Why Is There No *Harvard* Among Japanese Private Universities?

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Abstract

The social and academic reputation of private universities in Japan is generally far behind the national universities. We argue that heavy subsidy *and* the low tuition of national universities determined by the central government are both responsible for making the production of high academic quality difficult for private universities in equilibrium. Using several simulations based on a theoretical model of assignment of heterogeneous students and universities with respect to tuition and educational quality, we show that the distribution of tuitions and academic quality of private universities are affected by the low tuition and heavy subsidy policy of national university. Using the cross-section data of all universities in Japan, we present empirical evidence on the determinants of tuition of private universities that support our theoretical prediction.

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1 Introduction

The social and academic reputations of private universities in Japan are generally far behind national universities. This is a sharp contrast to the U.S. higher education market where the most academically successful universities are private, such as Harvard and Princeton. In Japan, there has not been any "Harvard" among private universities in the history of higher education in the sense that private universities have never surpassed national universities in terms of academic quality and social reputation. This paper seeks to answer why it has been so.

One of the obvious reasons would be the existence of heavy government subsidy into national universities since their establishment. One student of national universities receives 3.87 million yen per year as government subsidy, which is 25 times larger than the average private university student (Ministry of Education 1997). However, since state universities in the U.S. are also more subsidized than private universities, it is not immediately clear whether the subsidy story is sufficient in explaining a wide gap between national and private universities in Japan.

In this paper we show that the heavy subsidy into *and* the low tuition of national universities set by the central government are both responsible for making the production of high academic quality difficult for private universities in equilibrium. In our theoretical model, the key mechanism through which the quality and tuition of national universities affect behavior of private universities is a shift in the assignment of heterogeneous students and universities with respect to tuition and education quality. Students and private universities are assumed to be heterogeneous in ability and endowment, respectively, and the equilibrium distribution of private university quality and tuition is influenced by the governmental policy for national universities. Particularly under the Japanese setting where national universities are heavily subsidized while charging very low tuition to students, our numerical simulations suggest that private universities are

forced to charge low tuition and are not able to produce high academic quality due to the lack of sufficient financial revenue. Then using cross-section data of all universities in Japan, we present some empirical evidence on the determinants of tuition of private universities that support our theoretical predictions.

Previous theoretical studies of education market tend to focus on the role of peer effects and human capital externality on the prices of college education services and the sorting of students across schools.[1] The most closely related paper to ours is a recent paper by Epple, Romano, and Sieg (2003, ERS hereafter) that constructs a model of university market in which *all* universities, by choosing tuition, admission policy, and educational expenditure, maximize the quality of education determined by the peer student quality and the educational expenditure. Like their paper, our theoretical model is embedded in the literature of assignment (hedonic price) models, developed by Rosen (1974), Sattinger (1980), and Epple (1987). The main difference between ERS and ours is that we ask a different question from theirs and we focus on the effects of (exogenous) national university policies on the distribution of tuition and education quality among private universities, while ERS focus on the sorting of students by ability and income into different types of schools with no specific role for public university policy.

Giving independent roles to public university policy in the analysis of higher education market is an important step not only for seeking an answer to our specific motivation but also for providing alternative view of higher education markets for countries where public universities dominate the market.[2] In many countries in Asia and Europe, na-

[1] Rothschild and White (1995) analyze a competitive model in which consumer's own human capital is also input for human capital production of others, using higher education as their primary example. Epple and Romano (1998) construct a computational general equilibrium model of local public school system with student peer effects and profit-maximizing private school entry. Their assignment equilibrium shows that heterogeneous students are sorted into different types of schools in which public schools accommodate students of lowest ability and income.

[2] Another relatively technical role for public university policy is that it provides the sufficient boundary conditions for solving a differential equation for tuition function differentiated by the quality of education. ERS, in the absence of public university in their model, alternatively introduces an exogenous "tuition cap" in their model to ensure the calculation of equilibrium tuition and college quality. Which ways are reasonable should depend on the institutional context.

tional (or other public) universities tend to dominate in research and education, and the governmental policy over national universities have sizable impacts on the decision making and productivity of private universities. Our approach can provide a framework for analyzing a variety of mixed markets for higher education in various countries.

Our model is also different from Epple and Romano (1998) in that, unlike their model of local public school system in the U.S., there is no explicit link between the tuition and financing to national universities. In our model, students and universities are continuously differentiated in one dimension - in ability for students and in endowment for universities, respectively. So our equilibrium concept is most closely related to Sattinger (1980) in the sense that one (atomic) type of university is matched to only one (atomic) type of student.[3] Education quality of each private university is produced by the profit maximization.[4] An equilibrium in the public-private mixed market can be achieved through the adjustment of tuition and education quality of private universities, and the degree of queues to the national university. The equilibrium queues not only serve to equate demand and supply in our assignment model with the policy distortion, but also explains the widespread "ronin" in Japan - high school graduates who wait for one year or more to be admitted by their favorite university. Our model also allows the exit of private universities, and the choice of students on whether or not to go to college.

Our empirical analysis differs from previous studies of hedonic models of university tuition[5] in that we incorporate the effect of public intervention in the estimation of the hedonic tuition function explicitly based on the well-specified economic model. One of recent directions of hedonic analyses is to depart from the closed form solution with the

[3] In ERS, students are continuously distributed in two dimensions of ability and income, thus the heterogeneity within a school allows them to analyze the role of "average" peer effects on a particular student.

[4] An alternative formulation is to assume that private universities maximize education quality (ERS 2003). We are working to implement this case in our theoretical model and simulation to see which assumptions better describe the empirical facts of higher education market of Japan and other countries.

[5] Harford and Marcus (1986) estimated the determinants of levels of tuition at private colleges on their characteristics, including faculty-student ratios, library size, and the faculty quality, using a cross-section of 780 U.S. private colleges. In Japan, Yonezawa (1994) and Urata (1998) are the first who analyzed the relationship between tuition at private colleges and their characteristics.

traditional linear-quadratic specification (Epple 1987) to the identification of structural parameters using semiparametric models (Anglin and Gencay 1996; Ekeland, Heckman, and Nesheim 2002). Although our current numerical solutions give illustrations of special cases of our model and the full identification of structural parameters is beyond the scope of this paper, the flexibility of our numerical methods can be used to supplement and interpret any parametric – semiparametric estimations of hedonic tuition functions, which we envision as a future direction.

2 Background

The number of 4-year universities in Japan is 669 (99 national, 74 local public,[6] and 496 private) universities. The undergraduate enrollments are 2,487,133 (466,341 national, 97,453 local public, and 1,923,339 private).[7] Thus the student share of private universities is 77 %. In terms of the quality of education and research, the social and academic reputation of private universities in Japan are generally behind national universities. A recent worldwide university ranking (Shanghai Jiao Tong University, Institute of Higher Education 2003) shows that 5 Japanese national universities are among the top 100 universities in the world while only one private university is ranked among the world top 250-300 universities. As we will see later, in terms of the selectivity ranking of universities for entering students, national universities usually occupy the most selective schools.

On the other hands, in the United States, the most academically successful universities are private, of which the market share is smaller than that of Japan. In the U.S., share of private universities among all full-time student is about 27 %, including graduate students (Ministry of Education 2001). In the recent survey by U.S. News, 25 out of

[6] Local public universities are established and financially subsidized by prefectural or municipal governments.

[7] These are the numbers as of 2001 based on the Basic School Survey (Ministry of Education 2002).

the top 30 (doctoral) universities are private, among which the top is shared by Harvard and Princeton.

(Insert Table 1 and Figure 1)

To give a more concrete picture on the difference in the higher education markets in Japan and the U.S., Table 1 shows the comparison of key data for private and public universities of the two countries. Yearly education expenditure for one national/public university student in Japan is 4.36 million yen, which nearly matches to the amount to a student expensed by the U.S. *private* university. The expenditure for Japanese private university is 1.74 million yen, which is about 40.0 % of Japanese national university and about 70 % of the U.S. *state* universities. The proportion of government subsidy to the total expenditure is 89 % for national universities and 8.9 % for private universities in Japan. The tuition of national university[8] is about 64 % of the average tuition of private universities in Japan, while in the U.S. the average tuition of state university is about 20 % of private universities. These numbers suggest that in Japan national universities offer by far better quality education, at least in terms of expenditure, at lower cost than private universities. In the U.S. such a reversal of the relation between tuition and expenditure is not observed. This conjecture can be confirmed by other measures of education and research quality. Figure 1 compares four measures of quality between private and national universities. Consistent with the expenditure data, the per-student quality of education is much higher in national universities than in private.

(Insert Table 2)

For prospective students, the national universities are higher ranked and more selective at the entrance exam than most private universities. Table 2 shows the average admission "hensachi," which is the relative rating of the mean difficulty of entrance

[8] Regardless of major or institution, the first year annual tuition for undergraduate programs of the national university system (including admission and other additional fees) is set to 755,000 yen in 2000.

exam, and the ratio of the applicants to actual entrants of both private and national universities for 10 major departments. These figures show that national universities are generally more selective than private universities.

(Insert Figure 2)

In what way does national university policy affect the financial resources of private universities? Figure 2 shows the trends in average real tuition level of national universities, private universities, and social science and humanity majors of private universities which charge the lowest tuition among all majors.[9] The graphs show that the tuition of national universities has rapidly risen since the early 1970's, and that of private universities has risen remarkably at the similar rate. While the ratio of tuition of national to that of private has become smaller in recent years, the absolute gap remains large.[10] Tuition revenue occupies a major part of the financial resources of private universities in Japan. Table 1 shows that the tuition share of the total budget is 62.5 % for private universities in Japan and 40.7 % for private universities in the U.S. Thus the determinants of tuition level should have a larger impact on educational and research resources in Japan than in the U.S.

To summarize the facts, the Japanese higher education system has had distinctive features in contrast to the U.S.; a few highly ranked national universities provide the high-quality educational services at low tuition. Private universities are behind the national universities in terms of quality of education and reputation, and their tuition setting seems to be influenced by the tuition of national universities.

[9] Colleges of medicine or dentistry tend to charges the highest tuition among all majors within the same private university. In our empirical analysis we will focus on social science and humanity majors.

