An Ordered Probit Analysis of Factors Promoting A Regional Information Policy

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Abstract: This paper empirically analyzes the factors which determine the success or failure of regional information policies implemented by local governments in Japan. Based upon our field research on thirty-six local governments throughout Japan, we examine how each factor contributes to successful implementation. Our method of study is as follows: local governments are classified into three categories from our observation of their regional information policy through field research, namely, "developed," "progressing," and "underdeveloped". We then examine how geographical and social conditions (demand-side), economic and financial conditions (supply-side), and the human factors of each local government affect each of the above categories by using the "ordered probit analysis". Generally speaking, it appears reasonable to assume that economic and financial factors are most important. The most important was, however, found to be human factors such as the leadership taken by the heads of local governments. We comprehensively analyze why this is the case, contrary to what the theory suggests

Keywords: Regional Information Policy; Japanese Local Government; Ordered Probit Model

1. INTRODUCTION

Parallel to the development of information and communication technology, regional information policies as applications to the fields of education, medicine, health, welfare, and care at home have been implemented by many local governments.[1] The authors have been extensively analyzing those applications as shown in Tsuji et al. [1999b and 1999c] for tele-medicine and tele-care, and Tsuji et al.[1999a] for tele-education. One fundamental question, which arose while conducting field research, was what was the reason for the major differences among local governments in implementing those regional information policies.

Based on our field research of thirty-six local governments located throughout Japan, this paper empirically analyzes which factors are related to the successful performance of a regional information policy, and clarifies the conditions for its success. In an earlier paper by Tsuji et al. [1996], "canonical discriminant analysis" was utilized. This method, however, has less statistical and economic basis, and is not necessarily a common tool for economic analysis. On the other hand, this paper uses "ordered probit analysis" which is being increasingly used in economics.[2]

2. INDEX OF POLICY PERFORMANCE AND METHOD OF ANALYSIS

The most serious problem encountered in a quantitative analysis of a regional information policy is that there is no objective index representing the performance of such policies. The number of computers owned by local governments, the amount of expenditure for the various information policies, manpower, and the number of systems are part of the input into a regional information policy, rather than the output. Since the aim of a regional information

[1] The definition and the role of a regional information policy are provided by Tsuji et al. [2000].

[2] For the ordered probit model, see David and MacKinnon [1993], and Greene [2000], for example.

policy lies in the improvement of the quality of people's lives in a region, it is important to analyze how they have improved the living standard of that particular region. However, such policies have only been recently introduced and should be initiated by a local government in advance to meet the needs of the local residents. Therefore, it is still not deemed appropriate to evaluate the success or failure of a regional information policy only by the degree of interest shown by the local residents. This leads to the assertion that the performance of a regional information policy should be evaluated by outside observers, who conduct field research on such policies giving consideration to natural and social conditions, financial situation, and enthusiasm of the head of local governments in the region, in addition to the number and content of systems adopted in information policies. The evaluation and index of the performance of a regional information policy must be constructed in this way.

In evaluating such an index, one problem is how to express the index numerically, since it contains the subjective evaluation of the observers. In this paper, in order to indicate our evaluation qualitatively, the various regions which we investigated in our field research are classified according to the performance of a regional information policy, that is, we have classified the thirty-six regions into three categories, namely, "developed," "progressing," and "underdeveloped".

In regions evaluated as "developed," the regional information policy is being carried out effectively under the clear concept of improving the quality of life in the region. In regions categorized as "progressing," local governments are promoting policies in different fields, but there are some problems in these policies such as not being clear in purpose, or having an inappropriate combination of information systems. In this category of region, the regional information policy does not appear to be effectively promoted. In regions evaluated as "underdeveloped," it will require a relatively long time and much more effort to develop a regional information policy.

As stated above, our analysis of the performance of a regional information policy is based on the classification of the regions. Therefore, in order to clarify the relationships between various factors and the successful promotion of a regional information policy, we should be able to distinguish the effect of various factors contributing to the classification of a region into the above three categories. "Ordered probit analysis" is utilized as an analytical method which explains the classification of samples based on observed data and determines to which category a sample of the factors belongs. The characteristics of our analysis lie in the fact that the basis for classification of regions is our evaluation of the performance of local information policies and thus includes subjective elements.[3]

3. FACTORS DESCRIBING REGIONAL CHARACTERISTICS AND DATA FOR ANALYSIS

We visited the thirty-six local governments for field research, and from our observation of their information policy through field research, we classify regions into three groups: "developed," "progressing," and "underdeveloped".

