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Rural Transformation, Income Growth and Poverty Reduction by Province in China in the Past Four Decades

by
Jikun Huang
Pengfei Shi

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ISBN 978-92-9266-325-4
Printed June 2023

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Acknowledgements

The authors acknowledge the financial support from the International Fund for Agricultural Development (IFAD: 2000000866), the Australian Centre for International Agricultural Research (ADP/2017/024) and the National Natural Science Foundation of China (No. 71934003).

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Abstract

China has experienced rapid rural transformation in the past four decades. Accompanying the rapid transformation are a significant rise in rural household income and a substantial fall in rural poverty. Based on the indicators of rural transformation (share of high-value agriculture and share of rural labour employment in non-farm activities) and its outcomes (per capita income and poverty incidence), this paper examines the evolutions of and the relationships between provincial rural transformation and its major outcomes. The results show that all provinces have undergone significant rural transformation, but the level and speed of transformation has differed considerably among provinces. Both graphic and regression analyses indicate that there is strong correlation between the level of rural transformation and its outcomes: a higher level of transformation is often positively associated with a higher level of per capital income and a lower level of poverty incidence in rural China. Furthermore, a general category of provincial rural transformation in terms of high-value agriculture and rural labours' non-farm employment is conducted. The likely impacts of institutions, policies and investments on rural transformation are also discussed. The paper concludes with several policy implications.

Keywords: rural transformation, income, poverty, China.

1. Introduction

China has experienced rapid agricultural growth and rural transformation (RT) since the rural reform initiated in the late 1970s. Over the past four decades, the value of agricultural output has grown at an annual rate of 5.4 per cent in real terms. While grain production has grown steadily, other crops, such as horticulture, have grown much faster (NBSC, 2020). Compared with crops, livestock and fishery production have grown even faster, and their share in agricultural output value increased from less than 17 per cent in 1978 to 37 per cent in 2019 (NBSC, 2020). Over the same period, the structure of employment in rural China has also changed dramatically. Rural labour has gradually shifted from farm to non-farm activities. The share of full- or part-time off-farm work in rural labour increased from 9.3 per cent in 1978 to 84.4 per cent in 2018 (Li et al., 2021).

The rapid RT has been accompanied by rapid income growth and poverty reduction in rural China. Between 1978 and 2019, per capita rural income in real terms increased by nearly 22 times (NBSC, 2020). Based on the current poverty line in China (about US$3/day in 2011 purchasing power parity), the incidence of rural poverty declined from 97.5 per cent in 1978 to 0.6 per cent in 2019. Recently, the national leader declared that China had completely eliminated rural poverty by the end of 2020, implying that about 770 million people in rural areas have escaped poverty since 1978.

While success has been made throughout the whole country, the speed of RT and its effects on raising rural income and reducing rural poverty have differed across provinces over the past four decades. On the one hand, this relates to their performance in changing their agricultural production structure, moving from producing low-value to high-value commodities (Gao et al., 2014; Liu et al., 2016; Huang and Li, 2019). On the other hand, the participation rate of rural labour in non-farm employment has also varied substantially across provinces (Liu et al., 2018; Zhang et al., 2018). Although average rural income has increased significantly for all provinces, income disparities among and within regions have grown over time (Li et al., 2015; Huang and Shi, 2021).

Several recent studies have suggested that inclusive RT can be achieved through a faster RT. For example, the International Fund for Agricultural Development (IFAD) and the Food and Agriculture Organization of the United Nations (FAO) reported that successful RT is accompanied by faster rural poverty reduction (IFAD, 2016; FAO, 2017). For the developing countries in Asia, Huang (2018) also found that a faster reduction in rural poverty incidence is often associated with a faster RT. However, all these studies are based on aggregate national-level data.

Although RT has also received increasing attention in China, there is a lack of systematic analysis of its pathways and consequences in different regions. A series of studies have developed several indicators to measure RT and conduct RT typology analysis (Long et al., 2012; Meng et al., 2013; Zhao et al., 2014). However, most studies either focused on specific regions or analysed RT over a short time period. Considering the vast territory and the considerable variation in levels of rural development among provinces, it is more interesting to analyse regional RT at the provincial level over a much longer time frame.

To fill the above-mentioned research gaps in the literature, this study aims to analyse the pathways of RT and examine the relationship between RT and its outcomes at the provincial level. To achieve these goals, the rest of the paper is organized as follows. Section 2 presents the definition of RT and the indicators for RT and its outcomes in China. Section 3 illustrates the general trends and variations in RT by province between 1978 and 2018. Section 4 investigates the relationships between provincial RT and rural income, as well as rural poverty incidence, by both graphic illustration and regression analysis. Section 5 provides a general classification of provincial RT based on the major indicators. Section 6 discusses the major institutions, policies and investments (IPIs) that might have facilitated RT in China based on the existing literature. The final section concludes this study.

2. Measuring rural transformation in China

RT often refers to agricultural transformation and rural employment transformation (Timmer, 2017; Reardon et al., 2007; Haggblade et al., 2010; Otsuka and Fan, 2021). The definition of RT given by IFAD (2016) is "the process involving rising agricultural productivity, commercialization and diversification of production patterns and livelihoods, and expanded off-farm employment". In China, RT has also been characterized by more commercialized and diversified agricultural production (Liu et al., 2016; Huang and Li, 2019), as well as a rapid rise in off-farm employment among rural labor (Liu et al., 2018; Zhang et al., 2018). In this study, we define RT in China as a process that gradually shifts the structure of production from low-value (or grain-based) agricultural commodities to more diversified high-value agricultural commodities, and changes rural employment from farm to non-farm sectors.

More specifically, moving from grain-dominated agriculture to high-value crops, livestock and fishery is the main feature of agricultural transformation in China. Grain accounted for more than 80 per cent of total crop sown area in 1978, but it declined to less than 70 per cent in 2019 (NBSC, 2020). To capture such a process, we use the share of the output value of non-grain agriculture in gross agricultural output value (excluding forestry) as an aggregate indicator for RT in agriculture (or RT1, Table 1). Moreover, we use the share of non-farm activities in rural employment (or RT2, Table 1) to reflect the rural employment transformation over the past four decades.

While the outcomes of RT have many dimensions (e.g. growth, equity, sustainability), this study focuses on two major areas: rural household income and rural poverty. We measure them by using two indicators available at the provincial level, which are per capita income of rural households and rural poverty incidence (Table 1). These two indicators cover the period between 1978 and 2018.

