Rural income diversification patterns and their determinants in China

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Abstract: The article investigates the major rural income diversification patterns and their determinants in the context of China. Based on the data from a rural household survey, we first categorize the rural income diversification patterns according to the industry and the location in which the income is generated. Then we apply a Bayesian multinomial probit model to examine the determinants of various types of the rural income diversification. The major results demonstrate that a larger family size stimulates households to undertake various income diversification patterns, but its effects are discounted by an unproductive population structure within the household. Another interesting discovery is that a rural household chooses its income diversification pattern by referring to the surrounding neighbourhood; when most farm families depend on off-farm activities to boost their income, the individual household is more likely to follow the surrounding households by participating in the off-farm or mixed income activities or to migrate out to earn its income.

Key words: Bayesian multinomial probit, income generation, rural households

In developing countries, the rural households' participation in the off-farm income sources is growing over time and the income source diversification has become a key livelihood for rural households. China is among the countries where the wage salary and the off-farm business income have constituted a large portion of the rural household income (Luo and Zhu 2006), and the current rural income structure results from the economic and political reforms inthe recent years.

Beginning in the late 1970s, the economic reforms in China brought huge incentives and opportunities for rural households to diversify both within farm activities and through off-farm activities. The Household Responsibility System (HRS) – a rural reform measure popularized in the late 1970s – had two far-reaching effects on the rural income structure. First, the HRS increased the food supply dramatically, which led to the availability of food in the free market in cities and eventually led to the abandonment of food rationing. Second, the HRS allows rural labourers to freely allocate their time and to make private decisions regarding their economic activities (Zhao 1999). Since then, more and more rural labour has been released from grain production and channelled into other economic activities (De Brauw et al. 2002). The transfer of agricultural labour into the industrial sector is crucial to China's transformation into an industrial economy, and in turn, the expansion of urban industry helps to absorb the excessive numbers of rural labourers. Besides urban industry, rural industry offers an alternative for receiving agricultural labour from the areas without off-farm employment opportunities, and this feature results in China's rural-to-rural labour movements (Lohmar et al. 2001).

Later, in 2001, China joined the WTO, significantly accelerating the structural adjustments from the land-intensive grain production to more labour-intensive activities (Démurger et al. 2010). Due to the cheap labour costs, many export processing enterprises set up their factories in rural areas, and directly recruited local labourers, which brought numerous off-farm job opportunities to rural residents. Meanwhile, some provinces competed to attract foreign investment by offering many preferential conditions, and co-founded numerous labour-intensive industries to provide the off-farm employment for the local rural residents.

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With the rapid urbanization and greater liberation of labour and capital markets in China in the latest decade, massive migrations of rural labourers to urban areas have occurred in search of a more lucrative employment, often on behalf of the family members left behind. While mobilizing people and the flows of funds, these movements also produce overcrowding of cities and various types of governmental controls on migration. The local off-farm diversification has relieved some of the migration pressures, at least in the case of the suburbs of large cities or townships. Included among such activities are multiple forms of commerce, services, and manufacturing at the household level, in which rural identities are still preserved. The consequences of these emerging conditions provide a strong motivation for this study.

The purpose of this article is to investigate the current major rural income diversification patterns and to highlight their determinants in the context of China. We study the current major income diversification patterns and their determinants for at least two reasons. First, the rural income diversification reflects the farm households' optimal strategy to accustom themselves to the incomplete capital, insurance and land markets in China. Since the diverse income generation patterns are not equally profitable, understanding the incentive and constraints in households' decision regarding various income diversification patterns can offer important insights for the policy designed to boost the rural residents' income. Second, recognizing the major rural income diversification patterns could facilitate policy makers to formulate efficient paths for smoothly transforming the large agricultural population into urban residents in the rapid urbanization process in China.

This paper offers two important contributions with respect to the prior relevant studies. One is that our paper focuses on the analysis of various types of the rural income generation patterns rather than the indexed-based measures of the income diversification (e.g., the Berry index or the entropy measure of income diversification), as employed by most previous studies (McNamara and Weiss 2005; Mishra et al. 2010). Since the calculation of the diversification index is based on the number and shares of different income sources, the uniqueness of each income generating pattern could be obscured. For example, rural households with the same number of income sources and equally distributed income shares would be treated equally, based on the index measure of income diversification. Nonetheless, the income sources merely from the traditional farm work versus the non-farm work imply distinctive features of the rural income diversification patterns. Therefore, our study on the determinants of the categorized rural income generation patterns would provide a more comprehensive view for understanding the rural income generating activities.

Another contribution of this paper is that we apply a new Bayesian multinomial probit (MNP) model to study the determinants of the rural income diversification patterns. So far, all the relevant studies on the determinants of the rural income diversification exclusively employ the binary discrete choice models, restricting the comparisons to pairs of diverse income diversifications, or the multinomial logit model, imposing the independence of irrelevant alternatives (IIA) property on rural income patterns. The IIA assumption is very restrictive: it implies that the probability of a household's decision concerning one income pattern is independent of the other alternatives available and of the characteristics of the other alternatives. Imposing the IIA condition neglects the possibility that rural households that are dissatisfied with the on-farm income diversification, but are not willing to forego the farmland and to choose the off-farm diversification, might find that the mixed income diversification is a better income enhancement strategy.