On the other hand, we adopt the following ten variables as factors describing the regional characteristics. These variables are classified into the following four groups: The first group includes variables describing the need for a regional information policy, and therefore is classified as "demand-side factors". The variables of this group consist of population (POP, unit: 10,000, in March 1998) and area of the region (S, unit: km^2, in March 1998). The need for a regional information policy may be higher, the greater the population and the larger the area. Thus, it is expected that as a result of our analysis, local governments of areas with a greater population may be classified as "developed" or "progressing" regions, since they have a strong incentive to implement such policies. The area of the regions, for instance, may imply that the need for a regional information policy is high, because the wider area requires a local network system for the smooth communication between residents. On the other hand, however, a wider area implies the low efficiency of investments in such projects which leads to less incentive to implement such policies. It is thus difficult to predict *a priori* that the needs of a regional

[3] Therefore, even if we can identify some factors as significant to the development of local information policies as a result of ordered probit analysis, it may simply mean that our evaluation has been formed with greater importance attached to those factors. Although this interpretation of the results of our analysis cannot necessarily be excluded, our evaluation of the performance of an information policy is not peculiar to any other observers outside the regions.

information policy result in better performance. Among these, we choose POP for a representing variable.

The second group of factors consists of variables which describe the potentialities of the regions in economic activities, and thus can be classified as "supply-side factors". As variables included in this group, we select per capita taxable income (INCOME, unit: 1,000 yen, 1997) and the index of fiscal capacity of the local governments in the regions (FINANCE, 1997), where the ratio of standardized revenue of local taxes to the current local public expenditure was selected as the index of fiscal capacity. The higher the values of these variables, the higher the potentiality of the region, and it is thus highly probable that a region with a higher value of these variables is classified as a "developed" or "progressing" region. In the actual estimation, we select INCOME and FINANCE as presenting variables.

The third group consists of variables as "human factors," and we select the following two variables: (a) TOP, which describes how the leaders in the regions take the initiative in planning and promoting a regional information policy. The leaders include the mayor, head of the chamber of commerce, president of the local medical association, and so on; and (b) ADMIN, which indicates how enthusiastically the administrators of local governments promote a regional information policy. As mentioned earlier, since it is difficult to express these variables related to human factors in terms of numerical value, we define TOP and ADMIN as qualitative variables based on the facts and impression gained through our field research. When it was observed in field research that the leaders and administrators were taking the *initiative* and showing *enthusiasm* in planning and promoting a regional information policy, 1 was placed under the variables TOP and ADMIN, and 0 otherwise.

The fourth group of factors includes quantitative variables representing the number of information systems, volume of equipment, and manpower devoted to a regional information policy. Namely, they are SYSTEM, number of systems developed under a regional information policy in each region (1997), EQUIP, number of computers owned by the local government (per 1,000 residents, 1996), and MANP, number of staff engaged in computerization (per 1,000 residents, 1997). Since these represent the inputs to a regional information policy, we call this group of variables "input factors". We used DEVELOP, EQUIP, and MANPOWER for estimation.

4. ESTIMATION AND RESULTS FOR ANALYSIS

4.1 Ordered Probit Model

On the basis of the classification among regions and on the data for variables described above, the following ordered probit analysis was carried out. Local governments are ordered according to the pre-determined definitions of developed, progressing, and underdeveloped. In this case, the multinominal probit models would fail to account for the ordinal nature of the dependent variables. The ordered probit models have come into wide use as a framework for analyzing such a response [Zavoina and McElvey, 1975].

The performance of a regional information policy is affected by various factors as mentioned above. However, we cannot observe the performance of the policy and the only data sets we can observe are firstly 0 in case of "underdeveloped," 1 for "progressing," or 2 for "developed" according to the field research on the performance of the regional information policy of each local government. In modeling, we assume the performance of the regional information policy-- y_i^* is the unobserved variable (latent variable) and y_i^* is expressed in the following equation:

$$y_i^* = \beta_0 + \sum_{j=1}^{k} \beta_j x_{ji} + u_i, \qquad (1)$$

where x_{ji} are the above mentioned explanatory variables, such as demand-side factors, supply-side factors, human factors, and input factors. We assume that u_i is normally distributed across observations. As mentioned previously, y_i^* is unobserved and we can only observe whether the performance of a regional information policy is "0," "1," or "2". So what was observed is as follows:

$$y_i = \begin{cases} 0 \text{ if } y_i^* \le 0, \\ 1 \text{ if } 0 < y_i^* \le \mu, \\ 2 \text{ if } \mu < y_i^*. \end{cases} \qquad (2)$$

where μ is unknown parameters to be estimated with β_j. By assuming that u_i is normal and F is cumulative distribution function, we then we have the following likelihood function:

$$L(\mu,\beta_0,\beta_j)=\prod_{y_i=0}\left\{1-F\left(\beta_0+\sum_{j=1}^{k}\beta_j\cdot x_{ji}\right)\right\}$$
$$\times\prod_{y_i=1}\left\{F\left(\beta_0+\sum_{j=1}^{k}\beta_j\cdot x_{ji}\right)\right.$$
$$\left.-F\left(\beta_0+\sum_{j=1}^{k}\beta_j\cdot x_{ji}-\mu\right)\right\} \quad (3)$$
$$\times\prod_{y_i=2}\left\{F\left(\beta_0+\sum_{j=1}^{k}\beta_j\cdot x_{ji}\right)\right\}.$$

Table 1. Factors Determine Either Developed, Progressing, or Underdeveloped (Ordered Probit Estimation).