Table 1. Indicators for measuring rural transformation and outcomes

Dimensions	Indicators	Definitions
RT_1	Share of high-value agriculture	Share of the output value of cotton, oil crops, sugar crops, horticulture, livestock and aquaculture (or non-grain agriculture) in gross agricultural output value (excluding forestry)
RT_2	Share of rural labor employment in non-farm	Share of non-farm activities in rural employment
$Outcome_1$	Per capita rural income	Per capita income of rural households in real terms (at 2018 prices)
$Outcome_2$	Rural poverty incidence	Share of rural population living in poverty

Note: Data used to calculate the indicators in Table 1 are from the official data published by the Statistics Bureau of each province in China, and farm gate prices used to estimate the output value of high-value agriculture are from the *Data Compilation on Production Cost and Benefit of Nationwide Agricultural Commodities* published annually by the National Development and Reform Commission. The output value of high-value agriculture is calculated by the gross output value of farming, animal husbandry and fishery minus the output value of grain (e.g. rice, wheat, maize, other cereals, sweet potato, potato and soybean). The number of rural labors engaged in non-farm sectors is estimated by the total number of rural labors minus agricultural labors. Rural poverty incidence is comparable only within each of three sub-periods (1978-1999, 2000-2010 and 2011-2018) due to the change in the rural poverty line among these periods.

3. Provincial rural transformation and outcomes

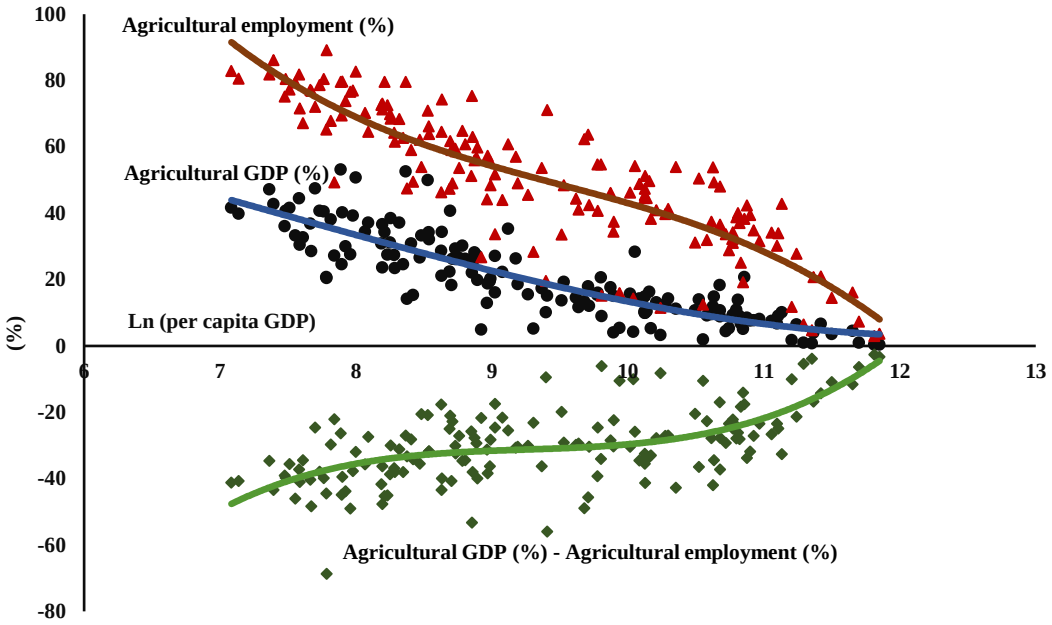
Considering that RT is embedded within structural transformation, so we first introduce structural transformation by using the share of agriculture in both gross domestic product (GDP) and employment (e.g. Timmer and Akkus, 2008; IFAD, 2016; Timmer, 2017; Huang, 2018a). To do this, we include all provinces in China in analyzing structural transformation due to the fact that structural transformation has occurred in every region in a similar way.

For RT, the major pathway of RT in China is also investigated. Notably, we exclude the provinces (Inner Mongolia, Tibet and Xinjiang) in the major pasture regions, the municipalities directly under the central government (Beijing, Tianjin and Shanghai), and an island province (Hainan). This is because RT within agriculture in those provinces and municipalities differs substantially from agricultural transformation in agricultural regions (e.g. moving from grain-based agriculture to more high-value agriculture).

3.1. Trend of provincial structural transformation

Figure 1 presents the structural transformation in all provinces between 1978 and 2018. Despite the rapid growth of agricultural GDP (an average annual growth rate of 4.5 per cent over the past four decades), the industry and service sectors have grown much faster, which has resulted in a significant fall in the agricultural share of total GDP. Structural transformation driven by urbanization and industrialization has created more employment opportunities for rural labor. Together with rising agricultural productivity, this means that the share of agricultural employment in the national economy has decreased by more than that of the agricultural share of total GDP. Over time, the gap between the share of agricultural employment in total employment and the share of agricultural GDP in total GDP has been narrowing (bottom line in Figure 1). This pattern of structural transformation is similar to those that occurred in many developed countries in the past. While it is also consistent with previous international comparison studies based on national aggregate data (Timmer, 2009; IFAD, 2016; Huang, 2018a), China has experienced a greater decline in the share of agricultural employment than many other developing countries, largely due to the faster growth of China's economy and the more significant expansion of labor-intensive manufacturing and service sectors that have created huge off-farm employment for rural labor (Cai and Wang, 2010; Huang and Shi, 2021). However, Figure 1 also shows that the level of structural transformation and the gap between the share of agricultural employment and the share of agricultural GDP differ considerably among provinces.

Figure 1. Convergence of the shares of provincial agricultural GDP and employment in 1978, 1988, 1998, 2008 and 2018



Source: See the note under Table 1.

Note: Per capita GDP is in real terms at 2018 prices. The triangle, circle and square dots represent agricultural employment (%), agricultural GDP (%), and the gap between agricultural GDP (%) and agricultural employment (%), respectively. Each dot represents an observation for a province in a year.

3.2. Trend of provincial structural transformation

Provincial RTs are presented in Figures 2 and 3. They show the changing trends in the share of high-value agriculture and the share of rural labor employment in non-farm, respectively. To simplify the presentation, we show data for only five years (1978, 1988, 1998, 2008 and 2018) from each province.

