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Specialized Villages in Inland China: Spatial and Developmental Issues

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Abstract: The development of specialized villages in China is an interesting trend. This paper studies specialized villages in China by using the rational small household theory, division of labor and specialization concepts, as well as the distance decay and neighborhood effect theories. We use the census data on specialized villages in Henan Province (the largest agricultural province in China) from 2010 as the basis for a case study, applying dummy variables representing sixteen types of specialized villages, and selecting environmental variables, such as land form, location, arable land area, and labor force characteristics. We find that significant factors related to specialization are location and production factors. Policy implications of this research are discussed.

Keywords: specialized villages; rural specialization; China

1. Introduction

Rapid economic growth in China has been accompanied by both significant structural changes and the division and redistribution of labor in the rural economy [1–3]. In the past 30 years, millions of rural workers have migrated to urban areas [4–7], and many of these migrant workers took jobs as unskilled laborers. Conversely, those still working in farming villages have become more specialized [8]. As many rural households in the same village specialized in the same economic activity to take advantage of economies of scale and locally preponderant production factors, a new geographic phenomenon has emerged in rural China and Asia [3,7]. According to Li et al. [9], a specialized village refers to a village in which most of the rural households are engaged in one single production and/or service-related activity, or several production activities and/or services that are closely related to each other in a production chain. Examples of a village dedicated to a single productive activity include those specializing in tea cultivation, rearing swine, or even certain types of manufacturing, such as ceramic arts. There are even Chinese villages that specialize in environmentally damaging activities, such as extracting metals from electronic components. Of course, not everyone in a village will be involved in a single activity or production chain, but if it is the dominant activity in a village then that village can be considered to be specialized in that activity. In general, as a city grows larger, it becomes less likely to remain specialized in a single activity. Suburban areas are not likely to be highly specialized,

and very small hamlets may lack both human and other resources to sustain specialized production, meaning that rural villages are the most likely to exhibit specialization. The economic output of such activities comprise the main portion of the village's total economic output.

In recent years, specialized villages have played an increasingly significant role in the development of rural China. By the end of 2010, the number of specialized villages in China reached 51,486 according to the national census, which is nearly 10% of the total of all Chinese villages. The average rural per capita net income of these specialized villages was 15.56% above the national average. The rural per capita income of the peasants engaged in the specialized industries was 25.82% higher than the national average [10]. Hence, on average, residents of specialized villages are wealthier than other Chinese, particularly rural ones. Recently, in order to stimulate rural development, both the central and local governments of China are providing assistance funds for the development and support of specialized villages. Comparatively, specialized villages are not commonly seen in most western developed countries, while such a practice has been found on a relatively small scale in Japan, South Korea, and Taiwan [11–13]. There are vestiges of historical (even feudal era) specialization in some parts of Europe. Examples include both villages that specialized in the production of fine wine or brandy associated with a chateau or estate in France or Spain, and rural cooperatives that produced a particular cheese in Italy or Switzerland. The European Union has programs to support specialization in food and wine production, in particular guarding regional appellations such as "*Parma ham*" or *Cognac*. In addition to regions being associated with specialized foods some smaller European villages have developed fame in certain foods such as Norcia in the Umbria region of Italy which is famed for smoked meats. However, China has singled out systematic development of specialized villages as one of its goals for rural economic sustainability [3].

Although a rich body of international literature has examined the factors affecting agricultural specialization, only a few articles focus on specialized villages, let alone the spatial and quantitative analysis of them. This may be partly due to lack of empirical data gathering practices in western countries. Many prior studies on "flexible specialization" and "industrial districts" have pointed out the role of household economies in generating local development, but they have mostly focused on industrial and manufactural systems [14,15]. According to some researchers, agricultural specialization is primarily affected by transportation costs [16–18], market transaction costs [19], material and technical resources [20], price risk and market scope [21], and national agricultural policy [22]. Others suggest that rural households with an entrepreneurial spirit are playing a leading role in fostering formation of specialized villages, especially in rural regions dominated by a small-scale "peasant" economy [23]. The new commercial activities created by pioneering households may spread to other residents by way of both demonstration effects and social networks. The same type of innovative households may lead to different types of specialized villages in different environments, based on differences in resource endowment, geographical location, economic foundation, and indigenous traditions and conventions [24]. Rural development in western developed countries is dominated by large farms [25], while the development of China's rural areas is mainly based on household farming fostered with Government assistance under the "contract responsibility system", which gives studies on specialized villages' special significance in China.

The goal of this paper is to discover whether or not the geographical environment and developmental conditions affect villages' specialization rates, based on data from Henan Province, the largest agricultural province in China (Figure 1) [26]. To achieve this result, we divided the analysis into three steps. First, we built a theoretical framework related to the formation of specialized villages. Second, we provided a description of the specialized villages that existed in Henan province in 2010. Finally, we examined whether or not the geographical environment and developmental conditions affect specialization rates in rural villages. The specialized villages in this paper are limited to ones dominated by agricultural production and/or agricultural processing industries, which is the most common type of specialized rural village in China.

