Livelihood capitals on income inequality among rural households: evidence from China

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ABSTRACT: *We used the data of the China Labor-force Dynamics Survey 2014 to examine the effects of livelihood capitals which include natural, material, human, financial, and social capitals on total household income, per capita income, agricultural income, wage income, operational income, and property income inequality among rural households in China. Results showed that different kinds of livelihood capitals have different effects on different types of rural households' income. Specifically; (1) although, the area of cultivated land reduces agricultural income inequality, it increases per capita income inequality. (2) Forest land area enlarges per capita income inequality and total household income inequality. (3) Tractor variable reduces inequality in agricultural income and total household income. (4) While reducing the property income inequality, education variable enlarges the wage income inequality, the per capita income inequality and the total household income inequality. (5) Book variable reduces property income inequality. (6) Loan variable increases inequality in agricultural incomes. (7) Party variable reduces the agricultural income inequality. (8) Although, the internet variable increases agricultural income inequality, and property income inequality, it reduces wage income inequality, operational income inequality, per capita income, and total household income inequality.*
Key words: *human capital, social capital, Gini coefficient, poverty alleviation, China.*

Efeito das capitais de subsistência na desigualdade de renda entre as famílias rurais: evidências da China

RESUMO: *Utilizamos os dados da Pesquisa de Dinâmica da Força de Trabalho da China de 2014 para examinar os efeitos dos capitais de subsistência, que incluem capitais natural, material, humano, financeiro e social sobre a renda total da família, renda per capita, renda agrícola, renda salarial, renda operacional e desigualdade de renda da propriedade entre as famílias rurais da China. Os resultados mostraram que diferentes tipos de capitais de subsistência têm efeitos diferentes sobre os diferentes tipos de renda das famílias rurais. Especificamente, (1) embora a área de terra cultivada reduza a desigualdade de renda agrícola, aumenta a desigualdade de renda per capita. (2) A área florestal aumenta a desigualdade de renda per capita e a desigualdade total de renda familiar. (3) A variável trator reduz a desigualdade na renda agrícola e na renda familiar total. (4) Embora reduza a desigualdade de renda da propriedade, a variável educação aumenta a desigualdade de renda salarial, a desigualdade de renda per capita e a desigualdade total de renda familiar. (5) A variável contábil reduz a desigualdade de renda da propriedade. (6) A variável empréstimo aumenta a desigualdade na renda agrícola. (7) A variável partidária reduz a desigualdade de renda agrícola. (8) Embora a variável internet aumente a desigualdade de renda agrícola e a desigualdade de renda da propriedade, reduz a desigualdade de renda salarial, a desigualdade de renda operacional, a renda per capita e a desigualdade total de renda familiar.*
Palavras-chave: *capital humano, capital social, coeficiente de Gini, alívio da pobreza.*

INTRODUCTION

In the past 40 years of reform and opening, China's economy has maintained a long-term and high-speed growth (LIU et al., 2018). Economic growth has promoted the growth of household income, but also widened the household income inequality. According to the National Bureau of Statistics, China's Gini coefficient in 2016 was 0.465 (Data source from the website of the National Bureau of Statistics, China. http://www.stats.gov.cn/ztjc/zdtjgz/yblh/zysj/201710/t20171010_1540710.html), exceeding the international warning line of 0.4. Income inequality hinders sustainable economic development, induces class antagonism and conflicts, and is not conducive to social solidarity and stability (JAYADEV & REDDY, 2011; PASKOV & DEWIDE, 2012; ZHANG, 2015; LIU et al., 2018). An effective measure to solve the problem of income inequality is to provide help to the disadvantaged groups and promote their income growth. Therefore, the Chinese government is currently implementing precise poverty alleviation in rural China, helping the poor to increase their income, getting rid of poverty and reducing income inequality. The study of income inequality among the rural households can provide the desired

tool to solve the poverty of the rural regions of the China and enrich the literature on income inequality.

Previous research on the micro level of income inequality has focused separately on the effect of natural, material, human, financial, and social capitals (FIELDS & YOO, 2000). FIELDS & YOO (2000) reported that the most important factors that explained the level of income inequality were job tenure, years of education, and occupation which separately belong to human and social capitals. MORDUCH & SICULAR (2002) also found that education which belongs to human capital plays a crucial role in income inequality. The study of GAO and YAO (2006), showed that the human capital of farmers can increase income inequality while the material capital has no statistically significant effect on income inequality. The study of LIU et al., (2018) found that social capital plays an important role among minority farmers in China. However, LIU et al., (2018) also reported that the impact of natural and human capital on income inequality is not evident.

From the above research, we can report that it has not reached a unified conclusion whether the natural, material, human, financial, and social capital have the significant effect on economic inequality. Moreover, the current research does not take account of these livelihood capitals simultaneously. However, all these forms of capitals may play an important role in affecting income and then affecting income inequality so all of them should be discussed in tandem.

The objectives of this paper are to understand the effects of livelihood capitals which included natural, material, human, financial and social capitals on the income inequality of rural households in China and to identify the reasons behind the widening income inequality in China. Unlike previous studies, we integrated five kinds of livelihood capitals into the analysis. Moreover, we considered the effect of livelihood capitals on different types of income inequality. In terms of methods, we first use the Foster–Greer–Thorbecke (FGT) poverty index, Gini coefficient, and Theil index to measure the income inequality of rural households, and then used quantile regression to examine the effect of different livelihood capitals on the income inequality of rural households.

We organized the remainder of this paper as follows. In section 2, we provided a theoretical analysis of the effect of livelihood capital on income inequality. In section 3, we introduced the data source, and methods used in this paper. In section 4, we present the empirical results. Conclusions and policy implications are shown in the final section.

Theoretical analysis and hypothesis

Sustainable Livelihood Analysis method (also called Sustainable Livelihoods Approach, SLA), as an integrated analysis framework to understand farmers' livelihood vulnerability and provided multiple solutions, which has gradually been widely used in theory and practice. In 1995, it became the conceptual and operational framework for sustainable poverty reduction in the United Nations Development Programme (UNDP). The analysis framework for sustainable livelihoods developed by the UK's Department for International Development (DFID), is the most typical one, which studies farmers in a context of vulnerability.

According to the SLA framework, livelihood capitals are the sum of all the capitals that farmers can use and maintain their livelihood, including human capital, natural capital, material capital, financial capital and social capital. The livelihood capitals reflected the livelihood resources that farmers can make use from many dimensions, and more comprehensively reflect the farmers' ability to cope with risks (CHAMBERS & CONWAY, 1992; SCOONES, 1998; ELLIS, 1999). The definition of the natural capital is that resources are generated, and people can use for their livelihood need, for example, water, land, forests, air, hydrological cycle and so on. The material capital refers to the basic infrastructure and the production equipment and technologies which enable people to derive benefits from any source. Moreover, financial capital is defined as cash, credit, debt, saving to build confidence in livelihood strategy. Lastly, the social capital included trust and solidarity, networks and connectivity, social cohesion and so on, and this kind of capital ensures coordination and cooperation for mutual benefits (KIBRIA et al., 2018; NATH & INOUE, 2009; PUTNAM et al., 1993).