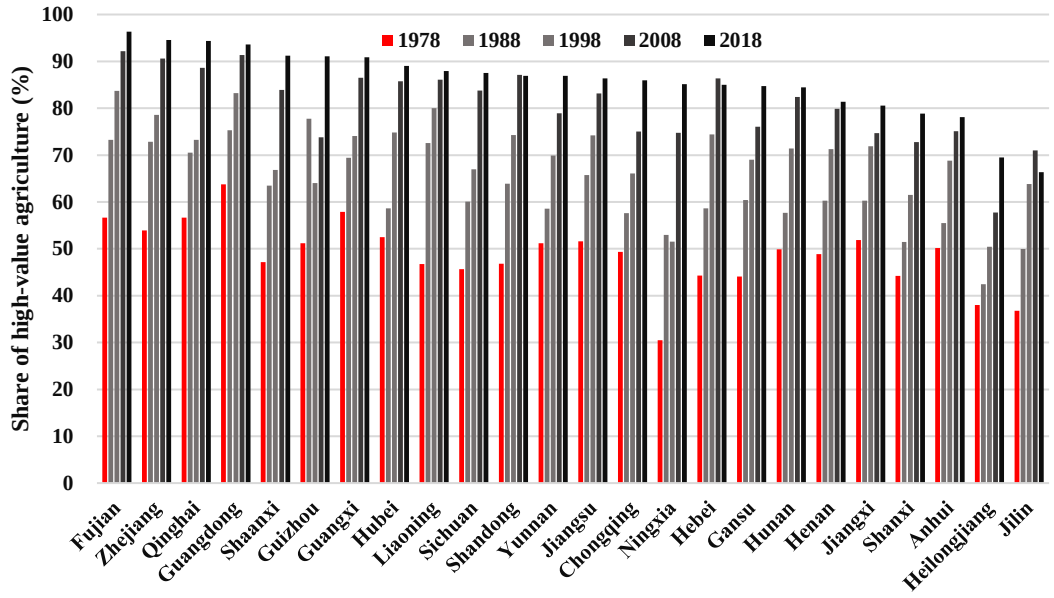
There are four interesting results regarding the move to high-value agriculture over the past four decades (Figure 2). First, all provinces have experienced rapid transformation from grain-based, low-value agriculture to more high-value agriculture, though there have been variations among provinces between 1978 and 2018. It is also interesting to note that the provinces with a higher share of high-value agriculture are generally associated with more developed market and transportation infrastructure (e.g. Zhejiang and Jiangsu). The provinces in northeast China with a relatively low level of high-value agriculture are closely linked to the national policy to promote grain production in this region (Huang and Shi, 2021).

Second, while the initial level of RT1 differed considerably across provinces, more than two thirds of provinces had a share of high-value agriculture exceeding 85 per cent in 2018. For example, the share of high-value agriculture in 1978 was 64 per cent in Guangdong, but only 31 per cent in Ningxia. By 2018, the share of high-value agriculture exceeded 85 per cent in Ningxia, which was only 9 percentage points less than in Guangdong (94 per cent).

Third, at the higher level of RT1, the speed of RT has slowed down significantly, particularly after the share of high-value agriculture exceeds 80 per cent, partly because China has implemented the Provincial Governor's Responsibility for Grain Security in all provinces.

Finally, many provinces with a lower initial level of RT1 have caught up by accelerating their RT in the later stage of transformation. Notably, Jilin is an exception in the most recent decade, since its share of high-value agriculture recorded a considerable fall between 2008 and 2018 (the last entry in Figure 2). This can be largely explained by the shift in agricultural production to maize and rice due to government polices supporting grain prices for the past decade (Huang and Shi, 2021).

Figure 2. Share of high-value agriculture by province in 1978, 1988, 1998, 2008 and 2018



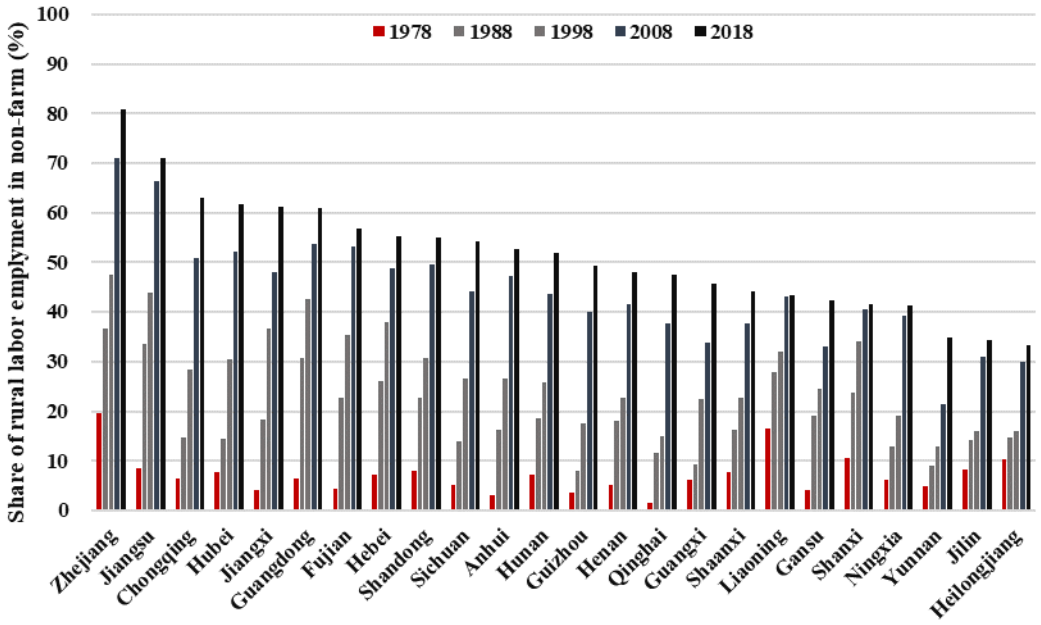
Source: See the note under Table 1.

Apart from rapid agricultural transformation, rural labor participation in non-farm activities also rose substantially between 1978 and 2018 (Figure 3). On average, only about 7 per cent of rural labor was engaged in non-farm sectors in 1978, but the share increased by 44 percentage points and reached 51 per cent in 2018. The most significant increase occurred between 1998 and 2008. However, Figure 3 also shows a large variation in RT in terms of rural non-farm employment across provinces. For example, rural households in the economically developed provinces (e.g. Zhejiang, Jiangsu, Guangdong and Fujian) have gained much more non-farm employment than those in the less developed regions (e.g. most provinces on the right-hand side of Figure 3), which is largely due to the faster urbanization and the more rapid expansion of labor-intensive manufacturing and service sectors in the eastern region over the past four decades (Huang and Shi, 2021).