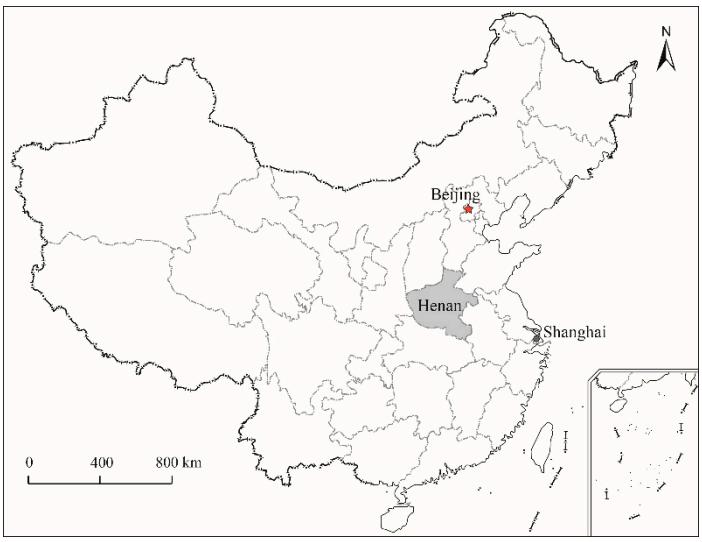

Figure 1. Location of Henan Province in China.

2. Theoretical Framework

There are several theories that we take into consideration in our analysis of agricultural workers' household behavior. Some researchers believe that agricultural households are just like enterprises in a market-oriented economy [27]. This "Schultz-Popkin small-scale rational proposition" suggests that small farmers are more inclined to act like investors, whether in the domain of economic activities or in political and social life [28]. In contrast, other scholars put forward the concept of "moral small farmers", suggesting that small farmers tend to apply a "security first" principle—that is, they would rather choose to avoid economic risks than seek to maximize profits [29]. This behavior can be interpreted as "survival rationality", while the entrepreneurial behavior can be seen as "economic rationality". Other commentators refuse to classify rural households as enterprises at all, instead viewing communalism as the driving principle behind behavior. However, altruistic behavior is mainly observed within a rural household, or between near neighbors in a hamlet. However, based on a village's economic interactions with outside entities, rural village economic behavior it can perhaps be best understood as that akin to a firm [30].

Since the household contract responsibility system was established in China's rural areas in the 1980s, Chinese farmers have been acting more closely in line with the principles of economic rationality. Thus, due to this reform, Chinese farmers' economic behaviors have been experiencing a shift from survival rationality to economic rationality [31]. This finding is consistent with Schultz's studies [24] on rural societies in India and Guatemala. That is, even in traditional agricultural communities, there is comparatively little inefficiency in the allocation of production factors.

The desire to maximize profits would tend to generate specialization under the conditions of free competition. As producers, small farmers will use production factors—such as land, labor force, and capital—to maximize profits. As the production factors are allocated according to the principle of marginal utility, small farmers will tend to undertake and develop economic activities with the highest marginal productivity [32]. Economic growth and capital accumulation will facilitate the specialization of production and division of labor in rural villages [33]. This will drive capital flows to the production areas of greater efficiency and realize economies of scale inherent in a particular endeavor, thus resulting in faster economic growth. Under certain social production conditions, even if external factors, such as technology and institutional systems, remain unchanged, the level of labor subdivision and specialization will rise gradually, thus driving economic growth [34].

When specialized rural households are clustered in a comparatively small area (like a village), a specialized village will emerge; and if those households scatter across a larger area, it will become a specialized region. According to Hagerstrand [35] and Murdoch [36], if some small farmers in a

village have successfully specialized, the neighboring households within the village are likely to be influenced by these early adopters of specialization. This pattern of diffusion of specialization is likely to show distance decay and neighborhood effects. Distance decay is regarded as Tobler's First Law of Geography, where "everything is related to everything else, but near things are more related than distant things" [37,38]. The neighborhood effect suggests an inverse relationship between the distance and formation of a relationship [39], where spatial correlation gradually becomes weaker with increasing distance [40]. Close neighbors tend to develop similar behavioral modes after constant and frequent interactions. The benefits of proximity can be translated into a force for spatial clustering, in relation to individual farmers or larger firms engaged in interactive learning and emulation [41]. Under the condition of traditional Chinese culture, strong kinship networks and neighborhood relationships in rural regions promote the spread of new economic activities in a village once one member of an extended family successfully adopts a new agricultural specialty [42,43].

In summary, under the assumption that small farmers are economically rational private firms, theories of specialization and neighborhood effects can be complementarily integrated into a theoretical framework that explains the mechanisms for the formation of specialized villages (Figure 2). As long as small farmers make decisions according to "economic rationality", they will certainly make choices utilizing the various unique environmental and resource conditions available to them and will allocate productive factors to maximize profits. Economic growth and capital accumulation will facilitate the specialization of production and division of labor [33]. The context of small farmers' rationality can foster the adoption and diffusion of innovative ideas generated by "pioneering" households, those with the most entrepreneurial bent [43]. The notion of "division of labor and specialization" means that the driving force for specialization is the efficient use of available resources. The theory of the "distance decay and neighborhood effect" accounts for why specialization is spatially concentrated at a close range—because the variation in environments and resource endowments may lead to differences in marginal productivity among villages. Thus capital and other production factors will specialize in those sectors with the greatest profits, thus resulting in economies of scale. The character of specialized villages are related to resource and environmental conditions in the villages. Geographical location related factors that result in efficient resource utilization will provide opportunities for obtaining new production factors, especially in less-developed rural regions [44]. In addition, traditional Chinese culture and convention are also important considerations related to adoption of a specialized agricultural village economy [24]. Thus, an area that has produced tea for centuries is likely to remain specialized in tea culture, while an area specializing in silk production is likely to remain specialized in silk production.

