ESTUDIOS DE ECONOMIA

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Mind the Remoteness! Income disparities across Japanese Prefectures

Mind the Remoteness! Income disparities across Japanese Prefectures

¡Importancia de la "lejanía"! Disparidades de renta en las prefecturas japonesas

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Abstract

In this paper we analyze the role played by Market access to explain income disparities among Japanese Prefectures for different periods of time. The results of the estimations suggest that 1) Market access plays an important role in the explanation of income disparities in Japan, 2) the effect of Market access is robust to the inclusion of control variables considered important in the explanation of the Japanese income disparities, 3) the estimations show a tendency for the Market access variable to lose explanatory power throughout the time. In this 10 year time span analyzed from 1996 to 2005 the decrease in explanatory power of Market access was around 15%.

Key words: *New economic geography, Market access, Income disparities, Japanese prefectures.*

Resumen

En este trabajo se analiza el papel que desempeña el potencial de mercado en la explicación de las disparidades de renta observadas en las prefecturas japonesas a lo largo de distintos períodos de tiempo. Los resultados de las estimaciones realizadas sugieren que 1) El potencial de mercado desempeña un papel importante en la explicación de las disparidades de renta en Japón, 2) El efecto del potencial de mercado es robusto a la inclusión de variables de control consideradas importantes en la explicación de las disparidades de renta en Japón, 3) Las estimaciones muestran una tendencia en el potencial de mercado a la pérdida de cierta capacidad explicativa a lo largo del tiempo. En el período analizado que abarca diez años (1996-2005) el descenso en el poder explicativo del potencial de mercado fue alrededor de un 15%.

Palabras clave: *Nueva geografía económica, Potencial de mercado, Disparidades de renta, Prefecturas, Japón.*

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

1. INTRODUCTION

A striking fact about world economic development is that economic activity is clustered in the space (Porter, 2000). In the case of Europe, a set of adjacent regions stretching from southeast England, through the Benelux countries, North France and Southwest Germany to Northeast Italy has been denoted the "Blue Banana". These regions are characterised by high levels of income. Other regions, generally peripheral ones, experience lower income levels. This geographic concentration of economic activities can be seen also at national level where a so called North-South divergent development reflects a Core-Periphery structure, with the rich North been the industrialized core and the poor South being left behind in the periphery. Examples in the case of Europe are for instance Portugal with significant differences in terms of development levels between Lisboa and the North of the Country versus the centre and the South. In France, Paris versus the rest of the country, in Spain Northeast and Madrid versus South and West and in UK South versus North to name a few of them. Japan is not an exception to this general trend we observe in the countries mentioned above. Japanese prefectures such us Tokyo and Osaka are much more developed than rural prefectures such us Akita and Kagoshima.

Table 1 shows the evolution of the Japanese income[1] (data is in the Japanese currency (JPY)) for the 47 Japanese Prefectures for the years 1996, 2000 and 2005. The results show quite clearly the dominance of the country's capital,

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[1]   Comparisons of per capita monetary amounts can be distorted if we do not use a relative price index for each prefecture. However as the wage equation of the model will be defined in nominal terms we have decided to present in table 1 the current values of the variables instead of weighting them by a relative price index for each prefecture.

TABLE 1
PER CAPITA PREFECTURAL INCOME (IN 1000 JPY)

Prefecture/Year	1996	2000	2005	Prefecture/Year	1996	2000	2005
Hokkaido	2,804	2,688	2,577	Shiga	3,551	3,352	3,275
Aomori	2,494	2,384	2,184	Kyoto	3,047	2,944	2,895
Iwate	2,593	2,608	2,363	Osaka	3,510	3,150	3,048
Miyagi	2,821	2,757	2,620	Hyogo	3,317	2,988	2,731
Akita	2,505	2,415	2,295	Nara	2,968	2,837	2,654
Yamagata	2,634	2,596	2,427	Wakayama	2,615	2,544	2,708
Fukushima	2,861	2,825	2,728	Tottori	2,647	2,574	2,308
Ibaraki	3,122	3,021	2,838	Shimane	2,570	2,639	2,453
Tochigi	3,237	3,160	3,101	Okayama	2,906	2,711	2,653
Gunma	3,058	2,948	2,859	Hiroshima	3,183	3,143	3,038
Saitama	3,263	3,091	2,955	Yamaguchi	2,919	2,855	3,001
Chiba	3,214	3,125	3,000	Tokushima	2,805	2,811	2,757
Tokyo	4,281	4,596	4,778	Kagawa	2,869	2,762	2,616
Kanagawa	3,589	3,361	3,204	Ehime	2,686	2,511	2,357
Niigata	2,910	2,811	2,772	Kochi	2,441	2,392	2,146
Toyama	3,356	3,141	3,097	Fukuoka	2,820	2,733	2,661
Ishikawa	2,994	2,972	2,852	Saga	2,617	2,564	2,507
Fukui	2,973	2,943	2,869	Nagasaki	2,386	2,326	2,222
Yamanashi	2,996	2,949	2,729	Kumamoto	2,422	2,423	2,384
Nagano	2,990	3,107	2,838	Oita	2,699	2,788	2,608
Gifu	3,034	2,892	2,794	Miyazaki	2,308	2,314	2,212
Shizuoka	3,305	3,287	3,344	Kagoshima	2,280	2,336	2,272
Aichi	3,711	3,422	3,524	Okinawa	2,037	2,077	2,021
Mie	3,024	2,979	3,068				
Av. Pref. Income	2,923	2,848	2,752	Highest/Av. Pref. Income	1.46	1.61	1.74
Highest Pref, Income	4,281	4,596	4,778	Lowest Pref. Income/Av. Pref. Income	0.7	0.73	0.73
Lowest Pref, Income	2,037	2,077	2,021	Highest Pref. Income/Lowest Pref. Income	2.1	2.21	2.36

Source: Authors' calculations based on data from the Ministry of Internal Affairs and Communications of Japan.

Tokyo, in terms of prefectural income over the three periods of time under the analysis. Tokyo is by far the richest prefecture in the country, being its income 46% higher than the average prefectural income in 1996, 61% higher in 2000 and 74% higher in 2005.

However the most important feature about the evolution of income disparities in Japan is not based on the fact that Tokyo outstands as the richest prefecture in

the country but on the fact that its income gap with the average prefecture income has been widening over the time increasing in this 10 year time span almost 61%. If we make comparisons with the poorest prefecture, the computations show the same tendency patterns. Prefectural income in Tokyo was 210% higher than in the poorest prefecture in 1996, increasing the gap to 221% in 2000 and 236% in 2005. If we exclude from the calculations the distortion generated by the capital values, the results still show that in Japan there is a strong regional contrast in terms of income. The second richest prefecture, Aichi, has a prefectural income which in 2005 (1996) was 30% (28%) higher than the average prefectural income. Moreover, these disparities show a "core-periphery" type of structure in the sense that we can see a clear income gradient for the Japanese Prefectural income. Figure 1 plots per capita prefecture income against distance to Tokyo. The results show that as we move further away from the capital, Tokyo, the per capita prefectural income (on average) decreases.