	Equation			
	(1.1)	(1.2)	(1.3)	(1.4)
POP	0.93	1.33	0.64	0.77
	(0.92)	(1.00)	(0.52)	(0.55)
INCOME	0.21	-------	0.27	-------
	(0.45)		(0.49)	
FINANCE	--------	-0.20	-------	0.06
		(-0.27)		(0.07)
TOP	0.96**	1.02**	0.82*	0.83*
	(2.16)	(2.27)	(1.69)	(1.70)
ADMIN	0.80*	0.81**	1.15*	1.16**
	(1.95)	(1.98)	(2.50)	(2.51)
DEVELOP	-------	-------	0.09†	0.10†
			(1.49)	(1.63)
MANP	-------	-------	-0.31	-0.34
			(-0.64)	(-0.72)
EQUIP	-------	-------	0.32**	0.31**
			(2.04)	(1.91)
D	1.14***	1.13***	1.22***	1.21***
	(8.73)	(8.75)	(8.53)	(8.55)
With Dep=0	10	10	10	10
With Dep=1	14	14	14	14
With Dep=2	12	12	12	12
Log likelihood	-32.66	-32.60	-29.56	-29.68

Note:
1. Dependent Variable is "developed (take value 2)", "progressing (take value 1)", or "Underdeveloped (take value 0)".
2. t-statistic in parentheses.
3. Statistical significance at the 1%, 5%, 10%, and 15% levels is indicated by ***, **, and *, and †, respectively.

First of all, the correlation among variables is examined. The correlation matrix for thirty-six samples, INCOME and FINANCE have a high correlation ratio such as 0.871. Since these variables might give rise to a problem of multi-collinearity in estimation, these two variables are not utilized together. Input factors, especially DEVELOP, are highly correlated with supply-side factors such as POP and demand-side factors such as INCOME and FINANCE. By considering this and selecting variables in the models, there are four combinations for variables, and these are described as (1.1), (1.2), (1.3), and (1.4). (1.1) and (1.2) do not include input factors such as DEVELOP and EQUIP, whereas the latter two contain these.

Table 1 shows the results of the ordered probit estimation.[4] This estimation captures the factors which characterize the local governments as developed, progressing and underdeveloped. In models (2.1) and (2.2), only variables such as TOP or ADMIN are significant statistically. Thus, ordered probit analysis shows that human factors are important for promoting a regional information policy. That is, it can be said that human factors such as the initiative of leaders in the region and the enthusiasm of the administrators of local governments are effective in determining whether the region is classified as a "developed," "progressing," or "underdeveloped" region. Furthermore, in models (1.3)and (1.4) in Table 1, EQUIP (number of computers) is statistically significant, whereas DEVELOP shows to be slightly significant with a 15% level of significance. Thus, it is found that neither demand-side nor supply-side variables are the factors for promoting a regional information policy, but human as well as input factors are effective.

4.2 Binomial Probit Model

In order to analyze in more detail factors which determine the degree of each category in successfully promoting a policy or not, let us utilize probit analysis, which compares the local governments belonging to the developed category with the rest.[5] In other words, we make an attempt to extract the essential factors, which classifies the local governments as being "developed (take value 1) or progressing (take value 1)" and "developed (take value 1) or underdeveloped (take value 0)".

The estimation is based on the equation (1). In this estimation, since the performance of the policy variable y_i^* is unobserved, and those

[4] Here, ordered probit analysis implies that we try to identify the factors which distinguish "developed," "progressing," and "underdeveloped" together.

[5] Here, probit analysis implies finding factors to distinguish any of two categories. In this analysis, only the comparison of "developed" with the remaining categories provides a significant result.

observed are dummy variables such as y_i which indicates "developed" (take value 1) or "progressing" (take value 0), "developed" (take value 1), or "underdeveloped" (take value 0)) in each case of equation (1). That is,

$$y_i = \begin{cases} 1 & y_i^* > 0 \\ 0 & y_i^* < 0 \end{cases} \tag{4}$$

Here we assume again that the distribution of disturbance u_i is normal, and F is its cumulative distribution. The following likelihood function is obtained:

$$L(\beta_0, \beta_j) = \prod_{y_i=0} \left\{ 1 - F\left(\beta_0 + \sum_{j=1}^{k} \beta_j \cdot x_{ji} \right) \right\} \times \prod_{y_i=1} \left\{ F\left(\beta_0 + \sum_{j=1}^{k} \beta_j \cdot x_{ji} \right) \right\} \tag{5}$$

The result of this probit analysis that classifies the local governments as being "developed" or "progressing" is shown in Table 2, in which

Table 2. Factors Determine either Developed or Progressing (Binomial Probit Estimation).