Moreover, the starting points or initial levels were more or less comparable in 1978, but the extent of the increase in rural non-farm employment has differed among provinces over time. From 1978 to 1998, off-farm employment increased more rapidly in eastern China. For example, between 1978 and 1998, the shares in Jiangsu and Guangdong rose from 8 per cent to 44 per cent and from 6 per cent to 43 per cent, respectively, while shares in central provinces and western provinces were less than 30 per cent, due to less developed urban enterprises (Liu et al., 2018). Over the last twenty years, a significant rise in rural non-farm employment has occurred within less developed provinces in central and western China, compared to their relatively weak performance between 1978 and 1998. Taking Qinghai in the western region as an example, the share of rural employment in non-farm sectors increased from 2 per cent in

1978 to 15 per cent in 1998 and reached 48 per cent in 2018. Other provinces (e.g. Jilin, Heilongjiang, Yunnan, Shaanxi, Ningxia etc.) followed a similar trend.

Figure 3. Share of rural labor employment in non-farm by province in 1978, 1988, 1998, 2008 and 2018

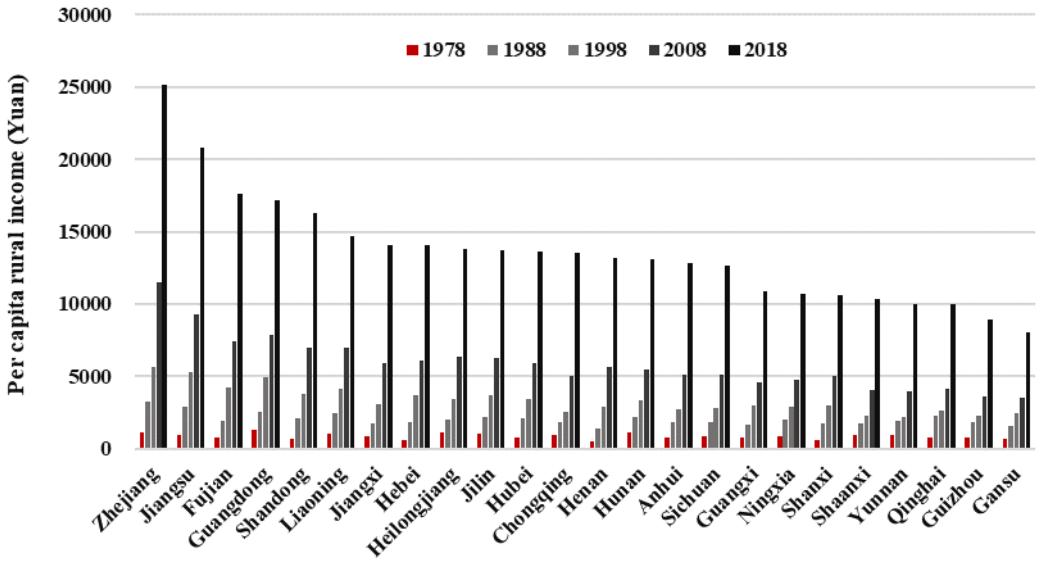


Source: See the note under Table 1.

3.3. Trend of per capita income and poverty incidence in rural areas

Figure 4 shows the per capita income of rural households at 2018 constant prices by province, where the provinces are ordered by income level in 2018 from the highest (left) to the lowest (right). There are a few interesting features characterized by the trend of per capita rural income for the last forty years. First, all provinces have experienced a significant increase in per capita income. Based on our estimation, the average income level in 2018 was 16 times that in 1978, ranging from about 10-13 times in western provinces (e.g. Yunnan, Guizhou, Gansu, Ningxia, Qinghai and Shaanxi) and some provinces in central China (e.g. Hunan) and northeast China (e.g. Heilongjiang and Jilin), to 22-25 times in several provinces in eastern coastal China (e.g. Zhejiang, Jiangsu, Fujian and Shandong) and Henan in central China. Second, there is a large variation in per capita income across provinces. In general, the provinces in eastern China have higher income than those provinces in central and western China. For example, in 2018, the top five provinces were all from the eastern region, and the bottom seven were all from the western region.

Figure 4. Per capita income of rural households by province in 1978, 1988, 1998, 2008 and 2018

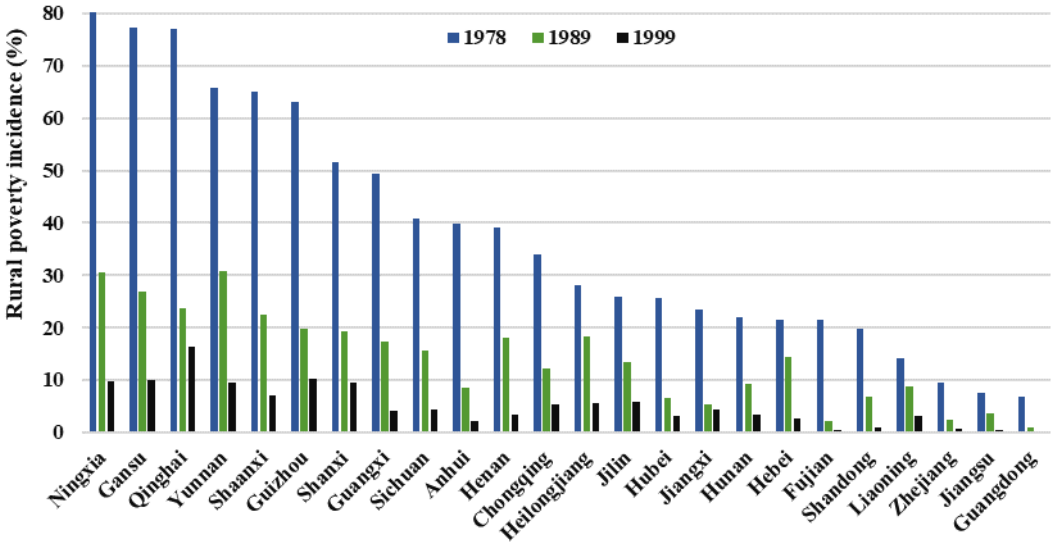


Source: See the note under Table 1.