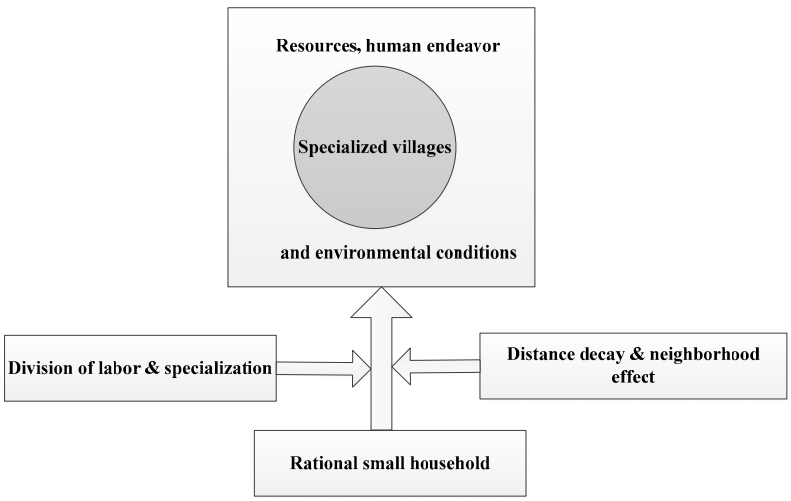

Figure 2. Theories related to the formation of specialized villages.

3. Specialized Villages and Their Environment

This section has been divided into subsections, with descriptions of the experimental results and interpretations of observed phenomena. There is also a discussion of conclusions which were drawn.

3.1. Economic Structure and Environment of Villages

Based on the assumption of rural households acting like firms in a competitive market, we can use a typical household model when analyzing economic activities of households in a village [45]. Chinese rural households became the main production and consumption units after the household contract responsibility system was introduced in 1980. In a village that consists of these households, production and consumption is maximized under constraints imposed by geographical factors, markets, and resource endowments.

The utility function of this representative village is $U(X^D, Z)$, which reveals the fact that the utility level fluctuates with the consumption of both village-produced goods X^D and non-village-produced goods Z(X^D and Z are vectors). The budget constraint of the village is $p'X^D + qZ = M$, in which p' represents the price vector of village-produced goods, q represents the price vector of non-village-produced goods, and M is the village's income from things such as the sale of village-produced goods, salaries from work in distant places earned by migrants and sent back to the village, and land rentals. In the equation $M = p'X^S + wL_w + rA_r$, p' is the price vector of village-produced goods; X^s is the production vector; w represents salaries; L_w is the labor force; r is land rental per unit of area; and A is the area of land that is rented.

If production volume i is determined by labor input L_i, land input A_i, and topography (terrain) T, then the production function is: $X_i{}^S = F_i(L_i, A_i, T)$. Terrain is an important variable in China since much land is too mountainous or arid to be highly productive. Restrained by limited resource endowments, the total production resources applied in every industry should be equivalent to a fixed resource endowment. Therefore, the constraint conditions of the resources in a village are given by $\sum_{i=1}^{I} L_i + L_w = L$ and $\sum_{i=1}^{I} A_i + A_r = A$, in which the total labor input of all industries is equal to the sum of labor supply, and the total land input of all industries is equal to the sum of land input and supply.

Let the net price of village-produced goods in a situation where a village budget imposes a constraint be set equal to the market price of the goods minus the production transaction costs per unit, $p'(p_i\prime = p_i - c_i)$. Because more trading capacity leads to lower production transaction costs per unit and longer haul distances lead to higher transaction costs, trading capacity and haul distance are decisive factors in determining the production transaction costs per unit of output. Thus, the function of production transaction costs per unit is defined as $c_i = G_i\left(\left|X_i{}^S - X_i{}^D\right|, D_i\right)$, with $\partial G_i\left(\left|X_i{}^S - X_i{}^D\right|, D_i\right) / \partial\left|X_i{}^S - X_i{}^D\right| < 0$, $\partial G_i\left(\left|X_i{}^S - X_i{}^D\right|, D_i\right) / \partial D_i > 0$, in which D_i is transportation distance, and $X_i{}^S - X_i{}^D$ is the net supply of good i that always imposes a transaction cost, no matter what i is. Consequentially, it is shown that transaction cost is a function of: $\left|X_i{}^S - X_i{}^D\right|$, which is the absolute value of net supply.

As an ideal rational consumer, the inhabitants in a representative village aim at maximizing the utility level of all village residents. This is known as maximizing the representative utility function. Based on the above constraint situation, a village will optimize its economic behavior as follows:

$$\max U(X^D, Z) \tag{1}$$

$$s.t. p'X^D + qZ = M \tag{2}$$

$$M = p'X^S + wL_w + rA_r \tag{3}$$

$$X_i^S = F_i(L_i, A_i, T) \tag{4}$$

$$\sum_{i=1}^{I} L_i + L_w = L \tag{5}$$

$$\sum_{i=1}^{I} A_i + A_r = A \tag{6}$$

$$p_i\prime = p_i - c_i \tag{7}$$

$$c_i = G_i\left(\left|X_i{}^S - X_i{}^D\right|, D_i\right) \tag{8}$$

What can be generated by using a Lagrangian resolution from the above equations is a first-order condition: $p_i \partial F_i(a_i, L_i, M_i)/\partial L_i = w$, where the equal marginal value of each village industry is the same as the marginal value of the work (salaries) in the village. This allocation of labor resources is supported by Gossen's Second "Law", known as the equi-marginal principle. This principle of the allocation of labor resources determines the industrial structure of a village (Figure 3).