[10] Without the data for private university tuition before 1975, it is not clear from the figure whether private universities have followed the national university tuition. Analysis of tuition using data from long periods remains to be worked.

3 Model of Higher Education Market

In this section, we introduce a simple theoretical model of higher education market which is built upon the assignment (hedonic price) theory. In this model, we attempt to describe an assignment of students to universities, and to evaluate the impact of national education policy (i.e. changes in tuition and quality at national universities) on the distribution of tuition and education quality at private universities.

3.1 Environment

Consider an economy where there are a continuum of students, a continuum of private universities, and a single national university.[11] Education services are supplied by both private and national universities. We assume that private universities are heterogeneous in terms of their initial positive "endowments," denoted e, which are short-run fixed resources, such as its historical reputation, library volumes, and building space. Endowment of private universities is distributed on an interval $[e_{\min}, e_{\max}]$ with density $g(e)$, and the total number of private university is $G = \int_{e_{\min}}^{e_{\max}} g(e)de$. To produce a given quality of education services, private universities use their initial endowments and the educational expenditure out of the tuition revenue. We assume that their objective is to maximize their profit, that is, they maximize tuition revenues minus educational costs by choosing education quality and tuition level. Private universities can also choose to exit from the university market when they cannot achieve the normal profit level at the optimum.[12] We assume that levels of quality and tuition at national universities, denoted q_p and t_p respectively, are given exogenously. The capacity of each (atomic) private university is assumed fixed to unity (one student) while the capacity of national university is C_p, which is also given exogenously.

[11] In the model we use "national university" to encompass any public universities for which education quality and tuitions are controlled by central or local governments.

[12] So precisely speaking, the distribution of endowment is given for "private university entrepreneurs," not necessarily for private universities that operate in equilibrium.

Each student is indexed by a positive "ability," denoted a. Ability of students is distributed on an interval $[a_{\min}, a_{\max}]$ with a density $f(a)$ and the total number of students is $F = \int_{a_{\min}}^{a_{\max}} f(a)da$. The utility of a student depends on the quality of education, composite consumption goods, and her own ability. Students divide their fixed income y, which is assumed homogeneous across the population, into tuition expenditure and consumption. There are three distinct modes of educational choice for students; applying to the national university, attending a private university, and participating labor market without university education. If they decide to attend private university, they will choose the quality of private university education, denoted q, taking the equilibrium tuition schedule, $t(q)$, as given. If they decide to apply the national university, they expect to consume the education service of quality q_p at the cost of tuition t_p if they are admitted. And if they choose not to attend any university, levels of education quality and tuition expenditure are both assumed to be zero. Each student is assumed to be a price-taker, and they make their decision to maximize utility given the tuition schedule of private universities, $t(q)$, a set of national university policy variables, t_p and q_p, and the behavior of the other students.

Given the distributions of student and private universities, the optimal choice of quality by both students and private universities yields the demand and supply of education service of each quality. A market equilibrium should exhibit a functional relationship, called "hedonic price function" in the literature, between tuition and quality for private universities, denoted $t(q)$, so as to equalize demand and supply at each quality level.

3.2 Student Behavior

We assume that the preferences of students with ability a be represented by the quasi-linear utility function with its sub-utility taking the generalized Cobb-Douglas form, $u(m, q; a) = m + a^{\alpha_1} q^{\alpha_2}$, where $0 < \alpha_1,\ \alpha_2 \leq 1$, and m is composite consumption goods consumed. Thus the marginal utility of education quality positively depends on the

student's ability.

We first consider the behavior of students who already have chosen a mode of attending a private university. The utility maximization problem for the student with ability a is described as

$$\begin{aligned} V(a) \equiv \max_{m,q} \quad & m + a^{\alpha_1} q^{\alpha_2} \\ s.t. \quad & m + t(q) = y, \end{aligned} \tag{1}$$

where y is income and $t(q)$ is the hedonic tuition function for private universities. Assuming the differentiability of $t(q)$ and the internal solution, the first-order condition of the utility maximization with respect to q is given by

$$t'(q) = \alpha_2 a^{\alpha_1} q^{\alpha_2 - 1}, \tag{2}$$

and the second-order condition is given by

$$t''(q) > \alpha_2(\alpha_2 - 1) a^{\alpha_1} q^{\alpha_2 - 2}. \tag{3}$$

The hedonic tuition function, $t(q)$, must satisfy equation (2) and (3). Note that if the S.O.C. is satisfied, the equilibrium quality choice of student, $q(a)$, has the following property.

$$dq/da > 0. \tag{4}$$

This means that students with higher ability choose higher quality of university education in equilibrium.

We next consider the case when students choose a mode of applying to the national university. Based on the observation that some high school graduates ("ronin") spend a year or more until passing the entrance examination of their favorite, mostly national,

universities, we assume that, in equilibrium, some of the applicants may fail to enter the national university and to try it again next year.[13] Let ρ be the probability of passing the entrance exam of the national university, and U_0, tentatively, be the students' utility achieved when they enter the national university. Then the expected utility of students to be maximized can be written as $U_0\rho + U_0(1-\rho)\rho\delta + \cdots = U_0\rho/(1-(1-\rho)\delta)$ where δ is the subjective discount rate. If we simply assume that ρ can be defined as the capacity of national university, C_p, divided by the number of total applicants, A_p, the term $p/(1-(1-p)\beta)$ is described as the function of C_p/A_p in equilibrium.[14] Therefore the expected utility of a student with ability a is $\frac{\rho}{1-(1-\rho)\delta} \cdot (y - t_p + a^{\alpha_1} q_p^{\alpha_2})$.

When the student chooses not to attend any university, her utility level is y regardless of her ability.

3.3 Private University Behavior

Each private university chooses the quality of education q so as to maximize the profit given the equilibrium tuition schedule. We assume that the production function of the education quality of private universities with the initial endowment e takes the following Cobb-Douglas form, $q = e^{1-\gamma}v^{\gamma}$, where $0 < \gamma < 1$ and v is the educational expenditure, measured in dollar per student. Then the cost function can be written as $e^{1-\beta}q^{\beta}$ where $\beta \equiv 1/\gamma$ and $\beta > 1$. Thus, to achieve a given level of quality, the current educational cost is lower with a higher level of endowment. The profit maximization problem of private universities is written as

$$\Pi(e) \equiv \max_{q} \quad t(q) - e^{1-\beta}q^{\beta}. \tag{5}$$

[13] The dynamics is introduced only to produce the expected return of applying the national university. A fully dynamic model with a sequential decision-making of students regarding university mode choice would be an interesting future extension.

[14] The probability of passing the exam may realistically depend on the student's ability. Doing so would unnecessarily complicate the following analysis with no major addition in the implications on the private university markets.

The first-order condition of this maximization problem with respect to q is given as

$$t'(q) = \beta e^{1-\beta} q^{\beta-1}, \tag{6}$$

and the second-order condition is given as

$$t''(q) < \beta(\beta-1) e^{1-\beta} q^{\beta-2}. \tag{7}$$

Note that if the S.O.C. is satisfied, the supply of education quality by private universities, $q(e)$, has the following property:

$$dq/de > 0. \tag{8}$$

As is the student case, this property means that more endowed universities choose to produce higher quality of university education in equilibrium. We also assume that the reservation profit level is zero for all universities.

3.4 Calculation of Sorting Equilibrium

We restrict our attention to equilibria where, like the higher education in Japan, the equilibrium assignment of students exhibit sorting by ability, and the national university has higher quality and attracts students with higher ability than any private universities. We show conditions with which such an equilibrium exists and students are divided into at most three groups by two threshold ability levels; the highest ability group who chooses the national university, the middle ability group who chooses private universities, and the lowest ability group who chooses no higher education. Let us denote the lower and upper boundary of students' ability who attend a private university by $\check{a}$ and $\hat{a}$, respectively. Then, students with $a \in [a_{\min}, \check{a}]$ will enter labor market without attending any university, $a \in [\check{a}, \hat{a}]$ will attend private universities, and $a \in [\hat{a}, a_{\max}]$ will choose the national university in equilibrium. We consider cases in which $a_{\min} \leq \check{a} < \hat{a} < a_{\max}$

holds, that is there are always some students who attend national and private university, but students who enter labor market without university education do not always exist in equilibrium.

3.4.1 Matching between Students and Private Universities

We first consider the matching of private universities and students who are willing to attend them, given the upper and lower boundaries of ability, $\check{a}$ and $\hat{a}$. For the ease of computation and presentation of equilibria, we assume that the ability of students and endowments of universities are both uniformly distributed with density equal to 1. Then the total demand for private universities by students with ability higher than a is given by $\int_a^{\hat{a}} f(a)da = \hat{a} - a$. Similarly, for each e, total supply of education by private universities with endowment higher than e is given by $\int_e^{e_{\max}} g(e)de = e_{\max} - e$. Market clearing requires the above two expressions are equated for any private student-university matched pair, so we need

$$\hat{a} - a = e_{\max} - e, \text{ for any matched pair } (a, e), \check{a} \leq a \leq \hat{a}. \tag{9}$$

Equalizing the F.O.C.s for students and private universities, equations (2) and (6), and eliminating e by equation (9), we have the demand for quality by a student with ability a,

$$q(a) = \left(\frac{\alpha_2}{\beta} a^{\alpha_1} (a + e_{\max} - \hat{a})^{\beta - 1} \right)^{1/(\beta - \alpha_2)}. \tag{10}$$

The optimal quality choice by private universities, $q(e)$, is obtained in the similar manner.

