless of their performance, and nearly all complete college education in exactly 4 years.[10] The number of years spent in *ronin* status is coded as the difference in years between the age at which the individual entered college and the age at which he started working after graduation minus 4 years.[11] This coding procedure resulted in a small number of individuals with *ronin* years greater than 3. For analytical convenience, these individuals were categorized in the *ronin* 3+ category.

I assume that individuals retire at the age of 60.[12] Expected working life is 38 for graduates who attended 4 years of college and began working at the age of 22, and 42 for high-school graduates. Expected working life for *ronin* is adjusted accordingly. Benchmark interest rates for *IRR* evaluation for fiscal year 1995 are provided in Table 2.[13]

Following our previous discussion, the *IRR* will be estimated for each male college graduate in the SSM survey by solving for *IRR* in the following equation:

$$\sum_{x=0}^{n}(Y_i-\overline{Y_{\mathrm{h}}})_x(1+IRR_i)^{-x} = \sum_{x=-s}^{-1}(\overline{Y_{\mathrm{h}}}+d_i)_x(1+IRR_i)^{-x}. \quad (7)$$

In Eq. (7), $d_i$ is the direct cost associated with college education specific to college graduate $i$, and $Y_{i,x}$ is his reported annual earnings at $x$ years of work experience. $\overline{Y}_{\mathrm{h},x}$ is the experience–earnings profile of the ''average'' high-school graduate, which becomes the indirect cost of college education on the right-hand side of Eq. (7). The costs associated with college and *ronin* used in the estimations are reported in the Appendix A.

[9]The means score of entrance examinations are specific to the college, department of study and entry year into college. See Ono (2004a,b) for description of coding procedure.

[10]For example, in 1995, 95% of college students graduated in exactly 4 years (Ministry of Education statistics).

[11]The SSM survey includes the year and month of the respondents' birth. Because the cutoff date for the new academic year is March 31 in Japan, I sorted the respondents' age of graduation accordingly. I eliminated college graduates from the prewar period because the prewar system of higher education required different durations of middle school, high school and college which will lead to mismeasurement of the *IRR*.

[12]The mandatory retirement age has been raised gradually in response to the aging population. In 1995, 80% of Japanese firms set the mandatory retirement at age 60. In 2000, this proportion was 92% (Ministry of Health, Labour and Welfare statistics).

[13]One should be reminded that interest rates in Japan have declined precipitously in the 1990s to reach an unprecedented low in recent years. Hence, the 1995 figures may not be the best investment criterion.

Table 2
1995 interest rates in Japan (% per annum)

| Official discount rate[a] | Government bonds listed on Tokyo stock exchange | Short-term prime lending rate | Long-term prime lending rate |
|---|---|---|---|
| 1.00 | 2.91 | 1.63 | 2.60 |

*Source:* Bank of Japan statistics.
[a]In April 1995.

Several limitations of my analysis are pointed out as follows. First, I assume that individuals are risk neutral, and undertake investments in human capital with reasonable certainty about their future earnings and employment outcomes. Second, rate of return estimations using cross-sectional data assume a constant experience–education–earnings relationship over time, which may underestimate lifetime earnings by education during periods of economic growth (Cohn & Geske, 1986). Third, rates of return are limited to monetary benefits. Non-monetary benefits may include certain non-financial advantages that accrue from college education, e.g. improved sorting in the marriage market through positive assortative mating (Becker, Landes, & Michael, 1977). I do not account for such benefits due to the difficulty of quantifying their worth. Fourth, I use the self-assessed grade point average (GPA) in ninth grade (= last year of middle school in Japan) as a proxy for individual ability. The usual caveats for self-assessed ability measures apply (see for example Maxwell & Lopus, 1994). And fifth, the earnings function approach may overstate the returns to education. I control for individual ability to reduce the non-schooling bias (following Griliches & Mason, 1972), but I cannot rule out the possibility that differences in other non-schooling attributes between high-school and college graduates, or among college graduates of differing college quality may account for some of the differences in the returns to college education.