RURAL INCOME GENERATION PATTERNS IN CHINA

As in other developing countries, most farm households in China derive their income from multiple sources. We analyse and summarize the major rural income generation patterns through our cross-sectional rural household survey spread over 12 provinces in China.

Rural household survey in China

Our cross-sectional survey was conducted on a door-to-door basis in the years 2007 and 2008 in China, obtaining 2894 valid observations. The survey includes 4 thematic complexes: (1) the demographic characteristics of rural households, including the age, gender, and formal education of the head of household, family size, and dependents within the household; (2) the farm production information, including resource endowments (farmland), the reported production assets, and the variable production costs; (3) the

Table 1. Variables definition

Variable code	Definition of variables
Demographic variables	
Age	Age of household head
Gender	Gender of household head
Education	Schooling years of household head
FamilySize	The number of family members
Dependent	Dependent ratio calculated by (Preschool children + students + household member over 65 years old)/total household members
Income and production variables	
PreIncome	Household income from the end of last year (¥10 000)
Farmland	Farmland in tillable acres (mu)
ProdAsset	Farm production assets (¥10 000)
Prodcosts	Variable production costs (¥10 000)
County, year and region variables	
County	County income feature measured by county average of non-farm income shares excluding each individual household
Year	Dummy variable represents the year 2008
Central	Dummy variable represents provinces located in Central area
Southern	Dummy variable represents provinces located in Southern area

detailed household income, including revenues from the agricultural plant industry with aggregation of farm grain and cash crops, aquaculture and animal husbandry; and the income generated from non-agricultural activities, which is categorized as earnings from the handicraft manufacture; construction and transportation industry; commerce (small businesses) and other services, such as machinery repair and rental services; the migration remittance from self-employed business or employment; subsidies or relief; and other monetary income.

The records of the rural household revenue were based on the verbal reports of the respondents[1]. This is the only choice in rural China, where all but the wealthiest residents neither keep records nor are required to report their income levels to external entities. Several factors contribute to the accuracy and consistency of the verbal reports. The culture and tradition among rural households are the willingness to inquire and to respond to inquiries about income levels. Falsifying such reports would lead to a diminished respect and other types of discipline by peers. Community leaders can also verify the general accuracy of the household responses. The presence of government officials in rural communities also enhances the veracity, and the farmers in the study were aware that the government supported the survey. In addition, the researchers had the resources to pay the respondents for their time and effort, and to give each a gift as a token of goodwill. Based on the geographical location, the provinces of Inner Mongolia, Liaoning, Jilin, and Heilongjiang are grouped into the Northern area; Shandong, Shanxi, Henan and Shaanxi constitute the Central area; and Anhui, Jiangxi, Hubei, and Hunan comprise the Southern area. The definitions of the household demographic variable and other related variables are illustrated in Table 1.

Recognition of rural income generation patterns in China

In China, rural households engage in multiple income generation activities based on their resource possession (such as land, labour and production assets) and the available job opportunities. Since the rural households arrange their investment, production and consumption based on the household

[1]Annual household income over 5 million Yuan are considered as outliers and are not considered in the analysis.

unit, our income generation pattern is measured at the household level. Among the surveyed households, about one-third of farm households focus on one single business to earn their income, either from the traditional agricultural industry or from the off-farm businesses. The remaining two-thirds obtain their income from at least two sources. To summarize the major household income generation patterns better, the specialized households with their revenue based on one single source are considered as the benchmark category, and the other available rural income diversification patterns are recognized according to the industry and location in which the household income is generated. As a result, all the households are included in both categories, with more detailed sub-groups within the respective industry and location categories.

Rural income diversification patterns categorized by industry

The types of the rural income generation patterns are first categorized by the on-farm, off-farm, or mixed income diversification based on the industry in which farm households are involved. If a household earns all its income from the traditional agricultural industry, such as crops, aquaculture or animal husbandry, and its number of income sources exceeds one, its income generation pattern is defined as the *on-farm income diversification*. Similarly, if the household earns its income exclusively from the off-farm business[2] with more than one source, its multiple income obtaining activities are defined as the *off-farm income diversification*. Otherwise, a household with both farm and off-farm income is considered to have the *mixed income diversification*.

The pattern of the on-farm income diversification is normally consist of complementary activities with a seasonal character. In this case, by engaging in several activities in different periods of the year, rural households can attain the full use of their productive resources and earn an additional income. For instance, farmers can rotate different crops according to the local agronomical conditions, in order to make a full use of their land resources. Moreover, their productive resources, especially labour, can be exploited in forestry or animal husbandry activities during the agricultural slack periods.

Off-farm income diversification houses a highly heterogeneous collection of trading, manufacturing, commercial and service activities. Even within the same province, strong differences emerge regionally as a result of the differing natural resource endowments, labour supply, location and infrastructural investments. These rural households are mainly concentrated in the suburbs of big cities or townships, and they continue to preserve their rural identity, but no longer engage in traditional agricultural operations. During the process of the city (or town) expansion, many households in this category have lost their farmland, becoming landless or near-landless.