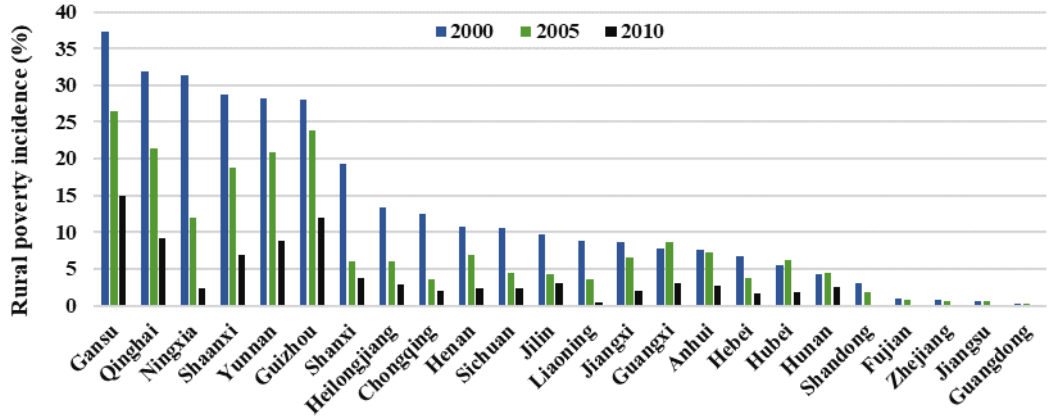
Figure 5 displays the trend in rural poverty incidence by different standards or periods: the 1978 standard for 1978-1999 (Panel A), the 2008 standards for 2000-2010 (Panel B), and the 2010 standard[1] for 2011-2018 (Panel C) (see Liu et al., 2018, for details). The order of provinces is based on the poverty incidence from the highest (left) to the lowest (right) in the last year within each period. As can be seen in Figure 5, the sharp decrease in rural poverty is the most successful story of China's RT and the national poverty alleviation plan. A close look at poverty incidence in three periods reveals that some provinces in eastern China have escaped rural poverty faster or earlier than other provinces. Although a significant decline in rural poverty incidences has occurred in each period in western China, the poverty level remains high under new poverty lines, compared with provinces in eastern and central China.

[1] The examination of rural poverty in China since the early 2010s is based on multiple dimensions. In addition to income poverty, the standard of poverty alleviation is defined as "no shortage of food and clothing, and compulsory education, basic medical care and housing are guaranteed".

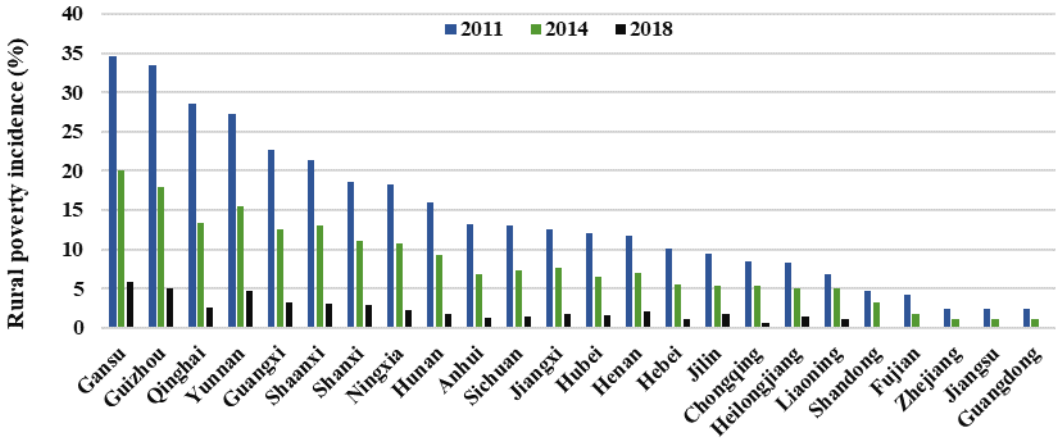
Figure 5. Rural poverty incidence by province between 1978-1999, 2000-2010 and 2011-2018 in China



Panel A. Rural poverty incidence at 1978 standard, 1978-1999



Panel B. Rural poverty incidence at 2008 standard, 2000-2010



Panel C. Rural poverty incidence at 2010 standard, 2011-2018[2]

Source: See the note under Table 1.

4. Correlation analysis between rural transformation and outcomes

We apply both graphic illustration and regression models to explore the potential relationship between RT and its outcomes[3]. The former method uses graphs to display the correlation between RT_1 or RT_2 and per capita income or poverty incidence. The latter method reveals the correlation between RT indicators and outcome variables by the ordinary least square (OLS) and the provincial fixed effect (FE) estimations. Moreover, we can calculate the turning points based on the estimated parameters as well.

4.1 Based on graphic illustration

To examine the relationship between provincial RT and per capita income of rural households, as well as rural poverty incidence between 1978 and 2018, we apply both the locally weighted scatterplot smoothing (LOWESS) method and the polynomial method to the fit the data for various provinces. Although the results based on the two methods are largely consistent, we find that the former performs better at fitting lines of provincial RT and per capita rural income, and the latter fits better for provincial RT and rural poverty incidence. To save space, we only present the results with a better fit.

As shown in Figure 6, the level and speed of RT1 differ among provinces, but there is a clear pattern: a higher RT1 is associated with a higher per capita rural income. It is interesting to note that their relationship is non-linear: per capita income tends to increase moderately in the early stage of RT1 and then rise dramatically after the share of high-value agriculture reaches about 60 per cent (Panel A). A much closer fit between RT1 and per capita rural income in the later stage of

