

**THE EFFECTS OF REMOTENESS IN JAPANESE
EDUCATIONAL LEVELS**

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The Effects of Remoteness in Japanese Educational Levels

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Abstract

In this paper we analyze the role played by remoteness to explain the spatial distribution of educational attainment levels across the 47 Japanese prefectures. Our study departs from the concept of market potential developed by Harris (Harris, 1954) to explain the interplay between human capital location and remoteness and then goes on to validate its effects with Japanese data for 2005. The results of our estimations show that the unequal distribution of population (workers) by educational level depends positively (negatively) on the prefecture's market potential (prefectures remoteness). High market potential prefectures have a high percentage of individuals with medium and high educational attainment levels whereas the opposite occurs for low market potential prefectures. Doubling a prefecture's market potential, would increase its percentage of individuals with medium and high educational levels by 25-30%. Moreover the econometric results show that between 55% and 64% of the spatial variation in human capital levels is explained by prefectures market potential.

Key Words: Remoteness, Market potential, Prefectures, Japan, Educational Attainment Levels

JEL Classification: R11, R12, R13, R14, F12, F23

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1. Introduction

The aggregate human capital at national or regional level has traditionally been used to characterize the development of a country or region and to explain its economic growth. Societies with a better endowment of human capital are considered to have a greater development potential than societies with scarce or inadequate human resources¹. It is well-known the fact that disparities in human capital endowment across nations, but especially across regions, are considerable and likely to affect the potential for convergence. A Well-known example is the case of the European Union (EU) where in the EU periphery there are big shortages in human capital stocks as compared with more central and Northern regions (Rodriguez-Pose and Vilalta-Bufi, 2005). Despite the wide scholarly agreement on the fact that human capital is an important determinant of economic growth, there are few empirical studies on the effects that economic geography variables, particularly the so called market potential (Harris, 1954), might play in human capital accumulation. Harris's (1954) market-potential function relates the potential demand for goods and services produced in a location $j = 1, 2, \dots, \phi$ to that location's proximity to consumer's markets. Therefore there is a clear link between market potential and economic remoteness in the sense that if a region has a low market potential, this fact can be thought of as if the region is far from the main consumer markets and therefore in the *center-periphery* or *core-periphery* dichotomy of New Economic Geography models can be referred to as "economic-periphery" or that the region is remote in an economic sense despite for instance the region being located in a central position in a pure geographical dimension. On the contrary if a region has a high market potential this fact is associated with proximity to main consumer markets and therefore the region that enjoys it is often equated with "centrality" in an economic sense and can be referred to as "economic-center" despite being located in a peripheral position in a pure geographical sense.

¹ Pioneering studies on the link between human capital and economic performance are those of Barro, 1991; Mankiw et al., 1992; Levine and Renelt, 1992

At empirical level the only studies we are aware so far are Redding and Schott, (2003) for a sample of 105 developed and developing countries and Lopez-Rodriguez et al. (2007) for a sample of 203 European Union NUTS 2 regions. However, there are no within country studies on the relationship between human capital and market potential still. This paper tries to fill in this gap by analyzing the relationship between market potential and the unequal distribution of population (workers) by educational level for the case of Japan. The paper will stress the fact that the concentration of human capital in specific geographical areas depends positively (negatively) on the prefecture's market potential (prefectures remoteness). High market potential prefectures have a high percentage of individuals with medium and high educational attainment levels whereas the opposite occurs for low market potential prefectures. Moreover, the econometric results show that between 55% and 64% of the spatial variation in human capital levels is explained by prefectures market potential.

The paper is divided into five further sections: section 2 briefly explains the Harris, (1954) market potential concept. Section 3 presents the econometric approach and data. Section four contains a descriptive analysis of educational attainment levels across the Japanese prefectures and its relationship with market potential. Section five discusses the econometric estimations. Finally section six presents the main conclusions.

2. The Harris (1954) Market Potential Concept

The idea that market potential is important in studies of cross-country performance dates back at least to Harris (1954) who approximates a market potential function, which expresses the potential demand for goods produced in a location as the sum of the purchasing power in all other locations, weighted by transport costs.

The concept of market potential in its simplest formulation obeys to the following expression:

$$MP_i = \sum_{j \neq i}^n \frac{M_j}{D_{ij}} \quad (1)$$

where MP_i is the market potential in location i , M_j is a measure of the volume of economic activity in location j , D_{ij} is a measure of the distance or transport costs between i and j and n is the number of locations considered.

The concept of market potential can be understood as a measure of how far a location is from its consumer markets and therefore it can be used as a proxy for the demand potential that the whole population exerts over every location in the space.

Since Harris (1954) formulation of the market potential concept, the empirical investigation on its significance for regional development has triggered a plethora of contributions, Breinlich (2006), Hanson (2005), Redding and Venables (2004), Lopez-Rodriguez and Faiña (2007) to name a few of them. However, the vast majority of these studies deal with the effects market potential has on the spatial income structure observed across different locations. Only, very recently Redding and Schott (2003) and Lopez-Rodriguez et al. (2007) carried out a comprehensive analysis of the effects of market potential on the unequal distribution of population (workers) by human capital levels for a sample of world countries and for a subset of 203 European Union NUTS 2 regions. Both studies provide evidence that educational attainment is higher in countries (regions) located in the economic center. These set of studies show therefore that the concentration of human capital in specific areas is affected by the location's market potential magnifying therefore the effect that economic geography can have on either cross-country or regional per capita income. Therefore, increasing a country's or region relative remoteness not only reduces contemporaneous factor rewards, but also lowers gross domestic product by suppressing human capital endowments and decreasing the supply of high-income skilled workers.