Compared with the on-farm and off-farm income patterns, obtaining income from both farm and non-farm sectors is the most prevalent category. Rural households in this group are at a transitional stage between the on-farm and off-farm income patterns. Mixed income diversification can be motivated by multiple purposes, such as the income enhancement, the risk-reduction concern, credit constraints, the asset accumulation, etc. For instance, activity adjustments can result from a strong liquidity need due to the lack of credit markets in rural areas. By growing cash crops (Fafchamps 1992) or undertaking a non-agricultural activity (Barrett et al. 2001; Lanjouw et al. 2001), farmers obtain liquid income that they can either consume or invest in a productive activity. Rural households in this category maintain the traditional agricultural function, while trying to participate in other lucrative off-farm jobs to expand the household income.

The incidences of the above income generation patterns in our survey show that the farm households categorized as having the on-farm income diversification comprise about 2.52%; the off-farm income diversification accounts for 5.04%; the rural households identified as having the mixed income diversification dominate the sample data with 59.33%; and the specialized households account for 33.11%.

Rural income diversification patterns categorized by migration

Consistent with the economic development experience in other nations, China's modernization has triggered a massive transfer of rural labour to industry and services. Migration has been an important means for many of China's rural workers to find a more lucrative off-farm employment (Lohmar et al. 2001). Rural to urban migration and rural to rural migration have become essential for rural areas

[2]These generally involve construction work, retailing businesses, machinery repair, and food and transportation services etc.

Table 2. Descriptive statistics of different types of rural income generation patterns

Variables	Specialized operation		Categorized by industry diversification						Categorized by location diversification			
			on-farm		non-farm		mixed		migration		local	
	mean	std	mean	std	mean	std	mean	std	mean	Std	mean	Std
Age	47.578	11.847	46.301	11.290	48.301	12.283	47.629	10.509	47.886	9.859	47.345	11.523
Gender	0.081	0.274	0.055	0.229	0.103	0.305	0.066	0.248	0.076	0.265	0.060	0.237
Education	7.514	3.677	7.753	3.099	7.890	3.572	7.750	3.032	7.639	3.044	7.895	3.109
FamilySize	4.086	1.646	3.959	1.419	4.459	1.554	4.542	1.654	4.792	1.647	4.206	1.579
Dependent	0.336	0.431	0.300	0.281	0.387	0.327	0.284	0.225	0.260	0.225	0.329	0.249
PreIncome	4.418	15.302	3.832	7.510	3.479	4.319	3.319	8.879	3.099	3.685	3.630	11.820
Farmland	26.721	60.929	22.301	31.230	6.075	16.114	19.898	44.906	16.514	39.076	21.643	47.042
ProdAsset	9.354	48.214	3.461	8.502	2.072	6.738	3.376	13.612	2.401	11.291	4.256	14.718
Prodcosts	4.801	49.281	2.809	4.594	3.687	9.894	4.439	56.548	5.658	73.334	2.838	5.736
Obs.	958		73		146		1717		1018		918	

Source: the author's own calculation

with limited job opportunities and farm families with the surplus labour capacity. Concerning the importance of this off-farm income source, the rural income generation patterns are identified based on the geographic location where the household income is earned; therefore, the migration status of the family labourer is an important attribute.

It is common in developing countries for family members who have migrated to other locations or countries to send remittances of cash or other items to the relatives they left behind. If the household's income source contains migration remittances in addition to its multiple farm or non-farm revenues, the household is defined as having the *migration income diversification*. Accordingly, the households with income from more than one farm or off-farm source within the living region are defined as engaging in the *local income diversification*. Since there is no clear agreed-upon definition of a "migrant" regarding internal migration in China, in this study, a migrant is defined as any family labour who spends time during the year engaged in any economic activity outside the township, and has left his/her village of origin (the place of *Hukou*[3]) for at least one month.

With the rapid urbanization and liberation of labour and capital markets in China, massive amounts of rural labourers have migrated to urban areas to take more lucrative jobs, which has significantly contributed to the increased levels and stability of rural income. Migrant rural labourers are normally poverty-penetrated, more distant from markets or townships and have a larger family size with more labourers, but fewer production assets and less land. In China, migration is related positively to the household labour endowments, but negatively to others, such as the land and the closeness to markets (Du et al. 2005). Migration remittances need not only be invested in the rural households' consumption, including leisure, rather than contributing to productive investments (De Brauw and Rozelle 2008), but they also foster the household farm investments in the emigration regions (Rozelle et al. 1999).

Our survey reports that about one-third of rural households diversify and increase their household income from the migrated economic activities, and another one-third of rural families diversify their household income locally. The remaining one-third of households earns their income through a specialized operation. The summary statistics regarding household characteristics with various types of income generation patterns are presented in Table 2.