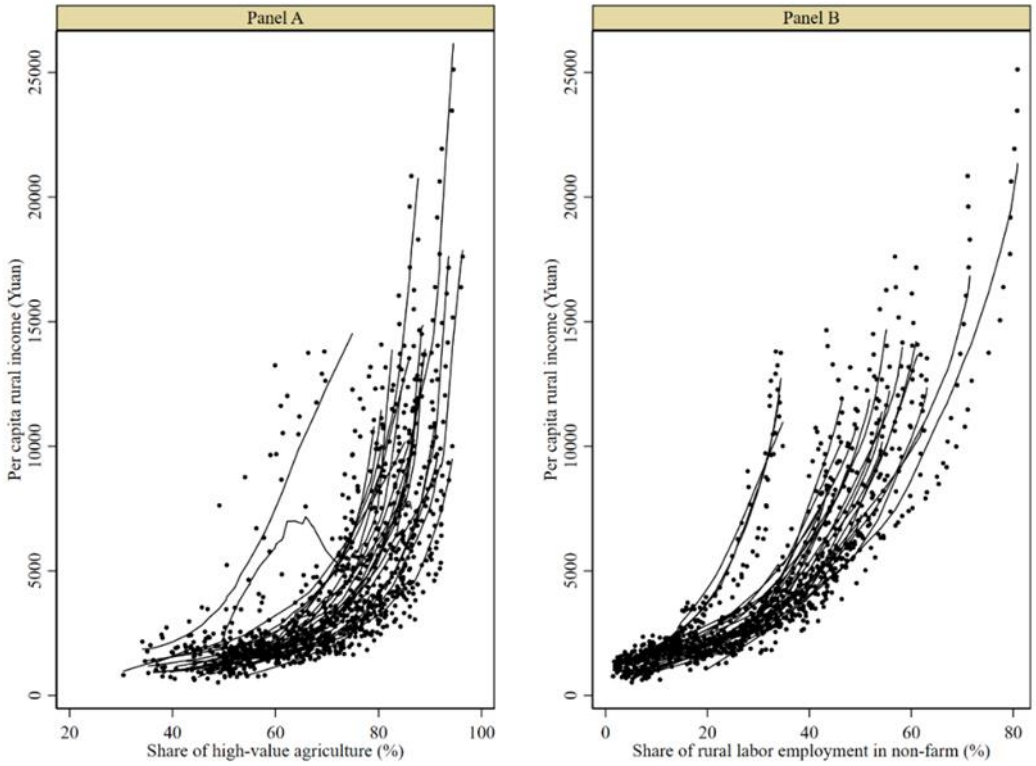
[2] By 2014, rural poverty incidence had fallen to 7.2 per cent. Further poverty alleviation has become more difficult because it is often not easy for the remaining people living in poverty to gain from overall economic growth and RT. Therefore, a targeted poverty reduction policy is necessary and has been implemented since 2014. With the government's political commitment to alleviate poverty by 2020, China has mobilized large amounts of resources to achieve its poverty alleviation goal in the short term. But given the likely risk of retuning to poverty for the population that has recently escaped poverty, China has moved to a new stage of development that focuses on consolidating and expanding poverty alleviation efforts in line with full implementation of the Rural Vitalization Strategy in the 14th Five-Year Plan (2021-2025).

3 According to the results of illustration and regression, income growth and poverty reduction are strongly associated with RT. The effect of RT is still significant among provinces, but the changes cannot be fully attributed to RT. Other factors such as wage may also be important.

RT could be explained by the following reasons: (i) additional high-value products may yield more profit for farmers; and (ii) in the later stage of RT, non-farm employment with a higher wage is the major contributor to rising rural income (Li et al., 2012). Notably, Jilin province is an exception, as mentioned above, with rising rural income accompanied by a declining share of high-value agriculture in recent years.

In terms of the relationship between rural non-farm employment and rural income, there is greater variation in the share of rural labor employment in non-farm than in the share of high-value agriculture across provinces, but a similar tendency is also observed in Panel B of Figure 6: the higher share of rural labor engaged in non-farm employment, the higher per capita income of rural households. Further, rural income growth starts to accelerate after the share of rural non-farm employment exceeds 30 per cent or so. This could be because rising rural non-farm employment was associated with a slower increase in rural income because wage did not rise (Li et al., 2012) in the early stage of RT, while both new non-farm employment opportunities and the rise in wage contribute to the exponential growth of per capita rural income in the later stage of RT.

Figure 6. LOWESS fit between rural transformation and per capita rural income by province in 1978-2018



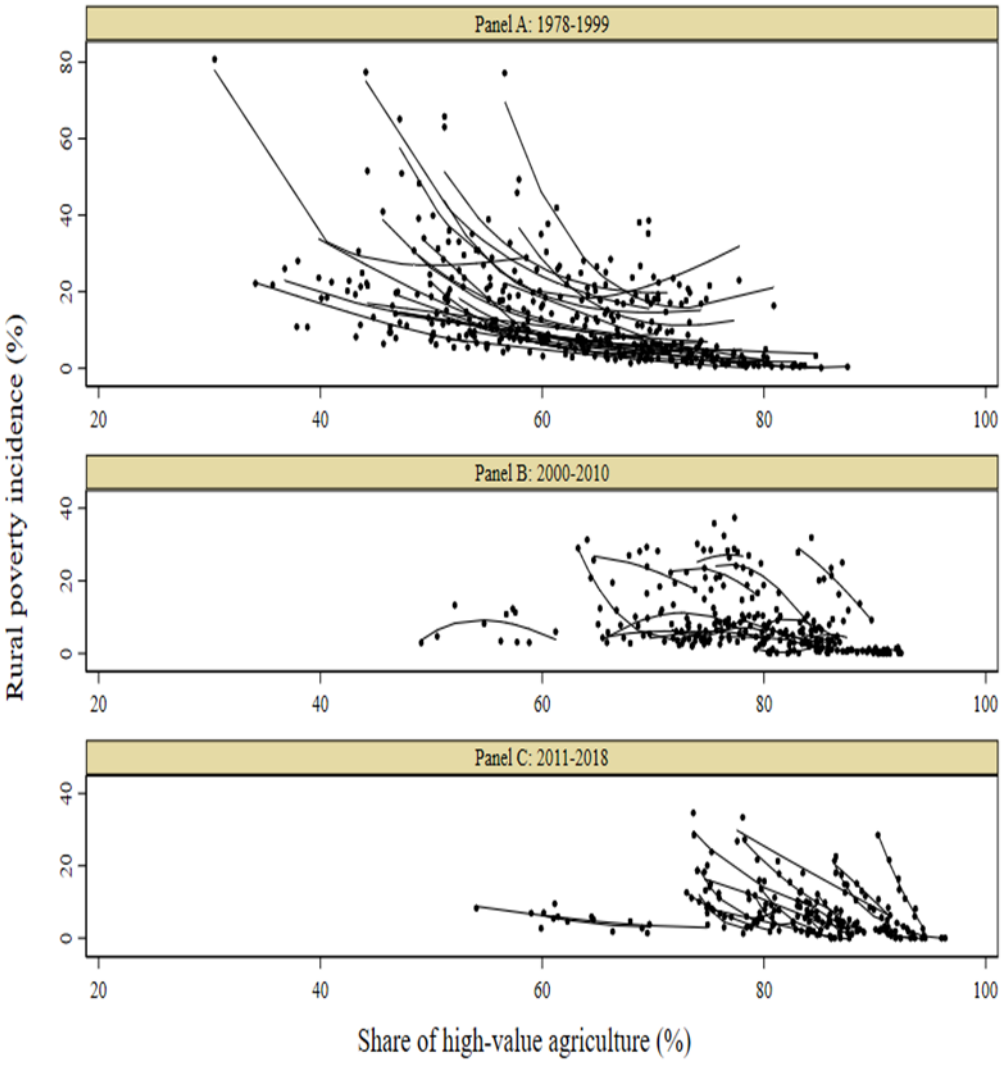
Source: See the note under Table 1.