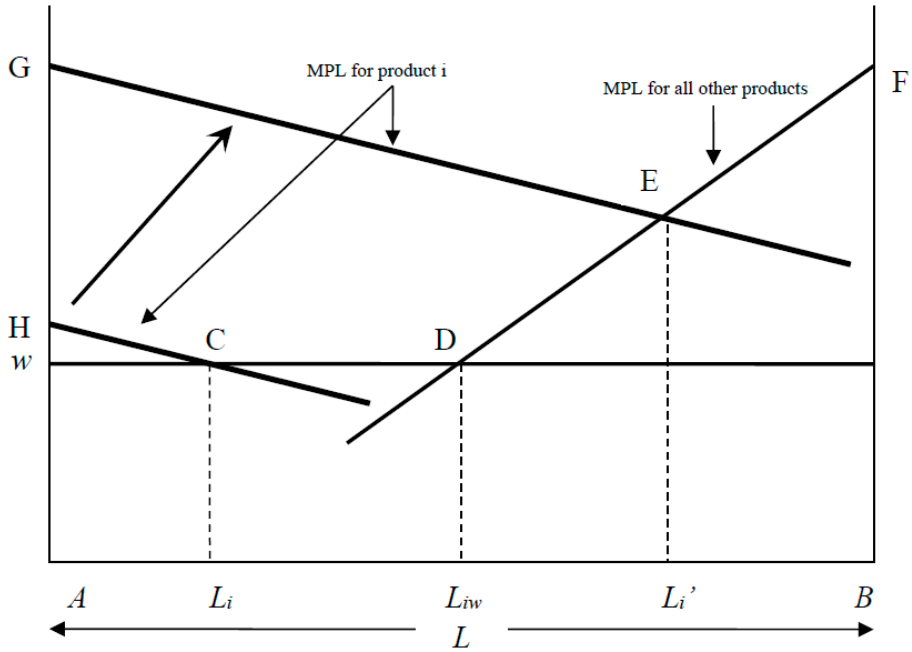

Figure 3. Production function leading to the formation of a specialized village.

Differences in environmental conditions and village resources may lead to different marginal productivity among villages. In addition, villages with different environments and different historical traditions may adopt different types of industries. There are three types of environmental factors presented in this paper—the first one is terrain and location factors, such as the terrain of land (flat, hilly, and mountainous regions) and the distance from a village to its county central town (seat), or nearby city. Here, we determine proximity of a village to a county seat by using a buffer zone generation function with a radius is 1 kilometer. The second type of factors that determine specialization are market factors, such as product prices and input factor prices, and the third type of factors are resource endowments, such as the area of arable land and the availability of the labor force.

3.2. Formation of Specialized Villages and the Environment

The segment $\overline{AB}$ in Figure 3 represents L, the labor resource of a village. The vertical axis is the marginal product of labor. The two lines from the upper left corner towards the lower right represent the marginal products of labor for good i under two different environmental conditions. The line from the upper right towards the lower left is the line for the marginal production of labor for other

goods, which is the horizontal summation of all marginal production of labor (MPL) for other goods. The horizontal line with height w represents the marginal production of labor for the outside society (other than home village work).

According to the principle of equi-marginal utility, the marginal product of labor in each industry should be the same as the wage w. If the production of product i is inefficient, then the two points C and D indicate that the labor input of product i is $\overline{AL_i}$, the labor input other than home village work is $\overline{L_iL_{iw}}$, and the labor input of other products is $\overline{L_{iw}B}$. If the environment is suitable for the production of good i, line H, representing the marginal product of labor for product i, will shift to line G, therefore making a new point E, which represents a new, more optimal allocation of the labor force. The labor input of product i will be $\overline{AL_i\prime}$ and the labor input of other products will be $\overline{L_i\prime B}$. However, the home village's production will be the only labor input in this case. When the labor input of product i is utilizing the largest portion of local labor resources, a village will be considered to have specialized in product i.

4. Data Analysis

Villages in China generally exist administratively and are naturally slightly separated from other villages within a given rural area, Administratively villages are divisions under a township. This study focuses on such administratively recognized villages. Data on hamlets is not available from the Chinese census. In this paper we used census data for specialized villages in Henan Province in 2010. This data came from the Department of Agriculture of Henan Province, which provides an important source for specialized village studies. There are 39 socio-economic indexes which are collected by the census. These indexes can be divided into the following five classes: industry categories, outstanding enterprises, leading products, economic income, and agricultural production "parks". From the data, it was found that there were 2276 specialized villages in Henan Province. After field investigations and telephone follow-ups, 51 specialized villages were identified to have been inappropriately classified as such and eventually 2225 specialized villages were retained in the dataset and used for analysis.

This paper also analyzes the location of these 2225 specialized villages. There are several inputs used to perform geographic spatial analysis. One factor is the topography of the specialized villages, and data on this was obtained from the Henan Survey Team of the National Bureau of Statistics of China. Another is the distance from the specialized village to the township seat, county seat, or municipal city it administratively belongs to. The distance data was obtained based on Euclidean distances between points representing these locations measured using the ArcGIS geographic information system software.

Due to missing information, inconsistency, or obvious errors, in this paper we further selected 2007 of the 2225 specialized villages identified in Henan province. After scrutinizing the data, we ultimately excluded the other specialized villages due to factors such as the villages not being agricultural. Thus, we have a total of 2007 specialized agricultural villages in the analysis, which is about 90% of the original number of specialized villages.

Figure 4 shows the distribution and characteristics of the seven most typical types of specialized villages in Henan in 2010. Our data shows that most of the specialized villages are located in the plain and mountainous regions. According to Figure 4, about 87.19% of specialized villages are distributed in the eastern plain regions (1470 specialized villages) and the south-western mountain region (280 specialized villages).