Natural capital and income inequality

Natural capital is a crucial factor which influences the income inequality among the rural household in China. SANDONATO & WILLEBALD (2018) identified the conception of natural capital with those assets which originate from nature, and they suggested that natural capital included lands, forests, minerals, rivers, coasts that yield a flow of valuable goods and services into the future, also can be exploited for economic purposes. Natural capital in our paper is measured at the household level and defined the natural capital as cultivated land and forest land.

NGUYEN et al. (2017) demonstrated that the more cultivated land the household have the more

possible returns the household can get in a village in central Vietnam. Generally, more cultivated land the household have means they can allocate more land for plantation of economics plants to earn more returns than planting rice, and less likely to immerse in poverty (HUANG et al., 2006).China is a country with very complicated terrain with geographical features characterized by mountains, hills, plateaus, and deserts, and the cultivated land is distributed unevenly over the country. So, we assumed that cultivated land ownership and cultivated land size may not have a significant relationship with the income inequality.

All the individuals from every income level can benefit from forest land in the south of China (HOGARTH et al., 2013). The forest land can provide the timber products and non-timber products (BARNES et al., 2017), such as the development of tourism; therefore, the forest lands have a potential to earn more income. DAS (2010) and PRADHAN (2014) argued that forest income reduces income inequality. Relatively speaking, the household can expect increased revenue by expanding the arable forest land with a relatively large amount. Therefore, the forest land size may be more likely to result in shrinking of the income inequality.

Material capital and income inequality

Material capital is demonstrated to be the one of most important key parts for income growth by the neoclassical growth theory (VILLAVERDE & MAZA, 2012), and they propose that the material capital can be a decisive factor effecting the income inequality. Some studies have been taken in China and reported that material capital has a significant relationship with income inequality (ZHOU et al., 2014). WAN & ZHOU (2005) reported that material capital has a positive relationship with income inequality, and the contribution rate of the material capital increased from 2% to 24% from 1990 to 2002 in all over the China.

In our paper we used the number of tractors, farm implements and livestock to measure the level of the material capital stock of the households. The use of farming fixed assets like tractors and farm implements can standardize and mechanize the farm production, heightening the crop yield, lowering the production cost. It also benefits to improve the farming efficiency. So, more tractors and implements provide more opportunities to increase the income for the household. Moreover, the feeding of livestock can be convertible into economic value, resulting in a higher household income.

Human capital and income inequality

Under the perfect market mechanism, human capital plays a decisive role in income distribution. The market allocation of labor resources will inevitably lead to higher income for laborers with high human capital stock, and lower income for laborers with low human capital stock. However, under imperfect market mechanisms, such as countries with economies in transition just like China, non-market factors such as policies and institutions, and political capital play a decisive role in income distribution. China is in economic transition now, so the impact of human capital on income inequality is still under discussion.

From the perspective of human capital investment, SCHULTZ (1961) proposed that education is an unneglected component to increase income. Since the introduction of the MINCER (1974) income equation, the relationship between education, and income inequality has been the focus of human capital research. BECKER & CHISWICK (1966) indicated that the average educational level of the population affects the income distribution. They conducted the research based on cross-sectional data from various regions of the United States, and the results showed that education inequality was significantly positively correlated. Likewise, BECKER (1993) based on the theory of human capital, arguing one of the rooted causes the poverty becomes poorer is human capital including education. With such a perspective, education is studied as a source which produces the inequality of income, and the others researcher aimed to estimate how much education contributed to income inequality (CARNOY, 2011; JAMISON & GAAG, 1987).

The ratio of adult working members with a junior college level education to total adult household mainly affects the level of wages by affecting job opportunities (BREEN & JONSSON, 2005). Therefore, human capital in this paper specifically refers to: 1) ratio of adult working members with a junior college level education to total adult household, 2) number of books a rural household has. The number of books a rural household has in our paper is considered as a crucial component of human capital, because the school compulsory education does not represent all abilities of the household. The more books in the household, the more opportunity of information family members can get in the books, including professional technology, life skills and so on; secondly, the more books in the family can make the family full of knowledge learning atmosphere.
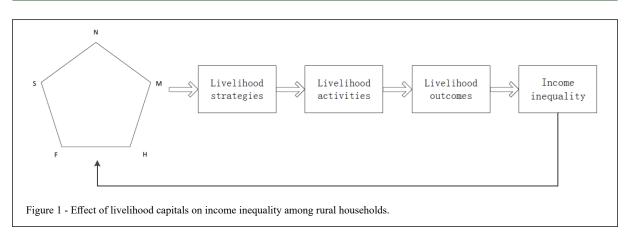
Financial capital and income inequality

The financial capital in the SLA built by the DFID refers to the accumulation and flow of money that can be used for a living, including cash, deposits, private borrowing and the amount of money raised through formal financial institutions. The most important financial capital for Chinese households in 2015 is deposits, accounting for as much as 45.8%, in addition, stocks account for 11.4%, loans are 10.3%, financial products account for 7.1%, cash is 5.3%, funds are 2.7%, bonds are 0.4%, and other financial capital occupies 17% (Data source from the website of the Survey and Research Center for China Household Finance, Southwestern University of Finance and Economics, China. http://www.chfsdata.org/). Thus, the stock of Chinese households' overall financial capital is very low. Therefore, there are very few studies on the relationship between the Chinese households' financial capital allocation and income inequality. However, many economists have provided qualitative and quantitative arguments showing that increases in loan stock of the household are the counterpart of the redistribution of income in the USA (CYNAMON & FAZZARI, 2008; BARBA & PIVETTI, 2009). IACOVIELLO (2008), using a DSGE model, showed that income inequality has primarily been increased by an expansion of credit from rich (saving) to poor (spending) households. RAJAN (2010) and REICH (2010) provided qualitative arguments linking income inequality to loan levels. BERISHA & MESZAROS (2017) evidence increases in household loan are associated with higher rates of unemployment households. The high growth rates in household loan are associated with negative growth in income inequality.

In our paper we chose two indexes to equal the household financial capital stock: 1) loan: did a rural household successfully borrow money from regular financial institutions such as banks and credit unions for productive investment? 2) financial product: if a rural household owns financial product, like stock, fund, and bond. Conversely, the greater the amount of money a household can borrow from a bank or financial institution, which means the higher its financial credit, the more deposits and the more collateral. At the same time, the more financial products the household can buy, the more income will not only be able to pay for your life, but also financial investment.

Social capital and income inequality

Due to its multi-disciplinary history and the SLA, social capital is defined in various ways, but most definitions emphasize a network or a communitarian focus (WOOLCOCK & NARAYAN, 2000). PUTNAM (1995) proposed the feature of social life-networks enable the participants to pursue the shared objectives more effectively. While a network focus on considering how individuals access resources within their networks of family, friends, and acquaintances for pursuing personal goals (PORTES, 1998). A communitarian focus considers how group or associational membership aids in pursuing collective goals, such as social and economic development (BERKMAN et al., 2000). Our research focused on how rural households' income in China ties to individuals and organizations where the kinship (*Guanxi*, a term for social network in China) characteristics is obtrusive. Therefore, we defined the social capital in a manner consistent with both social network and communitarian approaches: 1) number of CPC members in household members, 2) the internet being used by computer or smart phone at home.

