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Determinants of Public Goods Investment in Rural Communities in Mountainous Areas of Sichuan Province, China

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Abstract: This study aims to investigate two important issues: what are the determinants of public goods investment and what is the government's investment behavior in mountainous areas. The impacts of natural conditions, target, and demand elements on public goods investment are analyzed with statistical method, and the determinants of public goods investment in the areas are obtained by using population-weighted and stepwise regression models with Eviews6.0 software with survey data in 2008 and calculated data based on GIS of 20 typical villages in mountainous regions in Sichuan, China. The results showed: (1) natural conditions are the important determinants of public investment. Mountainous villages with steep slope have relatively high levels of investment; (2) concentration of population and the educational levels of the village leaders also have important impacts on public goods investment; (3) the government is more concerned with public investment resources particularly in areas characterized by fragile ecological environment and poor agricultural output. These results suggest that the current investment strategy helps to reduce disparities in regional development.

Keywords: Determinants; Eviews6.0; GIS; Public Investment; Regression Analysis; Rural Development

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Introduction

Public goods which are non-competitive on the consumption and non-exclusive on the income, refers to the goods and services produced and provided by the government (public sector) to meet the common needs of the people. Public goods investment is prerequisite and the basis of economic and social development especially in the rural communities. It is difficult for the poor people to enjoy the public goods investment in the developing countries, while the supply of public investment has an important role in poverty reduction, promoting modernization process in the rural communities and coordinating the rural-urban development. However, the generation of benefits only takes place when the services provide efficient response to effective demand (World Bank 1994). It is well-known that the public investment may generate positive benefits in improving economic growth, decreasing regional poverty and promoting sustainability. It intends to enhance the

regional capacity by increasing resources and enhancing the productivity of the resources. Aschauer (1989), Barro (1990), Munnell (1990a, b) and Fan et al. (2004) found a positive relationship between the public investment and the regional development in economically backward areas. A study was carried out in nine countries by Ram_ırez and Nazmi (2003) shows that for a short span of time (10 years), public investment has largely contributed to economic growth at the national level. In many previous studies, public capital was treated as an aggregate or divided into smaller categories. Other studies (Ratner 1983; da Silva Coata et al. 1987; Iwamoto 1990) also show the positive productivity effects of public capital when treated as a single aggregate. However, Evans and Karras (1994) observed its negative effects. Aschauer (2000) studied the effect of public capital on economic growth and found a non-linear relationship between them. Some scholars (Evans and Karras 1994; Garcia-Mila et al. 1996; Mitsui and Takezawa 1995; Ida and Yoshida 1999) divided public capital into smaller categories. Munnell (1990a,b), Garcia-Mila and McGuire (1992) noticed that some components of public capital such as highway, water and sewer system, and education contributed positively to private production. Research carried out by Calderon and Serven (2004) also shows that increasing numbers and quality improvement of public goods has significantly reduced the income gap in backward areas.

With spillover effect on the income, rural public goods, which is non-exclusive and non-competitive, refer to the goods and services and provide a base for the development of farmers and agriculture in the rural area, such as the medical insurance for farmers, the fundamental scientific research for agriculture and the treatment of major rivers, environmental protection, the construction of irrigation systems, roads and power grid and compulsory education in the rural areas. While governments at all levels pay more attention to public investment in mountain areas and per capita public goods and the investment capital are much higher than the plains, difficulties in transportation, medical care and education in mountainous rural China is common due to the lack of public goods (Chen et al. 2007). Mountainous areas of Sichuan in the South West China are compromised of deep valleys, dense population and backward economy, and are inhabited by a high percentage of poor people. The World Bank (2001) estimated that 100 million farmers still live below the poverty line in China. The income gap resulting from the economic reform in 1978 has always existed and continues until now (Rozelle 1996). Although the rural economy and farmers' income are continuously growing, the rural-urban income gap has not been effectively reduced (Fleisher and Dennis 2003). In order to accelerate the economic development and reduce regional disparities, China has drawn lessons from the economic development strategy and mode of some western developed countries, such as Europe and America, resulting in significant improvement of infrastructural facilities in the mountainous areas.