FIGURE 1
PER CAPITA PREFECTURAL INCOME AND DISTANCE TO TOKYO (2005)
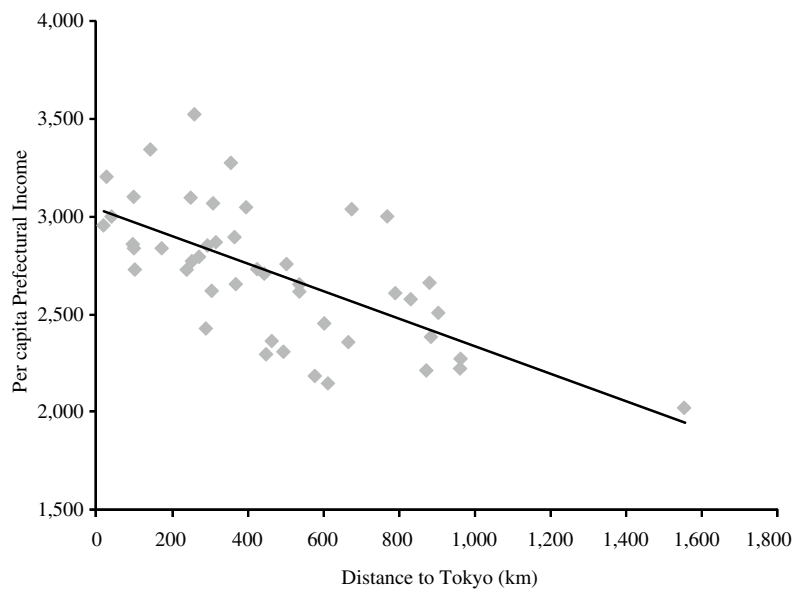
Source: Own elaboration based on data from the Ministry of Internal Affairs and Communications of Japan and the Geographical Survey Institute of Japan.

At a theoretical level there are many factors that explain why different regions within a territory do not converge. From the standpoint of economic growth theories (Barro and Sala-i-Martin, 1995) show that differences in savings rates, investment rates, skilled human capital and difficulties in technology

transmission could explain this lack of convergence. Traditional theories of economic development put more emphasis on the natural advantages of different locations, which is called *first nature geography*, access to navigable rivers, ports, airports, allocation of oil, sunshine, etc. (Gallap *et al*., 2000; Hall and Jones, 1999). Those regions with these natural advantages would have a higher level of wealth. But since the early nineties, thanks to the seminal work of Krugman (1991a, 1991b) which gave rise to the so called New Economic Geography, a new explanation of the phenomenon of agglomeration of economic activities in space was given by using general equilibrium models grounded in microeconomic decisions where the key ingredients are the existence of increasing returns at the firm level and transportation costs. This explanation of the agglomeration of economic activity based on *second nature geography* factors means that what really matters for location decisions is how far an industry or firm is from its consumer markets and from its input suppliers. This alternative explanation has reached a theoretical consolidation and it is a more satisfactory way to explain the agglomeration of economic activities than the explanations based on arguments of the *first nature geography*. At the empirical level, studies that attempt to explain the agglomeration of economic activity based on arguments of second nature geography can be divided into two major categories: On the one hand, the ones analyzing agglomeration of economic activity in big market areas (USA, global sample of countries, and the European Union) where remarkable works are Hanson (1998, 2005), Redding and Venables (2001, 2004), Breinlich (2006) and Lopez-Rodriguez and Faiña (2007) respectively. On the other hand, those explaining the agglomeration of economic activities at the country level Roos (2001) for Germany, De Bruyne (2003) for Belgium, Mion (2004) for Italy, Pires (2006) for Spain and Lopez-Rodriguez and Acevedo (2008) for Colombia.

In this paper we demonstrate that second nature geography plays an important role in explaining the income disparities observed in the Japanese prefectures. The results of our empirical estimates show that the spatial structure of income observed in Japan for the different time periods analyzed is consistent with the theoretical results arising from our core-periphery New Economic Geography model. Therefore we can conclude that *second nature geography* in a general sense or economic-geographical variables in a more general sense play an important role in the spatial structure observed in Japan. In addition, the results of this work fill out the gap in the empirical research concerning the estimation of New Economy Geography models.

The remaining part of the paper is structured as follows: Section 2 gives the microeconomic foundations of the market access concept and establishes the relationship between second nature geography (approximated by market access) and the income level of a particular location, which in the literature of the New Economic Geography is known as the nominal wage equation. Section 3 contains the econometric specifications, data source and construction of the variables. Section 4 presents the results of the estimations and finally, section 5 contains a summary of the main contributions of the paper.

2. MICROECONOMIC FOUNDATIONS OF THE MARKET ACCESS FUNCTION: NEW ECONOMIC GEOGRAPHY AND THE NOMINAL WAGE EQUATION

Our theoretical framework is a reduced form of a standard New Economic Geography model (multiregional version of Krugman 1991b model)[2] which incorporates the key ingredients to obtain the so called nominal wage equation which will constitute the workhorse of our empirical estimation.

We consider a world with R regions ($j = 1, 2, \ldots, R$), and we focus on the manufacturing sector, composed of firms that produce a great number of varieties of a differentiated good (D) under increasing returns to scale and monopolistic competition. Transportation costs of differentiated goods are in the form of iceberg costs so in order to receive 1 unit of the differentiated good in location j from location i, $T_{i,j} > 1$ units must be shipped, so $T_{i,j} = 1$ means that the trade is costless, while $T_{i,j} - 1$ measures the proportion of output lost in shipping from i to j. The manufacturing sector can produce in different locations.

On the demand side, the final demand in location j can be obtained by the Utility maximization of the following CES function:

$$(1) \qquad\qquad \max_{m_{i,j}(z)} D_j$$

Where D_j represents the consumption of the differentiated good in location j. D is an aggregate of the different industrial varieties defined by a CES function à la Dixit and Stiglitz (1977):

$$(2) \qquad\qquad D_j = \left[\sum_{i=1}^{R} \int_{0}^{n_i} m_{i,j}(z)^{\sigma-1/\sigma} dz \right]^{\sigma/\sigma-1}$$

where $m_{i,j}(z)$ represents the consumption of each variety z in location j and which is produced in location i, n_i is the number of varieties produced on location i, σ is the elasticity of substitution between any two varieties where $\sigma > 1$. If varieties are homogenous σ goes to infinite and if varieties are very different σ takes a value close to 1. Consumers maximize their utility (function #1) subject the following budget constraint:

$$(3) \qquad\qquad \sum_{i=1}^{R} n_i x_{ij}^{D} p_{ij} = Y_j$$

Solving the consumer optimization problem, we obtain the final demand in location j of each variety produced in location i.