Using these conditions, we next derive the hedonic tuition function. From the F.O.C. of students, equation (2), a general solution for the hedonic tuition function can be written as

$$t(q) = \int_{q(\check{a})}^{q} \alpha_2 a(q)^{\alpha_1} q^{\alpha_2 - 1} dq + C, \tag{11}$$

where C is the constant of integration, and $a(q)$ is the inverse function of $q(a)$. Since there is no general simple form for $a(q)$ that can be derived from equation (10), we change the variable of equation (11) using equation (10) to get the following alternative form of the general solution for hedonic tuition function:

$$\begin{aligned} t(a) &= \int_{\check{a}}^{a} \alpha_2 a^{\alpha_1} q(a)^{\alpha_2 - 1} \frac{\partial q}{\partial a} da + C \\ &= \tau(a; \hat{a}) - \tau(\check{a}; \hat{a}) + C, \end{aligned} \tag{12}$$

where $\tau(a; \hat{a})$ is the infinite integral of $\alpha_2 a^{\alpha_1} q(a)^{\alpha_2 - 1} (\partial q / \partial a)$, to which we emphasize its dependence on $\hat{a}$, and $\check{a}, \hat{a}$, and C are unknown parameters to be determined.

3.4.2 Consistency Conditions for Equilibrium

To complete the computation of the equilibrium hedonic tuition function, $t(a)$, we add the following consistency conditions to determine the upper and lower boundary of ability of private university students, $\hat{a}$ and $\check{a}$, and the constant of integration, C. First, students who choose to apply the national university in equilibrium must achieve at least as high utility level as what they would achieve by attending the most preferred private university. Second, students who choose to attend a private university in equilibrium must achieve at least as high utility level as what they would achieve by attending the national university. Third, students attending private university in equilibrium at least achieve their reservation utility level (i.e. utility level when they choose no university education). Finally, in order for private universities to participate in the market, they must earn positive profit in equilibrium. These conditions make students' decision making problem about their qualitative choice – choose no education, private university or national university – be globally optimal. Technically, these criteria generate the necessary boundary conditions to determine unknown parameters in equation (12), C, $\check{a}$, and $\hat{a}$.

First, we consider conditions derived from students' optimal choice between private and national university education. Given the equilibrium positive sorting of students into the three groups, (1) for a student with $a \in [\hat{a}, a_{\max}]$, the national university must be preferred to any private universities, (2) for a student with $a \in [\check{a}, \hat{a}]$, attending her (optimal) private university must be preferred to the national university under the given tuition schedule.

Given the sorting, the equilibrium number of applicants for the national university, A_p, is equal to $a_{\max} - \hat{a}$, and the probability to pass the national university exam, ρ, is defined as $\rho = C_p/(a_{\max} - \hat{a})$, where C_p is the given capacity of the national university. Since the expected utility of a student applying the national university with ability a is given by $p(\hat{a})(y - t_p + a^{\alpha_1} q_p^{\alpha_2})$, where $p(\hat{a}) = \rho/(1 - (1 - \rho)\delta)$, we need the following boundary conditions in equilibrium.

Upper Boundary Conditions:

Sufficient conditions for the positive sorting of students by ability to national and private universities in the assignment equilibrium are

UB1. *For student with ability $\hat{a} < a_{\max}$, attending the top private is equivalent to applying the national university. Namely,*

$$y - t(q(\hat{a})) + \hat{a}^{\alpha_1} q(\hat{a})^{\alpha_2} = p(\hat{a})(y - t_p + \hat{a}^{\alpha_1} q_p^{\alpha_2}). \tag{13}$$

UB2. $q(\hat{a})^{\alpha_2} < p(\hat{a}) q_p^{\alpha_2}$. *(National university has sufficiently high quality relative to top private university.)*

Leaving the formal proofs in the Appendix, here we provide an interpretation for these conditions. The first condition, UB1, ensures the existence of the national university in equilibrium. Because levels of utility of attending private and national university are both continuous functions with respect to student's ability, the (expected) utility level

of attending (top) private university must be equal to that of applying to the national university at the upper boundary of private university attendants. Otherwise some students would be better off by changing their choice (from private to national, or vice versa).

The second condition, UB2, ensures the positive sorting of students by ability to national and private universities, that is, students in the highest ability group optimally choose to apply the national university and those in the middle ability group choose to enter private universities. Since the probability to pass the national university's exam is identical for any students (regardless of their ability),[15] the term $p(\hat{a})q_p^{\alpha_2}$ can be viewed as the *discounted* (or *expected*) quality obtained by applying the national university. UB2 says that the level of national university quality, q_p, must be sufficiently high, given $p(\hat{a})$ and the quality of the top private university, $q(\hat{a})$. The single crossing property of student's utility function (or the complementarity between ability and education quality) implies that student's valuation for a given quality of education positively depends on her ability. When the *discounted* quality of the national university education is higher than the quality of the top private university, the complementarity in utility function immediately implies a positive sorting of students by ability. But if $q(\hat{a})^{\alpha_2} > p(\hat{a})q_p^{\alpha_2}$, students with $a < \hat{a}$ may have a greater valuation for the national university than those with $a > \hat{a}$, and positive sorting will not take place in equilibrium.

We next examine the lower boundary conditions. First, for students, two situations may occur in equilibrium:[16] (1) some students choose not to enter any universities, and (2) all students choose to attend some university. Let $V(a)$ denote the indirect utility function for student with ability a. Then the former case can be expressed by the condition $V(\check{a}) = y$[17]. The latter case can be written by the condition $\check{a} = a_{\min}$. Next, for private universities, two situations may also occur in equilibrium: (1) some

[15] Alternatively we could more realistically allow the probability of passing the national university to depend on ability. Clearly doing so would not change the single-crossing property described here.

[16] We exclude the third trivial case where all students choose not to attend any university.

[17] Then it can be shown that $V(a) < y \quad \text{for } \forall a < \check{a}$.

(potential) private universities choose not to participate in the market, and (2) all private universities participate in the market. Let $\check{e}$ denote the lowest level of endowment to participate the market, and $\Pi(e)$ denote the equilibrium profit as the function of e. Then the former case can be expressed by $\Pi(\check{e}) = 0$[18]. The latter case can be written by the condition $\check{e} = e_{\min}$ Now we can classify the four patterns of lower boundary conditions for an equilibrium, depending on market environment.

Lower Boundary Conditions:

Sufficient conditions for the positive sorting of students by ability to private universities and no university education in the assignment equilibrium take one of the following 4 forms:

LB1. $\check{a} = a_{\min}$ and $\check{e} = e_{\min}$ with $V(\check{a}) > y$ and $\Pi(\check{e}) > 0$. In this case all students go to some university and all private universities remain in the market.

LB2. $\check{a} > a_{\min}$ and $\check{e} = e_{\min}$ with $V(\check{a}) = y$ and $\Pi(\check{e}) > 0$. In this case some students do not go to any university and all private universities remain in the market.

LB3. $\check{a} = a_{\min}$ and $\check{e} > e_{\min}$ with $V(\check{a}) > y$ and $\Pi(\check{e}) = 0$. In this case all students go to some university and some private universities exit the market.

LB4. $\check{a} > a_{\min}$ and $\check{e} > e_{\min}$ with $V(\check{a}) = y$ and $\Pi(\check{e}) = 0$. In this case some students do not go to any university and some private universities exit the market.

With UB1, UB2, and one of the conditions LB1-4, we can determine the equilibrium values of upper and lower boundary of student's ability of private universities, and the hedonic tuition function, $t(a)$, from equation (12). The tuition function can be written in terms of endowment, denoted $t(e)$, using the market clearing condition (equation (9)).

[18] Then it can be shown that $\Pi(e) < 0 \quad$ for $\forall e < \check{e}$.

4 Numerical Examples of Equilibrium Tuition and Education Quality

This section presents some numerical examples to examine the effect of changes in national education policy (t_p, q_p, and C_p) on levels of tuition and quality at private universities. We focus on the case where equation (12) can be analytically solved under the LB3 of the lower boundary conditions.[19] In this case, all students will attend some university (private or national), but some private universities will exit from the higher education market in equilibrium. The full specification of the parameter values and details of the computation are described in the Appendix.[20]

Our baseline parameter values for the national university are that its capacity, C_p, is 5 (about 10% of the total capacity of higher education), the tuition, t_p, is 1000, and the education quality, q_p, is 700, respectively. Then, the tuition at the top private university (with $e = e_{\max}$) will become 1962.8, twice as large as that of national university, and its quality will be 636.74, almost as same as that of national university, in equilibrium. Students with their ability above 63.5 (about 28% of total population) will apply the national university, and the probability to pass the exam will be about 30% in equilibrium. Private universities with their initial endowment below 46.5 will exit from the higher education market.

We next examine the effect of national university policies on the behavior of private universities. We consider the following three types of policy changes from the baseline case separately, holding the other conditions constant; (1) 30% increase in q_p, (2) 100% increase in t_p, and (3) 50% increase in C_p. Figure 3 and 4 show the effects of alternative policies on the equilibrium tuition and the equilibrium education quality of private universities on the endowment domain, respectively. Since the policy change should shift

[19] The other cases are not difficult to calculate, and will be added shortly.

[20] In the current version, parameter values are chosen for an ease of computation of equation (12) and the intuitiveness of the results. We are working to assess the sensitivity of the results with various parameter values with better empirical support.

an equilibrium assignment of students and universities, it is also important to see the changes in tuition and education quality on the ability domain, that is from students' point of view. Those are presented in Figure 5 and 6. [21]

(Insert Figure 3)

Figure 3(a) shows the effect of quality improvement of national university on the private university tuition function. Two equilibrium tuition functions are plotted on the private university endowment, $e \in [e_{\min}, e_{\max}]$. The solid curve indicates the tuition function for the base-line case ($q_p = 700$), and the broken curve indicates the tuition function for the case where q_p is increased by 30% from the base-line value ($q_p = 910$). It is found that the levels of tuition at any private universities fall with an improvement of the quality at the national university. The economic interpretation of this result is fairly straightforward. An increase in q_p will have two opposing effects on the students decision making. First, since, with a higher quality, the national university becomes more attractive for potential applicants, some students, who previously attend a private university, will shift to applying the national university. But at the same time, an increase in the number of applicants makes it difficult for them to be admitted. Although the lower probability to pass the exam tends to dump the shift of students from private to national universities, more students apply the national university than before in equilibrium. As a result, this will tighten the private university market, and private universities will be forced to undercut their tuition in order to keep up with competition with high-quality national university. At the same time, some private universities exit from the higher education market as q_p increases. Private universities with their endowment level below 53.5 (the baseline case was below 46.5) will exit from the higher education market in under alternative education policy.