Based on the comparisons of mean values, specialized households exhibit the highest, yet most dispersed levels of income and production assets. Specialization, thus, reflects the combination of a higher efficiency, a greater profit margin, and a more risky operation

[3]*Hukou* refers to the household registration system in mainland China. The *Hukou* system normally divides family members into urban versus rural types. Only household members registered as rural *Hukou* are allocated farmland.

relative to the diversified rural households. In contrast, the migration diversification category has the lowest mean income as well as the largest family size, and the least dependent ratio. These contrasts suggest that some degree of migration is a necessity for the large farm families. As anticipated, the households in the non-farm diversification category have the lowest landholdings.

REVISITING THE DETERMINANTS OF RURAL INCOME DIVERSIFICATION PATTERNS WITH A BAYESIAN MNP MODEL

Much previous literature has investigated the determinants of the farm income diversification (Escobal 2001; Yunez-Naude and Taylor 2001). Rural household motives for carrying out diverse income activities, as well as the opportunities available to them, differ significantly across the settings, suggesting an important distinction between: the diversification undertaken for the accumulation of income and wealth, driven mainly by "pull factors", and the diversification undertaken to manage risk, to cope with economic shocks or to escape from agriculture in stagnation or in secular decline, hence driven by the "push factors". These terms of push and pull factors are found in many households and in the regional case studies that have examined the household income diversification in the developing world (Goodwin and Mishra 2004; Pieniadz et al. 2009, Mishra et al. 2010).

Due to the calculation complexity and the convergence difficulty of multiple choice models, the available literature exclusively applies the binary discrete choice model to examine the "pull" or "push" factors that result in the rural income diversification. Although the binary choice model is easy to implement, it only compares the diversified farm household with the specialized farm operation, ignoring the features from each specific income earning pattern. To model better the multiple choices of the rural income diversification faced by a farm household, we apply an unordered Bayesian MNP model to examine the determinants of the current major rural income diversification patterns. In addition, the MNP is used instead of the multinomial logit, because the MNP models are free of the independence of irrelevant alternatives (IIA) assumption.[4] We follow Munkin and Trivedi (2003) and use a Bayesian estimator to overcome the computational difficulty of contemporaneously dealing with the nonlinearity and the discreteness issues. Our model specification is grounded on the random utility maximization literature. We assume that the object of the rural household utility is composed of both the income improvement and the risk management simultaneously. The rural household may face multiple job opportunities with each having a different profit margin and risk level. If the household specializes on one type of the income generating activity[5] with the highest profit margin, it would be very risky to maintain its desirable income. Through the engagement of multiple income generating activities, the rural household may sacrifice its profit margin but gain the stability of its income. In this way, the rural household balances its income level and risk level implied in each income generation pattern, and it chooses the one that brings it the highest utility.

Household *i*'s utility for income generation pattern *j*, denoted as $U_{i,j}$, is given by:

$$U_{i,j} = Z_i'\alpha_j + X_{i,j}'\delta + \varepsilon_{i,j} \quad \text{with} \quad \varepsilon_{i,j} \sim N(0,\Sigma) \qquad (1)$$

where Z_i is a vector of the characteristics of the *i*th household (including a constant term), and $X_{i,j}$is a vector of the characteristics of the *j*th income diversification pattern related to household *i*. α_j and δ are vectors of parameter to be estimated, and the error term, $\varepsilon_{i,j}$, follows a multivariate normal distribution with mean vector 0 and variance-covariance matrix Σ.

In this paper, the determinant variables that are relevant to the household's decision on its income generation patterns contain the demographic factors, including the age, gender and education of the household head, the family size and its composition (Escobal 2001; Goodwin and Holt 2002; Goodwin and Mishra 2004); the household operation characteristics, including the household income (Andersson et al. 2005; Pieniadz et al. 2009), herein measured with the annual household income at the end of the previous year, the operated farmland by the household, and the farm production assets (Demurger et al. 2010; Babatunde and Qain 2010). The household's neighbourhood and regional characteristics are measured by the county dummy variable and the region dummy

[4]IIA implies that the ratio of selection probabilities for two outcome categories can depend on the characteristics of another category.

[5]The income earning opportunities could be accessed by the household.

variables (Yunez-Naude and Taylor 2001; Andersson et al. 2005). Other operator characteristics, such as the degree of the risk aversion and their career aspirations may also play an important role in explaining the observed rural income diversification patterns. Their effects are attributed to the model error components due to the unavailability of the data. In line with the random utility models, each household is assumed to choose the income generation pattern that provides it with the highest utility:

$$Y_i = j \quad \text{if} \quad U_{i,j} = \max(U_i) \tag{2}$$

where Y_i is the observed income generation pattern. Given that only the differences in utility matter, we can solve the identification problem by taking the specialized farm operation as the base alternative ($U_{i,Base}$) and defining $\widetilde{U}_{i,K} = U_{i,k} - U_{i,Base}$, k is the number of the major income generation patterns (excluding the base category) as the utility difference. The random utility model expressed as:

$$\widetilde{U}_i = W_i\tilde{\beta} + \tilde{\varepsilon}_i$$

with

$$W_i = [Z_i \otimes I_k, X_i^*], \qquad X_i^* = \begin{bmatrix} X'_{i,1} - X'_{i,Base} \\ X'_{i,2} - X'_{i,Base} \\ \cdots \cdots \\ X'_{i,k} - X'_{i,Base} \end{bmatrix}$$

$$\tilde{\varepsilon}_i = \left(\varepsilon_{i,1} - \varepsilon_{i,Base}, \varepsilon_{i,2} - \varepsilon_{i,Base}, \ldots\ldots, \varepsilon_{i,k} - \varepsilon_{i,Base}\right) \sim N_k(0, \tilde{\Sigma}) \tag{3}$$