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[2] Other related NEG models can be seen in Fujita *et al*. (1999). See also López-Rodríguez and Faiña (2008) for a detailed explanation of the building blocks of a NEG model and for the full derivation of a 2x2x2 canonical model.

(4)
$$x_{ij}^D = p_{ij}^{-\sigma} \left[\sum_{n=1}^R n_n p_{nj}^{1-\sigma} \right]^{-1} Y_j$$

where $p_{ij}\left(p_{ij} = p_i T_{ij}\right)$, is the price of varieties produce in location i and sold in j and Y_j represents the total income of location *j*.

If we define a price index for manufacturing goods as $P_j = \left[\sum_{n=1}^R n_n p_{nj}^{1-\sigma} \right]^{\frac{1}{1-\sigma}}$

This Industrial Price index of location j measures the minimum cost of buying 1 unit of the differentiated good D so it can be interpreted as an expenditure function. If we rewrite the expenditure on consumption as $E_j = Y_j$ the final demand in location *j* can be given by $x_{ij}^{consD} = p_{ij}^{-\sigma} P_j^{\sigma-1} E_j$. However, in order for x_{ij}^{consD} units to arrive to location *j*, $T_{i,j} x_{ij}^{consD}$ units must be shipped. Thus effective demand facing a firm in i from j is given by expression:

(5)
$$x_{ij}^D = T_{ij} p_{ij}^{-\sigma} P_j^{\sigma-1} E_j = p_i^{-\sigma} T_{ij}^{1-\sigma} P_j^{\sigma-1} E_j$$

Turning to the supply side, a representative country *i* firm maximizes the following profit function:

(6)
$$\Pi_i = \sum_{j=1}^R \frac{p_{ij} x_{ij}^D}{T_{i,j}} - w_i^D \left(F + c x_i^D \right)$$

The technology of the increasing returns to scale sector is given by the usual linear cost function: $l_{Dij} = F + c x_{ij}^D$, where l_{Dij}, represents the industrial labor force needed to manufacture 1 unit in location *i* and sell it in location *j, F*, are the fixed costs units which are needed for manufacturing the industrial good, *c* is the unit variable cost and x_{ij}^D is the quantity of each variety demanded in location *j* and produced in location *i* ($x_i^D \equiv \sum_j x_{ij}^D$ represents the total output produced by the firm in location i and sold in the different *j* locations) and w_i^D is the nominal wage paid to the manufacturing sector workers in location *i*. Increasing returns to scale, consumers love of variety and the existence of an limited number of potential varieties of the manufacturing good mean that each variety is going to be produced by a single firm in a single location. In this way the number of manufacturing firms coincides with the number of varieties. Each firm maximizes is own profit behaving as a monopolist of its own variety of the differentiated good. First order conditions for profit maximization lead us to the standard result that prices are a mark-up over marginal costs.

(7)
$$p_i = \frac{\sigma}{\sigma-1} w_i^D c$$

where $\dfrac{\sigma}{\sigma-1}$ represents the Marshall-Lerner Price-cost ratio. The higher this ratio, the higher the monopolistic power of the firm. Krugman (1991b) interprets σ as an inverse measure of the scale economies due to it can be interpreted as a direct measure of the price distortion and as an indirect measure of the market distortion due to the monopoly power. Due to $\dfrac{\sigma}{\sigma-1}$ is higher than 1, Krugman (1991b) interprets this result as a proof of increasing returns to scale. Substituting this pricing rule into the profit function we obtain the following expression for the equilibrium profit function:

$$(8) \qquad \Pi_i = \left(w_i^D \right) \left[\frac{c x_i^D}{\sigma - 1} - F \right]$$

Free entry assures that long-run profits will be zero implying that no firm will have incentives to move from one location to another. This implies that equilibrium output is the following one:

$$(9) \qquad x_i^D = \bar{x} = \frac{F(\sigma - 1)}{c}$$

The price needed to sell this many units is given by $P_i^\sigma = \dfrac{1}{\bar{x}} \sum\limits_{j=1}^{R} E_j P_j^{\sigma-1} T_{i,j}^{1-\sigma}$. Combining this expression with the fact that in equilibrium prices are a constant mark-up over marginal costs we obtain the following zero-profit condition:

$$(10) \qquad w_i^D = \left(\frac{\sigma - 1}{\sigma c} \right) \left[\frac{1}{\bar{x}} \sum_{j=1}^{R} E_j P_j^{\sigma-1} T_{i,j}^{1-\sigma} \right]^{1/\sigma}$$

This equation is called nominal wage equation which constitutes the key relationship to be tested in the empirical part of this work. According to equation (10) the nominal wage level in each location i depends on a weighted sum of the purchasing capacities of the different j locations where the weighted scheme is a decreasing function of the distance between locations. In the New Economic Geography literature the expression on the right hand side of equation (10) has been labelled with different names market access (Redding and Venables, 2001, 2004) and real market potential (see Head and Mayer, 2004)[3].

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[3] This expression is semantically analogous to the one employed by Harris (1954) but the term real refers to the fact that price difference between different locations are taken into account. The concept of nominal market potential of Head and Mayer (2004) is a concept similar to the Harris (1954) market potential.

We will refer to this expression as market access and will be labelled as (MA). The meaning of this equation is that access advantages raise local factor prices. More precisely, production sites with good access to major markets because of its relatively low trade costs tend to reward their production factors with higher wages.

If we normalize the way we measure production, choosing the units such as that $c = \dfrac{(\sigma - 1)}{\sigma}$, $F = \dfrac{1}{\sigma}$, $P_j = G_j$ and defining the market access of location i as $MA_i = \sum_{j=1}^{R} E_j G_j^{\sigma-1} T_{i,j}^{1-\sigma}$, we can rewrite the nominal wage equation as:

(11)
$$w_i^D = \left[MA_i \right]^{1/\sigma}$$

This simplification of the nominal wage equation is very similar to the Harris (1954) market potential function in the sense that economic activity is more important in those regions which are close to big markets.