A rise in tuition at the national university has completely an opposite effect. Figure

[21] See the Appendix for detail of derivation. We can also plot the utility level of students and the profit of private universities in equilibrium. Those figures can be sent upon request.

3(b) shows that an increase in t_p will increase the tuition levels at all private universities. The interpretation is essentially the same as the above. Since an increase in t_p will lower the utility level of all students who attend the national university, this leads to a shift of some students from national to private universities, and therefore private universities can now charge higher tuition than before. The effect of the national university capacity is shown in Figure 3(c). Since the applicants for the national university are more likely to be admitted when C_p is larger, some students will shift from private to national university. This forces private universities to charge lower tuition in equilibrium, as suggested in the figure.

(Insert Figure 4)

The national education policies also affect the academic quality of private universities. Figure 4 (a) shows the effect of quality improvement at the national university on levels of quality produced by private universities. There are two equilibrium quality functions of private universities plotted on endowment level. The solid curve indicates the quality function for the base-line case ($q_p = 700$), and the broken curve indicates the quality function for the case where q_p is increased by 30% from the base-line value ($q_p = 910$). It is found that the levels of academic quality at private universities uniformly decline as q_p rises. The interpretation is almost parallel to that of the tuition case. Since an increase in q_p leads to a shift of students from private to national university, the student ability matched to each private university declines. This makes private universities to produce lower quality education and charge lower tuition, since the marginal willingness to pay of matched students for given private university also declines. Figure 4 (b) and 4 (c) also present the effect of changes in t_p and C_p, respectively, on the equilibrium quality of private universities. Simulation results show that levels of quality produced by private universities are positively related to an increase in t_p, and negatively related to an increase in C_p. The interpretations of these results can be given in the similar

manner as above, and are omitted here.

(Insert Figure 5 and 6)

We can also see the above discussion from the student's point of view. Figure 5 shows the effect of national education policies on the tuition charged for each student on the ability domain, $[a_{min}, a_{max}]$. It is found that changes in education policies which favor the national university will always lead to the higher tuition for each student. These results may seem counterintuitive because the tuition of each private university fall at the same time as seen in Figure 3. Recall that changes in the national university policy reassign students to universities, in our case shifting students at the private universities to national university. After the change of education policy, students of a given ability who remain in the private sector will be matched to a higher-endowed private university than before, necessarily at a slightly higher tuition. Being matched with less able students, private universities at a given endowment choose to charge less tuition with lower education quality in a new equilibrium, as shown in Figure 3 and 4. Finally, changes in the optimal education quality chosen by each student are shown in Figure 6. The results show that the education policies which favor the national university will improve the quality of education consumed by each student of a given ability level, since they are matched to more endowed universities than before. This result is consistent with our discussions.

5 Empirical Evidence

In this section, we present some empirical evidences on the determinants of tuition of private universities using the cross-section data of Japanese private universities.

Our current empirical analyses rely on the idea that we can reasonably assume prefectural university markets are geographically separated to entering students. Let each

prefecture indexed by k, each private university indexed by j, and d_k represent the prefectural level quality of national universities.[22] Then our tests of the theoretical predictions are generally written by the following two equations:

$$\log(tuition_{jk}) = \alpha_1 + \beta_1 \cdot d_k + \theta_1 \cdot a_{jk} + \gamma_1 \cdot x_{1k} + \varepsilon_{1jk}, \tag{14a}$$

$$\log(tuition_{jk}) = \alpha_2 + \beta_2 \cdot d_k + \theta_2 \cdot e_{jk} + \gamma_2 \cdot x_{2k} + \varepsilon_{2jk}, \tag{14b}$$

where a_{jk} is the average ability of students in university j in prefecture k, e_{jk} is the endowment of university j in prefecture k, x_{ik} $(i = 1, 2)$ is the variables that proxy the distributions of endowments of private universities in prefecture k, a_i, β_i, γ_i, and θ_i are the coefficients, and ε_{ijk} is random errors. Thus we conduct the estimation of hedonic tuition function of Japanese private universities from demand and supply sides, separately.[23] Equation (14a) is an empirical counterpart of the tuition function $t(a)$ while equation (14b) is an empirical counterpart of $t(e)$ in our theoretical model.

This cross-section data of Japanese private universities are mainly compiled for academic year 2000-2001 from the following two sources. Data on entrance "hensachi," the mean standardized nation-wide test scores of entrants, was provided by Sundai Yobiko based on its nation-wide simulation test. It covers all Japanese four-year colleges. Other university characteristics are collected from *Nihon no Daigaku* (Toyo Keizai, 2001), a major college guide book containing information on the universities available to students. This book provides us with various characteristics of Japanese universities, including the location of university, tuition and other fees, number of enrollments, library volume, faculty size, areas of campus and building, etc. In addition to these main sources, the data

[22] Since levels of tuition at national university are set equal regardless of majors or regions, we cannot see the effect of changes in national university tuition here. All prefectures have at least one national university.

[23] By doing this, we currently assume that the distribution of student ability is invariant among prefectures. Ideally panel data of universities across prefectures over years would identify the effects of ability distribution under less restrictive assumption that the distribution is heterogeneous across prefectures but time-invariant. We are in the process to prepare such panel data.

on the financial subsidy to private educational institution is collected from the webpage of the Promotion and Mutual Aid Corporation for Private Schools of Japan[24]. Data on prefecture-level characteristics of higher education market, such as number of entrants for private and national universities located at the same prefecture of their high school, are collected from the Basic School Survey (Ministry of Education, 2001).

The data used in our analysis is restricted to samples of five major "arts" departments, economics, commerce, business, law, and literature, of all the private universities in Japan. There are two reasons for this sample restriction. First, because Japanese students tend to decide their college major at their early days in high school, we believe that the market structures may differ between majors of arts and science. Second, some of the important endowment measures at science courses, such as experimental facilities or lab wares, are not available for us. Our initial sample size is 351. However, due to missing observations, sample size in each estimation is slightly below this.

All the variables for private universities are constructed as the department (i.e., undergraduate major) level average since annual tuition is usually set at department level. Therefore, other variables that may vary within a department (mainly due to the differences in multiple admission processes), such as hensachi, are averaged to make a single observation at department level. The variable "log(tuition)," the dependent variable of our estimations, stands for the natural logarithm of annual tuition fee including other required fees. Corresponding to the theoretical model, the "hensachi" variable can be viewed as the mean ability of students enrolled in each university, a_{jk}. For data on endowment of private universities, we have following variables; "faculty-student ratio," "per-student area of campus," "per-student area of school building," and "per-student library volume" of each university. They are assumed to collectively measure e_{jk}. The variable "financial subsidy" stands for the per-student amount of the financial subsidy to private education institution.

[24] http://www.shigaku.go.jp/s_home.htm

Strictly speaking, we do not directly observe the true education quality of any university, national or private. However, using information on endowments of national universities, we construct the new variables that are thought to proxy the prefecture-level average quality of national universities in prefecture k, d_k; "per-student areas of campus" and "school building", and "per-student faculty" and "library size". Since those variables are highly correlated with each other, we do not include them at the same time in the regression. So we estimate the effect of these variables separately.

In addition to these variables, we also use several control variables in our analysis. "Female student ratio" is used to control the demographic characteristic of entrants. "Number of subjects," that is the number of subjects asked in the entrance exam, is used to capture the (implicit) preparation costs for the students.[25] We also include several variables that are expected to proxy prefecture-level characteristics of local university market, x_{ik}. They are the "share of entrants to private university who graduated high schools in the same prefecture" and the "share of entrants to the national university who graduated high school in the same prefecture as the university" in order to control for any effects of student migration across prefectures upon entering university[26]. We also include the "share of private university" in each prefecture (in terms of number of entrants). We also use five dummies for the departments of business, economics, commerce, law, and literature. We use the actual number of entrants as the frequency weight because the ideal unit of observation for this analysis is student.[27]

The definitions and descriptive statistics of variables are summarized in Table 3.

In Table 4, we present the estimation results of equation (14a), regressing log(tuition) on the entrance "hensachi" and several prefectural-level characteristics including various

[25] Majority of "arts" major departments of private universities ask 2 subjects such as English and Japanese, English and Short essay, for 90 minutes each.

[26] For example, among 100 high school graduates in a given prefecture, say, 20 students go to national universities and 30 go to private universities, and among them, 5 out of 20 national university attendants and 10 out of 30 private university attendants migrate out of the prefecture upon entrance. In this case, the first index is 0.75 and the second index is 0.67.

[27] Our coefficient estimates do not essentially change without the weights, but statistical significance are much lowered.

proxy measures of the average quality of the national universities, such as faculty/student ratio, areas of campus and building, and library volume. Our numerical simulations predict that the education policies that favor the national university will increase the levels of tuition charged for each students. The results show that all of these variables have significantly positive effect on the tuition. These results are consistent with our theoretical prediction that higher quality at the national university leads to a rise in tuition for each student.

Table 5 presents the estimation results of equation (14b), regressing log(tuition) on the endowment variables of private universities while excluding the "hensachi" variable. It is found that the prefecture averages of faculty/student ratio, per-student area of school building, and library volume of national university all have negative effects on the tuition of private universities at least 10% significance level. This is consistent with our theoretical predictions that the market pressure due to the quality improvement at the national university leads to a fall in tuition at private universities. It is also found that almost all endowment measures for private university, except for the per-student area of campus, are significantly and positively related to levels of tuition charged by private universities. This result implies that more endowed private university tends to charge higher tuition and thus to produce higher quality education in equilibrium.

6 Conclusion

In this paper we ask why private universities in Japan may not be able to produce high academic quality under the distortion made by the national university policy. We show, both in numerical examples and in empirical analyses, that the quality and tuition of national university do affect the distribution of tuition of private universities. The estimation results show, consistent with our theoretical predictions, that in prefectures where national universities have relatively high quality, the tuition of private universities

tend to be lower than average when controlling for the endowments of private universities, while the tuition tends to be higher when controlling for the average ability of entering students. Given the large share of tuition revenue in the budget of private universities as shown in Table 1, our theoretical and empirical results both point to the role of national university policies in determining the financial constraint on the private universities for improving their academic quality, again as shown in Table 1.