Note: Each dot represents the share of high-value agriculture (Panel A) or the share of rural labor employment in non-farm (Panel B) and per capita rural income for a province in a year.

Substantial poverty reduction has been achieved in most provinces in China, suggesting that RT is inclusive. Based on the results of the polynomial analysis in Figure 7, the share of the rural population living in poverty tends to decrease with an increase in RT1. More specifically, there has been a strong relationship between RT1 and rural poverty reduction in the early stage of RT and

under a relatively low poverty line (Panel A), which indicates that poor people indeed gain from an agricultural transformation from grain-based agriculture to more high-value agriculture. The inverse relationship between higher RT1 and lower rural poverty incidence still holds in the later stage of RT, as well as with higher poverty lines in the periods 2000-2010 (Panel B) and 2011-2018 (Panel C), even though the slopes of fit are negative but relatively less steep in 2000-2010. Not shown in the provincial labels in Panel B of Figure 7, Liaoning, Jilin and Heilongjiang in North-eastern China are exceptions to the slopes of fit over this period.

Figure 7. Polynomial fit between share of high-value agriculture and rural poverty incidence by province in three sub-periods, 1978-1999, 2000-2010 and 2011-2018



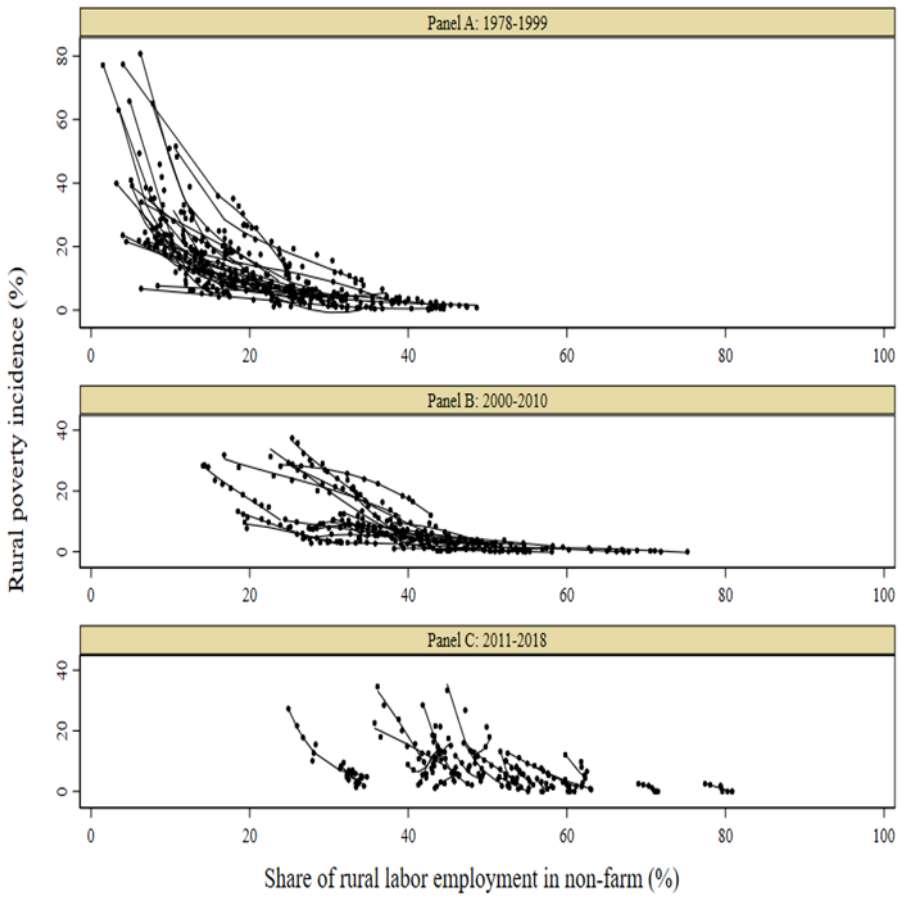
Source: See the note under Table 1.

Note: Each dot represents the share of high-value agriculture and the rural poverty incidence for a province in a year.

Figure 8 describes the relationship between the share of rural labour engaged in non-farm employment and rural poverty incidence by province in each of three periods between 1978 and 2018. In general, the higher the share of rural non-farm employment, the lower the poverty

incidence in rural areas. Compared with the relationship between RT1 and rural poverty incidence in Figure 7, more inclusive RT is also evidenced in rural non-farm employment: a stronger negative relationship between RT2 and rural poverty incidence is found in nearly all provinces. Furthermore, additional non-farm employment for rural labour could substantially reduce rural poverty in the early stage of RT (Panel A). With rising rural poverty lines, the above relationship still holds (Panels B and C).

Figure 8. Polynomial fit between share of rural labour employment in non-farm and rural poverty incidence by province in three sub-periods, 1978-1999, 2000-2010 and 2011-2018



Source: See the note under Table 1.

Note: Each dot represents the share of rural labour employment in non-farm and rural poverty incidence for a province in a year.

4.2 Based on regression models

To quantify the relationship between RT and corresponding outcomes, we include both RT_1 and RT_2 as right-hand-side variables. We also include the quadratic terms of RT_1 and RT_2 to control the non-linear relationship between RT_1 or RT_2 and per capita rural income or rural poverty incidence[4]. Given that rising rural non-farm employment is interconnected with structural

[4] We have also tried to add the inverse term of RT to capture the non-linear relationship (see Appendix Table). The major results are consistent with those presented in Table 2. Two model specifications have a similar R2, and most of the coefficients are statistically significant at the 1 per cent level.

transformation, we exclude structural transformation as the right-hand-side variable in both rural income model and rural poverty incidence model. As a whole, the models in Table 2 explain the variation of outcomes well: the values of R^2 are 0.785 (OLS) and 0.822 (FE) in the rural income equation, and it ranges from 0.336 to 0.775 in the rural poverty incidence equation for the three periods. Most estimated parameters are statistically significant at conventional levels.