## 5. *Ronin*, college quality and the *IRR*: is *ronin* a good investment?

I formulate a series of equations to estimate the effects of college quality and *ronin* on earnings. Table 3 reports the results using OLS. All models control for experience and experience squared but their output is suppressed in the table. The variable for years of education is not included because the current sample concerns only college graduates.

Table 3
Effects of *ronin* and college quality on logged earnings

| | 1 | 2 | 3 |
|---|---|---|---|
| *Ronin* 1 year | 0.163* | | 0.127 |
| | (0.072) | | (0.071) |
| *Ronin* 2 years | –0.021 | | –0.095 |
| | (0.096) | | (0.096) |
| *Ronin* 3+ years | 0.325** | | 0.230 |
| | (0.121) | | (0.121) |
| GPA | 0.043 | 0.002 | 0.002 |
| | (0.031) | (0.033) | (0.033) |
| College quality | | 0.019** | 0.017** |
| | | (0.005) | (0.005) |
| Constant | 14.497** | 13.682** | 13.734** |
| | (0.139) | (0.254) | (0.260) |
| $R^2$ | 0.494 | 0.502 | 0.523 |
| $N$ | 222 | 222 | 222 |

*$p<.05$, **$p<.01$.
Standard errors reported in parentheses.
All models control for experience and experience squared.

I find some evidence of *ronin* effect on earnings (Column 1), but this effect disappears after controlling for college quality (Column 3). On the other hand, the college quality effect on earnings is positive and significant (Columns 2 and 3). The coefficient for $Q$ in Column 2 is the marginal effect of college quality on earnings, from which we observe that a unit increase in college quality leads to a 1.9% increase in earnings.

I next calculate the *IRR* given the coefficients estimated from Model 2 of Table 3. I first estimate the experience–earnings profiles as a function of college quality, at the mean, minimum and maximum values of $Q$. The earnings profile for high-school graduates is illustrated in the graph as a reference category (Fig. 2). The earnings profiles for college graduates show that the payoffs from college quality are generous, and the *IRR* estimations confirm this (Table 4). The *IRR* ranges from a low

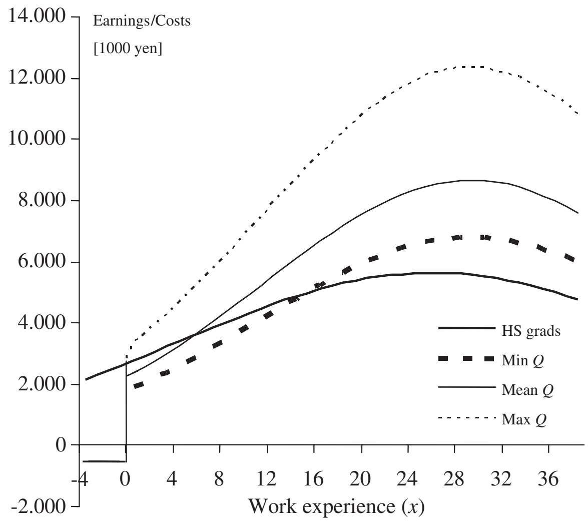


Fig. 2. Experience–earnings profiles by college quality.

of 0.1% to a high of 14.0% as a function of college quality. The mean *IRR* of 6.4% outperforms the benchmark rates reported in Table 2 and confirms that college education is still a sound investment. The results indicate that an increase in college quality from one standard deviation (about 6.4 points) below the mean to one standard deviation above the mean raises the *IRR* to college education from 3.6% to 9.2%. The results confirm the significant impact of college quality in Japan.

A shortcoming of the OLS estimation is that the causal structure underlying *ronin*, college quality and earnings cannot be properly specified. I next consider an instrumental variables (IV) approach which takes the following form:

$$Q = \gamma_4 r + \mathbf{Xf} + \varepsilon_4, \tag{8a}$$

$$\ln\, Y = \omega_3 \hat{Q} + \mathbf{Zh} + \varepsilon_3, \tag{8b}$$

where **X** and **Z** are vectors of covariates that are included in the equations. In Eq. (8b), $\omega_3$ is now the effect of $Q$ on $\ln Y$ purged of the stochastic disturbance of $\varepsilon_4$. By substituting Eq. (8a) into Eq. (8b), we obtain the total effect or $r$ on $\ln Y$.