3. Econometric Approach and Data

In this section we present the econometric approach we will use in the empirical estimations carried out in the next section of the paper. Harris (1954) market potential concept can be used to estimate the following regression equation:

$$\ln(EA_i) = \alpha_0 + \alpha_1 \ln(MP_i) + \varepsilon_i \quad (2)$$

EA_i represents the educational attainment level in prefecture ² “i”, MP_i represents the market potential for prefecture i and ε_i represents the error term. We use different measures of educational attainment levels in our estimations. Our first approach to the dependent variable, EA_i , was to measure the stock of human capital in each prefecture according to the figures provided by the Japanese Ministry of Education on the highest level of education reach by the population (Junior, College and University) and define three types of educational attainment levels based on the former computations. In first place we consider the percentage of individuals with college and university education and we labelled this variable as *log CollegeUniv* in our regressions. This variable can be considered as a proxy for the stocks of medium and high educational attainment levels in each prefecture. In second place we consider only the percentage of individuals with university education and we labelled this variable as *log Univ* in the regression estimations. *Log Univ* represents the Japanese stocks of high educational attainment levels. In third place we define a new educational attainment level variable which only considers the percentage of individuals enrolled in Junior School and we labelled this variable as *log JuniorSch*. This variable accounts for the stocks of low educational attainment levels in Japan. This third type of educational variable will constitute an indirect way to test the main predictions of the model. To complement the estimations of different equations for different educational attainment levels, we also report the results of two alternative estimations based on transformations in the definition of the dependent variable which will constitute our second and

² Japan is divided into 47 parts, which are called prefectures. Exactly speaking, some of them are called “to”, “dou” and “fu” instead of prefecture. However, for reasons of simplicity, the single terminology of “prefecture” is used in this paper as is in the majority of papers dealing with Japanese issues. This simplification may not affect any outcomes for our analysis. Prefectures are much smaller than States, Departments, Counties and Provinces but larger than Cities, Towns and Villages. Prefectures are administrative structures, as each prefecture has their own prefectural government. The prefectural government controls local economy, education, labor and many other services.

third approaches to the definition of the dependent variable. Our second approach to the dependent variable consists of ranking Japanese prefectures according to the highest share of education achieved. Therefore in the rank we assign the value 1 to a prefecture if low educational attainment levels represent the highest share of educational attainment and we assign the value 2 if medium and high educational attainment levels represent the highest share of education. Once we have this classification we estimate an ordered probit model. The third approach consists of estimating a single equation where the dependent variable is the average years of schooling in each prefecture instead of educational attainments.

In the different approaches taken to the dependent variable all the data refer to prefectural values for the year 2005³.

Equation (2) allows us to check if there is a spatial educational attainment structure in Japan, i.e., namely whether there is a positive correlation between medium and high educational levels and market potential or alternatively if those prefectures which have a high market potential index are also prefectures with relatively high levels of education. We begin by examining how much of the variation in cross prefectural human capital can be explained when only including information on market potential. This provides the basis for our baseline estimation where we assume that the error term is uncorrelated with the explanatory variables. Considering that this assumption can be violated and therefore the coefficient estimates be biased and inconsistent, we also present estimates using instrumental variables regression.

In order to control for the effects of outlying observations, we also estimate this alternative specification:

$$\ln(EA_i) = \alpha_0 + \alpha_1 \ln MP_i + \sum_{n=1}^N \gamma_n X_{i,n} + \varepsilon_i \quad (3)$$

Where X_{in} is a control variable and γ_{in} is the correspondent coefficient.

³ The Statistics Bureau and the Director-General for Policy Planning of Japan play the central role in the official statistical system in producing and disseminating basic official statistics, and coordinating statistical work under the Statistics Act and other legislation.

The variable on the right hand side of expression (#2) is the prefecture's market potential. Regarding the market potential variable, which according to Harris (1954) is a distance-weighted sum of the volume of economic activity in the surrounding regions, we build two types of market potential variables, one which proxies the volume of economic activity by the total population of each prefecture and another which proxies it by the total gross prefectural product. The calculation of distances in the market potential variable is made on the basis of the 47 prefectures in which Japan is divided. To calculate the distance between prefectures we take the distance between their capital cities expressed in kilometres and which was computed according to the following expression for the geodetic distance:

$$S = \frac{\sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}}{\frac{s}{S}}, \quad \frac{s}{S} = m_0 \left\{ 1 + \frac{1}{6R_0^2 m_0^2} (y_1^2 + y_1 y_2 + y_2^2) \right\}$$

S : Geodetic distance, x_1 : Coordinate x at position 1, y_1 : Coordinate y at position 1,

x_2 : Coordinate x at position 2, y_2 : Coordinate y at position 2, R_0 : Average radius of curvature (argument = φ_0), φ_0 : Latitude at the origin of coordinate system, m_0 : Scale factor at the origin of coordinate system ($m_0 = 0.9999$)

The official data of the latitude/longitude of each prefectural capital were obtained from the Geographical Survey Institute of the Government of Japan. There are two methods of calculation "Bessel" and "GRS80" respectively. Both calculations were done and it was clear from the outcome that we can choose either of them.

For the calculation of the internal distance within each prefecture, it is approximated by a function that is proportional to the square root of each prefecture area. The expression used for calculation is $0.66 \sqrt{\frac{Area}{\pi}}$ where

"Area" represents the size of the prefecture expressed in km². This expression gives the average distance between two points on a circular location (see Crozet 2004, Head and Mayer, 2000, and Nitsch 2000) for a discussion of this measure of internal distance). Internal distances within each prefecture are

approximated by a function that is proportional to the square root of the area of the corresponding prefecture. The expression used for calculation is $0.66\sqrt{\frac{Area}{\pi}}$

where "Area" represents the size of the prefecture expressed in square km. This expression gives the average distance between two points on a circular location (see Head and Mayer, 2000, Nitsch 2000, Crozet 2004 for a discussion of this measure of internal distance).