In the field of rural public investment, academic and related institutions have carried out extensive research. Previous studies show the determinants of public investment. Crain and Oakley (1995) investigated political factors and noticed that term limits, citizen initiative and budgeting procedures were significant determinants of state public investment. Kemmerling and Stephan (2002) used simultaneous equations to analyze the determinants of public investment and considered lobbying and political factors as the determinants, showing that the political affiliation, measured by the coincidence of party color between state and local government, is decisive in explaining the distribution of investment grants across cities. It further showed that the larger the majority of government in city council, higher the investment in the local infrastructural facilities. Kamada et al. (1998) investigates that how socio-economic conditions such as per capita income growth rate and population growth rate affected the regional allocation of public capital investment and observed that regional income inequality is an important factor in determining public investment.

Zhang et al. (2005) used statistics, regional population-weighted model and Tobit model to analyze the determinants of public and government investments policy in rural communities of China and noticed that local economic development level was an important factor in rural public investment. The work shows the standards and channel

through which the public investment flows into rural communities and provides the decision-making basis to the government agencies. However, most of the current studies on public investment in rural communities were carried on the national or large regional levels.

However, specialized studies on public investment in the rural mountain regions of China are still in the preliminary stage. The major questions raised in this paper are, what are the determinants of public goods investment in rural communities in mountain areas? How do these factors influence on public investment? What are the determinants of government's public goods investment in rural communities in mountain areas? How do these factors influence government's investment behavior? Qualitative and quantitative analysis was carried out to answer the above-cited questions. It should be pointed out that the government refers to the National Agricultural Comprehensive Development Office and other ministries or subordinate units (including Sichuan Province Traffic Bureau, related City, District and County Education Bureau, Territory Bureau, Power Bureau, Broadcasting Bureau, Forestry Bureau, Water Affairs Bureau, Highway Bureau and Organization Department, etc.)The present work is practically significant in providing insight for public goods, optimizing the distribution of public investment and coordinating urban-rural development.

1 Methods

1.1 Study areas and data source

Per capita industrial output value is a good predictor for living standards and development potential of a region (Rozelle 1990 and 1996). All counties (districts) in Sichuan Province were divided into five groups according to the amount of per capita industrial output value, and a county was randomly selected from each group and five counties, including Jiangyou, Shehong, Zigong (including Yantan and Ziliujing districts), Guang'an and Yuanba were selected. The majority of the sample counties are from the east of Sichuan (Figure 1). Using the method cited above, two townships in each county were randomly selected as samples, and two villages in each sample townships were randomly selected by drawing lots. Altogether, 20 villages - 15 hilly and 5 mountainous were case studied.

The socio-economic data of sample villages used in this paper were mainly from the field survey on public goods investment in rural communities of Sichuan Province which was carried out in 2008 by the Center for Chinese Agricultural Policy, Chinese Academy of Sciences (CAS), and the Institute of Mountain Hazards and Environment, CAS. The topographical data were calculated on the basis of 1:50, 000 DEM grid data of Sichuan Province with the support of the Geographical Information System (GIS) technologies. Elevation and slope were calculated with zonal statistics in spatial analysis. The relative height difference was obtained by analyzing square neighborhood window with neighborhood analysis tools in spatial analysis and statistical analysis method of mean change-point on raster DEM.

The data reveals that the public investment level was comparatively high in Sichuan. The total number of public projects in all 20 villages was 136 with 46.1 million RMB of total outlay. The number

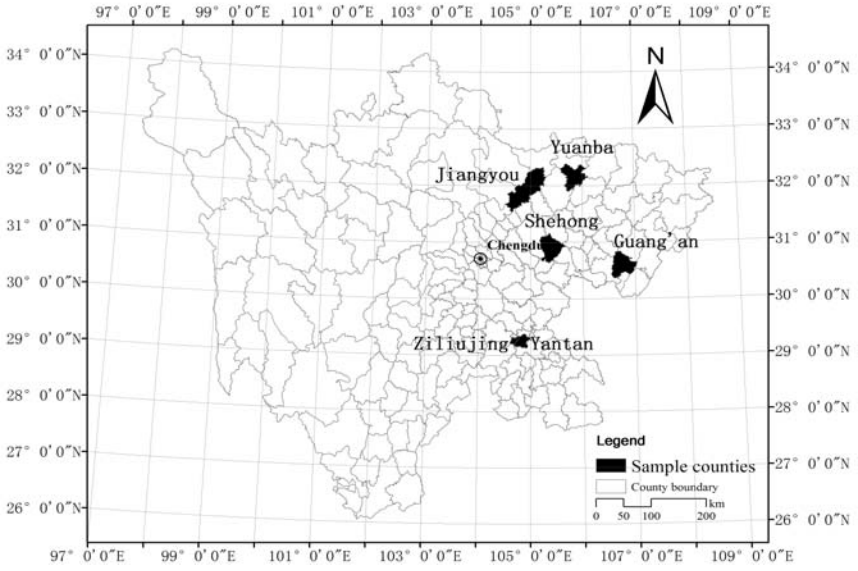

Figure 1 Location of the study area.