3. ECONOMETRIC SPECIFICATION

Taking logarithms in expression (11), the estimated nominal wage equation is based on the estimation of the following expression:

(12)
$$\log(w_i) = \theta + \sigma^{-1} \log\left[MA_i \right] + \eta_i$$

Where η_i is the error term and the other variables are as defined in the previous sections. This equation relates the nominal wage in region i with income in other regions, weighted by distance. Therefore, in accordance with the predictions of the theory, the higher the levels of income and price levels and reduced the distance between locations, the greater the level of local wages. This specification captures the notion of a spatial wage structure and allows us to verify the direct relationship between the nominal wage of a location and market access which is an important condition for us to observe agglomeration dynamics.

However equation (12) is a restricted specification to analyze the potential effects on wages of market access as we cannot say whether the regression captures the causality or simply captures correlations with omitted variables such as infrastructure, human capital, innovation levels and so on. To address these potential impacts and control for the possibility of other shocks that are affecting the dependent variable and are correlated with market access, we also estimate an alternative specification that explicitly takes into account the above considerations. The extended estimation of the nominal wage equation takes the following form:

(13)
$$Log(w_i) = \theta + \sigma^{-1} \ln MA_i + \sum_{n=1}^{N} \gamma_n X_{i,n} + \eta_i$$

Where X_{in} is a vector of control variables and γ_{in} the corresponding coefficient.

3.1. Data Source and Construction of variables

The data we use in our work refers to the years 1996, 2000 and 2005 which was taken from different sources: The data on gross prefectural income and total prefectural population was taken from the Ministry of Internal Affairs and Communications of Japan. The advantages of using prefectural income to proxy our dependent variable instead of per capita Gross Domestic Product (GDP) is that prefectural income allows us a better approximation of the wages paid within a prefecture than per capita GDP and we do not incur the typical overestimation issue that arises when people have to commute to their work places or there are foreign factors in the production. Although GDP better captures the added value generated by the factors of production in a region, prefectural income better captures what is left to remunerate domestic factors of production in a region by also taking into account fiscal transfers to the different regions.

With respect to market access, the theory-based measure derived from the model cannot be used as is for two reasons: a) The interregional trade flows data needed to compute this measure do not exist, b) There are no data on regional prices. In order to avoid the requirement of regional price data we are going to assume that the price index is equal in all regions ($P_j = P$).Therefore due to this inherent limitation of data availability, we use the Harris' (1954) formulation to compute market access[4]. Therefore, the market access variable in a similar vein to the theory-based measures is built as a distance-weighted sum of the volume of economic activity in the surrounding regions whereby the weighting scheme is a function declining with increasing distance between locations i and j. The distance between places i and j is measured in kilometres between the capital cities of the prefectures. For each year of our analysis we build two types of market access variables, one proxying the volume of economic activity by the total population of each prefecture and another proxying it by the total gross prefectural product. Additionally the market access variable has been unfolded into its domestic and external components. Population and total prefectural product are adequate proxies for the volume of economic activity when calculating the long-term effects of market access in integrated economic spaces. This is the case for instance in the former EU15 (see Faiña and López-Rodríguez, 2006; López-Rodríguez and Faiña, 2006) or case studies of the relationship between market access and levels of development at country level (López-Rodríguez and Acevedo, 2008). The advantage of using population as a proxy variable against income in studies of the relationship between wages and market access is presented in the study of economic spaces where the degree of integration is not strong such is the case with the enlargement of the European Union to Central and Eastern European countries (CEECs) for instance.

The calculation of distances in the market access variable is made on the basis of the 47 prefectures in which Japan is divided. To calculate the distance

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[4]   The results are not distorted by this adaptation. Works carried out at international level using both the theory-based measure and the alternative Harris (1954) market access formulation reach very similar results (see Redding and Venables, 2004). For other studies dealing with regional analysis that have used measures of market access similar to ours see Niebuhr (2004) and Hanson (2005).

between prefectures we take the distance between their capital cities expressed in kilometres which was computed according to the following expression for the geodetic distance:

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

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 $0.66\sqrt{\dfrac{Area}{\pi}}$ where "Area" represents the size of the prefecture expressed in km^2. 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).

Our market access computations using bilateral distances as a discount factor follow the so called traditional Harris market potential approach (Harris, 1954). However, a somewhat more sophisticated version of Harris' market potential, using road travel times for lorries as weights instead of great circle distances could theoretically be possible. At this respect we have followed an approach which is in line with the vast majority of the papers within this type of literature. Moreover, data availability on travel times would restrict our estimation using this alternative approach and finally, to our knowledge, the only paper which has compared both approaches (Breinlich, 2006) reveals that the two measures yield qualitatively as well as quantitatively similar results (the estimated coefficient of market access in the traditional Harris formulation is 0.455 and in the approach based on travel times is 0.436). Besides, in a developed country like Japan or in the case of the EU (as it was corroborated by Breinlich, 2006) would not seem reasonable that important differences emerged using these two alternative discount factors in the computation of market access. This phenomenon would in fact be important in countries where only a few locations (regions) are well served by road, rail, etc. with the capital or the main business centres while the rest of the country locations are relatively isolated, such is the case for instance in some countries in Eastern Europe like Romania.

As control variables in our work we have decided to incorporate those that might be affecting the nominal wages through market access. These variables are the degree of innovation approximated by the number of registered patents per 100,000 inhabitants, human capital stock proxy by the percentage of population with secondary and tertiary education and physical capital stock proxy by the number of km in each prefecture expressed as a percentage of the prefecture´s area. The data on registered patents was taken from Japan Patent Office (2007), data on km of prefecture road comes from the Japanese Road Bureau of the Ministry of Land, Infrastructure and Transport and finally human capital data comes from Japanese Ministry of Education.

4. Empirical Results

### 4.1. Market Access and Prefectural Income: Preliminary Analysis

In this section we plot and discuss a series of graphs which give us a first approach to the empirical estimates presented in the next section of the paper. Figure 2 shows the relationship between per capita prefectural income and market access[5] for the year 2005. The set of points containing the pair of values (income, market access) is distributed along a positive slope trend line, which is in line with the theoretical predictions derived from the model presented in Section 2 of the paper.

In the composition of the Japanese market access it is interesting to unfold it in its domestic and foreign components. The domestic market access (DMA) of a region refers to the contribution made to total market access (TMA) by the region itself and the foreign market access (FMA) of a region is the contribution made to total market access (TMA) by the surrounding regions. Therefore, the analysis of these two components of the TMA allows us to clarify where the main sources of demand for each prefecture come from. Table 2 shows the breakdown of the TMA into its two components (DMA and FMA) and the percentage that each component represents in the total market access.