The identification of parameters, $\theta = \left(\tilde{\beta}, \tilde{\Sigma}\right)$, can be achieved by normalizing the parameters with respect to $\tilde{\sigma}_{1,1}$ $\theta' = \left(\tilde{\beta}, \tilde{\Sigma}\right) = \left(\frac{\tilde{\beta}}{\tilde{\sigma}_{1,1}}\right)$. The likelihood for the multinomial probit model is then given by

$$f(Y|\mathrm{W}, \tilde{\beta}', \tilde{\Sigma}') = \prod_{i=1}^{n} Pr(Y_i|W_i, \tilde{\beta}', \tilde{\Sigma}') \tag{4}$$

$$Pr(Y_i|W_i, \tilde{\beta}', \tilde{\Sigma}') = \int_{\mathrm{A_j}} \phi_k(\widetilde{U}_i|W_i, \tilde{\beta}', \tilde{\Sigma}')\mathrm{d}\widetilde{U}_i \tag{5}$$

Where ϕ_k is the multinomial probability density function and

$$A_j = \begin{Bmatrix} \widetilde{U}_i: \widetilde{U}_{i,k} > \max\left(\widetilde{U}_{i,-k}, 0\right) & \text{if} \quad Y_i = k \\ \widetilde{U}_i: \widetilde{U}_i < 0 & \text{if} \quad Y_i = base\ category \end{Bmatrix} \tag{6}$$

The posterior density of the parameters is given by the Bayes theorem as

$$\pi(\tilde{\beta}', \tilde{\Sigma}'|W) \propto f(Y|\mathrm{W}, \tilde{\beta}', \tilde{\Sigma}')\pi(\tilde{\beta}')\pi(\tilde{\Sigma}') \tag{7}$$

where $\pi(\tilde{\beta}')$ and $\pi(\tilde{\Sigma}')$ denote the prior densities of $\tilde{\beta}'$ and $\tilde{\Sigma}'$.

The available applications of the MNP models generally use the maximum likelihood estimation, relying on the asymptotic normality in making inferences about the error variance and the covariance parameters (Akoten et al. 2006). However, asymptotic approximations often result in a convergence problem during the maximum likelihood optimization process (Imai and van Dyk 2005). This problem is solved by using the Bayesian approach based on the data augmentation, wherein the latent $\widetilde{U}_i$ are treated as unknown parameters, and the parameter space is augmented with the latent $\widetilde{U}_i$. As McCulloch and Rossi (1994) argue, the Bayesian approach based on the Gibbs sampling allows exact finite sample inferences to be made without relying on the large sample theory. The Bayesian approach is particularly appropriate for a relatively small dataset. In this paper, our model is fit through the Markov chain Monte Carlo (MCMC) simulation, using the Gibbs sampling algorithm, rather than being analytically integrated.

RESULTS DISCUSSION

In this section, we first report the Bayesian estimates of the MNP model, and we calculate the marginal effects of household characteristics to identify further the key determinants that affect the rural income generation patterns.

Bayesian MNP estimates

Table 3 reports the posterior means and 95% Bayesian credible intervals of the parameters in our MNP model; the household income diversification is categorized by industry (Model I) and migration (Model II), respectively.

The coefficients from Model I, Table 3 indicate that age, gender and household income impose no significant impacts, at the 95% level, on the major income generation patterns. For other demographic variables, although the education of the household head does not significantly affect the on-farm and off-farm income diversification, better educated households have a greater probability of undertaking the mixed income diversification strategy (0.026) relative to the specialized farm operation. In addition, the households with a larger family size tend to rely on the off-farm (0.027) and mixed income diversification (0.152)

to earn their income, while more dependent family members within the household would restrict the farm family from participating in the mixed income generation activities (–0.846), although the effects on the on-farm and off-farm income generation patterns remain insignificant.

In comparison with specialized farms, rural households holding more production assets would reduce