of public investment in each village ranges from 2 to 13 and the invested capital ranges from 4.66 million to 23.856 million RMB. The proportion of number of government-invested projects varied from 33% to 100%. Meanwhile, both number and capital were significantly different in mountainous and hilly villages as they averaged 6.4 and 6.93 respectively.

Similarly, the average number of government-invested projects was more than the village-financed projects in all case studied villages. The ratio was 62.5% and 37.5% respectively in mountain villages and in hilly villages; it was 74.04% and 25.96% respectively. The average public investment capital of mountainous villages (5.8163 million) was more than the hilly villages (1.1344 million) and similarly, the average capital of government-invested projects was more than the village-financed projects. Further, the ratio of government-invested projects and the village-financed projects was 90.23% and 9.77% respectively in the mountain villages, and 76.37% and 23.63% respectively in the hilly villages. We observe from the above description that the government has invested tremendously in public projects in the hilly villages and large scale investment was also carried out in the mountain villages.

1.2 Statistical analysis method

Statistical analysis method was used to demonstrate the relation between public investment and factors affecting the formation of public investment which are complex in rural areas. According to a previous study (Zhang et al. 2005), and taking into account the special natural and geographical environment of mountain areas, this paper investigated the effect of socio-economic and natural factors on the public investment. In order to make the study more clear, all selected factors were divided into four kinds of elements, including natural conditions (slope), target (total population, distance from villages to townships and from village to the nearest concrete road), demand (the number of village enterprises, the proportion of migrant workers in total labor force and per capita cultivated land) and others (the number of persons from the villages, working in government and whether the village director was changed between 2007 and 2008 year). Target elements refer to the ones considered by the higher level of government in order to achieve a certain goal. The demand elements reveal some features of village that prompt the villagers to be more willing (or unwilling) to implement public investment in the village (Zhang et al. 2005). We first classified each factor data into five levels (Table 1) and then counted the public projects and the public investment capital at every level in each village.

1.3 Regression analysis method

By using Eviews6.0 software and a series of multivariate regression analysis, including population-weighted least squares estimate and stepwise regression estimate, the determinants of the public goods investment capital were investigated. The main sources of village-level public investment can be divided into two categories: one is the high-level government (township and the higher-level government) and the other is the village self-financing (raising funds

Table 1 The grading standards of natural conditions, target, demand and other elements in statistical analysis

Elements		Units	Grading standards				
			Level I	Level II	Level III	Level IV	Level V
Natural Conditions	A1	degree	<1	1-3	3-5	5-12	≥12
Target	B1	person	<2550	2550-3600	3600-3900	3900-4350	≥4350
	B2	Km	<1	1-4.5	4.5-5.5	5.5-15	≥15
	B3	Km	<0.04	0.04-1	1-4	4-5	≥5
Demand	C1		<1	1-2	2-4	4-8	≥8
	C2	%	<15	15-50	50-70	70-75	≥75
	C3	Ha	<0.04	0.04-0.06	0.06-0.08	0.08-0.2	≥0.2
Others	D1	person	<2	2-4	4-5	5-9	≥9
	D2		Yes=1		No=0		

Note: A1: slope; B1: total population in 2007; B2: the distance from the village to the township government; B3: the distance from the village to the nearest concrete road; C1: the number of village enterprises; C2: the proportion of migrant workers; C3: per capita cultivated land; D1: the number of persons from village working in government; D2: whether the village director was changed (1 = Yes, 0 = No), the same below.

of the village collective organizations and the villagers). As the mountainous areas are usually poorer, village self-financing projects are relatively fewer. In addition, these two types of investments may have different determinants and the same factor may also have different directional effects on these two types of investment. So, some obvious relationships will be covered up and some important causal relationships may be ignored if the total amount of investment is merely analyzed using regression model. Simultaneously, the determinants analysis on these two types of investment can provide targeted decision-making references for the government to develop relational policies and to learn more about the influencing factors of the village public investment carried out by the high-level government. In view of these, the amount of government's public investment is also selected as dependent variables in the regression besides the total public goods investment capital. The explanatory variables are 16 indicators divided into four types of elements, including natural conditions, target, demand and others. The outputs of regression model include coefficient, t statistics and p value. The mean, standard error, change range, and units of regression variables are listed in Table 2.