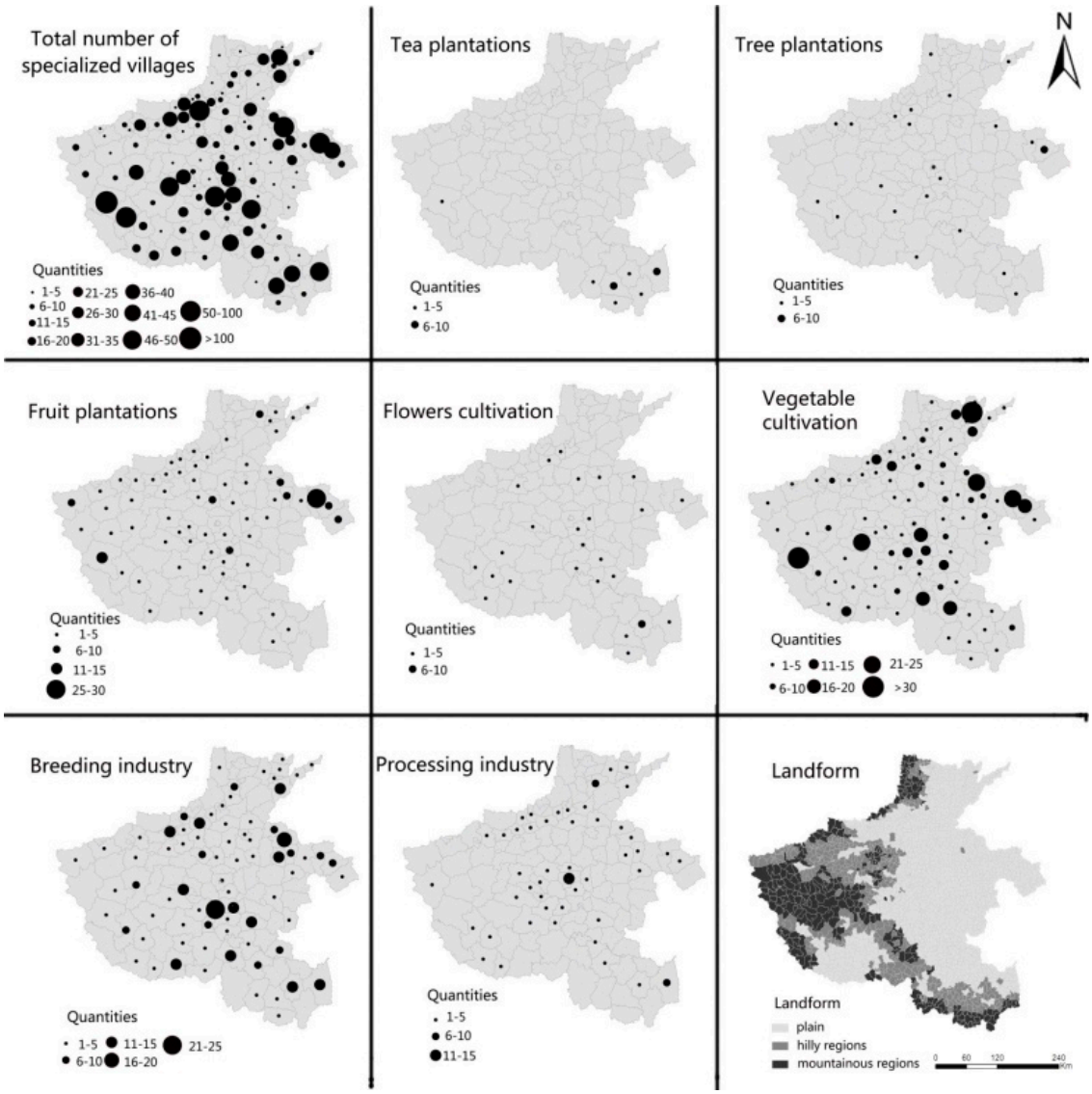

Figure 4. Distribution of specialized villages in Henan Province, China.

Geographical factors are important determinants in the development of specialized villages that are engaged in different productive activities. In general, villages in the vegetable-growing and animal husbandry industries are widely distributed across various regions, while those of the tea plantation, flower growing, and forestry industries are clustered in several counties because of their heavy reliance on factors in the natural environment such as hill slopes or protected valleys. In the tea plantation and processing industry, there were 9 villages specializing in tea planting in the southern subtropical area, and 8 of them were located in the Xinyang city administrative area. The processing industry is scattered among the developed cities in the northern or central areas of Henan. Of all the 51 villages specializing in tea processing, 26 (about 51%) were located within a radius of 100 km of Zhengzhou City. Zhengzhou City is the provincial capital of Henan and located in the north central part of the province, it has a 2010 population of over 9.3 million residents placing it in the second tier of Chinese cities in importance. In order to examine whether environmental factors had significant effects on the location and characteristics of a given specialized village in Henan province, we conducted multivariate analysis. The dependent variable in the analysis is the ratio of labor input in the leading industry in a village to its total labor force resources. The independent variables in the empirical model are environmental factors of the resource endowment (the size of the labor force resource), the relative intensity of land

use (the ratio of the leading industry's land input to labor), transportation conditions (the measured distance of a village to its county seat, township seat, or nearest administrative city), the market condition (whether there is a wholesale market in neighboring villages and towns), and 16 dummy variables representing the specialization characteristics of specialized villages. A detailed breakdown of the variable definitions is provided in Table 1. Regression results indicate that the environment of a village has a significant effect on its specialization ratio. Moreover, different specialized villages require specific environmental conditions.

Table 1. Variables used in the analysis and their definitions.