Table 3. Posterior means and 95% Bayesian credible intervals for the parameters

	Model I			Model II	
	on-farm_I_1	off-farm_I_2	mixed_ I_3	migration_ M_1	local_ M_2
Constant	–0.122 (–0.428, 0.105)	**–0.458** **(–0.886, –0.079)**	0.125 (–0.423, 0.692)	**–1.249** **(–1.753, –0.761)**	0.080 (–0.049, 0.229)
Household demographic characteristics					
Age	–0.001 (–0.006, 0.002)	0.0002 (–0.003, 0.004)	0.0002 (–0.008, 0.008)	–0.004 (–0.011, 0.003)	–0.000 (–0.002, 0.002)
Gender	–0.070 (–0.291, 0.071)	0.033 (–0.093, 0.182)	–0.127 (–0.445, 0.207)	0.066 (–0.200, 0.340)	–0.039 (–0.131, 0.041)
Education	0.006 (–0.004, 0.018)	0.009 (–0.001, 0.023)	**0.026** **(0.001, 0.052)**	0.011 (–0.010, 0.033)	**0.007** **(0.001, 0.014)**
FamilySize	0.006 (–0.024, 0.028)	**0.027** **(0.005, 0.055)**	**0.152** **(0.100, 0.209)**	0.205 **(0.161, 0.250)**	0.030 **(0.017, 0.046)**
Dependent	–0.096 (–0.296, 0.012)	0.018 (–0.072, 0.111)	**–0.846** **(–1.175, –0.509)**	–0.982 **(–1.274, –0.702)**	–0.108 **(–0.195, –0.033)**
Household operation characteristics					
PreIncome	0.003 (–0.001, 0.006)	0.001 (–0.005, 0.006)	0.001 (–0.009, 0.011)	–0.008 (–0.030, 0.006)	0.001 (–0.002, 0.003)
Farmland	–0.000 (–0.001, 0.001)	**–0.003** **(–0.007, –0.001)**	0.001 (–0.001, 0.003)	0.001 (–0.001, 0.002)	–0.000 (–0.000, 0.000)
ProdAsset	–0.001 (–0.004, 0.001)	**–0.005** **(–0.013, –0.001)**	–0.007 **(–0.013, –0.002)**	–0.011 **(–0.021, –0.006)**	–0.002 **(–0.003, 0.000)**
Prodcosts	**–0.020** (–0.031, –0.012)	–0.000 (–0.001, 0.001)	0.001 (–0.001, 0.003)	0.002 (–0.000, 0.008)	**–0.002** **(–0.004, 0.000)**
County, year and region variables					
County	–0.005 (–0.272, 0.234)	**0.354** **(0.111, 0.712)**	**1.403** **(0.789, 2.002)**	2.714 (2.198, 3.243)	0.303 **(0.134, 0.481)**
Year	**–0.120** (–0.299, –0.015)	**–0.136** (–0.281, –0.030)	**–1.070** (–1.299, –0.844)	–0.266 **(–0.483, –0.058)**	–0.233 **(–0.386, –0.162)**
Central	0.021 (–0.064, 0.126)	**0.123** **(0.017, 0.260)**	0.158 (–0.064, 0.376)	–0.091 (–0.262, 0.088)	0.047 (–0.007, 0.120)
Southern	–0.102 (–0.301, 0.025)	–0.088 (–0.259, 0.048)	**–1.087** **(–1.390, –0.793)**	–0.399 **(–0.650, –0.135)**	–0.250 **(–0.412, –0.161)**
Covariance					
$Cov(I_1,I_2)$	**0.096** (0.019, 0.228)	$Cov(I_2,I_3)$	**0.301** (0.066, 0.576)		
$Cov(I_1,I_3)$	0.202 (–0.044, 0.569)			$Cov(M_1,M_2)$	**0.457** (0.374, 0.620)

The inclusion of zero values within the 95% Bayesian credible intervals implies the insignificance of the estimates. The significant estimates are highlighted in bold

their chances of engaging in the off-farm (–0.005) and mixed business (–0.007) activities, implying that the well-equipped on-farm production may be more lucrative than the wage-earning jobs in the off-farm sectors. The empirical estimates from the MNP model demonstrate that the access to farmland is inversely related to the household off-farm business. Households with more farmland are less likely to adopt the off-farm income diversification (–0.003), relative to specialized households. They also show that greater production costs will discourage households from engaging in the on-farm income diversification (–0.020), while their impacts on the off-farm and mixed income diversification are not significant.

Regarding the county income effect, the results indicate that, on average, when more households within the county obtain their income from the non-farm sectors, the individual household has a greater propensity to select the off-farm (0.354) and mixed income (1.403) diversification, relative to the specialized operation. The significant county income feature of the farm households' income diversification patterns may lie in two aspects. One is that the county average of the off-farm income percentage reflects the surrounding on-farm and non-farm job opportunities for the household. For example, when a farm household resides in an area where the off-farm income share is small for most farm families, it implies the limitedness of the off-farm job opportunities in that region. Therefore, it is less likely that the household will rely on the off-farm income as its primary revenue source. Another possible reason is that most farm households tend to follow their neighbouring households in arranging their economic activities. When most farm families abandon farming and engage in the off-farm business, the non-farm work must have its advantageous (a higher marginal return or lower risks) features to attract the rural residents. As a result, it benefits an individual farm family to "go with the Joneses". Finally, the 2008 year dummy variable imposes consistent negative effects on each income diversification pattern, indicating that the global financial crisis also hindered Chinese rural households from improving their income through various types of the rural income diversification patterns.