Overall, as can be inferred from the results presented in Table 2, the foreign contribution to total market access (Foreign market access) is higher than the domestic contribution (DMA), with the only exception of the capital of Japan, Tokyo, in which the DMA represents a share of 57% in the total market access. It is worth mentioning the significant weight the domestic component of market access has in other dynamic regions of Japan such us Okinawa (share of 34% of the DMA in the TMA), Aichi (35%), Fukuoka (40%) and Osaka (48%).

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[5]   The market access variable for plotting this graph was computed approximating the volume of economic activity by the Gross Prefectural Product.

FIGURE 2
PREFECTURAL INCOME AND MARKET ACCESS
(Japan, 2005)
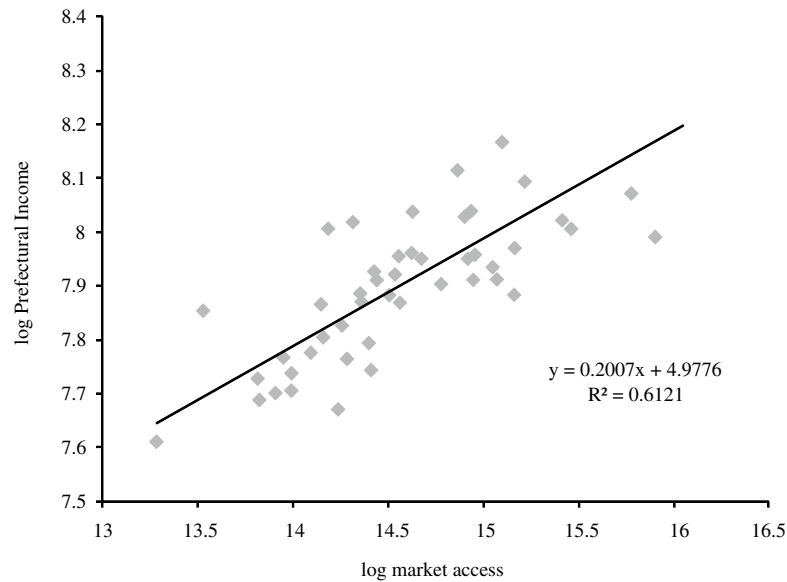
Source: Own elaboration based on data from the Ministry of Internal Affairs and Communications of Japan and the Geographical Survey Institute of Japan.

TABLE 2
DOMESTIC MARKET ACCESS (DMA) AND FOREIGN MARKET
ACCESS (FMA): JAPAN (2005)

Prefecture	Total Market Access	% DMA/ TMA	% FMA/ TMA	Prefecture	Total Market Access	% DMA/ TMA	% FMA/ TMA
Hokkaido	760,154	25	75	Shiga	4,079,916	6	94
Aomori	1,026,850	13	87	Kyoto	3,875,020	10	90
Iwate	1,161,885	9	91	Osaka	5,021,768	48	52
Miyagi	1,748,972	16	84	Hyogo	3,562,978	17	83
Akita	1,210,040	8	92	Nara	3,874,511	4	96
Yamagata	1,817,309	8	92	Wakayama	2,645,093	5	95
Fukushima	1,887,199	10	90	Tottori	1,830,067	5	95
Ibaraki	3,017,359	13	87	Shimane	1,421,753	6	94
Tochigi	3,061,024	9	91	Okayama	2,010,515	12	88
Gunma	3,127,759	8	92	Hiroshima	1,657,662	21	79
Saitama	7,960,284	11	89	Yamaguchi	1,449,598	14	86
Chiba	5,138,448	14	86	Tokushima	2,073,340	6	94

Prefecture	Total Market Access	% DMA/ TMA	% FMA/ TMA	Prefecture	Total Market Access	% DMA/ TMA	% FMA/ TMA
Tokyo	9,185,641	57	43	Kagawa	2,130,144	11	89
Kanagawa	7,058,250	25	75	Ehime	1,616,336	11	89
Niigata	1,855,104	14	86	Kochi	1,541,236	5	95
Toyama	2,261,701	12	88	Fukuoka	1,712,179	40	60
Ishikawa	2,102,685	9	91	Saga	1,560,664	10	90
Fukui	2,244,149	6	94	Nagasaki	1,200,324	16	84
Yamanashi	3,091,013	4	96	Kumamoto	1,328,457	14	86
Nagano	2,371,936	9	91	Oita	1,404,919	12	88
Gifu	3,366,503	6	94	Miyazaki	1,105,571	11	89
Shizuoka	2,840,710	18	82	Kagoshima	1,007,910	15	85
Aichi	3,531,707	35	65	Okinawa	585,001	34	66
Mie	2.937.968	9	91				

TMT: Total Market Access

DMA: Domestic Market Access

FMA: Foreign Market Access

Source: Own elaboration based on processed data.

FIGURE 3
PREFECTURAL INCOME AND DOMESTIC MARKET ACCESS
(Japan, 2005)
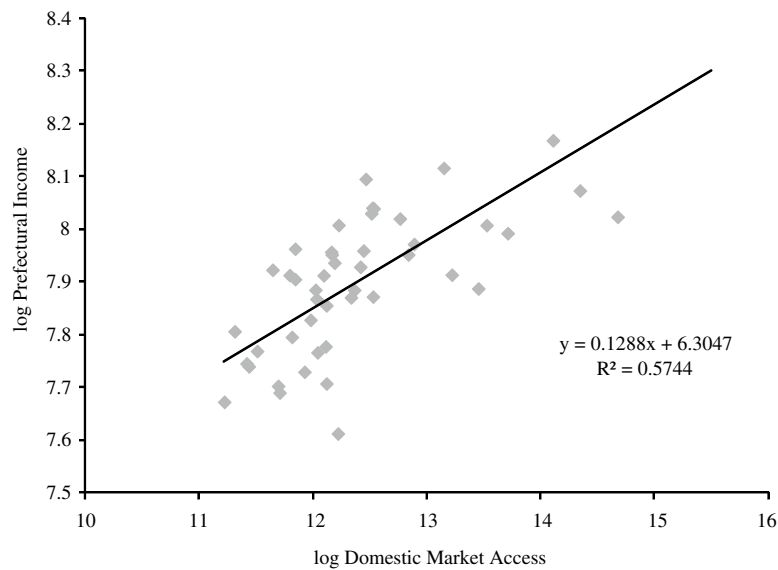
Source: Own elaboration based on data from the Ministry of Internal Affairs and Communications of Japan and the Geographical Survey Institute of Japan.