Since selection into *ronin* and into higher and lower quality colleges is not random, two instruments are necessary to answer both questions posed. Individuals pursue higher quality college education because they believe that it will improve their rewards in the future. The first-stage equation which predicts college quality must therefore include: (i) the same variables included in the earnings equation; (ii) variables that are correlated with college quality, in this case individual ability proxied by GPA in ninth grade; and (iii) an instrument which is correlated with college quality but not with earnings. In this case, I use supplementary education during middle school as an instrument. This variable is coded one if the respondent received any form of supplementary education during elementary school and middle school (e.g. tutoring, cram schools) and zero if he did not. The variable is highly correlated with college quality with a partial $F$ significant at .01, while its correlation with earnings is low with a partial $F$ significance level of .70. The coefficient for supplementary education in the college quality equation is actually negative (Table 5). This result may seem counterintuitive, but it is consistent with past findings (see for example, Seiyama & Noguchi, 1984). Since the competition into college intensifies in high school, supplementary education during elementary school and middle school may not necessarily have the desired effect of improving the chances of successful entry into college. Indeed, many students engage in supplementary education during middle school simply as an "insurance" or because their friends and colleagues did so (Blumenthal, 1992; Rohlen, 1983). My analysis suggests that this insurance did not pay off.

The above formulation rests on the assumption that selection into *ronin* status is a random process. However, individuals choose the *ronin* option should they decide ex-ante that *ronin* will improve their future earnings, more so than if they went straight to college. I consider this possibility and estimate a separate equation in order to establish the selection criteria of individual's advancement into *ronin* status. This equation (hereafter the *ronin* equation) must incorporate the same variables as specified in the earnings equation, since the variables that determine one's future earnings are the same variables that motivate *ronin* investments. Predicted *ronin* status is then entered into the first-stage equation to predict college quality. In this

Table 4
Estimated *IRR* by university type and college quality (%)

| Mean $Q$ | Min $Q$ | Max $Q$ | SD below Mean | SD above Mean |
|---|---|---|---|---|
| 6.4 | 0.1 | 14.0 | 3.6 | 9.2 |

Estimated from Model 2, Table 3.

Table 5
*Ronin*, college quality and earnings

| | 1 | 2 |
|---|---|---|
| *First-stage regressions (Dependent variable=college quality)* | | |
| *Ronin* 1 year | 2.023* | |
| | (0.961) | |
| *Ronin* 2 years | 4.473** | |
| | (1.295) | |
| *Ronin* 3+ years | 4.720** | |
| | (1.642) | |
| Predicted *ronin* | | 6.410** |
| | | (1.010) |
| GPA | 2.342** | 2.201** |
| | (0.422) | (0.366) |
| Supplementary education | −2.731** | −2.064** |
| | (0.864) | (0.756) |
| Constant | 46.665** | 46.141** |
| | (2.015) | (1.744) |
| $R^2$ | 0.304 | 0.357 |
| *Instrumental-variables regressions (Dependent variable=logged earnings)* | | |
| College quality | 0.029* | 0.029** |
| | (0.013) | (0.008) |
| GPA | −0.027 | −0.034 |
| | (0.048) | (0.035) |
| Constant | 13.223** | 13.306** |
| | (0.606) | (0.363) |
| $R^2$ | 0.491 | 0.479 |
| *N* | 222 | 222 |

*$p<.05$, **$p<.01$.
Standard errors reported in parentheses.
All regressions control for experience and experience squared.