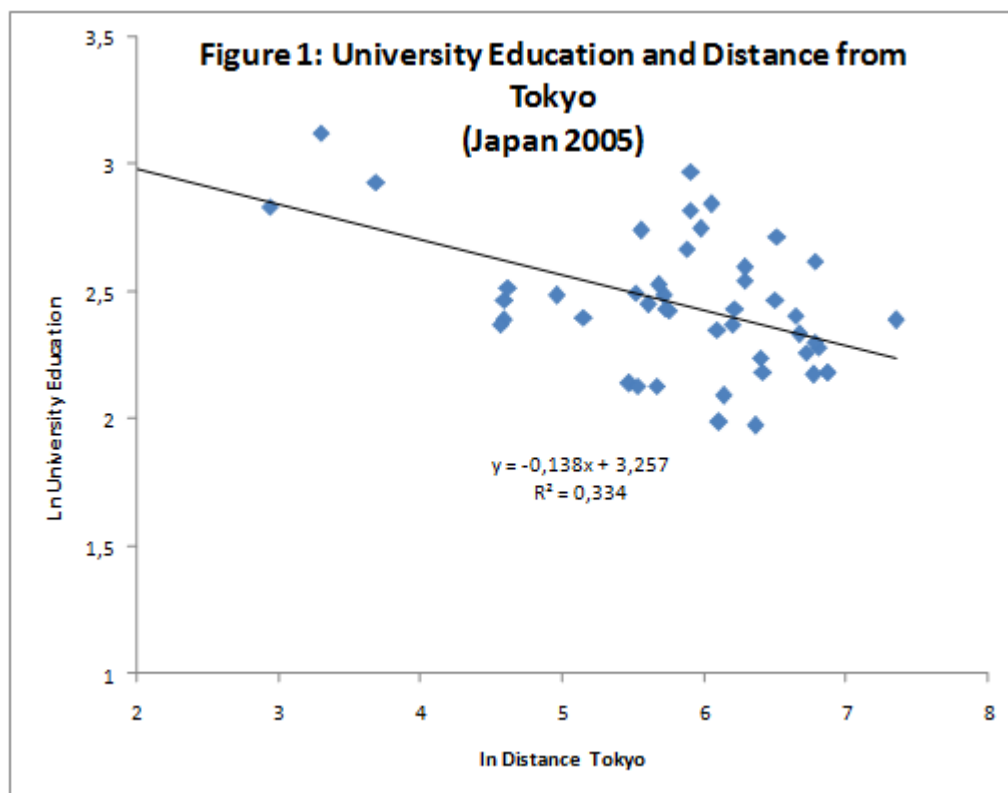
4. Educational Attainment Levels in Japan: Descriptive Analysis

The educational attainment of the Japanese prefectures varies greatly. Table 1 shows the percentage of population with low, medium and high educational levels for the 47 Japanese prefectures in the year 2005. The capital of Japan, Tokyo, ranks first in terms of the percentage of population with university degree (24.2 %), and second in percentage of population with college degree behind Kanagawa (14.6%). It is worth remarking the outstanding position of Tokyo in comparison with the average values for the country. As it can be seen in the summary of the statistics of table 1, Tokyo's population with university degree is twice as much as the country average. Tokyo is also the prefecture with the lowest percentage of population with low educational attainment levels (Junior School) with a percentage of 13.6%, being a figure which is almost half of the country's average. Among the prefectures with the highest levels of educational attainment (university degree) are those located in the so-called *economic center* of Japan (Tokyo, Kanagawa, Saitama, Nara, Hyogo and Osaka). The lowest educational attainment levels are in those prefectures located in the Japanese economic periphery (Akita, Iwate, Kagoshima, Miyazaki, Nagasaki and Kochi).

Table 1: Disparities in Educational Attainment Level Across Japanese Prefectures (Year 2005)

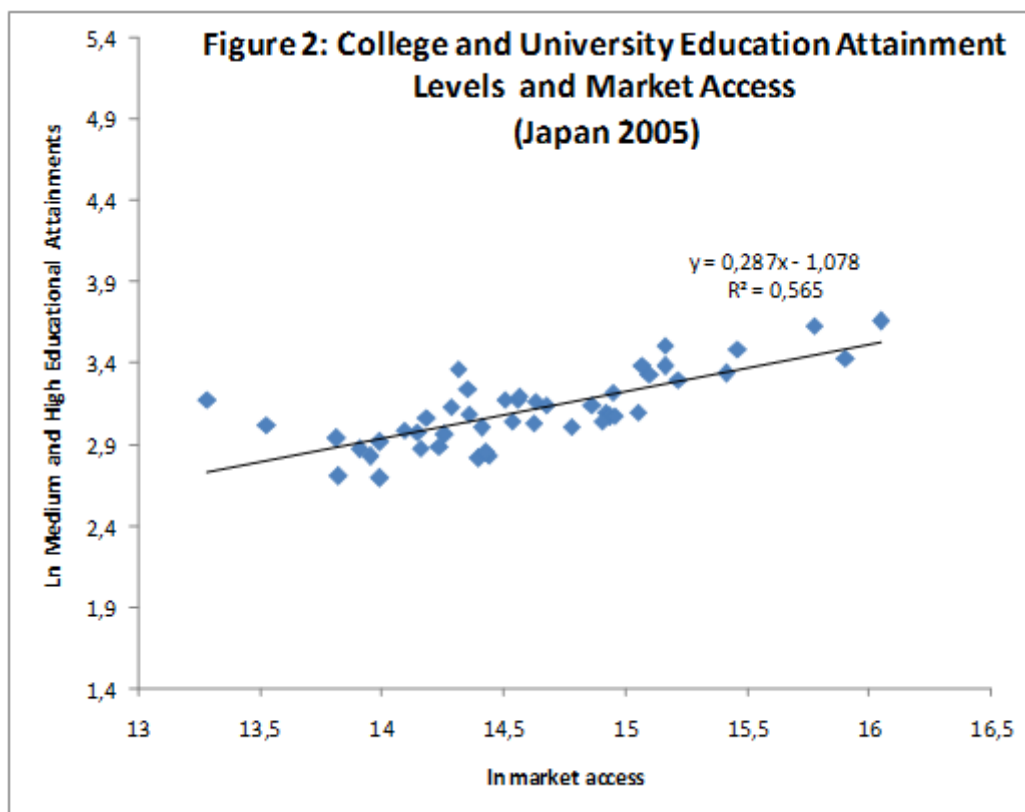
Prefecture	Junior School	College	University	Prefecture	Junior School	College	University
Hokkaido	28,9	11,0	9,6	Shiga	24,9	12,6	14,4
Aomori	36,8	7,8	7,2	Kyoto	19,9	12,6	16,8
Iwate	37,4	8,8	8,1	Osaka	20,2	12,6	15,6
Miyagi	25,6	10,0	12,0	Hyogo	21,2	12,3	17,2
Akita	35,9	7,5	7,3	Nara	18,8	14,0	19,5
Yamagata	32,9	8,3	8,4	Wakayama	30,3	9,8	10,5
Fukushima	32,9	8,5	8,5	Tottori	27,8	9,5	10,7
Ibaraki	28,1	10,4	11,8	Shimane	36,2	8,4	9,4
Tochigi	28,1	10,7	10,9	Okayama	23,9	11,2	12,7
Gunma	29,2	11,0	10,7	Hiroshima	19,8	13,9	15,1
Saitama	19,4	14,0	17,0	Yamaguchi	24,1	10,3	11,1
Chiba	18,3	13,9	18,7	Tokushima	31,8	9,6	11,4
Tokyo	13,6	14,6	24,2	Kagawa	25,7	11,1	13,4
Kanagawa	15,2	15,2	22,7	Ehime	30,1	11,1	11,8
Niigata	35,6	8,9	8,4	Kochi	35,7	9,1	8,9
Toyama	29,2	11,6	12,1	Fukuoka	20,5	12,0	13,7
Ishikawa	29,3	11,4	12,5	Saga	29,8	9,5	9,8
Fukui	32,6	9,4	11,3	Nagasaki	33,1	9,6	8,9
Yamanashi	25,5	12,7	12,4	Kumamoto	30,1	9,8	10,0
Nagano	26,2	12,2	11,0	Oita	24,8	9,4	10,3
Gifu	31,0	10,6	11,6	Miyazaki	33,5	8,9	8,8
Shizuoka	27,8	11,2	12,0	Kagoshima	32,0	10,0	8,9
Aichi	25,5	12,6	15,5	Okinawa	29,6	13,0	10,9
Mie	31,7	9,6	11,4				
Descriptive Statistics:							
Maximun	37,4	15,2	24,2	Average	27,7	10,9	12,2
Minimun	13,6	7,5	7,2	Source: Authors' calculations based on data from the Ministry of Internal Affairs and Communications of Japan			