FIGURE 4
PREFECTURAL INCOME AND FOREIGN MARKET ACCESS
(Japan, 2005)

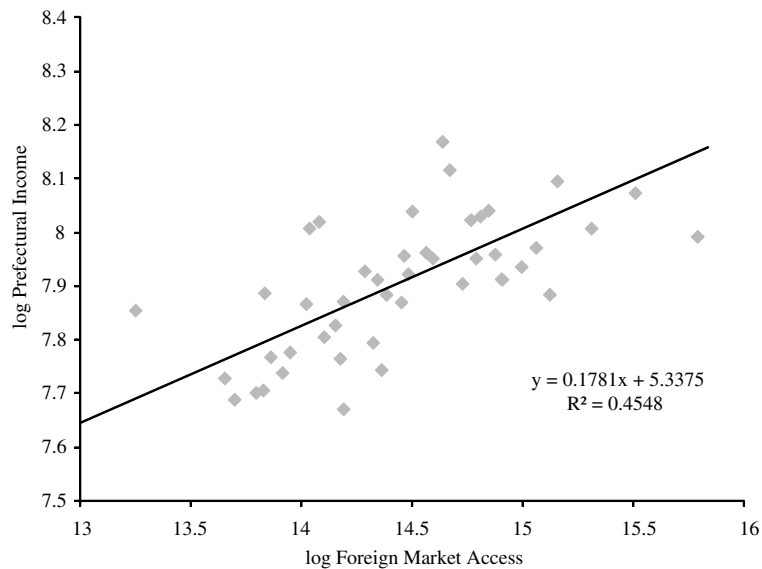*Source:* Own elaboration based on data from the Ministry of Internal Affairs and Communications of Japan and the Geographical Survey Institute of Japan

Figures 3 and 4 give a first approximation to the importance that the domestic and foreign components of market access represents in relation to the income of each prefecture. As it can be seen in the figures, both the domestic market access and the foreign market access have a positive effect on the income levels observed in each prefecture but the relative importance of the domestic component of market access in the explanation of income levels is higher than the foreign component as it is shown by the fit of the trend line. This fact contrast with the weight the domestic and foreign components of market access have in the conformation of the total market access but on the other hand reflects the importance of proximity to sources of demand and supply to explain income levels.

4.2. Market Access and Prefecture Income: Econometric Estimations

The previous descriptive analysis characterizes the relationship between prefecture income and market access and between market access and other variables such as human capital, physical capital and innovation. In this section we extend the analysis with a regression model. Taking into account our theoretical framework OLS and Instrumental Variables regressions of prefecture

income for the years 1996, 2000 and 2005 are conducted on the market access 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) for the 47 prefectures in which Japan is divided.

Table 3 summarizes the results. In Equations 1 to 4 we regress prefectural income for the year 1996 and each market access variable built for the year 1996. In equations 5 to 8 we repeat the estimation for the year 2000 and in columns 9 to 12 for the year 2005. Throughout the table, pair columns gather the results for OLS estimations whereas unpaired columns gather the results of the same estimations by using instrumental variables (IV). With regard to the IV estimations, we follow Breinlich (2006) and López-Rodríguez *et al*. (2007) and use as instruments geographical variables which are the most suitable candidates for such estimation. Therefore, we instrument market access with distance from Tokyo and with the size of the prefecture. The first instrument captures the market access advantages of locations close to the economic-geographic centre of Japan, while the second instrument captures the advantage of large regional markets in the composition of domestic market access. The instruments are highly statistically significant and have the expected signs. The p-value for an F-test of the null hypothesis that the coefficients on the excluded instruments are equal to zero is 0.00. Distance to Tokyo and size of the prefecture explains between 64% and 68% of prefectures market access depending on the volume of economic activity incorporated in the computations of the market access (gross prefectural product or population). Since the instruments represent quite distinct source of information and are uncorrelated, we can trust them to be reliable instruments. We examine the validity of the instruments using a Hansen J test of the model overidentifying restrictions. For our market access measure and we are unable to reject the validity of the instruments (J-Statistic 0.67).

Several indications can be extracted from Equations 1 to 12 (Table 3). First of all, the coefficient of the different market access indicators is always positive and statistically significant. This is in line with the theoretical expectations of the model signalling the idea that a high market access index for a given prefecture indicates a better locations in terms of proximity to consumers´ markets as well as to input suppliers. Therefore as manufacturing firms have to sell their output in different locations and incur in transportation cost, the added value left to remunerate domestic factors of production, among them labour, is higher in central locations (high market access index) than in remote ones. Second, the introduction of the most commonly used proxy for the volume of economic activity in the computations of the market access, gross domestic product, which in this study corresponds with gross prefectural product, reveals a better performance in terms of explanatory power of prefectural income than the alternative proxy, population (regressions, 2, 4, 6, 8, 10 and 12). Third, the results of the estimations show a tendency for the market access variable to lose explanatory power throughout the time. In this 10 year time span analyzed from 1996 to 2005 the decrease in explanatory power of market access was around 15%.

TABLE 3
MARKET ACCESS AND PREFECTURE INCOME: BASELINE ESTIMATIONS

Dependent Variable	Log Prefect. Income 1996				Log Prefect. Income 2000				Log Prefect. Income 2005			
Regressors	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Constant	4.98**	4.85**	4.97**	4.91**	5.24**	5.03**	5.21**	5.10**	4.99**	4.94**	4.98**	5.00**
	(0.28)	(0.36)	(0.27)	(0.33)	(0.30)	(0.37)	(0.28)	(0.34)	(0.36)	(0.45)	(0.35)	(0.42)
MAPOP1996	0.23**	0.23**										
	(0.02)	(0.02)										
MAGPP1996			0.20**	0.21**								
			(0.02)	(0.02)								
MAPOP2000					0.20**	0.22**						
					(0.02)	(0.03)						
MAGPP2000							0.19**	0.19**				
							(0.02)	(0.02)				
MAPOP2005									0.22**	0.22**		
									(0.03)	(0.03)		
MAGPP2005											0.20**	0.20**
											(0.02)	(0.03)
Estimation	OLS	IV	OLS	IV	OLS	IV	OLS	IV	OLS	IV	OLS	IV
Inst. variables		64		67		64		68		64		68
First stage R2												
R2	0.70	0.70	0.72	0.72	0.64	0.64	0.67	0.67	0.59	0.59	0.61	0.61
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
Number observations	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 access on the instruments set, Instruments: Distance to Tokyo and Prefecture Size.

Robustness Checks

The above preliminary analysis shows a positive relationship between income levels and market access. However these positive relationships may be due to third variables that are affecting prefectural income levels through the market access and work through accumulation incentives such as innovation, human capital, physical capital and so on.