Likewise, most discussion of social capital has considered it to be a positive asset for a society to have. On the topic of how social capital mostly affects the wealth of households by job hunting, Granovetter's related researches are classic that cannot be circumvented. The New Economic Sociology School represented by GRANOVETTER (1973) specifically links economic returns with social networks and believes that individual actions are embedded in social networks. Social networks influenced their information acquisition, interpersonal trust, normative compliance, and loyalty, sense of responsibility. While in the relationship-based society of China the social capital exerts a strong influence. Joining the Communist Party of China allows families to be close to their relatives or friends who are the staff in the government sector. It is more conducive to get the access to government resources to get a job. Internet be used by computer or smart phone shows the active willingness of families to communicate with the outside world reflecting their interaction needs in social networks, which is useful to get access to the private information to find a job. By obtaining job information from a close-knit approach, it is easier to obtain positions with higher status and higher income. Therefore, in this research we proposed that increment of social capital has been shown to shrink income inequality (Figure 1).

Figure 1 - Effect of livelihood capitals on income inequality among rural households.
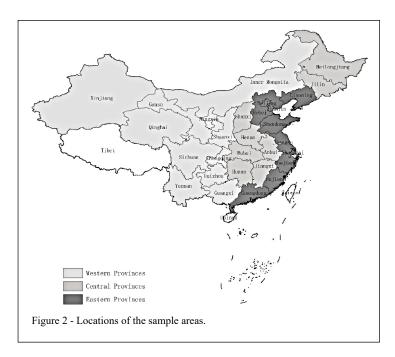
MATERIALS AND METHODS

Data

This paper uses data from the China Labor-force Dynamics Survey 2014 (CLDS2014), conducted by the Social Science Research Center of Sun Yat-sen University in China. The purpose of this survey was to provide basic data for empirical-oriented theoretical and policy research related to Chinese labor force. CLDS2014 is an interdisciplinary survey, covering many research topics such as education, work, migration, health, social participation, economic activities, and grass-roots organizations. To ensure national representativeness, CLDS's samples cover 29 provincial administrative units except for Hong Kong, Macao, Taiwan, Tibet, and Hainan. Specifically, the 29 provincial administrative units include Beijing, Shanghai, Tianjin, Chongqing, Hebei, Shanxi, Neimenggu, Heilongjiang, Jilin, Liaoning, Shaanxi, Gansu, Qinghai, Xinjiang, Ningxia, Shandong, Henan, Jiangsu, Zhejiang, Anhui, Jiangxi, Fujian, Hubei, Hunan, Guangdong, Guangxi, Sichuan, Yunnan, Guizhou (Figure 2). In the sampling method, the multistage cluster, stratified, PPS sampling was used. Therefore, this data was very representative in the study of China. It is a public piece of data that all researchers can apply for. The survey was conducted by the Computer Assisted Personal Interviewing (CAPI) technology.

Methods

Ideally, income or earning equations are estimated by structural models. When estimating structural models can't be realized, a standard Mincian model is a good alternative selection (LIU et al., 2018). We used log of different kinds of household income as dependent variables, as income was better approximated by log normal functional form (WAN & ZHOU, 2005; LIU et al., 2018):

$$log1_{q_i} = c + \beta_{q_{nat}}nat_{q_i} + \beta_{q_{mat}}mat_{q_i} + \beta_{q_{hum}}hum_{q_i} + \beta_{q_{fin}}fin_{q_i} + \beta_{q_{soc}}soc_{q_i} + \beta_{q_x}x_{q_i} + \varepsilon_q$$

$$log2_{q_i} = c + \gamma_{q_{nat}}nat_{q_i} + \gamma_{q_{mat}}mat_{q_i} + \gamma_{q_{hum}}hum_{q_i} + \gamma_{q_{fin}}fin_{q_i} + \gamma_{q_{soc}}soc_{q_i} + \gamma_{q_x}x_{q_i} + \varepsilon_q$$

$$log3_{q_i} = c + \delta_{q_{nat}}nat_{q_i} + \delta_{q_{mat}}mat_{q_i} + \delta_{q_{hum}}hum_{q_i} + \delta_{q_{fin}}fin_{q_i} + \delta_{q_{soc}}soc_{q_i} + \delta_{q_x}x_{q_i} + \varepsilon_q$$

$$log4_{q_i} = c + \mu_{q_{nat}}nat_{q_i} + \mu_{q_{mat}}mat_{q_i} + \mu_{q_{hum}}hum_{q_i} + \mu_{q_{fin}}fin_{q_i} + \mu_{q_{soc}}soc_{q_i} + \mu_{q_x}x_{q_i} + \varepsilon_q$$

$$log5_{q_i} = c + \partial_{q_{nat}}nat_{q_i} + \partial_{q_{mat}}mat_{q_i} + \partial_{q_{hum}}hum_{q_i} + \partial_{q_{fin}}fin_{q_i} + \partial_{q_{soc}}soc_{q_i} + \partial_{q_x}x_{q_i} + \varepsilon_q$$

$$log6_{q_i} = c + \theta_{q_{nat}}nat_{q_i} + \theta_{q_{mat}}mat_{q_i} + \theta_{q_{hum}}hum_{q_i} + \theta_{q_{fin}}fin_{q_i} + \theta_{q_{soc}}soc_{q_i} + \theta_{q_x}x_{q_i} + \varepsilon_q$$

Here, $log1 - log6$ represent respectively a logarithm of total household income, per capita income, agricultural income, wage income, operational income, and property income of a rural household. c is constant, q is a quantile, and ε_q is the error term. i represent the i th household. Important variable groups are denoted by nat_q, mat_q, hum_q, fin_q, and soc_q, which represent respectively the natural capital variables (cultivated land, and forest land), the material capital variables (tractor, implement, and livestock), the human capital variables (education, and book), the financial capital variables (financial product, and loan), and the social capital variables (party, and internet), and the estimated coefficients of β, γ, δ, μ, ə, and θ are the marginal contribution of different variables to different types of income. In addition, these models also included other control variables represented by x_q, which include soil pollution, cost, labor, family size, relationship, and province. For a detailed definition of variables in this paper, see table 1. We choose three levels of q: 25%, 50%, and 75%, which represent respectively the low-income group or poor group, the middle-income group, and the high-income group.

We check the role of natural, material, human, financial, and social capitals on income inequality among rural households in the study areas which almost are the representative of China. We estimated the marginal contribution of different kinds of livelihood capitals to different income quantiles. If

Figure 2 - Locations of the sample areas.

the marginal contribution of any of these variables is higher in a low-income quantile than in a middle- or high-income quantile, that variable narrows income inequality, whereas the reverse widens income gap.