Our theoretical and empirical analyses are constrained by the limitations of the data, particularly of individual students and on the quality of education at individual university level. We hope to expand our research by including more of such data. We are also working to implement more sophisticated semiparametric estimations of our hedonic tuition function to recover more information on the behavior of individual students and universities. We believe that our simulation results will help interpreting and understanding estimation results with more flexibility than what we presented here.

Appendix

A Proof of Upper Boundary Conditions

Upper Boundary Condition:

Sufficient conditions for the positive sorting of students by ability to national and private universities in assignment equilibrium are

UB1. At the upper boundary of student's ability, $\hat{a} < a_{\max}$,

$$y - t(q(\hat{a})) + \hat{a}^{\alpha_1} q(\hat{a})^{\alpha_2} = p(\hat{a})(y - t_p + \hat{a}^{\alpha_1} q_p^{\alpha_2}) \tag{A1}$$

must be satisfied in equilibrium. (For student with ability $\hat{a}$, attending the top private is indifferent to applying the national university.)

UB2. $q(\hat{a})^{\alpha_2} < p(\hat{a}) q_p^{\alpha_2}$. (national university has sufficiently high quality relative to private.)

Proof:

When the first and second order conditions are satisfied both for students and private universities, among those who choose private universities, students with higher ability always choose a university of higher quality in equilibrium. This is verified by the single-crossing property of indifference curves of students on q and t.

Under UB1, the assignment is in equilibrium if and only if (a) those with $a > \hat{a}$ would be strictly better off by choosing the national university rather than choosing the top private university and (b) those with $a < \hat{a}$ would be strictly better off by choosing their optimal private university rather than the national university.

(a) For those with $a > \hat{a}$, $U(national) - U(top\ private) = p(\hat{a})(y - t_p + a^{\alpha_1} q_p^{\alpha_2}) - (y - t(\hat{a}) + \hat{a}^{\alpha_1} q(\hat{a})^{\alpha_2}) = (p(\hat{a}) q_p^{\alpha_2} - q(\hat{a})^{\alpha_2})(a^{\alpha_1} - \hat{a}^{\alpha_1})$ using equation (13). Therefore, applying the national university is strictly preferred if and only if $(q(\hat{a})^{\alpha_2} < p(\hat{a}) q_p^{\alpha_2})$.

(b) Similarly for those with $a < \hat{a}$, under $q(\hat{a})^{\alpha_2} < p(\hat{a})q_p^{\alpha_2}$, $U(national) - U(top\ private) = (p(\hat{a})q_p^{\alpha_2} - q(\hat{a})^{\alpha_2})(a^{\alpha_1} - \hat{a}^{\alpha_1}) < 0$. Since for those with $a < \hat{a}$, choosing less than top private university is the best choice among all the private universities, they will not choose the national university.

B Details of Numerical Examples

We first describe the derivation of $t(a)$ in more detail, and show cases for which equation (12) is analytically solvable.

Differentiating equation (10) with respect to a, we obtain

$$\frac{dq}{da} = \frac{1}{\beta - \alpha_2} q(a)[\alpha_1 a^{-1} + (\beta - 1)(a + e_{\max} - \hat{a})^{-1}].$$

Then the integrand in the right-hand-side of equation (12) can be written as

$$\frac{\alpha_2}{\beta - \alpha_2} \left(\frac{\alpha_2}{\beta}\right)^{\frac{\alpha_2}{\beta - \alpha_2}} a^{\frac{\alpha_2 \beta}{\beta - \alpha_2}} (a - e_{\max} + \hat{a})^{\frac{\alpha_2(\beta-1)}{\beta - \alpha_2}} [\alpha_1 a^{-1} + (\beta - 1)(a + e_{\max} - \hat{a})^{-1}] \quad \text{(A2)}$$

It is known that the analytical expression of the infinite integral of the above expression can be obtained if either $\alpha_2\beta/(\beta - \alpha_2)$, $\alpha_2(\beta - 1)/(\beta - \alpha_2)$, or $\alpha_2\beta/(\beta - \alpha_2) + \alpha_2(\beta - 1)/(\beta - \alpha_2)$ is an integer.

Since $\alpha_2(\beta - 1)/(\beta - \alpha_2) = 1$ if $\alpha_2 = 1$, we set $\alpha_2 = 1$ in our example. A full specification of parameter values are given as follows. Potential students are distributed on $[a_{\min}, a_{\max}] = [20, 80]$, and private universities are distributed on $[e_{\min}, e_{\max}] = [10, 90]$. Parameters for utility function, α_1 and α_2, are set 1/3 and 1, respectively. A parameter for cost function, β, is set to be 3/2. Subjective discount rate, δ, is set to be 0.95. Income of each student, y, is assumed 10000. Finally, the baseline values for the key parameters for our analysis, the quality, tuition, and capacity of national university is set to be $q_p = 700$, $t_p = 1000$, and $C_p = 5$, respectively.

To determine the values for $\hat{a}$, $\check{a}$, and C of the hedonic tuition function under UB1, UB2, and LB3 numerically, we impose $\check{a} = a_{\min}$, $\Pi(e_{\min}) = 0$, and $y - t(q(\hat{a})) + \hat{a}^{\alpha_1} q(\hat{a})^{\alpha_2} = p(\hat{a})(y - t_p + \hat{a}^{\alpha_1} q_p^{\alpha_2})$. Given the equilibrium values of $\hat{a}$, $\check{a}$, and C, substituting these values into the solution of equation (12) yields the numerical hedonic tuition function, $t(a)$. After solving $t(a)$, we can change the variable from a to e by using the market clearing condition (equation (9)) to obtain $t(e)$. Also, once we determine the equilibrium value for $\hat{a}$, the equilibrium quality function, $q(a)$ and $q(e)$, can be easily calculated.

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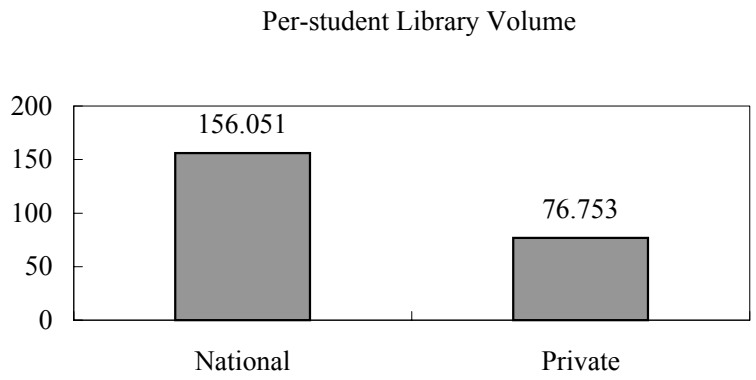
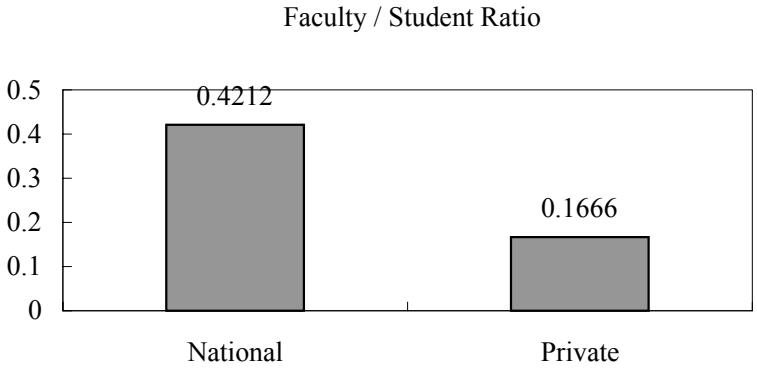
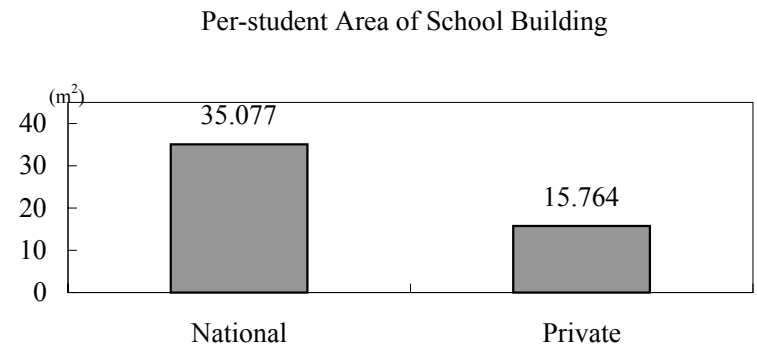
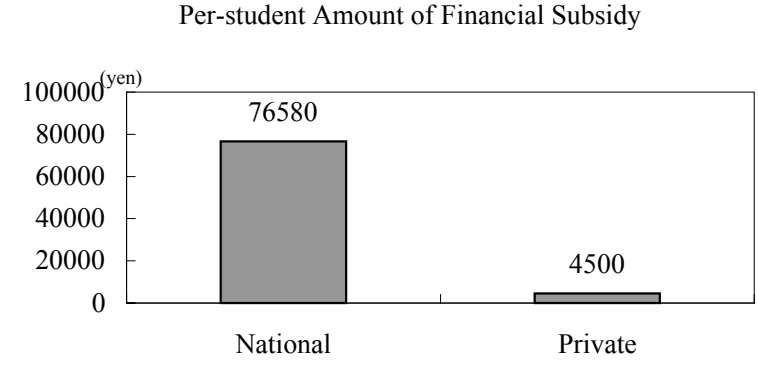
Figure 1: Quality Measures of Education for Both Private and National University