Table 2 Descriptive statistics of dependent and independent variables

Variables		Units	Mean	S.E.	Min.	Max.
Dependent variables						
a*			6.80	3.56	2.00	13.00
b*		million	230.49	525.84	4.66	2385.60
c*		million	196.17	495.81	1.00	2221.60
Independent variables						
Natural conditions	A1	degree	7.09	5.94	0.00	19.93
	A2	meter	505.70	217.63	288.00	1160.00
	A3	meter	110.75	81.32	32.00	348.00
Target	B1		1507.80	674.07	608.00	2853.00
	B2	km	5.44	4.67	0.00	20.00
	B3	km	1.69	2.96	0.00	10.00
	B4	yuan	3789.15	1025.51	2350.00	5800.00
Demand	C1		1.95	3.12	0.00	12.00
	C2	%	43.25	21.12	6.25	77.50
	C3	ha	0.08	0.12	0.01	0.56
	C4	%	6.54	6.69	0.00	28.27
Others	D1		5.30	9.72	0.00	45.00
	D2		0.4	0.5	0.00	1.00
	D3	yuan	11.69	34.48	0.00	154.55
	D4	Year	9.70	1.47	7.50	12.00
	D5	Year	10.15	1.93	6.00	14.00

Notes: a*, b*, c* denote the numbers of public investment, the public investment capital, and the public investment capital from government, respectively.

A2: altitude; A3: the relative height difference; B4: per capita income; C4: the proportion of self-employed industrial and commercial households; D3: per capita debt in 2007; D4: years of the village director's education; D5: years of the village secretary's education, the same below.

S.E. means Standard error.

2 Results and Analysis

2.1 Factors affecting the public investment

The statistical analysis method shows that the public project number are correlated positively with slope (A1), the numbers of village enterprises (C1), the numbers of persons from village working in government (D1), and correlated negatively with the distance from the village to the township government (B2), and the distance from the village to the nearest concrete road (B3) (Table 3). Similarly, the public investment capital is correlated positively with slope (A1), and negatively with the distance from the village to the nearest concrete road (B3), the proportion of migrant workers (C2), and per capita cultivated land (C3). We also can see the villages where the director was changed between 2007 and 2008 year have much higher level public investment (Table 3).

2.2 Determinants of public goods investment

The mode estimation results are summarized in Table 4 and Table 5. The overall results seem to be reasonable: the fit of the selected equations is high with R^2 ranging from 0.9521 to 0.9528. From the estimation results, the following conclusions can be drawn.

The regression model result of determinants of public goods investment shows that, topography, population, and geo graphic conditions have significant impact on public invest-

ment (Table 4). The slope has a positive effect on the public investment capital. The greater the slope is, the more the public investment capital. For target elements, the more the total population of the village are, the more the public investment capital; the closer the distance from village to the township government, the more the public investment capital. Through regression analysis we also find that demand elements are important determinants of public investment in rural communities. The smaller the proportion of migrant workers in the total labor force is, the more the public investment capital; the less the per capita cultivated land, the more the public investment capital. In addition, village-level governance variables also affect the level of public investment significantly. The higher the educational level of the director is, the higher the level of the public investment.

The public investment capital of government has a positive correlation with slope and the population, and a negative correlation with per capita cultivated land (Table 5). The further the distance from the village to the township government is the less the government's public investment capital, which may be correlated with the convenient implementation of the projects and the better demonstrating the performance. Regression analysis also shows that the government pays attention to villages where the local labor force who have moved away to work in other areas is less. Village-level governance variable is another important determinant of government's investing tendencies.