RESULTS

Descriptive statistics

The descriptive statistics of all the variables used in the paper are shown in table 1. In the natural capitals, the average amount of cultivate land owned by households was 1.416 hectare. The average amount of forest land owned by households was 0.387 hectare. In the material capitals, about 13.2% of households own tractor, about 2.1% of households own large farm implement, and about 8.1% of households own livestock (like cow, horse, mule, or donkey) used for production. In human capitals, the average ratio of adult working members with a junior college level education to total adult household members was 4.4%. On average, each family has 7.436 books. In financial capitals, 1.4% of households have financial product (like stock, fund, or bond), and 1.3% of households can get loans from regular financial institutions such as banks or credit unions for productive investment. In social capitals, approximately 16% of families have the member of the Communist Party of China (CPC). 43.6% of households can use smart phones or computers to access the internet.

We compared income1 – income6 which represent respectively a logarithm of total household income, per capita income, agricultural income, wage income, operational income, and property income of a rural household by using the logarithmic transformation. The kernel density estimations for income1 – income6 are shown in figure 3.

We separated the whole study area into three sub-areas—western provinces, central provinces, and eastern provinces. This division is made by the National Bureau of statistics of China according to the economic development of each province and we use it. We calculated the FGT poverty index, Gini coefficient, and Theil index of the whole study area and three sub-areas (table 2).

The FGT poverty index showed that the poverty incidence rate (breadth of poverty) is 22.8%, depth is 14.8%, and intensity is 11.3% in the whole area. The poverty breadth, depth, and intensity have a certain degree of remission from western provinces, central provinces, to eastern provinces. It indicated that the poverty status of rural households in western provinces is the most serious, followed by the central provinces and the lightest is the eastern provinces, which means that there are differences in income inequality among different regions.
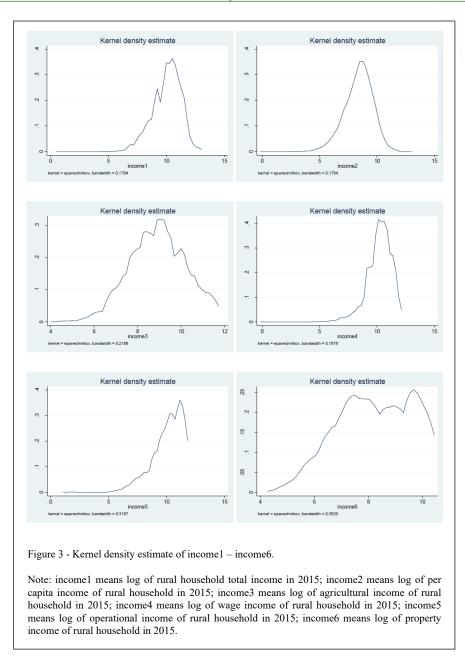
Table 1 - Summary statistics of variables.

Variable	Description	Mean	SD
Dependent variable			
Income1	Log of rural household total income in 2015	10.039	1.219
Income2	Log of per capita income of rural household in 2015	8.397	1.245
Income3	Log of agricultural income of rural household in 2015	8.934	1.305
Income4	Log of wage income of rural household in 2015	10.221	1.092
Income5	Log of operational Income of rural household in 2015	10.076	1.370
Income6	Log of property income of rural household in 2015	8.240	1.367
Natural capital			
Cultivated land	Per capita effective irrigation area (hectare)	1.416	3.169
Forest land	Per capita forest land area (hectare)	0.387	2.118
Material capital			
Tractor	If a rural household has a tractor or more (1 = yes, 0 = no)	0.132	0.339
Implement	If a rural household has a large farm implement or more (1 = yes, 0 = no)	0.021	0.145
Livestock	If a rural household has a livestock (like cow, horse, mule, donkey) used for production or more (1 = yes, 0 = no)	0.081	0.273
Human capital			
Education	Ratio of adult working members with a junior college level education to total adult household members	0.044	0.103
Book	Number of books a rural household has	7.436	13.272
Financial capital			
Financial product	If a rural household owns financial product, like stock, fund, or bond (1 = yes, 0 = no)	0.014	0.116
Loan	Did a rural household successfully borrow money from regular financial institutions such as banks or credit unions for productive investment? (1 = yes, 0 = no)	0.013	0.113
Social capital			
Party	Are there any CPC members in household members? (1 = yes, 0 = no)	0.160	0.367
Internet	Can the internet be used by computer or smart phone at home? (1 = yes, 0 = no)	0.436	0.500
Other variables			
Soil pollution	Severity of soil pollution of a rural household (From 1 to 4, the degree of pollution is getting lighter gradually)	3.455	0.694
Cost	Log of total cost of agricultural production	7.894	1.475
Labor	Ratio of agriculturally labor working members to total family members	0.377	0.298
Family size	Number of household members	6.080	3.516
Relationship	Relationship between family members (From 1 to 10, the relationship of family members is getting closer gradually)	7.177	1.573
Province	Province in which a rural household is located	——	——

Note: The data in this table are calculated by authors. SD = standard deviation. CPC is the abbreviation of the Communist Party of China.

The values of Gini coefficient showed that the highest is the western province areas, and the lowest is the eastern province areas, which means that the income inequality of rural households in western provinces is the most serious, while the eastern provinces was the lightest. The values of Theil index reflected a similar trend. We can also report that the values of Gini coefficient in the whole area and three small sub-areas are all more than 0.4 (international warning line of income inequality), which means the income gap between rural households in the whole study area and three small sub-areas is very large.

Quantile regression

We used quantile regression to examine the influence of livelihood capitals on rural household

Figure 3 - Kernel density estimate of income1 – income6.

Note: income1 means log of rural household total income in 2015; income2 means log of per capita income of rural household in 2015; income3 means log of agricultural income of rural household in 2015; income4 means log of wage income of rural household in 2015; income5 means log of operational income of rural household in 2015; income6 means log of property income of rural household in 2015.

income. Separately, we used 6 quantile regressions to check the effect of livelihood capitals on income1 to income6 which represent total household income, per capita income, agricultural income, wage income, operational income, and property income of a rural household.

Livelihood capitals affecting income1

Table 3 reports the results of livelihood capital variables affecting income1, viz., total household income. We can observe from table 3 that not all variables related to natural, material, human,

financial, and social capitals have significant effects on increasing rural households' income across different quartiles.

In natural capitals, cultivated land variable has no significant effect on total household income. The coefficient of return to forest_land variable of the high- and middle-income groups is higher than that of the low-income group, which means the area of forest land magnifies income inequality among rural households.

In material capitals, the coefficient of return to tractor variable of the low-income group is higher

Table 2 - Variation of income inequality in the entire study area and sub-study areas.

	Western provinces	Central provinces	Eastern provinces	entire study area
---FGT poverty index--				
Breadth of poverty (H)	0.282	0.235	0.185	0.228
Depth of poverty (PG)	0.175	0.153	0.127	0.148
Intensity of poverty (SPG)	0.125	0.118	0.102	0.113
Gini coefficient	0.546	0.527	0.533	0.549
Theil index	0.514	0.444	0.451	0.496

Note: The data in this table are calculated by authors. FGT poverty index means Foster–Greer–Thorbecke poverty index.

than that of the middle- and high-income groups, which means the number of tractors narrows income inequality among rural households.

In human capitals, the coefficient of return to education variable of the high-income group is higher than that of the middle- and low-income groups, which means the education magnifies income inequality among rural households. Coefficients of return to book variable of the low-, middle-, and high-income groups were similar, which means books can improve income of the three groups, and it neither widen nor narrow the income gap among rural households.