Table 6
*IRR* as a function of *ronin* and university type (%)

| *Ronin* years | 0 | 1 | 2 | 3+ |
|---|---|---|---|---|
| *IRR* | 5.3 | 5.7 | 6.0 | 5.2 |

case, I use a binary *ronin* variable as the outcome—zero for non-*ronin* and one for any *ronin*—given the relatively few number of students with *ronin* experiences of more than 1 year. The results of the probit equation are reported in the Appendix A.

Selection into *ronin* also requires a valid instrument which is correlated with *ronin* but not with earnings. Such an instrument may be costs of or access to *ronin* resources. The instrument chosen for this purpose is the average quality of colleges within the respondent's prefecture of origin (= prefecture in which the respondent resided prior to college entry). Following Ono (2004b), I constructed the average college quality variable for each prefecture by taking the average of the examination scores for all colleges located within that prefecture. The effect of this variable was found to be significant in the *ronin* equation, but not in the earnings equation. This makes sense because *examination hell* is likely to be more intense in regions endowed with higher quality colleges, and these regions are also better endowed with "*examination hell* resources" such as college preparatory schools and other types of supplementary education (Ono, 2004b).

Table 5 reports the results of the IV estimations. The first-stage regressions predict college quality given *ronin*, and the IV (or the second-stage) regressions predict earnings given college quality. First, we find that *ronin* significantly improves college quality, but at a diminishing rate (Column 1). Column 2 reports the estimation results using predicted *ronin*. The results also confirm that *ronin* boosts college quality. And finally, the IV regressions confirm that college quality significantly improves earnings.

Table 6 reports the *IRR* estimated using the coefficients obtained from Table 5. The results suggest that *ronin* is generally a good investment, but subject to the risk of overinvestment. *Ronin* improves *IRR* but at a diminishing rate. The optimal investment in *ronin*—or the years of *ronin* in which the *ronin* premium is maximized—is somewhere between 1 and 2 years. In comparison to the no-*ronin* group, the mean *IRR* is higher among the *ronin* 1 year and 2 year groups but lower among the *ronin* 3+ group.[14] The "premium" from *ronin* investments—the difference in *IRR* between the *ronin* versus the no-*ronin* group—is therefore positive for the first 2 years of *ronin*, but negative for 3 years and beyond. The *IRR* using the predicted *ronin* method (or the binary *ronin* category) was also estimated substituting *ronin*=2 years as the approximate mean years of *ronin*. *IRR* were found to be 5.1% for the non-*ronin* group, and 6.8% for the *ronin* group.

## 6. Simulations

Using the formulas and coefficients obtained from my analysis, we can apply the decision rule to simulate the change in college quality required

[14]For analytical convenience, I estimate the *IRR* for the *ronin* 3+ group assuming *ronin* years to be 3.

from *ronin* which will make the *ronin* investment worthwhile; that is, if an individual were to invest in *ronin*, then what is the increase in college quality (say $dQ^*$) that he must achieve which will make his *ronin* investment break even? This question can be answered by applying the decision rule and solving for $dQ^*/dr$ which sets the *ronin* premium equal to zero, i.e. we set marginal benefit equal to marginal cost ($dIRR/dr=0$), such that Eq. (6′) can be expressed:

$$\frac{dIRR}{dr}=0 \quad \text{if} \quad \frac{\partial IRR}{\partial Q^*}\frac{dQ^*}{dr}=\frac{\partial IRR}{\partial r}. \tag{9}$$

Table 7 and Fig. 3 show the results of the simulations. The actual changes in $Q$ from my previous estimations are reported for reference. Since the current exercise requires discrete units of *ronin* years, I conduct the analysis using the three category distinction of *ronin*. The required changes in $Q$ are by definition the break-even points, or the change in $Q$ which sets the *ronin* premium equal to zero. Therefore, individuals must improve their $Q$ by *at least* this much in order to make their *ronin* investment break even. For example, (from Table 7) *ronin* 1-year students must improve their $Q$ by at least 2.05 points. Otherwise, their *ronin* premium will be negative. Since $dQ > dQ^*$ for both the *ronin* 1 and 2 years categories, their *ronin* premium is positive.