Table 3 The related trend analysis of the numbers and public investment capital and natural conditions, target, and demand elements

Elements		Level I	Level II	Level III	Level IV	Level V
A1	a	5.00	6.00	8.25	7. 75	11.29
	b	0.3666	1.032	2.0815	6.6416	8.1096
B1	a	6	9.5	6.75	5	6.75
	b	6.4512	0.5889	2.4156	0.9071	1.1618
B2	a	11	7.11	5. 75	5.25	6
	b	1.5262	3.2179	1.7445	1.3784	1.5930
B3	a	7.42	10	6.33	5	4.33
	b	3.4152	2.328	0.286	0.2056	0.5746
C1	a	6.33	4.5	8.33	8.5	9.5
	b	1.0378	0.3904	1.0744	12.2091	3.7776
C2	a	7.33	7.11	6. 4	7.5	3
	b	9.9335	1.4257	0.4869	0.441	0.15
C3	a	7	10	4.5	5.25	5
	b	4.717	1.722	1.4424	0.8028	0.2056
D1	a	4.63	5.67	8	9.17	11
	b	0.8351	0.8723	0.6632	5.7399	1.0347
D2	a	7.00		6.67		
	b	3.5751		1.4582		

Notes: "a" denotes the numbers of public investment; "b" denotes the public investment capital.

Table 4 Regression results with the public investment capital as independent variable in population-weighted regression model (Model 1) and stepwise regression model (Model 2)

Variables		The public investment capital			
		Model 1		Model 2	
		Coefficient	T statistics	Coefficient	T statistics
Constant		718.6558	0.441563	238.2901	0.166749
Natural conditions	A1	178.1017	2.483926*	189.28	3.238025**
	A2	-0.541392	-0.361779	0.317344	0.272286
	A3	0.363500	0.127311	-1.197267	-0.472983
Target	B1	0.629616	3.082870*	0.694797	2.612890*
	B2	-187.5798	-2.169639	-212.1298	-2.501063*
	B3	49.00088	0.884711	24.63131	0.366782
	B4	-0.068202	-0.310942	-0.023221	-0.135108
Demand	C1	-92.41996	-1.729052	-48.52829	-0.953085
	C2	-39.58631	-6.286607***	-34.30112	-4.637078**
	C3	-358.3604	-4.467266**	-328.1166	-3.930939**
	C4	40.77518	1.606709	41.95166	1.77249
Others	D1	-74.93846	-0.796161	-123.9612	-1.595278
	D2	-911.8854	-2.385618*	-856.9706	-2.050019
	D3	11.24198	0.470976	25.96406	1.29503
	D4	301.0891	3.770716**	300.9433	3.417094**
	D5	-146.6921	-2.090749	-170.973	-2.542629*
R-squared		0.9417		0.9528	

Note: *, **, *** denote significance at the 10% level, 5% level, 1% level, respectively.

The higher the educational level of village directors is, the higher the level of the government's public investment.

The regression results of the public investment capital as dependent variable are approximately consistent with that of the

public investment capital from government in the aspects of determinants, their impact directions and their impact degrees, indicating that the public investment capital is mainly from the government public investment to some extent. At the same time, there are differences in the impacts of total population and the distance from the village to the township government. According to the population-weighted regression model, the public investment capital of government is positively correlated with the distance from the village to the township government, and the total public investment capital is unrelated. The population quantity is significantly correlated with the total and the government's public investment capital at 10% and 5% levels, respectively.

Table 5 Regression results with the amount of government's public investment as independent variable in population-weighted regression model (Model 1) and stepwise regression model (Model 2)

Variables		The public investment capital from government			
		Model 1		Model 2	
		Coefficient	T statistics	Coefficient	T statistics
Constant		492.0017	0.319673	37.25039	0.027439
Conditions	A1	172.6772	2.546669*	183.6976	3.307968**
	A2	-0.24708	-0.174597	0.485337	0.438349
	A3	0.598656	0.22172	-0.846474	-0.352006
Target	B1	0.637392	3.300293**	0.68574	2.714597*
	B2	-201.2378	-2.461375*	-219.7267	-2.727019*
	B3	65.91562	1.258498	42.05525	0.65921
	B4	-0.044842	-0.216189	0.003903	0.023906
Demand	C1	-79.75098	-1.577775	-41.37259	-0.855326
	C2	-37.76826	-6.342568***	-33.10583	-4.711106**
	C3	-355.9484	-4.692192**	-326.9671	-4.123391**
	C4	41.04741	1.710385	42.09733	1.872284
Others	D1	-83.86709	-0.942225	-125.686	-1.702628
	D2	-934.4411	-2.585113*	-882.4252	-2.222042
	D3	14.06414	0.623068	26.51533	1.392153
	D4	284.4354	3.766859**	282.8811	3.381105**
	D5	-139.0138	-2.095174	-158.6258	-2.483201*
R-squared		0.9439		0.9521	

Note: *, **, *** denote significance at the 10% level, 5% level, 1% level, respectively.