In financial capitals, the coefficients of variables are all not significant. The coefficients of return to financial_product and loan variables of high-income group were both positive, while the coefficients of return to the two variables of low- and middle-income groups were negative, which means the financial_product and loan widen the income gap among rural households to some extent.

In social capitals, the coefficient of return to internet variable of low-income group was the largest, the coefficient of middle group was in the middle, and the coefficient of high-income group was the smallest, which means the internet narrows the income gap among rural households.

Livelihood capitals affecting income2

Table 4 reports the results of livelihood capital variables affecting income2, viz., per capita income of rural household. In natural capitals, the coefficients of return to cultivated_land and forest_land variables of the high-income group are higher than that of the low-income group, which means the areas of cultivated and forest lands magnify per capita income gap among rural households.

In material capitals, no variable has positively significant effect on per capita income. However, the coefficients of return to tractor variable

of low-income group is positive, while the coefficient of high-income group was negative, which means the tractor narrows the per capita income gap among rural households to some extent.

In human capitals, the coefficient of return to education variable of the high-income group is higher than that of the middle- and low-income groups, which means the education magnifies per capita income inequality among rural households. Coefficients of return to book variable of the low-, middle-, and high-income groups are similar, which means books can improve income of the three groups, and it neither widen nor narrow the per capita income gap among rural households.

In financial capitals, the coefficients of financial_product and loan variables of low- and high-income groups are both not significant. However, the coefficients of return to financial_product variable of high-income group was positive, while the coefficient of low-income group was negative, which means the financial_product widens the per capita income gap among rural households to some extent.

In social capitals, the coefficient of return to internet variable of low-income group was higher than that of the middle- and high-income groups, which means the internet narrows the per capita income gap among rural households.

Livelihood capitals affecting income3

Table 5 reports the results of livelihood capital variables affecting income3, viz., agricultural income of rural household. In natural capitals, the coefficient of return to cultivated_land variable of the low-income group is higher than that of the high-income group, which means the areas of cultivated land narrow agricultural income gap among rural households.

In material capitals, the coefficient of return to tractor variable of the low-income group

Table 3 - Quantile regression result of variables affecting income1 (total household income).

Variables	Q25	Q50	Q75
Cultivated_land	0.013	0.003	0.009
	(0.009)	(0.007)	(0.007)
Forest_land	0.008	0.016[*]	0.022[**]
	(0.012)	(0.010)	(0.010)
Tractor	0.110[*]	0.066	-0.022
	(0.060)	(0.051)	(0.050)
Implement	0.156	0.160	0.070
	(0.130)	(0.111)	(0.108)
Livestock	-0.285[***]	-0.332[***]	-0.264[***]
	(0.073)	(0.063)	(0.061)
Education	0.348	0.350	0.549[**]
	(0.274)	(0.234)	(0.227)
Book	0.006[***]	0.007[***]	0.005[***]
	(0.002)	(0.002)	(0.002)
Financial_product	-0.157	-0.239	0.229
	(0.230)	(0.196)	(0.191)
Loan	-0.060	-0.013	0.006
	(0.178)	(0.152)	(0.148)
Party	0.047	0.044	0.016
	(0.064)	(0.055)	(0.053)
Internet	0.709[***]	0.569[***]	0.374[***]
	(0.049)	(0.042)	(0.041)
Soil_pollution	-0.005	-0.029	-0.020
	(0.034)	(0.029)	(0.028)
Cost	0.220[***]	0.172[***]	0.135[***]
	(0.017)	(0.014)	(0.014)
Labor	-0.406[***]	-0.288[***]	-0.074
	(0.103)	(0.088)	(0.086)
Family_size	0.024[***]	0.042[***]	0.071[***]
	(0.009)	(0.008)	(0.007)
Relationship	0.063[***]	0.063[***]	0.045[***]
	(0.015)	(0.013)	(0.013)
Central_provinces	0.110[***]	0.090[***]	0.067[***]
	(0.029)	(0.025)	(0.024)
Eastern_provinces	0.093[***]	0.091[***]	0.078[***]
	(0.019)	(0.016)	(0.015)
Constant	6.605[***]	7.704[***]	8.553[***]
	(0.216)	(0.184)	(0.179)
Observations	---4,306--		

Note: Standard errors in parentheses. [***] $P<0.01$, [**] $P<0.05$, [*] $P<0.1$.

is higher than that of the middle- and high-income groups, which means the tractor narrows agricultural income gap among rural households.

In human capitals, no variable has a significant effect on agricultural income of rural households. However, the coefficients of return to education variable of low-income group was positive, while the coefficients of middle- and high-income groups are both negative, which means the education narrows the agricultural income gap among rural households to some extent.

In financial capitals, the coefficient of return to loan variable of the high-income group was significantly positive, while the coefficient of that of low-income group is negative. It means loan magnifies agricultural income gap among rural households.

In social capitals, the coefficient of return to party variable of the low- and middle-income groups are higher than that of the high-income group, which means party narrows agricultural income gap among rural households. The coefficient of return to

Table 4 - Quantile regression result of variables affecting income2 (per capita income of rural household).

Variables	Q25	Q50	Q75
Cultivated_land	0.020**	0.010	0.023***
	(0.008)	(0.007)	(0.007)
Forest_land	0.002	0.020**	0.024**
	(0.011)	(0.009)	(0.010)
Tractor	0.077	0.041	-0.034
	(0.059)	(0.048)	(0.051)
Implement	0.114	0.097	0.025
	(0.128)	(0.105)	(0.111)
Livestock	-0.273***	-0.370***	-0.285***
	(0.073)	(0.059)	(0.063)
Education	0.349	0.280	0.537**
	(0.270)	(0.221)	(0.235)
Book	0.005***	0.006***	0.005***
	(0.002)	(0.002)	(0.002)
Financial_product	-0.234	-0.307*	0.043
	(0.227)	(0.185)	(0.197)
Loan	0.031	-0.027	0.108
	(0.176)	(0.144)	(0.153)
Party	0.092	0.084	0.041
	(0.063)	(0.052)	(0.055)
Internet	0.649***	0.499***	0.320***
	(0.048)	(0.039)	(0.042)
Soil_pollution	0.009	-0.025	-0.027
	(0.034)	(0.027)	(0.029)
Cost	0.197***	0.165***	0.122***
	(0.017)	(0.014)	(0.015)
Labor	0.202**	0.279***	0.344***
	(0.102)	(0.083)	(0.088)
Family_size	-0.107***	-0.087***	-0.067***
	(0.009)	(0.007)	(0.008)
Relationship	0.066***	0.064***	0.050***
	(0.015)	(0.012)	(0.013)
Central_provinces	0.116***	0.110***	0.076***
	(0.029)	(0.024)	(0.025)
Eastern_provinces	0.104***	0.112***	0.094***
	(0.018)	(0.015)	(0.016)
Constant	5.634***	6.622***	7.626***
	(0.213)	(0.174)	(0.185)
Observations	----------------------------------4,306----------------------------------		

Note: Standard errors in parentheses. *** P<0.01, ** P<0.05, * P<0.1.

internet variable of the high-income group is higher than that of the low- and middle-income groups, which means internet magnifies agricultural income gap among rural households.