Table 7
Improvements in $Q$ required to make *ronin* investments worthwhile

| | *Ronin* years ($r$) | | |
|---|---|---|---|
| | 1 | 2 | 3 |
| Actual ($dQ$) | 2.67 | 5.51 | 5.96 |
| $dQ/dr$ | (2.67) | (2.84) | (0.45) |
| Required ($dQ^*$) | 2.05 | 4.15 | 6.33 |
| $dQ^*/dr$ | (2.05) | (2.10) | (2.18) |

In Figs. 2(a) and (b), the distance between the actual and the required change in $Q$ illustrates the magnitude of the *ronin* premium: the larger the distance between the two points the larger the premium. For the *ronin* 3 year category, $dQ < dQ^*$ so the *ronin* premium is negative. These individuals required an improvement in $Q$ of at least 6.33 points to break even, but their actual improvement was only 5.96, hence resulting in a negative premium. This is also seen in Fig. 3 (a) where the actual change in $Q$ lies below its required change.

From Table 7, we can see that $dQ/dr$ diminishes as $r$ increases ($d^2Q/dr^2 < 0$) while the reverse holds true for $dQ^*/dr$ ($d^2Q^*/dr^2 > 0$). This relationship is illustrated in Fig. 3(b) where $dQ/dr$ is shown to be concave, $dQ^*/dr$ to be convex, and maximization occurs at the point where the distance between the two curves is largest. In other words, while the actual relationship between $r$ and $Q$ is one of diminishing returns, from an investment perspective, it must be one of increasing returns, because the marginal cost curve is upward sloping but the marginal benefit curve is downward sloping. The annual cost of *ronin* for a student going into his third year of *ronin*, for example, is more "expensive" than the annual cost of a student who is going into his second year of *ronin*, because opportunity cost for the former is greater. Given $\partial^2 IRR/\partial r^2 > 0$, it follows from Eq. (9) that $d^2Q^*/dr^2 > 0$; as students undergo more years of *ronin*, they must increase their $Q$ at an increasing rate.

A number of simulations can be performed using the decision rule to evaluate the returns to *ronin* investments. One possibility is to relax the assumption that all individuals retire at the age of 60, and

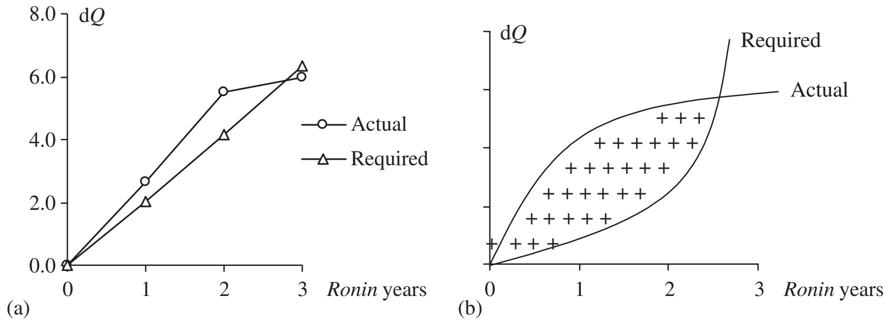


Fig. 3. Improvement in $Q$ required to make *ronin* investments worthwhile.

examine the effect of different retirement ages on the *IRR*. Alternatively, we may estimate how young an individual could retire and *ronin* still be worthwhile. We may simulate changes in *IRR* under different specifications of costs. Such simulations would have valuable implications not only for individuals but also for educators and policy-makers.

## 7. Summary and discussion

*Examination hell* refers to the competitive environment under which students cram and compete to gain entry into the preferred colleges in Japan. *Examination hell* is motivated by the hierarchical ranking of Japanese colleges, and the generous benefits associated with graduation from the elite institutions. If students are not accepted on their first attempt, they may repeat the process under *ronin* status, and spend an additional year, or as many years as it may take to enter the college of their choice. The enormous investment undertaken in *examination hell* warrants a cost–benefit analysis that quantifies the costs and benefits in a unifying framework.