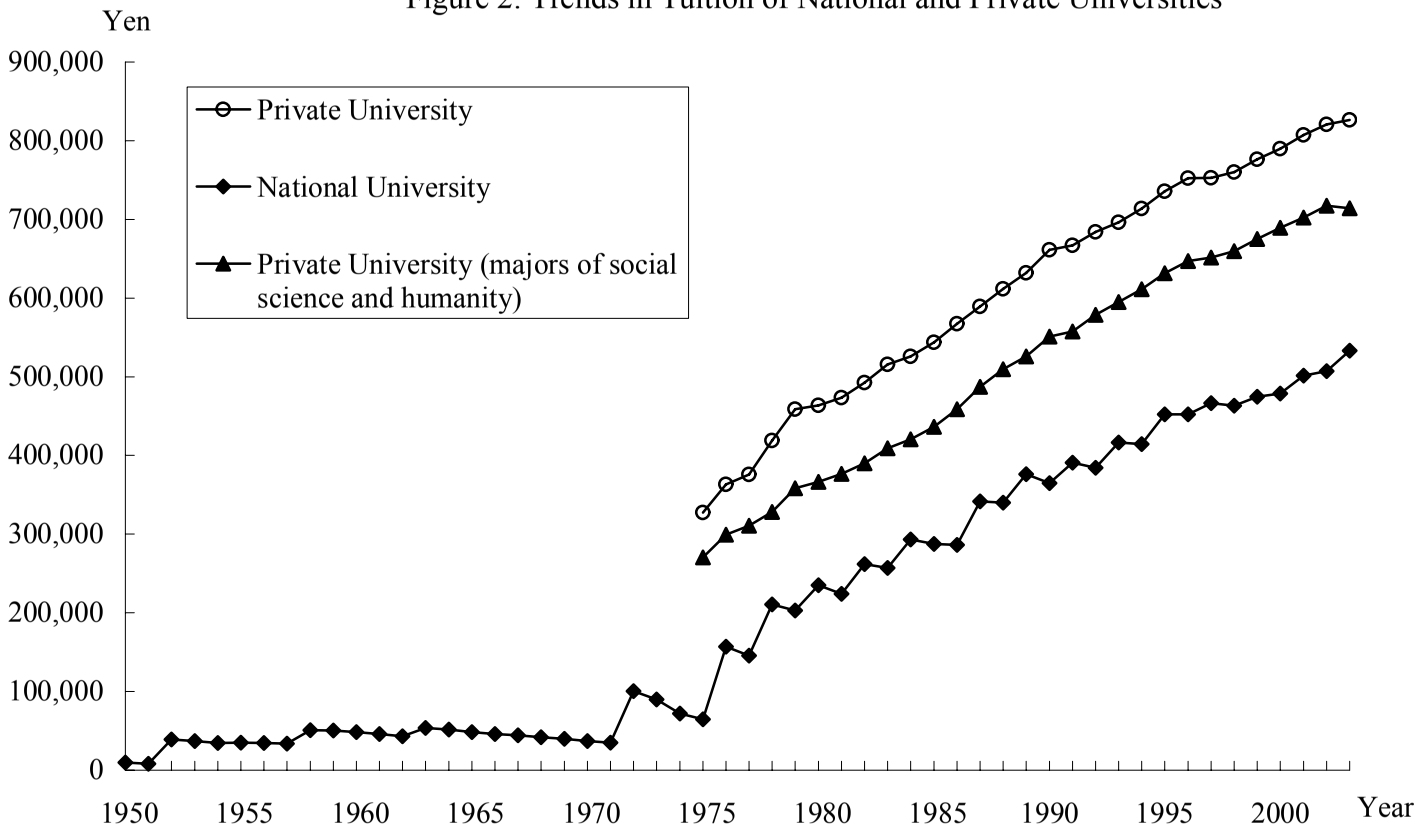






Note: See Section 4 for details of data used here. Samples are for all 4-year colleges in Japan.

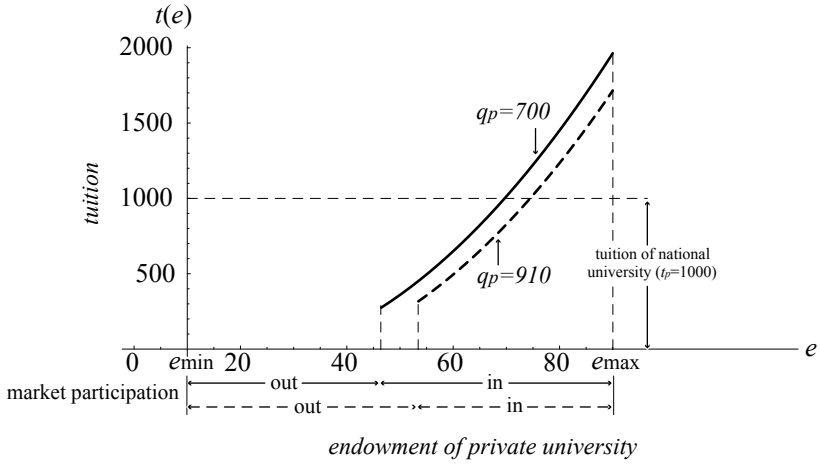
Figure 2: Trends in Tuition of National and Private Universities



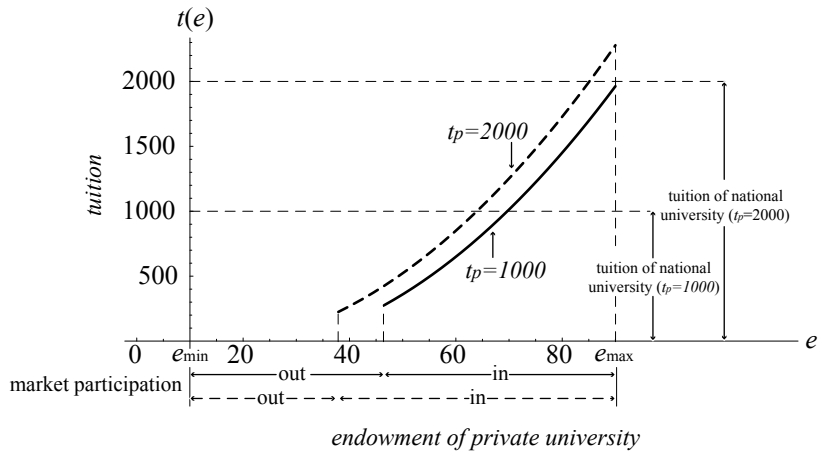
Source: Documents provided by the Ministry of Education

Table 3: Effect of National University Policy on the Private University Tuition (plotted on endowment domain)

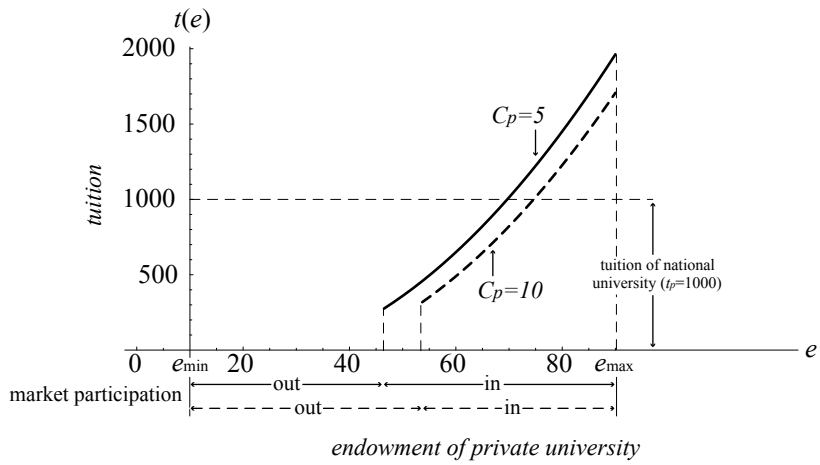
(a) Effect of National University Quality



(b) Effect of National University Tuition



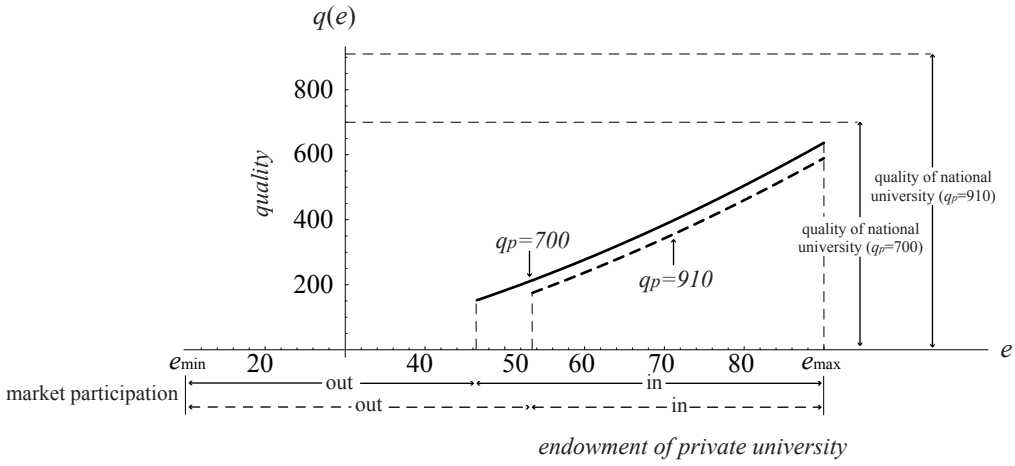
(c) Effect of National University Capacity



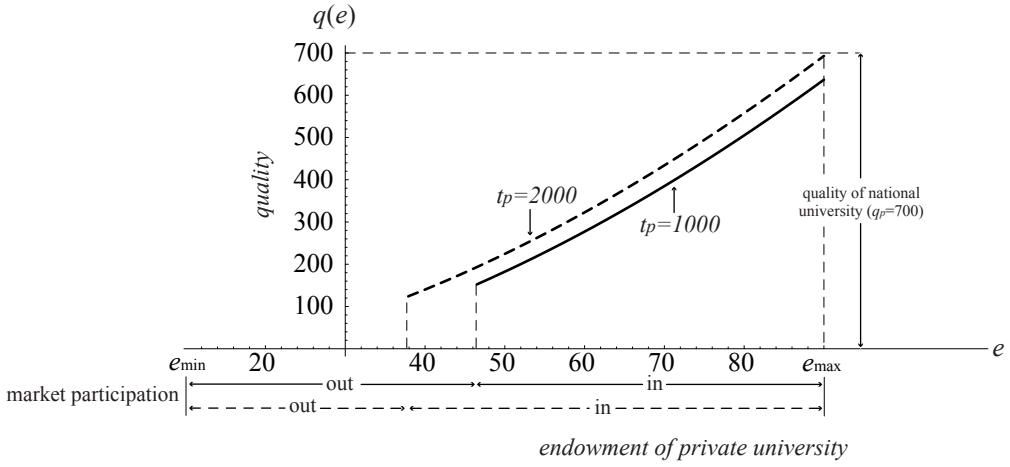
Note: q_p is quality of national university. t_p is tuition of national university.
C_p is capacity of national university.