Livelihood capitals affecting income4

Table 6 reports the results of livelihood capital variables affecting income4, viz., wage income of rural household. We can observe from table 6 that

Table 5 - Quantile regression result of variables affecting income3 (agricultural income of rural household).

Variables	Q25	Q50	Q75
Cultivated_land	0.018**	0.011*	0.007
	(0.008)	(0.007)	(0.008)
Forest_land	-0.005	0.020**	0.019
	(0.011)	(0.010)	(0.012)
Tractor	0.348***	0.290***	0.247***
	(0.052)	(0.044)	(0.055)
Implement	0.143	0.093	0.152
	(0.111)	(0.095)	(0.119)
Livestock	0.011	-0.039	-0.101
	(0.064)	(0.054)	(0.068)
Education	0.018	-0.081	-0.186
	(0.244)	(0.208)	(0.261)
Book	-0.000	-0.000	0.001
	(0.002)	(0.001)	(0.002)
Financial_product	-0.280	-0.042	0.076
	(0.210)	(0.179)	(0.225)
Loan	-0.154	0.012	0.279*
	(0.154)	(0.131)	(0.165)
Party	0.099*	0.111**	0.045
	(0.058)	(0.050)	(0.062)
Internet	0.147***	0.141***	0.220***
	(0.044)	(0.038)	(0.047)
Soil_pollution	0.055*	0.036	0.047
	(0.031)	(0.026)	(0.033)
Cost	0.572***	0.602***	0.494***
	(0.016)	(0.013)	(0.017)
Labor	0.189*	0.153*	0.225**
	(0.105)	(0.089)	(0.112)
Family_size	0.003	0.006	0.003
	(0.009)	(0.007)	(0.009)
Relationship	0.024*	0.018	0.024
	(0.014)	(0.012)	(0.015)
Central_provinces	0.064**	0.013	-0.034
	(0.026)	(0.023)	(0.028)
Eastern_provinces	-0.002	-0.010	-0.026
	(0.017)	(0.014)	(0.018)
Constant	3.140***	3.661***	5.094***
	(0.200)	(0.170)	(0.214)
Observations	--3,513--		

Note: Standard errors in parentheses. *** P<0.01, ** P<0.05, * P<0.1.

just three variables (education, book, and internet) have significant effect on wage income for all low-, middle-, and high-income groups. the coefficient of return to education variable of the high-income group is higher than that of the middle- and low-income groups, which means education magnifies wage income inequality among rural households. The coefficients of return to book variable of the low-, middle-, and high-income

Table 6 – Quantile regression result of variables affecting income4 (wage income of rural household).

Variables	Q25	Q50	Q75
Cultivated_land	-0.012	-0.001	-0.007
	(0.012)	(0.011)	(0.010)
Forest_land	0.000	0.006	0.012
	(0.014)	(0.013)	(0.012)
Tractor	-0.240***	-0.052	-0.025
	(0.082)	(0.073)	(0.070)
Implement	-0.081	-0.263*	-0.171
	(0.174)	(0.155)	(0.148)
Livestock	-0.173	-0.051	-0.152
	(0.113)	(0.100)	(0.096)
Education	0.551*	0.822***	1.019***
	(0.335)	(0.298)	(0.285)
Book	0.004*	0.004*	0.004*
	(0.002)	(0.002)	(0.002)
Financial_product	-0.203	-0.051	0.486**
	(0.284)	(0.252)	(0.242)
Loan	-0.081	-0.129	0.150
	(0.269)	(0.239)	(0.229)
Party	-0.001	0.001	-0.030
	(0.079)	(0.070)	(0.067)
Internet	0.441***	0.308***	0.223***
	(0.062)	(0.055)	(0.053)
Soil_pollution	-0.108**	-0.083**	-0.047
	(0.044)	(0.039)	(0.037)
Cost	0.029	0.026	0.056***
	(0.022)	(0.020)	(0.019)
Labor	-0.523***	-0.270**	-0.135
	(0.135)	(0.120)	(0.115)
Family_size	0.029**	0.044***	0.067***
	(0.011)	(0.010)	(0.010)
Relationship	0.030	0.030*	0.023
	(0.020)	(0.018)	(0.017)
Central_provinces	0.080**	0.079**	0.076**
	(0.039)	(0.035)	(0.033)
Eastern_provinces	0.079***	0.108***	0.098***
	(0.024)	(0.022)	(0.021)
Constant	9.052***	9.437***	9.548***
	(0.280)	(0.249)	(0.238)
Observations	---2,018---		

Note: Standard errors in parentheses. *** $P<0.01$, ** $P<0.05$, * $P<0.1$.

groups are same, which means books can improve income of the three groups, and it neither widen nor narrow the wage income gap among rural households. The coefficient of return to internet variable of low-income group is the largest, the coefficient of middle group is in the middle, and the coefficient of high-income group is the smallest, which means internet narrows the wage income gap among rural households.

Table 7 - Quantile regression result of variables affecting income5 (operational income of rural household).

Variables	Q25	Q50	Q75
Cultivated_land	0.003	0.004	0.002
	(0.049)	(0.034)	(0.027)
Forest_land	0.033	0.019	0.002
	(0.044)	(0.031)	(0.025)
Tractor	-0.071	-0.181	0.086
	(0.334)	(0.230)	(0.185)
Implement	-0.653	-0.360	-0.500[*]
	(0.528)	(0.363)	(0.292)
Livestock	0.450	0.002	-0.608[***]
	(0.404)	(0.278)	(0.223)
Education	-0.572	-0.510	-0.685
	(1.152)	(0.792)	(0.636)
Book	-0.002	-0.001	0.004
	(0.009)	(0.006)	(0.005)
Financial_product	0.812	0.217	-0.393
	(1.142)	(0.785)	(0.631)
Loan	0.335	0.254	0.117
	(0.597)	(0.410)	(0.329)
Party	-0.074	0.028	0.130
	(0.304)	(0.209)	(0.168)
Internet	0.707[***]	0.463[***]	0.203
	(0.252)	(0.173)	(0.139)
Soil_pollution	-0.208	-0.014	-0.097
	(0.161)	(0.110)	(0.089)
Cost	0.162[**]	0.120[**]	0.186[***]
	(0.074)	(0.051)	(0.041)
Labor	0.129	-0.323	-0.619[*]
	(0.605)	(0.415)	(0.334)
Family_size	0.058	0.044	0.019
	(0.047)	(0.032)	(0.026)
Relationship	-0.058	0.044	0.038
	(0.096)	(0.066)	(0.053)
Central_provinces	0.216	0.273[***]	0.106
	(0.153)	(0.105)	(0.084)
Eastern_provinces	0.259[***]	0.270[***]	0.142[***]
	(0.090)	(0.062)	(0.050)
Constant	7.596[***]	7.759[***]	8.911[***]
	(1.104)	(0.759)	(0.610)
Observations	---376---		

Note: Standard errors in parentheses. [***] P<0.01, [**] P<0.05, [*] P<0.1.