3 Discussion and Conclusion

This article examines the effect of socio-economic and natural condition elements on public goods investment using recent village survey data and calculated data based on GIS in two different methods, including statistic analysis and regression analysis. It can reflect the public investment status in the region by the analysis. The empirical results are as follows:

The overall status of the public goods investment in Sichuan province is as follows: (1) Population quantity has an important impact on public goods investment. Villages with more population quantity have higher level public goods investment, which reflects government's consideration of the demand for public goods in the investment process. (2) The educational status of the village director is another determinant of public goods investment. Because the coefficient of the years of the village director's education variable show a positive sign, if the years of the village director's education are longer, then the public capital investment becomes more. So, the effect in promoting public investment of village leader's educational level is significant. (3) The level of public goods investment is relatively much higher in mountainous areas where the slope is steeper. It largely demonstrates that government is inclined to invest much capital into poor mountainous areas with fragile natural conditions. Also, the investment status and strategy have positive significance in promoting rural development and are helpful to reduce overall regional development differences. (4) The irrelevant factors are the same for the total and government's public goods investment, including altitude, the relative height difference, per capita income, the number of village enterprise, per capita debt, and the proportion of self-employed industrial and commercial households.

In comparison, the number of village enterprises and the proportion of self-employed industrial and commercial households are all positively correlated in China (Zhang et al. 2005). These may demonstrate the phenomenon that the industrial and commercial activities are fewer in mountainous area of Sichuan province, and have no effect on public goods investment. The

economic development level is not significant in the regression model, the reason of which is not particularly clear and further analysis need to be made. Since the 1980s, especially when the new rural development strategy was implemented at the beginning of this century, the Chinese government has been increasing investment in rural communities, such as providing key public services (including public infrastructure and capital investment of public services in rural communities) to increase agricultural productivity, reduce regional disparities and achieve poverty reduction (Fan et al. 2002). The government has been also helping farmers shift from traditional agricultural production to agricultural product processing industry and services field with higher added value (Huang et al. 2003). Public investment in rural communities has kept a substantial and rapid increase in absolute terms.

Nevertheless, there are also some problems to pay much attention to. Public investment is needed to be coordinated and adjusted in order to gradually implement the regional co-ordination development. (1) Growing numbers of workers leaving their hometown to go out to work has greatly restricted and will continue to restrict public investment. Especially for Sichuan, a province with a lot of labor force output a large number of villagers leaving their hometown to work outside, to those the effectiveness of public services is relatively reduced, will not be so eager to pay attention to the village-level public goods investment. (2)Those villages with more per capita cultivated land have less public investment. This situation may be due to the phenomenon that China's fiscal and financial system usually tilt to industrial (Wong 1997), and it must be considered in the future of public investment decision for ensuring the country's grain supply. (3) In order to facilitate project implementation or better display the performance, government usually show solicitude for villages relatively closer to it, suggests the pitched allocation strategy to some extent. In previous studies, to increase the government's presence in the economy through the acquisition of many enterprises, as was the case during the 1970s (Aspe and Beristain 1984), leading to a skewed allocation of public funds in favor of the most developed states (Katz 1998; Rodr_1guez 1997).

In view of the current situation of Sichuan province, public goods investment should ideally be focused on increasing productivity and further concerned about the coordinated development of the region. On the one hand, it is necessary to search for the areas where social returns are the highest. On the other hand, it is critical to select different types of public investment in different areas with the greatest practical significance. Hansen (1965a, b) suggests that in order to eliminate regional imbalances, public investment allocation should be differentiated among areas. In congested regions (areas with a high concentration of population and economic activity), there should be investment in both categories in the first phase, then in economic capital in the second phase. For intermediate (areas with plentiful labor and raw materials) and lagging regions (areas of little interest to firms) there is a deficit of investment in both regions in the first phase, and in the second phase, economic capital should be allocated in intermediate regions and social capital in lagging regions. So, it is crucial that government should consider establishing institutions able to make sufficient planning, cost-benefit analysis, ongoing monitoring and evaluation. In a nutshell, to achieve balanced regional development, there are still a lot of efforts to be done in improving the level of public goods investment in rural communities, especially in backward rural communities of mountainous area of Sichuan in China.

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