Model II (in Table 3) categorizes the household income generation pattern as the specialized farm operation, the migration income diversification and the local income diversification. Again, age, gender and household income are not significant factors in determining the household income generation pattern. Higher education enables the household to increase its probability of adopting the local income diversification strategy (0.007) relative to the specialized operation. *Ceteris paribus*, a larger family size greatly increases the household's propensity to rely on migration remittances (0.205) to increase its income, but its effects on the local income diversification are much lower (0.030). Meanwhile, the households with more dependent family members are less likely to engage in the local income diversification (–0.108) and the migration diversification (–0.982) relative to the specialized operation.

Households with greater production assets are less likely to migrate out (–0.011) or to adopt the local income diversification strategy (–0.002). Rather, they tend to focus on the specialized production to utilize their production equipment better. The county income characteristics impose remarkable positive effects on the household migration (2.714), but a smaller effect on the local income diversification (0.303). Similar to Model I, both migration and local income diversification are seriously affected by the year dummy variable that approximates the effects from the global financial crisis. In 2008, the impacts of the global financial crisis reached China's export-dependent economy. The economic shock halted production in factories across China, leading to high levels of unemployment in the rural migrant labour force (Johnson and Batson 2009; Huang et al. 2011). As a result, it was less likely for farm households to migrate (–0.266) or to adopt the local income diversification (–0.233) strategy to expand their income in 2008.

Marginal effects of household characteristics on rural income diversification

The coefficients reported in Table 3 are difficult to interpret directly due to the non-linear functional form of the MNP model and the fact that the household's utilities are expressed with respect to the baseline alternative of the specialized farm income generation pattern. In order to assess the relative impact of different factors that account for the rural households' income diversification patterns, we calculate the marginal effect of the determinant variables on the probability with respect to each income earning pattern, using the "first differences" approach developed by King et al. (2000).

For each household in the sample, we compute the vectors of choice probabilities with respect to each

income generation pattern,[6] based on the value of the regressors and the Gibbs sample draws of the models' parameters using the GHK algorithm for 5000 times. It is worth mentioning that each household could either engage in the specialized operation or choose any type of the income diversification pattern, and the summation of these choice probabilities, in model I and model II, should be equal to 1, respectively. Then we alter one independent variable in a series of one unit changes and recompute the predicted probabilities for each household, holding other variables constant. Finally, we average the differences between the corresponding probabilities over the sample households, each with 5000 simulations, and obtain the mean value and 95% credible intervals for each predictor variable under analysis.

Table 4 summarizes the marginal effects of the determinant variables on the probability change with respect to each income diversification pattern. Consistent with the estimates from the Bayesian MNP model, the marginal effects calculated from Model I indicate that when the household increases its family size by one additional member, the farm household will increase its probability (0.031) of adopting the mixed income diversification and reduce its chances (–0.002) of undertaking the on-farm income generation activities. Meanwhile, an increase of one more dependent within the household will reduce the household's possibility of adopting the mixed income generation pattern (–0.019). Regarding the household production, we find that greater farm production costs significantly decrease the household's probability of utilizing the on-farm income diversification (–0.004). The county income feature significantly affects the household's probability of selecting different types of the income diversification patterns. When the average off-farm income share (at the county level) increases by 1%, the probabilities of the households' adoption of the off-farm and the mixed income diversification strategy increase by 0.017 and 0.056, respectively.

The marginal effect of the family size in Model II, Table 4 indicates a positive sign, implying that one more additional household member within the family will increase the household's probability of adopting the migration income diversification strategy (0.059). Nonetheless, increasing the household dependent ratio by one unit will decrease the household's probability of migration (–0.029). Lastly, the marginal effects of the county income feature impose positive effects on the migration income diversification (0.132), but negative effects on the local income generation pattern (–0.065).

The above empirical findings are, overall, consistent with the current practice in rural China, where farmland is scant, the household production is poorly equipped and the rural area is concentrated with an excessive labour force. The common results from the Bayesian MNP model and the calculated marginal effects from the determinant variables demonstrate that the family size and the household population structure are essential factors in the households' choice of their income generation pattern. In both models, the county income feature imposes uniform significant impacts on the households' selection of the non-specialized income generation patterns. When the surrounding farm families increase their off-farm share of the household income, the probability of an individual household participating in the off-farm diversification, the mixed income diversification or the migration would also increase.

CONCLUSION AND POLICY IMPLICATIONS

This article investigates the major rural income diversification patterns and their determinants in the context of China. Based on the data from a cross-sectional rural household survey, we consider the specialized farm income generation pattern as the benchmark and categorize the rural income diversification patterns according to the industry in which the households obtain their income: the rural income diversification patterns are classified as the on-farm, off-farm and mixed income diversification. When the classification is based on the location where the household income is generated, the rural income diversification patterns are divided into the migration income diversification and the local income diversification.

To overcome the convergence problem of the classical MNP models, we apply a new Bayesian MNP model to examine the determinants associated with various types of the rural income generation patterns. The marginal effects of the determinant variables are also calculated to shed more light on the probability

[6]In model I: [$p_{I,i1}$(specialization), $p_{I,i2}$ (on – farm diversification), $p_{I,i3}$(off – farm diversification), $p_{I,i4}$(mixed diversification) and $p_{I,i1} + p_{I,i2} + p_{I,i3} + p_{I,i4} = 1$; in model II: [$p_{II,i1}$(specialization), $p_{II,i2}$ (migration diversification), $p_{II,i3}$(local diversification), and $p_{II,i1} + p_{II,i2} + p_{II,i3} = 1$.