Livelihood capitals affecting income5

Table 7 reports the results of livelihood capital variables affecting income5, viz., operational income of rural household. According to our observation, only the results of the internet have enlightening significance. The coefficient of return to internet variable of low-income group is the largest, the coefficient of middle group is in the middle, and

the coefficient of high-income group is the smallest, which means internet narrows the operational income gap among rural households.

Livelihood capitals affecting income6

Table 8 reports the results of livelihood capital variables affecting income6, viz., property

Table 8 - Quantile regression result of variables affecting income6 (property income of rural household).

Variables	Q25	Q50	Q75
Cultivated_land	-0.031	0.032	-0.012
	(0.058)	(0.061)	(0.052)
Forest_land	0.211	-0.004	-0.018
	(0.186)	(0.196)	(0.165)
Tractor	0.272	0.022	-0.187
	(0.510)	(0.538)	(0.454)
Implement	1.130	0.259	-0.143
	(1.109)	(1.171)	(0.987)
Livestock	-0.664	-1.015	0.118
	(1.229)	(1.297)	(1.093)
Education	3.663[*]	1.320	0.808
	(1.964)	(2.073)	(1.748)
Book	0.026[**]	0.014	0.001
	(0.012)	(0.012)	(0.010)
Financial_product	-0.320	1.179	-0.464
	(1.476)	(1.558)	(1.313)
Loan	0.858	0.685	0.566
	(1.019)	(1.076)	(0.907)
Party	-0.355	-0.428	0.295
	(0.458)	(0.483)	(0.408)
Internet	-0.090	0.556	0.608[*]
	(0.401)	(0.424)	(0.357)
Soil_pollution	0.256	-0.278	-0.197
	(0.240)	(0.253)	(0.213)
Cost	0.260[**]	0.300[***]	0.117
	(0.104)	(0.109)	(0.092)
Labor	0.917	0.737	0.216
	(1.078)	(1.138)	(0.959)
Family_size	0.009	0.007	0.050
	(0.069)	(0.073)	(0.061)
Relationship	-0.070	0.053	0.004
	(0.136)	(0.143)	(0.121)
Central_provinces	0.063	-0.099	0.032
	(0.270)	(0.285)	(0.240)
Eastern_provinces	-0.056	-0.425[***]	-0.266[*]
	(0.152)	(0.161)	(0.135)
Constant	3.998[***]	6.296[***]	8.643[***]
	(1.442)	(1.522)	(1.283)
Observations	--135--		

Note: Standard errors in parentheses. [***] P<0.01, [**] P<0.05, [*] P<0.1.

income of rural household. Coefficient of return to education variable of the low-income group is higher than that of the middle- and high-income groups, which means education narrows property income inequality among rural households. The coefficients of return to book variable of the low-income is higher than that of the middle-, and high-income groups, which means books narrow the property income gap among rural households. The coefficient of internet variable of high-income group is significantly positive, while the coefficient of low-income group was negative, which means internet widens the property income gap among rural households.

A concluding analysis

The influence of various livelihood capitals on various income inequalities of rural households is reported in table 9. We can observe from table 9 that; although, the area of cultivated land reduces agricultural income inequality, it increases per capita income inequality. Forest land area enlarges per capita income inequality and total household income inequality. Tractor reduces inequality in agricultural

income and total household income. While reducing the property income inequality, education enlarges the wage income inequality, the per capita income inequality and the total household income inequality. Books variable reduced property income inequality. Loans increased inequality in agricultural incomes. Party variable reduced the agricultural income inequality. Although, the internet variable increased agricultural income inequality, and property income inequality, it reduced wage income inequality, operational income inequality, per capita income, and total household income inequality. In total, different livelihood capital has different effect on the income inequality of rural households.
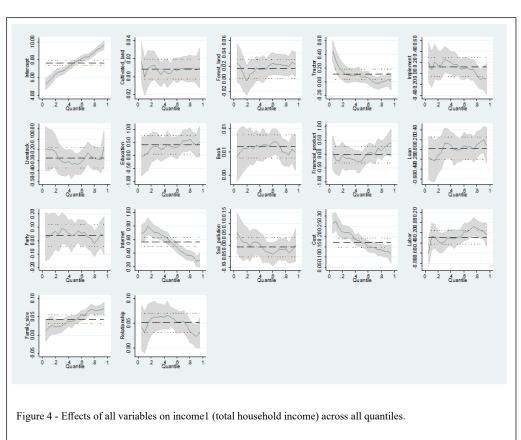
Stability analysis

Quantile regression model can explain the change of different kinds of rural household income intuitively and adequately as shown in figure 4, 5, 6, 7, 8, and 9. The fluctuation of solid line reflected the change of regression coefficient. From figure 4, 5, 6, 7, 8, and 9 we can find that overall, the quantile regression results are consistent with the significant variables in table 3-8, indicating that the results are

Table 9 - Livelihood capital variables affecting income inequality.

	Income1	Income2	Income3	Income4	Income5	Income6
---Natural capitals--						
Cultivated_land			Increased	Decreased		
Forest_land	Increased	Increased				
---Material capitals--						
Tractor	Decreased		Decreased			
Implement						
Livestock						
---Human capitals--						
Education	Increased	Increased		Increased		Decreased
Book						Decreased
---Financial capitals--						
Financial_product						
Loan			Increased			
---Social capitals--						
Party			Decreased			
Internet	Decreased	Decreased	Increased	Decreased	Decreased	Increased

Note: income1 means log of rural household total income in 2015; income2 means log of per capita income of rural household in 2015; income3 means log of agricultural income of rural household in 2015; income4 means log of wage income of rural household in 2015; income5 means log of operational income of rural household in 2015; income6 means log of property income of rural household in 2015.

Figure 4 - Effects of all variables on income1 (total household income) across all quantiles.

Note: The dotted line shows the estimation of quantile regression for the quantiles from 0.1 to 0.9; the line of departure in the middle part of each figure represents the OLS coefficient. Dotted lines indicate 90% confidence intervals.

stable.

CONCLUSION AND POLICY IMPLICATIONS

We used the data of the China Labor-force Dynamics Survey 2014 to examine the effects of livelihood capitals which include natural, material, human, financial, and social capitals on total household income, per capita income, agricultural income, wage income, operational income, and property income inequality among rural households in China. The results showed that different kinds of livelihood capitals have different effects on different types of rural households' income.

Our findings can help policy makers and anti-poverty workers to better understand what livelihood capitals play important roles in income inequality among rural household in China and their effects across different quantiles of the income groups. It may be beneficial to bring accurate poverty alleviation policies into force in rural regions of China by identifying the livelihood capitals that are connected to poverty.

Our findings have several policy implications. First, the reason why natural capitals including cultivated land and forest land widen the income gap was that low-income farmers lack agricultural technology, which leads to low productivity from land. Therefore, the government and poverty alleviation workers should provide more agricultural technology training to low-income farmers to help them improve land productivity.