My research clearly shows that graduates from higher quality colleges achieve higher earnings. I find that the *IRR* to college education in Japan varies considerably as a function of college quality, ranging from 0.1% to 14% (with mean of 6.4%).

On average, *examination hell* does pay off, when evaluated by the returns to *ronin* investments. My OLS results show that the direct effect of *ronin* on earnings is weak. When *ronin* is modeled using instrumental variables regression, I find that *ronin* increases earnings indirectly through its improvement in college quality. This makes sense because individuals invest in *ronin* for the sake of improving the quality of the college that they attend, which subsequently leads to higher earnings. The *IRR* with respect to *ronin* peaks somewhere between 1 and 2 years of *ronin*. Hence, *ronin* is generally a good investment, but subject to the risk of overinvestment.

Although *ronin* may bestow benefits for individuals, the social implications are not so optimistic. Considering that one-third of the college-bound population undergoes a moratorium of at least 1 year, the social cost resulting from the lost output is substantial. It is therefore not surprising that the Education Ministry views *ronin* as a social problem. An extension to the current research would be to investigate the existence and magnitude of the negative externalities associated with the *ronin* phenomenon.

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## Appendix A. Estimation of costs associated with college education

The annual direct cost of college education was estimated as tuition minus part-time earnings in 1995 (Ministry of Education (1995) statistics). *Ronin* cost was estimated as the average cost of college preparation schools and other supplementary education expenditures based on data provided by Sakurai (1997) and Stevenson and Baker (1992). Part-time earnings of *ronin* students were assumed to be zero since *ronin* students are assumed to be preparing full-time for the college entrance examinations, and it is unlikely that these individuals held part-time jobs. Financial aid and scholarships in Japan are rare and were not accounted for in the estimations. A small percentage of students receive some type of financial assistance, but they are only offered in the form of interest-free loans that require repayment (see Japan Student Services Organization homepage for further description: http://www.jasso.go.jp/).

Indirect costs of college education were estimated from the standardized experience–earnings profile for male high-school graduates generated from the following equation ($N = 475$, $R^2 = .192$):

$$\ln\ Y = \underset{(.104)}{14.412} + \underset{(.008)}{.065x} - \underset{(1.71E-4)}{.001x^2} + \underset{(.023)}{.057\,\mathrm{GPA}}.$$

See Tables A.1–A.3.

Table A.1
Descriptive statistics

| Variables | Mean | SD |
|---|---|---|
| *High-school graduates* ($N = 475$) | | |
| Experience | 23.68 | 11.64 |
| GPA | 3.05 | 1.04 |
| *College graduates* ($N = 231$) | | |
| Experience | 18.29 | 11.79 |
| GPA | 4.00 | 0.94 |
| College quality ($Q$) | 51.90 | 6.39 |
| Mean $Q$ in respondent's prefecture of origin | 51.94 | 9.72 |
| Supplementary education | 0.51 | 0.50 |
| *Ronin* 1 year | 0.19 | 0.17 |
| *Ronin* 2 years | 0.09 | 0.05 |
| *Ronin* 3+ years | 0.09 | 0.05 |

Table A.2
Tuition, part-time earnings and *ronin* costs in annual terms

| | |
|---|---|
| *Tuition* | |
| National universities | 497,000 |
| Private universities | 1,095,300 |
| *Part-time earnings* | |
| National university students | 349,200 |
| Private university students | 412,200 |
| *Ronin* cost | 350,000 |

Unit: yen.

Table A.3
*Ronin* selection equation

| Variable | Coef |
|---|---|
| GPA | −0.013 |
| | (0.101) |
| College quality ($Q$) | 0.042** |
| | (0.015) |
| Average $Q$ within the respondent's prefecture of origin | 0.020* |
| | (0.010) |
| Constant | −3.761** |
| | (0.936) |
| Log-likelihood | −149.1 |

*$p<.05$, **$p<.01$.
Standard errors reported in parentheses.
Model controls for experience and experience squared.

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