Variable	Definition
L_i	Labor input in leading industry
L	Labor force resource
K	Ratio of land to labor input of leading industry
D_1	The distance from the village to its nearest prefectural city
D_2	The distance from the village to its county central town or county-level city
D_3	The distance from the village to its nearest town in the countryside (other than the county central town)
W	Wholesale market variable, 1 for wholesale market, 0 otherwise
T_1	Plain region variable, 1 for presence in plain region, 0 otherwise
T_2	Hilly region variable, 1 for prescence in hilly region, 0 otherwise
T_3	Mountain region variable, 1 for prescence in mountain region, 0 otherwise
I_1	Tea plantation variable, 1 for tea plantation, 0 otherwise
I_2	Dry fruit variable, 1 for dry fruit, 0 otherwise
I_3	Medicinal plantation, 1 for medicinal plantation, 0 otherwise
I_4	Forestry variable, 1 for forestry, 0 otherwise
I_5	Oil seed plantation variable, 1 for oil seed plantation, 0 otherwise
I_6	Grain farm variable, 1 for grain farm, 0 otherwise
I_7	Fruit orchard variable, 1 for fruit orchard, 0 otherwise
I_8	Cotton and linen plantation variable, 1 for cotton and linen plantation, 0 otherwise
I_9	Flower production variable, 1 for flower production, 0 otherwise
I_{10}	Tobacco plantation variable, 1 for tobacco plantation, 0 otherwise
I_{11}	Vegetable farm variable, 1 for vegetable farm, 0 otherwise
I_{12}	Aquaculture and poultry raising variable, 1 for aquaculture and poultry raising, 0 otherwise
I_{13}	Processing industry variable, 1 for processing industry, 0 otherwise
I_{14}	Building material industry variable, 1 for building material industry, 0 otherwise
I_{15}	Service industry variable, 1 for service industry, 0 otherwise
I_{16}	Other non-agricultural industries variable, 1 for other non-agricultural industries, 0 otherwise

The three topographic dummy variables T1, T2, and T3 are interlinked in the model. For example, when a village is mainly plain, T1 is assigned "1", whereas T2 and T3 are "0", respectively.

A bivariate Pearson correlation test was performed using the SPSS Statistics 21.0 software package to examine the relationship between the dependent variable and independent variables. We found that there were 12 variables (including the interacting variables) which correlated significantly with the dependent variables (p-value < 0.05). These variables were K, D3*I10, I13*D2, W, I5*W, I12*W, I13*W, T2, T3, I11, I12, and I13. Then, we ran the Ordinary Least Squares regression (OLS) using these 12 variables to diagnose the model. The VIF (multicollinearity issue) and Breusch-Pagan test (heteroscedasticity issue) were carefully examined. It turned out that nine variables were appropriate and reasonable for the model, since the VIF value (i.e., <4) was acceptable and the Breusch-Pagan value (15.7790, $p = 0.0716$) was insignificant. As a result, multi-collinearity and heteroscedasticity were not issues for the model. The nine variables were K, I13*D2, W, I12*W, I13*W, T2, I11, I12, and I13. Next, we tested the spatial dependence of the residuals using the global Moran's I index. The result showed that there was no significant spatial autocorrelation in the model (Moran' I = −0.0957, p-value = 0.0503). Therefore, the use of the OLS model with nine independent variables was appropriate in our study.

The result of the OLS model is shown in Table 2. Generally, the OLS has an acceptable model goodness of fit, because its adjusted R square value is moderate (0.360) and the F statistic is significant (10.10075, $p = 0.000$). It was found that the resource endowment and relative intensity of the land have a significant effect on the specialization ratio of these villages. A unit increase in the labor force will make the specialization ratio decrease by 0.000036 (Table 2), while an increase of the ratio

for land-labor input by one unit will decrease the specialization ratio by 0.01. The reason for this phenomenon is because for regions that have abundant labor forces, little arable land is available for new specialized commercial use, as the limited arable land available has already been allocated to the resident farmers for their own consumption. Thus, the availability of land stimulates specialized agricultural production.

Table 2. Specialization rate results by OLS method (Dependent variable: Specialization rate Li/L; number of observations: 2007).

Explanatory Variable	Coefficient	t-Statistics	*p*-Value
C	0.769230	38.98746	0.0000
L	−0.000036	−3.060082	0.0022
K	−0.010253	−4.594774	0.0000
I13*D2	−0.000010	−3.169145	0.0016
W	0.077522	3.399308	0.0007
I12*W	0.177702	2.699341	0.0070
I13*W	0.254196	2.983513	0.0029
T2	−0.058460	−2.518279	0.0119
I11	−0.045142	−2.442569	0.0147
I12	−0.116278	−5.094755	0.0000
I13	0.112042	1.900470	0.0575
Adjusted R Square	0.360		
f-statistics = 10.10075		*p*-value = 0.000000	

Only significant explanatory variables and interactions are listed.

Ease of transportation and advantageous market conditions can facilitate the formation of specialized villages. Interaction I13*D2 explains that relationships between the specialization rate of processing industries and the distance from a specialized village to its county central town are quite different from those of other industries. With each one-kilometer decrease from a village to its township or county seat or county-level city, the specialization ratio in an agricultural processing village will increase by 0.00001, since the town and city provides markets for villages. Interactions I12*W and I13*W show that having a wholesale industry nearby has a greater positive influence on specialization ratio in aquaculture and poultry-raising industries and processing industries than in other industries. If a village has a wholesale market nearby, the specialization ratio increases by 0.08. This effect is even larger for villages specializing in processing industries (0.33), and in aquaculture and poultry raising industries (0.25). Assuming other environmental elements are equal, the specialization ratio in hilly regions is lower than in other regions (0.05).