The figures on the spatial distribution of educational attainment levels for the Japanese prefectures show a well established core-periphery gradient, a pattern that is commonly observed when we refer to the analysis of the spatial distribution of incomes (poor regions predominantly located in the so called “economic periphery” whereas rich ones are located in the so called “economic center”). Figure 1 illustrates this fact by plotting the percentage of population with university education (in logs) in 2005 against distance from Tokyo, the approximate geography centre of Japan.

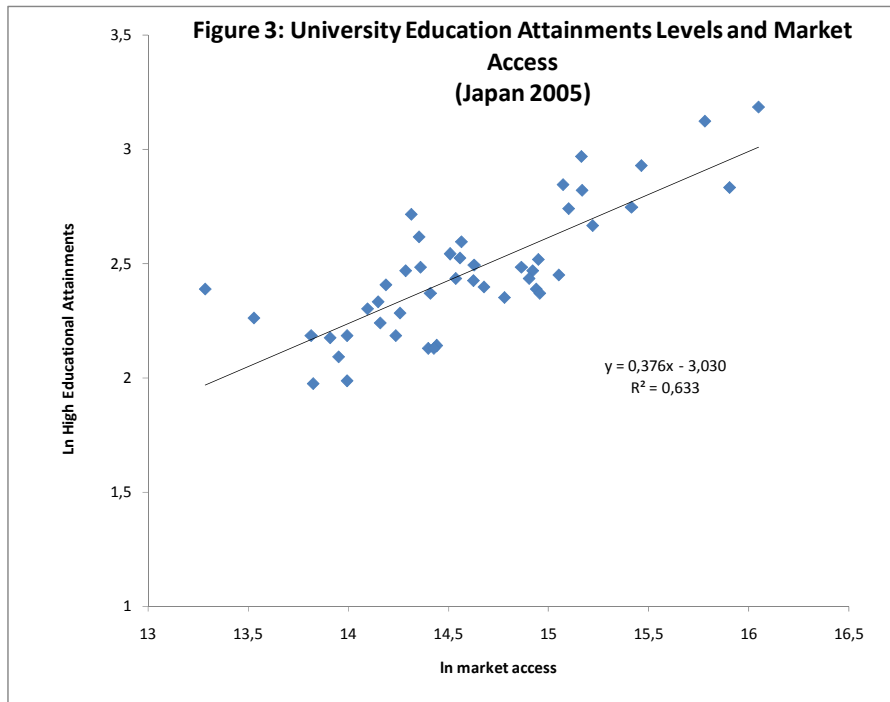


This core-periphery pattern of the Japanese educational attainment levels can also be analyzed by testing econometrically expression (2), which specifically tests for the correlation between human capital investments and market potential. Consistent with the model, in the next section of the paper we provide evidence that educational attainment levels in Japan are higher in those prefectures that have greater market potential.

In the rest of this section we present a set of graphs which give a first insight using the concept described in section 2. Figure 2 shows the relationship between market potential and percentage of individuals with medium and high educational attainment levels (College plus University degrees). As it is clear from figure 2, the set of points are distributed along a trend line of positive slope corroborating, at least graphically, the idea that high market potential prefectures are endowed with higher stocks of human capital. When we include in the graph only the percentage of population with tertiary education (university degree) the results holds (Figure 3), i.e., prefectures with higher market potential are those with greater endowments in human capital. The relationship is robust and is not due to the influence of a few individual prefectures.