Figure 5 shows the relationship between the number of patents (registered patents per 100,000 inhabitants) in each Japanese prefecture and its corresponding market access. As it can be seen in the graph the relationship is positive, showing that those prefectures with higher market access have registered more number of patents.
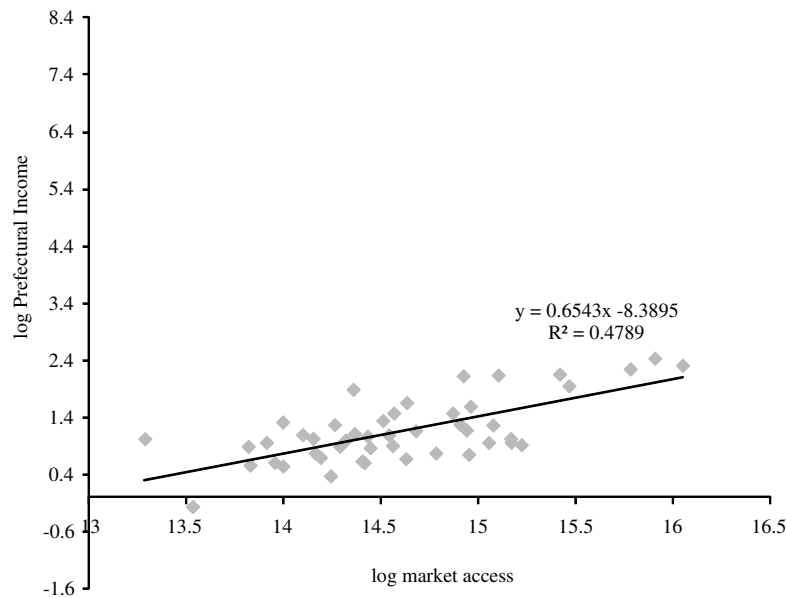
FIGURE 5
PATENTS AND MARKET ACCESS
(Japan, 2005)
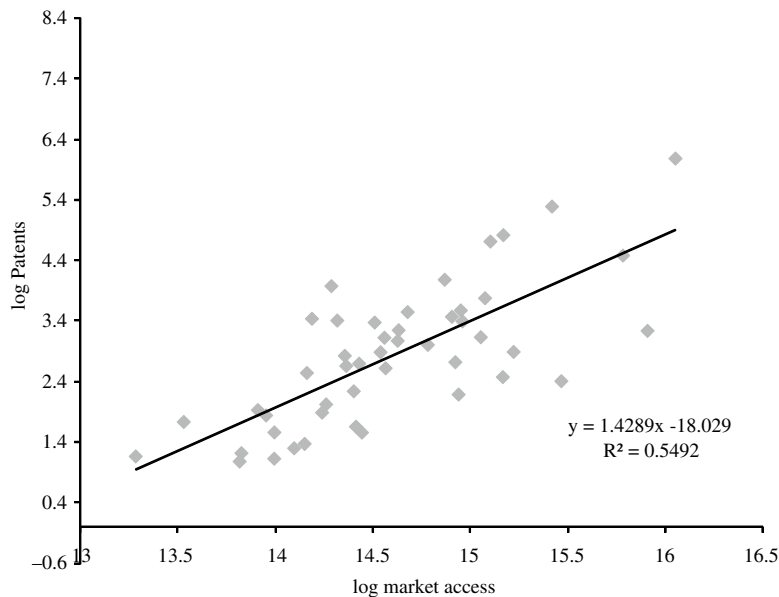
$$y = 1.4289x - 18.029$$
$$R^2 = 0.5492$$

Source: Own elaboration based on data from the Ministry of Internal Affairs and Communications of Japan, the Geographical Survey Institute of Japan and the Japan Patent Office (2007).

Figure 6 depicts the relationship between Physical capital (proxy by the number of road km in each prefecture as percentage of the prefecture´s area) and market access. Again the graph shows that those prefectures that have higher market access values are also endowed with more physical capital.

FIGURE 6
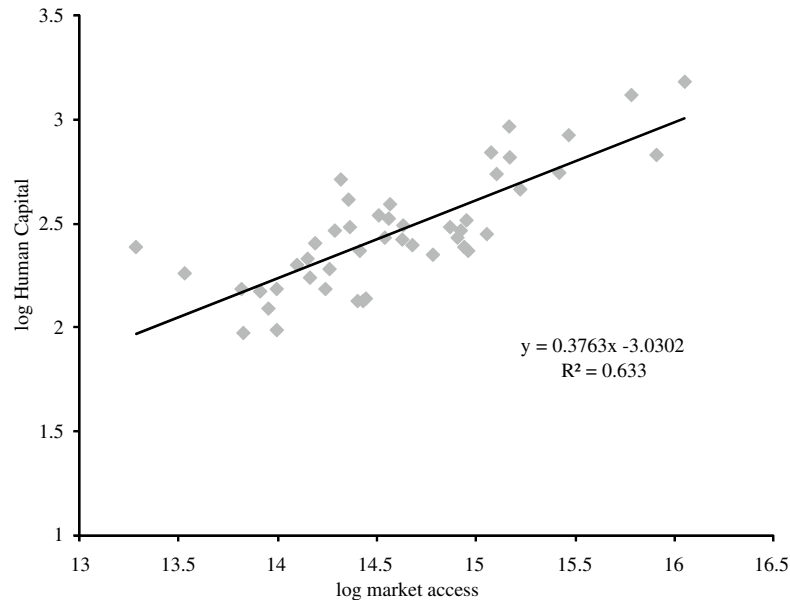PHYSICAL CAPITAL AND MARKET ACCESS
(Japan, 2005)

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 Road Bureau, Ministry of Land, Infrastructure and Transport.

The stock of human capital is also highly correlated with the market access of the corresponding prefecture. Figure 7 depicts the percentage of the population in each county with university education and market access. This preliminary analysis of human capital-market access show a quite robust relationship but of course, there are a wide number of factors affecting human capital accumulation which are far beyond the scope of this paper. However these findings support a potential long-term effect of market access on educational levels.

Therefore, assuming that a significant portion of the benefits of centrality operates through accumulation incentives (innovation, physical capital and human capital), the econometric estimations of this paper will try to disentangle the effects that market access have on per capita prefectural income by controlling for the size of innovation, physical capital and human capital.

Table 4 shows the regression results of market access for the year 2005 on the levels of registered patents per 100,000 inhabitants, the percentage of population with tertiary education (university educations) and the total number of road km

FIGURE 7
UNIVERSITY EDUCATION AND MARKET ACCESS
(Japan, 2005)

$y = 0.3763x - 3.0302$
$R^2 = 0.633$

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.

in each prefecture weighted by the prefectures area. Although testing for the determinants of patents, human capital and physical capital in Japan is beyond the scope of this paper, these findings support a potential impact of market access in shaping the distribution of innovation, human capital and physical capital across the Japanese prefectures. As it can be seen from the estimations in table 4, the number of patents, the stocks of students with university degree and the km of prefectural roads are highly correlated with market access.