To further examine why different villages specialized in different categories of industries, the authors employed multivariate statistical analysis on different categories of specialized villages. We selected seven industry types (tea plantation, forestry, fruit orchard, flower growing, vegetable farm, aquaculture and poultry-raising industries, and agricultural production processing industries) out of the 16 industries in the prior analysis. Since the dependent variable was of a binary data type (1: has this industry; 0: has others), we employed the maximum likelihood multinomial logistic regression model to analyze how the environment of the villages influenced the adoption of different agricultural specializations by villages.

The results of the logistic regression model is presented in Table 3. The seven models all have a fair goodness of fit, since their likelihood ratio (LR) statistics are all significant. The Z-statistics and *p*-value presented in Table 3 indicate that specialized villages in all seven industries are heavily dependent on labor force resources, the relative abundance of land, the distance to their county central towns, the availability of a wholesale market, and its terrain. The positive sign of the coefficient β reveals the increasing probability of a certain tendency of the specialized village, and its negative sign

represents a decreasing probability. Table 4 presents data for all variables in response to the seven types of specialized villages.

Table 3. Regression results for specialized villages in seven types of industries.

Industry	Explanatory Variable	Coefficient *B*	*Z*-Statistics	*p*-Value	*Probability (LR stat)*
Tea Plantation	C	−8.306503	−11.29755	0.0000	0.000000
	K	0.055699	2.445053	0.0145	
	D1	0.000027	5.079006	0.0000	
	D2	0.000055	2.817967	0.0048	
	T2	2.026622	4.469687	0.0000	
Forestry	C	−5.698801	−9.062818	0.0000	0.000000
	K	0.053013	2.609554	0.0091	
	D1	0.000011	2.313369	0.0207	
	T1	1.295145	2.496868	0.0125	
Fruit Orchard	C	−1.839102	−12.26013	0.0000	0.000072
	K	0.050143	2.810887	0.0049	
	D1	−0.000010	−3.516604	0.0004	
	W	0.295596	1.655381	0.0978	
	T3	0.419428	1.686963	0.0916	
Flower Growing	C	−3.797910	−10.00634	0.0000	0.001232
	L	0.000507	2.964706	0.0030	
	D2	−0.000037	−2.158742	0.0309	
Vegetable Farms	C	−0.664145	−6.689597	0.0000	0.000000
	D2	−0.000013	−2.666373	0.0077	
	W	1.035929	8.546508	0.0000	
	T2	−0.949708	−5.230769	0.0000	
Aquaculture and Poultry Industry	C	−2.542629	−10.67397	0.0000	0.000000
	W	−0.935605	−4.880739	0.0000	
	T1	1.307841	5.291630	0.0000	
	T2	1.360484	4.828995	0.0000	
Processing Industry	C	−3.201584	−14.38177	0.0000	0.011941
	T1	0.584188	2.379257	0.0173	

Table 4. Direction of environmental impacts on specialized villages.

Industry	*L*	*K*	*D1*	*D2*	*D3*	*W*	*T1*	*T2*	*T3*
Tea Plantation		+	+	+				+	
Forestry		+	+				+		
Fruit Orchard		+	−			+			+
Flower Growing	+			−					
Vegetable Farms				−		+		−	
Aquaculture and Poultry						−	+	+	
Processing Industry							+		

"+" stands for the increasing probability for a specialized village to appear; "−" stands for the declining probability for a specialized village to appear.

In terms of the different industries, the results from the qualitative model (Table 4) indicate that: (1) Tea plantations require specific specialized environments. Most villages with tea plantations in Henan are clustered in remote, subtropical, hilly, and low mountainous regions in the Xinyang prefecture. This shows the importance of the abundance of land and hilly terrains for these plantations and the climate with cold weather being an issue for tea cultivation. It also shows that being far away from its prefectural city, county central town, or county-level city is not a real disadvantage, as tea is a high value/low weight product. (2) In the formation of forestry-oriented villages, more abundant lands are important as forestry is an extensive rather than an intensive activity and distances further away from the prefectural city make it likely for more land to be available, so this is not a significant disadvantage. There are more villages specializing in forestry in flat regions than in hilly and mountainous regions. (3) In the formation of fruit orchard-specialized villages, abundance of land and close proximity to a prefecture city play an important role. Fresh fruit may be more difficult to

transport across long distances without damage and high costs. Mountainous land and the existence of a nearby wholesale market may also encourage fruit-orchard specialized villages. (4) Villages specializing in flower growing (*floriculture*) will tend to be formed where there is an abundance of labor and where village locations are closer to a county central town or county-level city. (5) Villages where vegetables are farmed tend to develop in places closer to a county central town or county-level city, and closer to a wholesale market. As with fresh fruit, long-distance transportation of fresh vegetables to markets may be problematic. Specialized villages of this kind are formed more easily in the plains and mountainous regions than in hilly regions. (6) Because of transportation accessibility, villages specializing in aquaculture and poultry tend to be formed in the plains and the hilly regions instead of mountainous regions. Also, fish ponds are certainly easier to construct in river flood plains than elsewhere particularly in mountains. Close proximity to wholesale markets tend to preclude the formation of this kind of specialized village since the rental cost (price) of land close to wholesale markets is too high for villages in this industry to be formed. (7) Convenient transportation in the plains make specialized villages in the processing industry more likely to be formed in flat regions, rather than in hilly and mountainous regions.