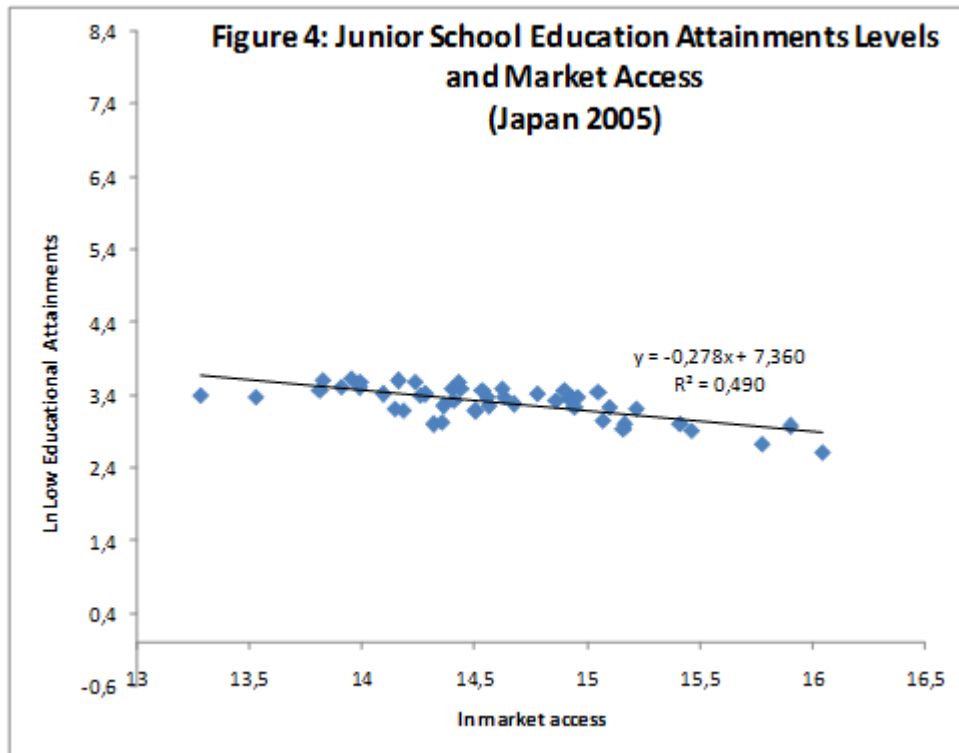


Source: Own elaboration based on data from the Ministry of Internal Affairs and Communications of Japan, the Geographical Survey Institute of Japan and the Japanese Ministry of Education



Source: Own elaboration based on data from the Ministry of Internal Affairs and Communications of Japan, the Geographical Survey Institute of Japan and the Japanese Ministry of Education

Finally, an indirect way to check the previous results is by plotting low educational attainment levels against market potential (Figure 4). The trend line shows that an increase in prefectural market potential is negatively correlated with the percentage of population who has Junior School education or alternatively there are more individuals with qualifications above Junior School.



Source: Own elaboration based on data from the Ministry of Internal Affairs and Communications of Japan, the Geographical Survey Institute of Japan and the Japanese Ministry of Education

5. Market Potential and Educational Attainment Levels: Empirical Results

The previous descriptive analysis characterizes the relationship between different classifications of the educational attainment levels in Japan and market potential. In this section we extend the analysis with a regression model. Taking into account our theoretical framework OLS and Instrumental Variables regressions of Medium and High Educational attainment levels for the year 2005 are conducted on the market potential levels (computed both by using Gross Prefectural Product and Population as proxies of the volume of economic activity for each prefecture and labelled in the table as MAGPPyear and MAPOPyear respectively).

Table 2: **Market potential and Educational Levels: Baseline Estimations Japan (2005)**

Dep. Variable	<i>log CollegeUniv</i>				<i>Log Univ</i>				<i>Log JuniorSch</i>				<i>EAI_{i,j}</i>			
Regress.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Constant	-1.10* (0.55)	-0.53 (0.9)	-1.21 (0.55)	-0.54 (0.88)	3.20** (0.05)	-3.20** (0.62)	-2.66** (0.97)	- (0.63)	- (1.04)	2.64** (0.05)	7.40** (0.62)	6.11** (1.07)	7.50** (0.62)	5.99** (1.03)	3.20** (0.05)	-2.41** (0.42)
MPGPP05	0.28** (0.04)	0.25** (0.06)				0.43** (0.04)	0.39** (0.07)					-0.28** (0.04)	-0.19** (0.07)			0.33** (0.03)
MPPOP05			0.32** (0.04)	0.26** (0.06)				0.38** (0.04)	0.37** (0.07)					-0.31** (0.04)	-0.20** (0.07)	
Dist.Osaka					- 0.0003** (0.00)					- 0.0005** (0.00)						0.0003** (0.00)
D _{i,j}																0.65** (0.03)
Est. Inst. variables	OLS	IV	OLS	IV	OLS	OLS	IV	OLS	IV	OLS	OLS	IV	OLS	IV	OLS	OLS
First stage R2		0.73		0.71			0.73		0.71			0.73		0.71		
R2	0.56	0.55	0.58	0.55	0.15	0.65	0.64	0.63	0.63	0.22	0.49	0.44	0.50	0.44	0.08	0.85
J-Statistic																
Prob (F-statistic)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
N.obs.	47	47	47	47	47	47	47	47	47	47	47	47	47	47	47	94

Note: Table displays coefficients and Huber-White heterocedasticity robust standard errors in parenthesis, ** indicates coefficient significant at 0.01 level , "First stage" R2 is the R2 from regressing market potential on the instruments set, Instruments: Distance to Tokyo, Distance to Osaka and prefecture size
Source: Own Elaboration

Table 2 summarizes the results of the econometric estimations of equation (2) for the 47 Japanese Prefectures for the year 2005. Columns 1 to 5 show the results of regressing the percentage of population with college and university education (expressed in logs) and labelled as *Log CollegeUniv* against different measures of market potential, different sets of variables and different estimation methods. In Column 1 we regress *Log CollegeUniv* against market potential. In this case we compute market potential incorporating Gross Prefectural Product (GPP) as the proxy for the volume of economic activity which appears in the numerator of the market potential expression. The results of the OLS estimation show that an increase in market potential is positively correlated with the percentage of population who has college and university education. The market potential coefficient is positive and statistically significant at the usual critical levels. The results also tell us that doubling prefectures' market potential would increase college and university education attainment levels by 28%. Moreover 56% of the spatial structure of the college and university attainment levels is explained by our market potential measure. In column 3 we have the same regression than in column 1 with the only different of the market potential measure which in this case is computed taking into account the population of each prefecture as a proxy for the volume of economic activity instead of their gross prefectural products. Again the results show a positive and statistically significant influence of market potential on the levels of college and university educational attainment levels with a slightly better fit of the regression. In Columns 6 to 10 we modified the dependent variable in order to take into account only tertiary education though regressing percentage of population with university education (expressed in logs) and labelled as *Log Univ* against the same variables as in the previous regressions. In general terms the results show again a positive influence of market potential in shaping the spatial structure of tertiary education. The market potential coefficients are positive and statistically significant. Moreover their values increase from the range of (0.28-0.32) in columns 1 and 3 to 0.39-0.37 in column 6 and 8. Moreover the explanatory power of the regression increases from 56-58% to 65-63%.