Table 4: Effect of National University Policy on the Private University Quality (plotted on endowment domain)

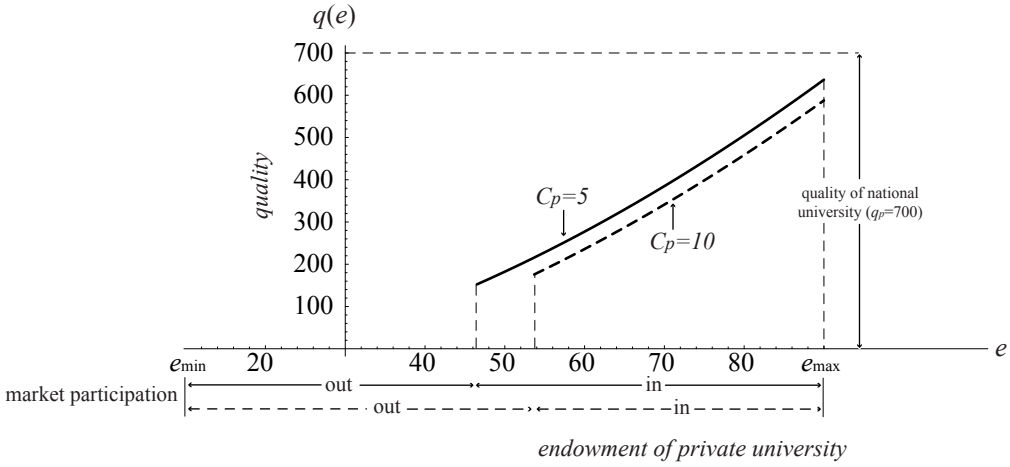
(a) Effect of National University Quality



(b) Effect of National University Tuition



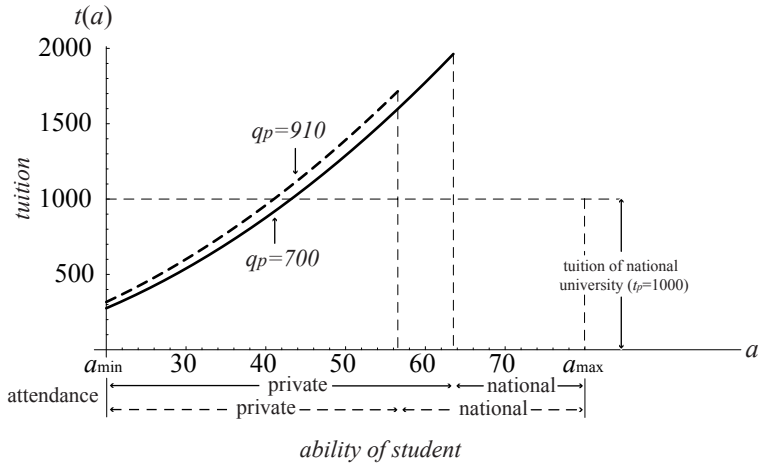
(c) Effect of National University Capacity



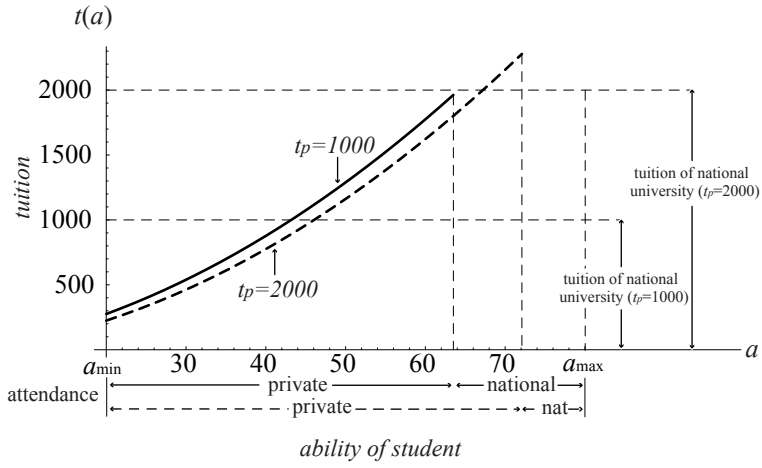
Note: q_P is quality of national university. t_P is tuition of national university. C_P is capacity of national university.

Table 5: Effect of National University Policy on the Private University Tuition (plotted on ability domain)

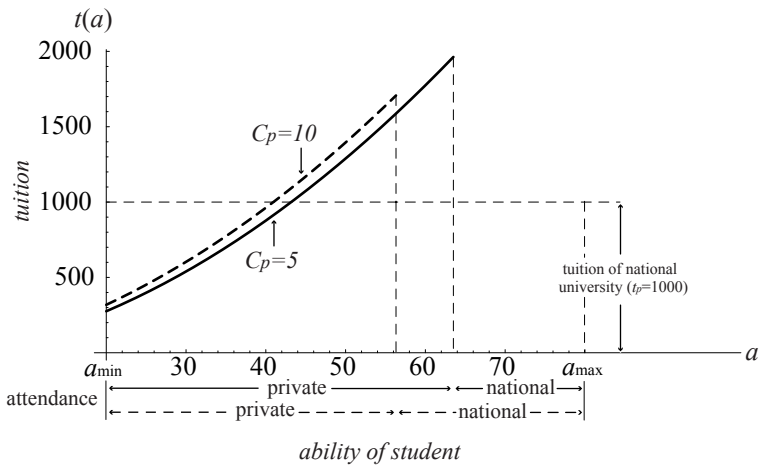
(a) Effect of National University Quality



(b) Effect of National University Tuition



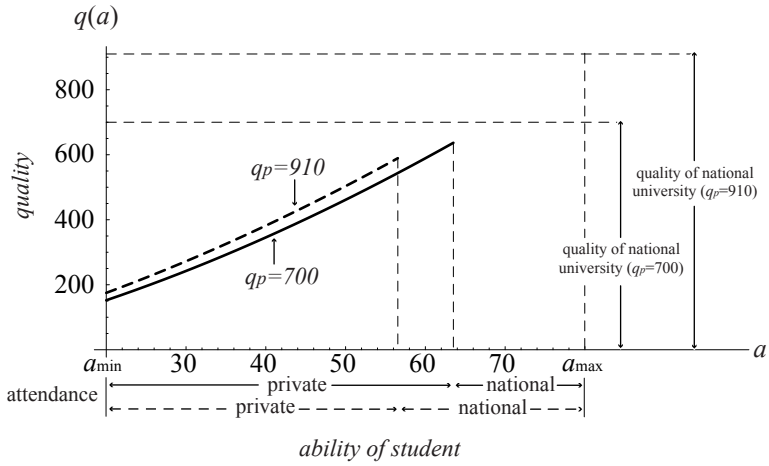
(c) Effect of National University Capacity



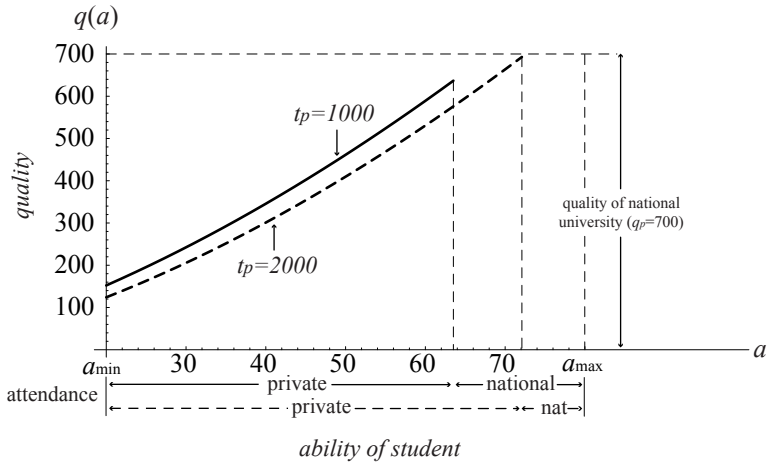
Note: q_p is quality of national university. t_p is tuition of national university. C_p is capacity of national university.

Table 6: Effect of National University Policy on the Private University Quality (plotted on ability domain)

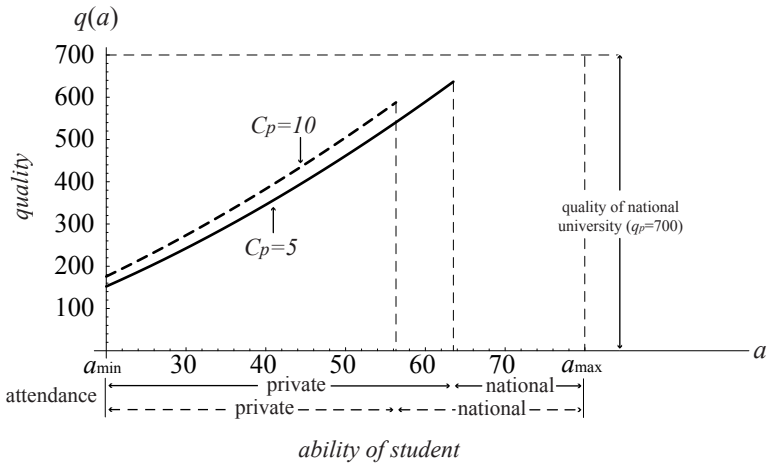
(a) Effect of National University Quality



(b) Effect of National University Tuition



(c) Effect of National University Capacity



Note: q_P is quality of national university. t_P is tuition of national university.
C_P is capacity of national university.