In summary, the environment influences specialized villages in the following ways: (1) *Labor force resources*. An abundant labor force benefits villages specializing in floriculture, since much manual work is needed in floristry. (2) *Land resources*. An abundance of land resources benefits villages specializing in tea, forestry, and fruit orchards, since these industries are land extensive. (3) *Location and transportation*. Being located far away from a city benefits villages specialized in tea and forestry, since the environment is more suited to the production of tea and forestry goods and tea is a high value low weight product. Villages specializing in fruits, vegetables, and floriculture tend to exist in regions near cities, due to both transportation costs and concerns over the freshness of the products. (4) *Wholesale markets*. The location of a village near a wholesale market benefits villages specializing in fruits and vegetables, as these are products that need to be fresh. In contrast, close proximity to wholesale markets negatively influences the aquaculture and poultry industries, because price (rental costs) for land near wholesale markets may be more expensive. (5) *Terrain*. A village in a flat region is more suited to the forestry and aquaculture industries. Hilly regions provide good opportunities for tea plantations. The tea plant can neither grow in poorly-drained soil nor in high mountains, due to its intolerance to cold. Villages specializing in fruit orchards are located in mountainous regions, partly because some fruit crops, such as apples, need colder weather at certain times of the year and these weather conditions are not found in the flat or hilly parts of Henan.

5. Conclusions and Discussion

This paper affirms that concepts of "rational small farmers", "division of labor and specialization", and "distance decay and the neighborhood effect" are the main economic and geographical theories pertaining to the establishment of specialized villages in China. As long as small farmers make decisions based on "economic rationality", they will take into consideration the diversity and features of the environment and resource availability. They would then seek to maximize profit by optimally allocating the productive factors available to them. It is the large variation in environments and resources in a province like Henan in China that brings about the differences in marginal productivity among villages, which in turn engenders various specialized types. Under such circumstances, the realization of "division of labor and specialization" may boost economies of scale by distributing capital to sectors generating the greatest profit. The theories of distance decay and neighborhood effects shed light on why specializations are clustered spatially. This is the scale at which the factors function, shaping and reshaping the village specialization. An important fact is that specialized villages in Henan are still in the process of development. Thus, systems needed to transport fresh fruit and vegetables and flowers to distant markets do not yet exist. During this period of transition, individual farmers may not always act with economic rationality, yet over the long term they are generally likely to make more rational choices.

Therefore, based on the three aforementioned theories, this paper offers insights on the correlation between the industrial structure of a village and its environment through the use of spatial analysis and statistical methods. Our conclusion is that diverse environments may result in different marginal productivities in villages, which will ultimately shape various industrial structures. If the environment provides better opportunities for a certain industry, then its marginal income derived from investments in labor and capital will be far more profitable than that of other sectors, which will, in turn, stimulate the formation of specialized villages.

Although there are multiple environmental variables, this paper focuses on several of particular relevance to agricultural economics. These are terrain, geographical location, availability of arable land, and labor force availability. The study obtained data from a final subset of 2007 specialized villages in Henan. Using this data, we further scrutinized the influence of the labor force, land resources, accessibility, land forms, and market conditions. These environmental elements not only influenced the specialization ratio of the villages, but also determined their establishment in the first place. Regression analysis suggests that: (1) greater availability in the labor force leads to a lower specialization ratio; (2) abundant land fosters better production; (3) closer proximity of a village to the city-level county seat will benefit specialized villages; (4) having a wholesale market nearby will improve the specialization ratio for all villages, especially for those specializing in aquaculture, poultry, and processing industries; and (5) even if situated in the same environment, the specialization ratio of hilly regions is 0.05 lower than in other regions, due to its inconvenient transportation accessibility and its minimal arable land availability per capita. One should note that in Henan the mountainous regions have other properties that render them attractive for specialized farming even though they have even worse transportation characteristics than hilly regions.

This paper also points out that the multiple effects which environmental factors have on various specialized villages follow this typical pattern: Firstly, land fertility has a positive influence on villages specializing in tea plantations, fruit orchards, and forestry; secondly, abundant labor forces support the establishment of labor-intensive industries, such as floriculture; thirdly, transportation accessibility provides positive effects for villages specializing in fruit and vegetables and floriculture, but has indirect negative effects on tea plantations and forestry; and fourthly, having a wholesale market nearby helps villages specializing in fruit and vegetable farming. These empirical findings can be linked back to the theoretical discussions mentioned at the beginning of the paper on the relationship between village environment and its specialization. Furthermore, they have various policy implications, including that villages with particular environment advantages should explore development potentials of related specialized industries.

The findings of this paper have to be evaluated within the context of its limitations. First, in terms of categories and development, specialized villages in Henan may differ from those in other regions and countries, especially those in coastal areas. Additionally, this paper calls attention to the lack of available statistical data on other relevant factors that are important to specialized villages, such as cultural norms, the strength of local institutions and available capital. This analysis has relied on Euclidean distances measured from villages to towns, both treated as points. In fact, a travel (wheel) distance from the centroid of each place represented as a polygon would be superior, as would an analysis of the travel time. This would require additional geospatial data and a detailed understanding of the modes of transport used in Henan. The application of spatial regression could also improve the research findings.

The original function of rural settlements in China was to provide shelter and subsistence to its residents, rather than optimal production in a global economy. However, the function of the often-thriving specialized villages in Henan today are focused on providing production and services at maximum profit. As social and economic development in China continues apace, numerous villages in the twenty first century have shifted themselves from the goal of subsistence to specialized villages. This is a model that can offer an alternative to the abandonment of rural areas and the flight to overcrowded cities in many other developing countries. It may even go as far as promoting a return of the diaspora to rural areas in some developed nations. In any case, it is an important model to study

and can be better understood by using spatial models and analysis. Given the assumption that small farmers are economically rational private firms, then theories of specialization and neighborhood effects can help largely explain how a village will become specialized. This does not necessarily mean that a village will automatically become a specialized village. There are also other important facts which might affect the formation of specialized villages in China, such as local government policy, traditions, the availability of capital and individual entrepreneurship.

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