In columns 11 to 15 we summarize the results of regressing the percentage of population with primary education (labelled as *Log JuniorSch* educational level in the table) against market potential. The results in columns 11 and 13 indicate that an increase in prefectural market potential is negatively correlated with the percentage of population who has primary education. Considering that we are dealing only with figures of educated people (population who has attained primary, secondary or tertiary education) and therefore the share of population with primary education is one minus the share of population with secondary and tertiary education, this result constitutes an indirect way of checking the theoretical predictions of the model.

A potential shortcoming of the previous analysis is the one referring to the endogeneity of the market potential measure, i.e., good market potential can be correlated with other determinants of the level of educational attainment of the prefectures and therefore cause inconsistent and biased estimates. To avoid problems of endogeneity between human capital levels and prefectural market potential, the paper presents instrumental variables estimates. IV estimation is based on the existence of a set of instruments that are strongly correlated with the original endogenous variables but asymptotically uncorrelated with the error term. Furthermore, they should also be variables that are not driven by an unobservable third variable the authors suspect might be jointly affecting market potential and human capital levels. Once these instruments are identified, they are used to build a proxy for the explanatory endogenous variables which consists of their predicted values in a regression on both the instruments and the exogenous variables. However, it is difficult to find such instruments because most socioeconomic variables are endogenous as well. In this paper we propose to use mainly accessibility variables as instruments, since they are highly correlated with our market potential variable but also non contemporary correlated with the errors. Following Breinlich (2006), in this paper we instrument market potential with distance from Tokyo, distance to Osaka and with the prefectural size. The first two instruments capture market potential advantages of regions close to the geographic centre of Japan. The third

instrument captures the advantage of large prefectural markets in the composition of domestic market potential.

Columns 2, 4, 7, 9, 12 and 14 present the results for the corresponding instrumental variables estimation. Instruments are highly statistically significant and have the expected signs in the first stage. Distance to Tokyo, Osaka and prefectural size explains 71% (73%) of prefectural market potential when using population (gross prefectural product) as the proxy for the volume of economic activity. Since the instruments represent quite a distinct source of information and are uncorrelated, we can trust them to be reliable instruments. In the second-stage estimation we again find positive and highly statistically significant effects of market potential. The effects of market potential on educational attainment levels are lower than in the OLS estimations. The market potential coefficients change from the interval 0.28-0.32 to 0.25-0.26 for the first set of regressions (Columns 1 to 5), from 0.43-0.38 to 0.39-0.37 for the second set of regressions (Columns 6 to 10) and from -0.28- -0.31 to -0.19- -0.20 for the last set of regressions (columns 11 to 15).

For comparison purposes, columns 5, 10 and 15 of table 3 report results of regressing educational attainment levels against distances from Osaka instead of using market potential. The results provide evidence of the negative correlation between college and university educational attainment levels and prefectures' distance from Osaka, university educational attainment levels and prefectures' distance from Osaka and a positive correlation with low educational attainment levels (Junior School).

The estimation of two different equations *log CollegeUniv* and *Log Univ* is based on the fact that the coefficient estimates are significantly different for the two equations. In order to check this fact we run this alternative regression:

$$\ln(EA_{i,j}) = \alpha_0 + \alpha_1 \ln(MP_{i,j}) + \alpha_2 D_{i,j} + \varepsilon_{i,j} \quad (4)$$

Where $i = 1, 2, \dots, 47$ represents the 47 Japanese prefectures of our sample, $j = \{0, 1\}$ stands for the level of educational attainment, being 0 if educational attainment is defined as college plus university education and 1 if educational

attainment is defined as university education, so $EA_{1,0}$ is the proportion of population in region 1 who has medium and high educational levels and $EA_{1,1}$ is the proportion of population in region 1 who has high educational levels. $MPGPP00_{i,j} = MPGPP00_i$ for all $j = \{0,1\}$ is the market potential of region $i = 1,2,\dots,47$ and $D_{i,j} = \{0,1\}$ is a variable that takes the value 0 if $j = \{1\}$ and 1 if $j = \{0\}$, $\varepsilon_{i,j}$ stands for the error term.

In this alternative specification our main parameter of interest is α_2 such that if α_2 is statistically different from zero, we can reject that the estimated coefficient α_1 is equal for the different equations and thus it confirms our approach to the problem. The results reported in column 16 of table 3 shows that α_2 is significantly different from zero, thus justifying the estimation of two different equations for the different levels of educational attainments.

However, the models given in table 2 are marked by outlying observations. The outlying prefectures do not correspond with the spatial educational attainment structure determined by the majority of the observations. Outliers will seriously affect the coefficient estimates, if they are influential leverage points, i.e. outlying observations with regard to our market potential measure. We identify outliers as those observations for which Cook's distance is greater than 1. In order to control for the effects of the identified outlying observations, dummy variables for the outliers are introduced. The most significant outliers are, Iwate and Akita in the northern region of Hokkaido and the ultra peripheral prefecture of Okinawa.

Columns 1 to 8 in table 3 summarize the results of including dummies for outlying prefectures. We have again regressed $\log CollegeUniv$ and $\log Univ$ on the two different measures of market potential we have previously computed. Looking at the market potential coefficients in the different regressions carried out in table 3, they point out to a general trend of reinforcement of the effects of market potential on educational attainment levels; doubling market potential would increase college and university educational levels by 37% and university levels by 42-47%. Moreover, the fit of the regressions improves considerably

when we incorporate into the analysis the dummies for the outliers moving from R2s of 0.56-0.58 to R2s of 0.74 for the first set of regressions (*log CollegeUniv*) an increase of about 32% and from 0.63-0.65 to 0.74 for the second set of regressions (*log Univ*) which means also an increase but more moderate (15%). Columns 2, 4, 6 and 8 summarize the results of controlling for the potential endogeneity problem which arises with market potential measures. Our instruments are again distance to Tokyo, distance to Osaka and prefecture size. In the second stage we again find positive and statistically significant effects with the IV estimates. Again, the effect of market potential on educational attainment levels is reinforced when IV estimations are carried out.