Second, tractor variable reduces inequality in agricultural income and total household income. This means that tractors bring more income to low-income farmers. However, a real problem is that low-income farmers may not have enough income to invest in tractors. Therefore, this problem can be solved by establishing tractor leasing market. Low-income farmers rent tractors to solve the problem of lack of production tools and lack of income to invest in tractors.
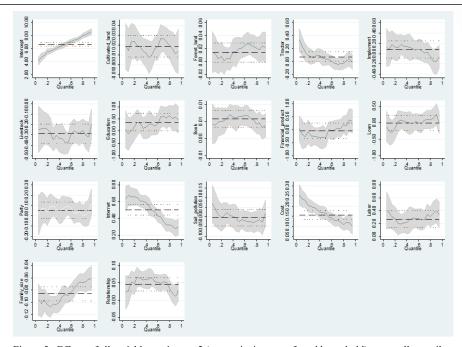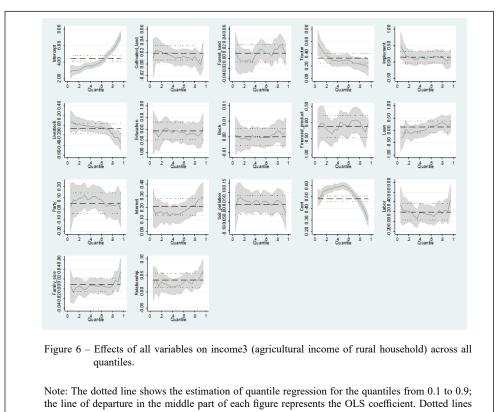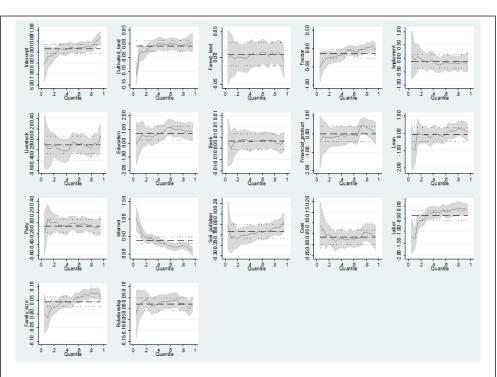
Figure 5 - Effects of all variables on income2 (per capita income of rural household) across all quantiles.

Note: The dotted line shows the estimation of quantile regression for the quantiles from 0.1 to 0.9; the line of departure in the middle part of each figure represents the OLS coefficient. Dotted lines indicate 90% confidence intervals.
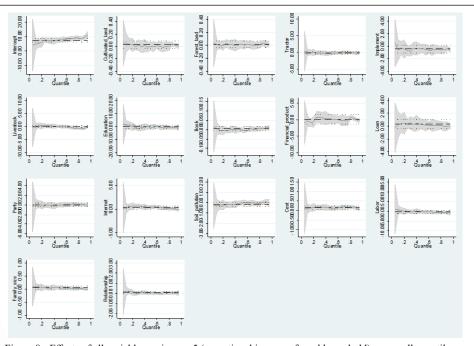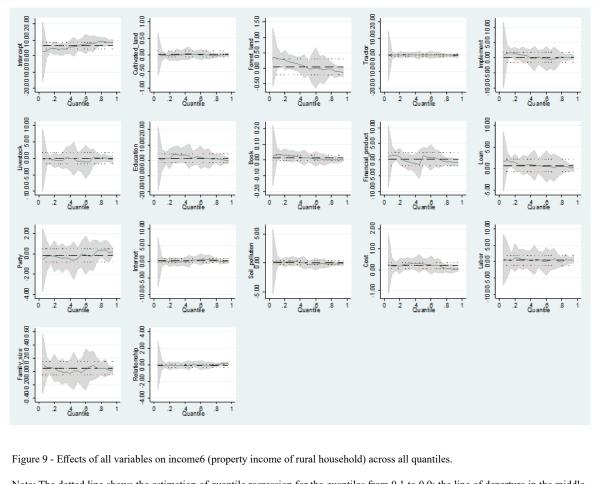

Figure 6 – Effects of all variables on income3 (agricultural income of rural household) across all quantiles.

Note: The dotted line shows the estimation of quantile regression for the quantiles from 0.1 to 0.9; the line of departure in the middle part of each figure represents the OLS coefficient. Dotted lines indicate 90% confidence intervals.

Figure 7 - Effects of all variables on income4 (wage income of rural household) across all quantiles.

Note: The dotted line shows the estimation of quantile regression for the quantiles from 0.1 to 0.9; the line of departure in the middle part of each figure represents the OLS coefficient. Dotted lines indicate 90% confidence intervals.

Figure 8 - Effects of all variables on income5 (operational income of rural household) across all quantiles.

Note: The dotted line shows the estimation of quantile regression for the quantiles from 0.1 to 0.9; the line of departure in the middle part of each figure represents the OLS coefficient. Dotted lines indicate 90% confidence intervals.

Third, overall, education increases income inequality. The education level of low-income group is generally low. Therefore, government or poverty alleviation workers should help low-income farmers improve their education. Starting from two aspects, one is to re-educate adults and provide vocational training for adults, the other is to help minors receive education, such as subsidizing tuition fees and nutritional meals. Relevant research showed that the development of about 30% of children aged 0 to 3 in remote rural areas in China is relatively lagging, and they are called "vulnerable children". These children may face unemployment and poverty when they grow up, which will cause great burden to society. Therefore, it is necessary for the government and families to invest in children's early education.

Fourth, book variable reduces property income inequality. Books are an information base. Books can help farmers get the technology of increasing income and market information of production. Therefore, the government could provide farmers, especially low-income farmers, with some production technology books, and books related to market information free of charge. At the same time, improve their reading ability through training.

Fifth, loan variable increases inequality in agricultural incomes. The reason for the possibility is that the low-income group has insufficient experience in the use and management of loan funds. Therefore, the government or poverty alleviation workers should provide investment decision-making suggestions for low-income farmers, help them better use loans, so that loans can promote income growth, rather than increasing the income gap between low-income group and high-income group.

Sixth, party variable reduces the agricultural income inequality. Therefore, we should

Figure 9 - Effects of all variables on income6 (property income of rural household) across all quantiles.

Note: The dotted line shows the estimation of quantile regression for the quantiles from 0.1 to 0.9; the line of departure in the middle part of each figure represents the OLS coefficient. Dotted lines indicate 90% confidence intervals.

attach importance to the development of CPC members among low-income farmers. Although, their income is low, they still have public political consciousness. Moreover, this political consciousness is conducive to their access to resources and income.

Seventh, the internet is generally conducive to reducing income inequality. Therefore, the government or poverty alleviation workers should build internet infrastructure in rural areas, especially in remote rural areas of China. Through training low-income farmers to use the internet to obtain market information, learn agricultural technology, sell their agricultural products, achieving income growth.

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DECLARATION OF CONFLICT OF INTERESTS

The authors declare no conflict of interest. The founding sponsors had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript, and in the decision to publish the results.

AUTHORS' CONTRIBUTIONS

All authors have made contributions to the present research. Fan Yang was fully engaged in the paper writing and revision. Yao Jiang was offered great insights in theoretical part and as the co-first author. Weizhong Zeng played the role of a supervisor.

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