Table 1: Comparison of Public and Private University in Japan and the U.S.

	Japan (1998)		U.S. (1995)	
	Public[a)]	Private	State	Private
Education expenditure/student (Japan: million yen / U.S.: 1000 dollar)	4.36	1.74	22.41	35.66
Consumption expenditure/student (Japan: million yen / U.S.: 1000 dollar)	3.28	1.45	20.14	31.67
Ratio of government subsidy to total expenditure (%)	88.82	8.92	51.05	16.41
Ratio of tuition revenue to total expenditure (%)	11.18	62.5	17.51	40.72
Government subsidy/student (Japan: million yen / U.S.: 1000 dollar)	3.87	0.16	11.44	5.85
Student/faculty ratio	11.39[b)]	30.27[b)]	15.8[c)]	12.8[c)]
Average annual tuition (Japan: million yen / U.S.: 1000 dollar)	5.41	8.43	3323	16552

Note: Japanese data is for year 1998, and the U.S. data is for year 1995. Both are taken from Ministry of Education (2001) which is originally based on the Basic School Survey (Japan) and Digest of Education Statistics (U.S. Department of Education).

(a) Column "Public" for Japan covers both national and local public universities.

(b) The number of faculty for Japanese universities is for year 1999.

(c) 1999 Fall staff survey (U.S. Department of Education.)

Table 2: Measures of Entrance Difficulty for Both Private and National Universities

	Private		National	
	Hensachi	Applicants/Entrants	Hensachi	Applicants/Entrants
Business	45.4	2.4	58.5	3.5
Economics	46.1	2.5	54.7	4.1
Commerce	46.9	2.7	55.3	3.2
Arts	43.2	1.8	53.3	3.5
Literature	49.0	3.0	59.3	3.9
Law	50.2	2.8	59.8	3.5
Engineering	46.3	2.6	51.9	3.5
Science	54.6	3.2	54.8	3.8
Science and Engineering	53.3	3.4	49.8	3.7
Medicine, Dentistry and Pharmac	58.1	6.3	56.9	5.1

Note: Data on "Hensachi" indicate the mean standardized test scores of entrants, based on nation-wide simulation test by Sundai Yobiko.
See Section 4 for detail of data used here.

Table 3: Definitions and Descriptive Statistics of Variables

Variable name	Definition	Obs	Mean	Std. Dev.	Min	Max
log(tuition)[a)]	Natural logarithm of annual tuition including other required fees	351	4.524	0.124	4.184	4.975
Hensachi[a)]	Average "hensachi" of entrants	351	46.874	7.743	35	69
Faculty / Student ratio[a)]	Faculty / Student ratio	346	0.121	0.115	0.040	1.725
Area of building[b)]	Per-student area of school building (m^2/student)	317	0.0013	0.0011	0.0005	0.0118
Library volume[b)]	Per-student library volume	345	0.0077	0.0038	0.0024	0.0463
Financial subsidy[b)]	Per-student governmental financial subsidy (1000yen/student)	349	100.327	64.303	0	368.592
Faculty / Student ratio (national)[c)]	Faculty / Student ratio of the national university (prefecture-level average)	337	0.295	0.073	0.119	0.422
Area of campus (national)[c)]	Per-student area of campus of the national university (prefecture-level average) (m^2/student)	337	0.1291	0.4027	0.0049	2.0026
Area of building (national)[c)]	Per-student area of building of the national university (prefecture-level average) (m2/student)	335	0.0048	0.0022	0.0012	0.0075
Library volume (national)[c)]	Per-student library volume of the national university (prefecture-level average)	337	0.0256	0.0106	0.0075	0.0392
Female student ratio[b)]	Share of female students total enrollment	349	0.381	0.270	0	1
Number of subjects[a)]	Number of subjects required in the entrance exam	351	2.312	0.401	1	3
One subject[a)]	Dummy variable (1: number of subjects=1, 0: otherwise)	351	0.023	0.149	0	1
Two subjects[a)]	Dummy variable (1: 1<number of subjects<=2, 0: otherwise)	351	0.769	0.422	0	1
Three subjects[a)]	Dummy variable (1: number of subjects=3, 0: otherwise)	351	0.208	0.406	0	1
Share of entrants[a)]	Share of each university among total entrants to private universities in the same prefecture	351	0.814	0.098	0.508	0.931
Share of private university[c)]	Share of total entrants in private universities in each prefecture	349	0.187	0.254	0.001	1.000
Share of private university entrants who graduated highschool in the same prefecture[c)]	Share of entrants to the private university who graduated highschool in the same prefecture	351	0.510	0.183	0.034	0.776
Share of national university entrants who graduated highschool in the same prefecture[c)]	Share of entrants to the national university who graduated highschool in the same prefecture	351	0.386	0.168	0.067	0.728

Notes: a) depertment-level variable, b) university-level variable, c) prefecture-level variable

Table 4: Empirical Result 1 (Demand Side)

log(tuition)[1]	Coef.	Coef.	Coef.	Coef.
	(Std. Err.)	(Std. Err.)	(Std. Err.)	(Std. Err.)
Hensachi	0.0280 **	0.0313 **	0.0267 **	0.0269 **
	(0.0015)	(0.0014)	(0.0015)	(0.0015)
Quality measure of national university	0.0560 **	0.0533 **	3.6684 **	0.7508 **
	(0.0049)	(0.0008)	(0.1861)	(0.0372)
Female students ratio	0.0496 **	0.0513 **	0.0516 **	0.0505 **
	(0.0014)	(0.0014)	(0.0014)	(0.0014)
Share of private university	0.3738 **	0.4580 **	0.3554 **	0.3527 **
	(0.0030)	(0.0032)	(0.0031)	(0.0030)
Share of private university entrants	0.0110 **	-0.0050 *	0.0182 **	0.0054 *
who graduated high school in the same prefecture	(0.0021)	(0.0021)	(0.0021)	(0.0021)
Share of national university entrants	-0.1289 **	-0.1513 **	-0.1405 **	-0.1330 **
who graduated high school in the same prefecture	(0.0023)	(0.0018)	(0.0023)	(0.0021)
Two subjects	1.3907 **	1.5222 **	1.3465 **	1.3575 **
	(0.0578)	(0.0543)	(0.0583)	(0.0584)
Three subjects	1.1418 **	1.2496 **	1.0860 **	1.0990 **
	(0.0579)	(0.0544)	(0.0586)	(0.0586)
Two subjects × Hensachi	-0.0365 **	-0.0396 **	-0.0354 **	-0.0357 **
	(0.0015)	(0.0014)	(0.0015)	(0.0015)
Three subjects × Hensachi	-0.0327 **	-0.0353 **	-0.0313 **	-0.0316 **
	(0.0015)	(0.0014)	(0.0015)	(0.0015)
Constant	3.2146 **	3.0363 **	3.2817 **	3.2793 **
	(0.0584)	(0.0545)	(0.0586)	(0.0586)
Quality measure of national university	Faculty/Student ratio	Area of campus	Area of building	Library volume
Department dummy[2]	Yes Yes	Yes Yes		
N	335	335	333	335
R^2	0.3645	0.3779	0.3650	0.3652

Notes: **, *, and # indicate that the estimated coefficient is at the 0.01, 0.05, and 0.1 significance level, respectively.
Standard errors are White's HCSE.

1) Samples used here is for the department of economics, law, commerce, business, and literature.
2) "Yes" if department dummies are controlled.

Table 5: Empirical Result 2 (Supply Side)

log(tuition)[1]	Coef.	Coef.	Coef.	Coef.
	(Std. Err.)	(Std. Err.)	(Std. Err.)	(Std. Err.)
Faculty/Student ratio	0.1218 **	0.1208 **	0.1256 **	0.1139 **
	(0.0323)	(0.0353)	(0.0302)	(0.0332)
Area of campus	-0.2209	-0.2740	-0.2579	-0.2128
	(0.2001)	(0.1888)	(0.1973)	(0.1976)
Area of building	36.3523 #	42.2179 *	38.2795 #	33.5063 *
	(21.1403)	(20.0408)	(20.9941)	(21.1389)
Library volume	5.0307 *	4.3894 #	4.8563 *	4.9111 *
	(2.4747)	(2.4333)	(2.4648)	(2.4642)
Financial aid	-0.0007 **	-0.0007 **	-0.0007 **	-0.0007 **
	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Quality measure of national university	-0.2767 **	0.0488 **	-6.2613 #	-2.2595 *
	(0.1045)	(0.0160)	(3.8254)	(0.8635)
Share of entrants	-0.1817 **	-0.1587 **	-0.1936 **	-0.1911 **
	(0.0308)	(0.0324)	(0.0325)	(0.0352)
Share of private university	0.0846	0.1660 *	0.0988	0.1436 #
	(0.0764)	(0.0783)	(0.0799)	(0.0776)
Share of private university entrants who graduated high school in the same prefecture	-0.1986 **	-0.1908 **	-0.1769 **	-0.1856 **
	(0.0468)	(0.0476)	(0.0476)	(0.0475)
Share of national university entrants who graduated high school in the same prefecture	-0.0163	-0.1378 **	-0.0562	-0.0280
	(0.0453)	(0.0412)	(0.0466)	(0.0429)
Number of subjects	-0.0795 **	-0.0756 **	-0.0754 **	-0.0723 **
	(0.0185)	(0.0185)	(0.0190)	(0.0189)
Constant	4.8278 **	4.7004 **	4.7557 **	4.7404 **
	(0.0881)	(0.0867)	(0.0905)	(0.0874)
Quality measure of national university	Faculty/Student ratio	Area of campus	Area of building	Library volume
Department dummy[2]	Yes Yes	Yes Yes		
N	303	303	301	303
R^2	0.3071	0.3095	0.3096	0.3067

Notes: **, *, and # indicate that the estimated coefficient is at the 0.01, 0.05, and 0.1 significance level, respectively.
Standard Errors are White's HCSE.

1) Samples used here is for the department of economics, law, commerce, business, and literature.
2) "Yes" if department dummies are controlled.