	Equation			
	(2.1)	(2.2)	(2.3)	(2.4)
POP	0.76	1.66	1.88	2.09
	(0.67)	(0.69)	(0.72)	(0.50)
INCOME	-0.09	-------	1.13	-------
	(-0.14)		(0.82)	
FINANCE	-------	-1.31	-------	-0.48
		(-0.99)		(-0.21)
TOP	1.37 **	1.54 **	2.35 **	2.10 **
	(2.33)	(2.41)	(2.14)	(1.96)
ADMIN	0.86 †	1.12*	1.85*	2.35*
	(1.47)	(1.69)	(1.77)	(1.70)
DEVELOP	-------	-------	-0.00	0.10
			(-0.01)	(0.54)
MANP	-------	-------	2.93	2.49
			(1.32)	(0.97)
EQUIP	-------	-------	0.73	0.60
			(1.05)	(0.87)
With Dep=0	14	14	14	14
With Dep=1	12	12	12	12
Log likelihood	-12.78	-12.13	-6.386	-6.716

Note:
1. Dependent Variable is "developed (take value 1) or progressing (take value 1)".
2. See, Table1.

human factors are found to be the most important. Input factors, on the other hand, are not significant, in contrast to the results shown in Table 1.

Let us summarize the above results. Among the developed and progressing categories, the human factor is essential, while for "developed", "progressing", and "underdeveloped" categories, it is the human factor and input factor. In other words, the human factor determines whether the local government is developed or progressing, whereas input factor indicates whether developed or underdeveloped.

5. CONCLUSION

In sum, the following conclusion can be obtained from our analysis: First, for a region to be evaluated as "developed," it is important for its leaders to have a strong initiative and for the administrators of local governments to possess enthusiasm. In addition, it is also indispensable for local governments to own an adequate number of computers which are expected to play a central role in information technology in the age of an information society.

This conclusion is compatible with the impression gained from our field research. However, it is rather surprising that in our analysis, demand- and supply-side factors, especially the regional income level and fiscal capacity, had little effect on the separation of the regions into the three groupings.[6]

The reason why a weakness in fiscal capacity does not necessarily determine the progress of a regional information policy is partially found in the fact that even a local government with a low level of fiscal capacity can promote information policies by concentrating its funds on a small number of policies with a clear project concept.[7] Furthermore, by collaborating with the projects of the central or prefectural government, local governments can avoid financial difficulties in promoting a regional information policy. Most local governments listed in this analysis are promoting local information policies in

[6] Some local governments have been promoting policies in order to cope with the rapidly aging population. But even at the present stage of our research, one of the reasons why the ratio of the aged does not necessarily have a significant correlation with the development of local information policies is found to be the existence of a wide variety of regions with a high or low ratio of aged.

[7] As voiced by several regions with relatively low fiscal capacities, it is also reasonable to say that difficulties in financing policies are the main obstacles to promoting a regional information policy.

collaboration with national projects in the field of tele-medicine and tele-education. Further field research must be conducted in the various regions to verify the generality of the conclusion stated above.

According to the authors' field research on regional information policies, the condition for their success is dependent on the leadership of the head of local governments. In addition to human factors, there is the historical tradition of a region. Traditional backgrounds merge the new information technology and both lead to the success of a regional information policy.

The largest obstacles to the success of a regional information policy are social systems, regulation, and attitude towards information technology. They are constructed on the basis of past systems. The current medical insurance system and adherence to traditional medical practices stand in the way of information technology. That is, existing medical insurance does not cover the cost of tele-medicine, and it is restricted basically only to face-to-face medical practices. The same can be said as to copyrights. Even TV educational programs cannot be used for tele-education without permission because of copyright. One reason why Okazaki City was able to proceed with tele-education via VOD is that they own many self-produced videos.[8] Another example is telecommunications charges.[9] The current rate system for telecommunications is based upon the transmission of voice via metal cables, thus rates depend on the time and distance of calls. However, telephone calls via optic fibers do not depend on those factors due to the capacity of optic fibers. The current Japanese rate system is thus an obstacle to the introduction of Internet as well as multimedia.

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[8] As for tele-education in Okazaki City, see Tsuji et al. [1999a]. Okazaki City has the most advanced tele-education system based on its CATV network.

[9] See Tsuji [2000] for more details.