Table 3: **Market potential, Regional Dummies, Educational Levels and Average Years of Education Japan (2005)**

Dep. Variable	<i>ln CollegeUniv</i>				<i>lnUniv</i>				<i>Average Years Education</i>		<i>Educational Levels</i>	
	1	2	3	4	5	6	7	8	9	10	11	12
Regress. Constant	-1.18*	-1.31	-1.18*	-1.02	-3.66**	-3.66**	-	-	1.65**	1.60**		
	(0.48)	(0.9)	(0.48)	(0.86)	(0.59)	(0.59)	3.80**	3.36**	(0.16)	(0.16)		
MPGDP00	0.37**	0.30**			0.42**	0.42**			0.09**		2.19**	
	(0.03)	(0.06)			(0.04)	(0.04)			(0.01)		(0.62)	
MPPOP00			0.37**	0.31**			0.47**	0.44**		0.1**		2.63**
			(0.03)	(0.06)			(0.04)	(0.07)		(0.01)		(0.73)
Regional Dummies	yes	yes	yes	yes	yes	yes	yes	yes	no	no	no	no
Est.	OLS	IV	OLS	IV	OLS	IV	OLS	IV	OLS	OLS	Ord. Probit	Ord. Probit
Inst. variables												
First stage R2		0.73		0.71		0.73		0.71				
R2	0.74	0.73	0.74	0.72	0.74	0.74	0.75	0.75	0.61	0.63	0.40	0.43
J-Statistic												
Prob (F-statistic)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
N.obs.	47	47	47	47	47	47	47	47	47	47	47	47

Note: Table displays coefficients and Huber-White heterocedasticity robust standard errors in parenthesis, ** indicates coefficient significant at 0.01 level, "First stage" R2 is the R2 from regressing market potential on the instruments set, Instruments: Distance to Tokyo, Distance to Osaka and prefecture size

To complement the estimations of different equations for the different educational attainment levels, Columns 9 to 12 of table 3 summarize the results of two alternative estimations based on transformations in the definition of the dependent variable. In column 9 and 10 we transform prefectural educational attainment levels into average years of schooling and then we estimate a single equation using average years of schooling as our dependent variable. This synthetic indicator for human capital levels has been used in many empirical studies see (Benhabid and Spiegel 1994, Temple 1999, Krueger and Lindahl 1999 and De la Fuente and Domenech 2001). To do the transformation of educational levels into average years of education we use information of the Japanese school system provided by the Ministry of Education, Culture, Sports, Science and Technology. Japanese school system is organized in a 6-3-3 format for primary and secondary education, that is, 6 years of elementary school, 3 years of lower secondary school and 3 years of upper secondary school. Generally the elementary school and the lower secondary schools are called as junior high schools in Japan. Japanese compulsory education goes through 9 years of elementary school and junior high school from ages 6-15. Those who have completed nine-year compulsory education in elementary and lower secondary school may go on to upper secondary school (also called high school) for 3 years (from ages 15 to 18) or colleges such as college of technology, special training college or other miscellaneous schools. The university and junior college are categorized as higher education and they normally requires at least 4 years for bachelor's degree and 2 years duration of studies, for colleges of technology respectively.

The results of the regressions show that the coefficient on market potential is positive and statistically significant at the usual critical values, showing that an increase in a prefectures' market potential increases the average years of education of its population.

Column 11 and 12 summarize the results of estimating an ordered probit model where the dependent variable was transformed into a binary variable given to it the values 1 or 2 according to the relative importance of the proportion of population who has medium or high educational levels. Therefore a region that

has the highest proportion of population with low education is ranked 1, if the highest proportion is medium or high education is ranked 2. In ordered probit models, the sign of the coefficient shows the direction of the change in the probability of falling in the endpoint rankings, in our case (Educational attainment level 1-low educational attainment levels or level 2 medium and high educational attainment levels) when market potential changes. Probability of Educational Attainment level 1 changes in the opposite direction of the sign of the estimated coefficient and probability of educational attainment level 2 changes in the same direction. The coefficient reported in columns 11 and 12 of table 3 are positive showing that the probability of having higher educational levels is higher in regions with high market potential. The estimated coefficient is statistically significant at the conventional critical values⁴. Therefore the results reported in columns 9 to 12 can be taken as additional proofs that geographic location matters for determining educational levels across Japanese prefectures.

Our results are in line with those obtained by Redding and Schott (2003) for a sample of world countries. In their estimations market potential itself explained 23% of the variation in educational attainment levels (105 countries) and excluding from the sample OECD countries, US, Japan and Belgium (66 countries) the explanatory power of the regression raised to 26%.

These results shed new light to the pioneering work initiated by Redding and Schott (2003), showing that for the Japanese prefectures, geographical location matters for the analysis of the unequal distribution of population by human capital levels, i.e., there is a positive correlation between higher educational attainment levels and market potentials.

6. Conclusions and Policy Implications

This paper has analysed the impact of market potential on the geographical distribution of population by educational level for the 47 Japanese prefectures in 2005. The results of the estimates carried out for the 47 Japanese prefectures

⁴The statistic reported in ordered probit models to check the significance of the estimated coefficient is z-statistic instead of t-statistic from OLS.

show that the unequal distribution of population (workers) by educational level is linked to the prefectures market potential, i.e. the concentration for instance of people with college and university degrees is higher in those geographical areas with high market potential. Therefore, we can conclude that there is a spatial structure of educational attainment levels in Japan. Estimations carried out for different definitions of the dependent variable show that if we double the market potential of a prefecture the percentage of individuals with college plus university education would increase around 25% and the percentage of individuals with university education between 37% and 39%. Moreover, the estimation results show that between 55% and 64% of the spatial variation in educational attainment levels would be explained by market potential. The alternative estimations of the percentage of individuals with low educational attainment levels (*Log JuniorSch*) against market potential backs indirectly the results of the direct estimates.