Table 4. Marginal effects of the determinants on the probabilities of the diverse income diversification

	Model I				Model II		
	specialized operation	diversification			specialized operation	diversification	
		on-farm	off-farm	mixed		migration	local
Age	0.000 (–0.005, 0.006)	0.000 (–0.002, 0.002)	0.000 (–0.003, 0.003)	0.000 (–0.006, 0.006)	0.000 (–0.005, 0.006)	–0.001 (–0.007, 0.004)	0.001 (–0.004, 0.007)
Gender	0.017 (–0.038, 0.053)	–0.009 (–0.028, 0.019)	0.013 (–0.029, 0.040)	–0.021 (–0.006, 0.045)	0.018 (–0.037, 0.056)	0.025 (–0.043, 0.061)	–0.043 (–0.086, 0.070)
Education	**–0.006 (–0.013, –0.001)**	0.001 (–0.001, 0.004)	0.001 (–0.001, –0.005)	0.004 (–0.001, 0.011)	**–0.006 (–0.012, –0.000)**	0.001 (–0.004, 0.006)	0.005 (–0.001, 0.011)
Dependent	0.013 (–0.001, 0.028)	0.000 (–0.006, 0.005)	0.006 (–0.001, 0.017)	**–0.019 (–0.035, –0.004)**	0.013 (–0.002, 0.029)	**–0.029 (–0.047, –0.007)**	0.016 (–0.007, 0.036)
FamilySize	**–0.027 (–0.038, –0.012)**	**–0.002 (–0.006, –0.000)**	–0.001 (–0.005, 0.002)	**0.031 (0.015, 0.040)**	–0.029 **(–0.041, –0.012)**	0.059 **(0.029, 0.071)**	–0.030 **(–0.052, –0.003)**
PreIncome	–0.001 (–0.006, 0.005)	0.001 (–0.001, 0.003)	0.000 (–0.003, 0.003)	0.000 (–0.006, 0.005)	0.000 (–0.006, 0.005)	–0.002 (–0.007, 0.004)	0.002 (–0.004, 0.007)
Farmland	0.000 (–0.005, 0.006)	0.000 (–0.002, 0.002)	–0.001 (–0.004, 0.002)	0.001 (–0.005, 0.007)	0.000 (–0.006, 0.006)	0.000 (–0.005, 0.006)	0.000 (–0.006, 0.005)
ProdAsset	0.002 (–0.004, 0.008)	0.000 (–0.002, 0.003)	–0.001 (–0.004, 0.002)	–0.001 (–0.007, 0.005)	0.002 (–0.004, 0.008)	–0.003 (–0.008, 0.003)	0.001 (–0.005, 0.007)
Prodcosts	0.002 (–0.004, 0.009)	**–0.004 (–0.010, –0.000)**	0.001 (–0.002, 0.004)	0.001 (–0.005, 0.008)	0.000 (–0.005, 0.006)	0.001 (–0.005, 0.006)	–0.001 (–0.006, 0.005)
County	**–0.066** (–0.119, –0.021)	**–0.006** (–0.014, –0.000)	**0.017** (0.004, 0.024)	**0.056** (0.010, 0.116)	–0.066 (–0.121, –0.021)	0.132 (0.060, 0.188)	–0.065 (–0.123, –0.015)

The inclusion of zero values within the 95% Bayesian credible intervals implies the insignificance of the estimates. The significant estimates are highlighted in bold

change with respect to each income diversification pattern, when the determinant variables have one unit change. The major conclusions of this study disclose that the rural human capital (measured by the family size) is the key factor stimulating the households to undertake the off-farm diversification, the mixed income diversification, and the migration income diversification activities. However, these positive effects would be discounted by an unproductive population structure when the dependent ratio is high within the farm family. In addition, as indicated by the large effect from the county income feature variable, the rural households choose their income diversification pattern primarily by referring to the neighbouring household behaviour; when most farm families depend on the off-farm activities to boost their income, the individual household is more likely to follow the surrounding neighbourhood by participating in the off-farm or mixed income activities or to migrate out to earn its income.

The evidence in this article yields several useful policy insights. First, rural households in China no longer depend only on the classical farm businesses to earn their income. Rather, they adopt various types of the income diversification strategies. Understanding the rural residents' income generation patterns is a prerequisite for the policy makers to help them to boost their income. Second, most farm families in China depend on human capital to undertake the off-farm income activities, while the families with

an excessive number of dependents may restrict the household from choosing the efficient revenue enhancing channels. Thus, the effective approaches to improving the welfare of the rural households not only involve the non-farm job opportunities provided in rural areas, but also the improvement of the health, nutrition and education status of rural residents. Finally, since the rural household income diversification patterns are affected by the surrounding neighbourhood, it would be less costly for the policy makers to convince some households to adopt certain efficient income generation patterns, and the remaining households may follow those patterns automatically.

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