The theoretical foundations for the relationship between market access and educational levels have been put forward by Redding and Schott (2003). They proved that high market access provides log-run incentives for human capital accumulation by increasing the premium of skilled labour. Empirical works carried out at international and European level have confirmed this relationship (see López-Rodríguez *et al*., 2007 and Redding and Schott, 2003). Innovative activity is also affected by spatial proximity and geography (see Bilbao-Osorio and Rodríguez-Pose, 2004; Bottazzi and Peri, 1999, 2003; Moreno *et al*., 2005 and Rodríguez-Pose, 1999, 2001).

TABLE 4
MARKET ACCESS, PATENTS, HUMAN CAPITAL AND PHYSICAL CAPITAL
(Japanese Prefectures, 2005)

Dep. Variable:	Log (Junior School Level)	Log (Patents)	Log (University Education)	Log (Prefectural Roads)
Regressors	–1.76**	0.38**	1.68**	0.86**
MAGPP05	(0.26)	(0.05)	(0.19)	(0.18)
Estimation	OLS	OLS	OLS	OLS
R2	0.49	0.55	0.63	0.31
N. observations	47	47	47	47

Notes: Table displays coefficients and Huber-White heterocedasticity robust standard errors in parenthesis; MAGDP05 refers to the market access index for the year 2005 computed using gross prefecture product as a proxy for the volume of economic activity.

** Indicates coefficient significant at 0.01 level * significant 0.05 level

Finally, based on the potential effect market access can have on the above variables, we carried out a set of alternative estimations incorporating as controls into the equation 13 the number of registered patents and the percentage of the population with high school and university degrees. These controls allow us to disentangle the effects market access have on prefecture income by means of looking at the effects these control variables can potentially have on income levels through market access.

Table 5 summarises the results of the extended estimations of the nominal wage equation (equation 13). In order to control for the endogeneity problems arising in the estimations, we run and report only the results of the instrumental variable estimations. In columns 1, 3 and 5 the set of instruments we use are the same as those used in the regressions performed in the baseline estimations (table 3), whereas in the columns 2, 4 and 6 we add distance to Osaka as an additional instrument to not violate the order condition of insufficient instruments.

In columns 1, 3 and 5 we regress the prefecture income in the years 1996, 2000 and 2005 on the market access of the corresponding year and controlling for the size of innovation proxy by the number of registered patents. As we can see from the results of the estimations, the estimated coefficients are in line with the expectations and the coefficient of our main variable of interest, market access, is still positive and statistically significant although its value has decreased almost by half. Even in this case if we double the market access, prefecture income would increase by 12% after controlling for the number of patents. At the same time the explanatory power of the regression has increased, on average, ten percentage points from the baseline estimations (70% to 79% in 1996, 64% to 73% in 2000 and 61% to 71 % in 2005).

We add as an additional control variable into the previous estimations the percentage of population with high school and university degrees. The results

TABLE 5
MARKET ACCESS AND PREFECTURE INCOME: EXTENDED ESTIMATIONS

Dependent Variable	Log Prefect. Income 1996		Log Prefect. Income 2000		Log Prefect. Income 2005	
	(1)	(2)	(3)	(4)	(5)	(6)
Regressors						
Constant	5.85**	4.91**	6.03**	5.26**	6.08**	5.33**
	(0.33)	(0.81)	(0.37)	(0.88)	(0.42)	(1.05)
MAGPP1996	0.13**	0.12**				
	(0.02)	(0.02)				
PATENTS	0.05**	0.05**				
	(0.01)	(0.01)				
High School and Univer.		0.27				
		(0.21)				
MAGPP2000			0.12**	0.11**		
			(0.03)	(0.03)		
PATENTS			0.04**	0.04**		
			(0.01)	(0.01)		
High School and Univer.				0.22		
				(0.23)		
MAGPP2005					0.11**	0.10**
					(0.03)	(0.03)
PATENTS					0.06**	0.06**
					(0.02)	(0.02)
High School and Univer.						0.21
						(0.27)
Estimation	IV	IV	IV	IV	IV	IV
Inst. Variables First stage R2	0.70	0.72	0.70	0.72	0.70	0.72
R2	0.79	0.80	0.73	0.74	0.71	0.71
Prob (F-statistic)	0.00	0.00	0.00	0.00	0.00	0.00
Number observations	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" R^2 is the R^2 from regressing market access on the instruments set, Instruments: Distance to Tokyo and prefecture size for regressions 1, 3 and 5 and distance to Tokyo, distance to Osaka and prefecture size for regressions 2, 4 and 6.

are reported in columns 2, 4 and 6. When patents and human capital are included in the estimates, the coefficients of the variables are again in line with the expectations. However, the variable which approaches the stock of human capital is not significant.

In conclusion, the regression analysis confirms the results of the theoretical model showing that market access is an important variable when we analyze the difference in income levels across the Japanese prefectures. Moreover we discover that innovation might arise as an additional channel that might be affecting the income levels in the Japanese prefectures.

5. Conclusions

In this paper we have built a New Economic Geography model an estimate an econometric specification which relates the levels of wages paid in each location with a weighted sum of the volume of economic activity of the surrounding locations. The estimations have being performed for a sample of 47 Japanese prefectures for the years 1996, 2000 and 2005. The estimation results demonstrate clearly that market access is a crucial variable in explaining the spatial structure of incomes observed across the 47 Japanese prefectures. In our analysis we also show the indirect benefits high market access prefectures have on the incentives to the accumulation of innovation, human capital and physical capital. The coefficient of market access prove to be robust to the estimation of an extended regression where we incorporate as control variables the number of registered patents and the percentage of population with high school and university degrees. When we incorporate the two controls together, the percentage of population with high school and university degrees control variable fails to be significant, although market access continues to show its strength in explaining the spatial structure of income across Japanese prefectures. A final feature of our analysis is the tendency for the market access variable to lose explanatory power throughout the time. Potential explanations for this phenomenon can be related to the improvement in transport infrastructure which would lead to the idea that closeness to large consumer markets, or in other words market access, is losing explanatory power for prefectural income. Other potential explanations quite related to the previous one refers to the improvements in information and telecommunication technologies which brings closer together the different locations. However an exhaustive analysis of this phenomenon is far beyond the scope of this paper and it can be a fruitful research avenue.

This research is open for further research. Perhaps the most important things to analyze in future extensions of this paper is to consider other hypotheses that can compete in explaining the spatial structure of incomes observed in Japan, or seek alternative channels that may be affecting incomes in addition to innovation and human capital.

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