Based on the fact that remoteness hampers human capital accumulation which is considered a key engine to fuel economic growth and therefore to accelerate the development of countries and regions, an obvious policy implication is that the central government should expand interregional network of transportation and more higher education opportunities can be available for students who are placed at remote locations and therefore distant from the central. Another is that the central government partly disperses their administrative functions regarding education matters, and the local authorities may be able to expand opportunities to provide intraregional education facilities for local residents which are unnecessary to rely on the central-place system. Such alternative spatial policies can be seen in detail in Nakamura and Lopez-Rodriguez (2011). The policy of increasing market potentials has its downsides; while for university students moving to a different place might be considered even a benefit rather than a cost, for younger students who are attending primary and secondary education levels a permanent move to a distant location has very important costs in social and psychological terms. Therefore, increasing the market potential probably is a good idea for university education but it is not clear for

primary and secondary education levels. These types of problems are clearly discussed in Redding and Schott (2003)⁵.

Finally fruitful research avenues may consider applying this framework to other countries. Our analysis is also applicable to those countries which rely on a severe central-place system.

⁵ We thank a Funcas referee for pointing out this fact.

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Annex: Descriptive statistics

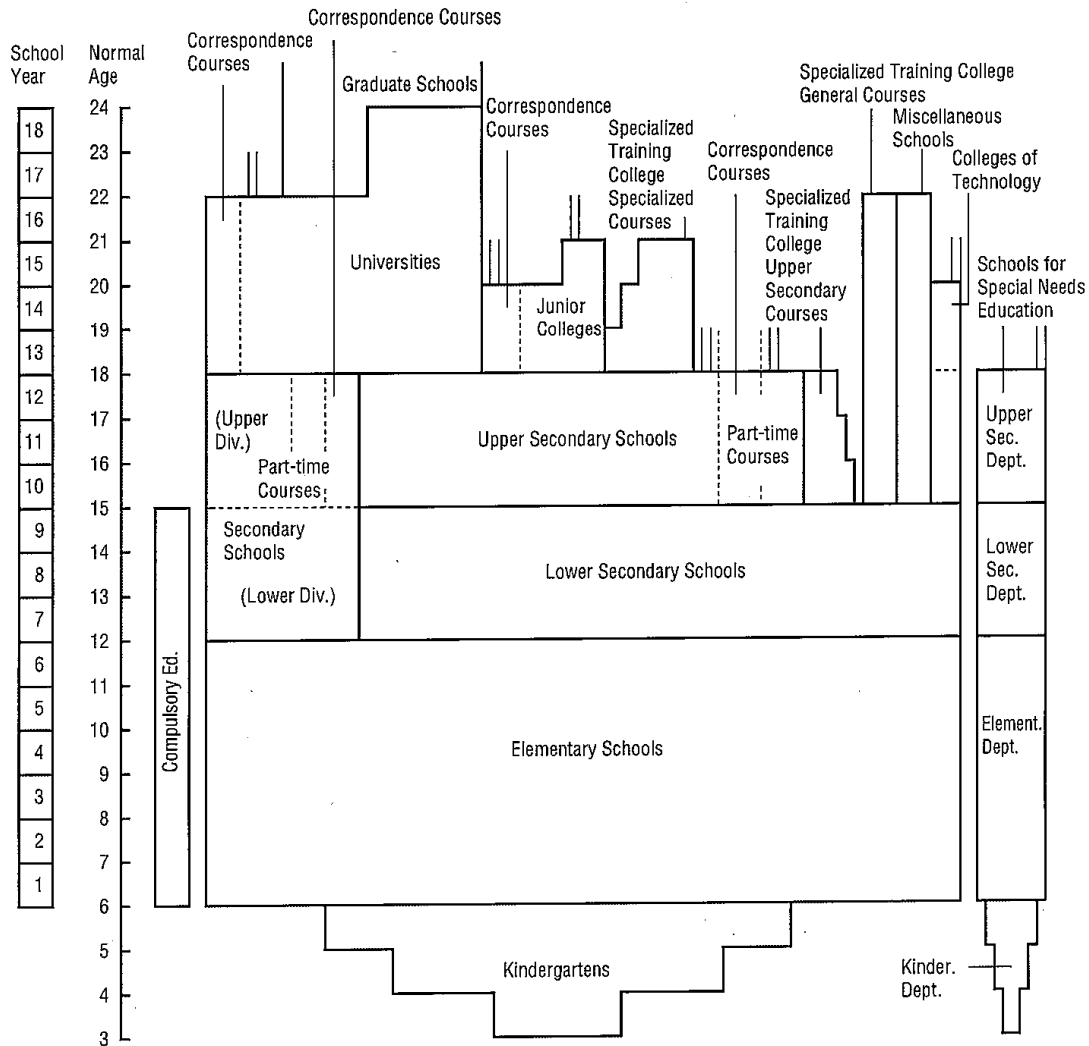
Table 4: Main descriptive statistics of the Educational Attainment level Sample:

(% of Population According to the Educational Attainment Level, Japanese Prefectures, 2005)

EA Level	N. Obs	Mean	Std. Dev.	Min	Max
Junior School	47	27.67021	5.916224	13.6	37.4
High School	47	46.69362	2.822842	38.5	53.2
College or Training	47	10.89787	1.913055	7.5	15.2
University	47	12.23617	3.777532	7.2	24.2

Source: Own elaboration based on Data from the Ministry of Education

Figure 5: School system in Japan (Source: MEXT, 2006)



The compulsory education ends with the Lower Secondary Schools but a majority of individuals continue to their study at the Upper Secondary Schools. After the Upper Secondary Schools, one of choices is to enroll in the university. Japanese universities have several systems such as national universities, public universities and private universities. Individuals those who desire to study at the university are generally required to take the entrance screening examination. Due to the severe competition to pass the screening, it has been very common for Japanese students to study at “cram schools”, which are generally operated by private education institutions. As

they are under the control of neither central government nor local authorities, courses for students of Upper Secondary Schools are held after school, weekends and holidays.

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