The relationship between the share of high-value agriculture and per capita rural income is a U-shaped relationship due to a statistically significant negative parameter of RT1 and a statistically significant positive parameter of RT12 (column 1, Table 2). Based on the OLS estimation, the calculated turning point of the U-shaped curve for the share of high-value agriculture is at about 57 per cent (176.43/2/1.55). Given the data on RT1 presented in Panel A of Figure 6, we observe that most observations are located to the right-hand side of the turning point of the U-shaped curve. When we apply the FE estimation (column 2, Table 2), the U-shaped relationship no longer exists and the relationship becomes exponential growth, with the parameter of RT12 statistically significant at 10 per cent and the parameter of RT1 statistically insignificant. The above results suggest that the higher level of RT1 enhances rural income growth.

The relationship between the share of rural labour employment in non-farm and per capita rural income is also a U-shaped relationship. Of which, the results based on the OLS estimation (columns 1, Table 2) show that a rising share of rural labour engaged in non-farm employment accelerates the average income of rural households even in the early stage of RT. While the results based on the FE estimation (column 2, Table 2) suggest that the turning point of the U-shaped curve for the share of rural labour employment in non-farm is as low as 10 per cent (76.58/2/3.74), the average share of rural non-farm employment was already about 10 per cent in the initial year (1978) in Figure 3. The above analyses further confirm the importance of RT with more rural non-farm employment to raise rural income.

The relationships between RT1 and rural poverty incidence reveal two interesting findings (Table 2). First, in the early stage of RT with a relatively low rural poverty line, the estimated parameters of RT1 and RT12 are statistically significant in the FE estimation (column 4), but not in the OLS estimation (column 3) between 1978 and 1999. This implies that the U-shaped curve between RT1 and rural poverty incidence exists when controlling the initial level of rural poverty incidence over the same period, and the turning point for RT1 is at about 77 per cent (1.36/2/0.0088). Second, the results of the OLS estimation in 2000-2010 (column 5) and both the OLS and the FE estimations in 2011-2018 (the last two columns) display the inverse U-shaped curve between RT1 and rural poverty incidence (positive parameter of RT1 and negative parameter of RT12). We calculate the turning point of RT1 at 75 per cent (2.67/2/0.0178) based on the OLS estimation between 2000 and 2010. Under the current poverty line, the estimated turning point of RT1 is at about 80 per cent (3.57/2/0.022) by using the OLS estimation, and about 60 per cent (3.68/2/0.03) by using the FE estimation. The results of the former estimation seem more reasonable than those from the latter one. This is also evidenced from R2 values (0.336 in OLS and 0.775 in FE).

On the relationship between RT2 and rural poverty incidence, the estimation results are consistent across three sub-periods (rows 3-4, Table 2). All regression results show a U-shaped relationship, with most observations located to the left-hand side of the turning point (Figure 8). In other words, the poverty incidence in rural areas falls with the rise in rural non-farm employment, and the marginal rise in non-farm employment is associated with a smaller reduction in rural poverty. These results may also suggest that a more targeted poverty alleviation program is required to more effectively reduce rural poverty by offering more non-farm jobs to rural labours. The turning point occurred at about 35 per cent (2.36/2/0.034, OLS) and 32 per cent (2.59/2/0.04, FE) when the poverty line was at a very low level (1978-1999). With a higher poverty line in the recent two periods, the turning point rose to about 60 per cent in 2000-2018.

Table 2. The relationships between the path and outcome of rural transformation

	Rural income		Rural poverty incidence		

	1978-2018		1978-1999		2000-2010		2011-2018	
	OLS	FE	OLS	FE	OLS	FE	OLS	FE
RT_1	-176.43***	-23.93	-0.44	-1.36***	2.67***	-0.72	3.57***	3.68***
	(41.47)	(38.78)	(0.38)	(0.35)	(0.54)	(0.62)	(0.72)	(0.56)
RT_1^2	1.55***	0.56*	0.00	0.01***	-0.02***	0.00	-0.02***	-0.03***
	(0.31)	(0.30)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
RT_2	-21.67	-76.58***	-2.36***	-2.59***	-1.37***	-1.64***	-0.66***	-2.72***
	(14.22)	(14.64)	(0.18)	(0.17)	(0.16)	(0.11)	(0.24)	(0.45)
RT_2^2	2.72***	3.74***	0.03***	0.04***	0.01***	0.01***	0.00	0.02***
	(0.19)	(0.18)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Constant	6,405.01***	1,211.54	64.76***	94.84***	-55.38***	84.38***	-108.92***	-5.71
	(1,318.77)	(1,225.65)	(11.10)	(10.46)	(19.98)	(23.22)	(27.00)	(23.64)
Sample	984	984	377	377	264	264	192	192
R^2	0.768	0.818	0.593	0.636	0.538	0.661	0.336	0.775

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

5. Category of rural transformation

Both illustration and regression analyses confirm that a higher level of RT is strongly associated with a higher per capita income of rural households and a lower poverty incidence in rural areas. Moreover, identifying the status and category of RT at the provincial level can provide useful information for decision makers in central and local government on the future direction of facilitating RT and achieving inclusive rural development.

In this section, we rely on RT1 and RT2 to categorize provincial RT. To avoid year-on-year fluctuations in these two indicators, we calculate the average of RT1 and RT2 for each province for 2016-2018. Then, all provinces are divided into three groups by their RT level: low RT1 (or RT2), medium RT1 (or RT2) and high RT1 (or RT2). Here we use RT1 as an example for illustration. let dX be the gap between the largest (Xmax) and lowest (Xmin) RT1 among all provinces. Then, all provinces are divided into the following three groups by using dX/3: low RT1 if RT1 < (Xmin+ dX/3), medium RT1 if (Xmin+ dX/3) < RT1< (Xmin + 2dX/3), and high RT1 if RT1 > (Xmin + 2dX/3). The same approach can be used to group provinces by RT2. Finally, the category of provincial RT in China is generated based on the status of RT1 and RT2. The results are summarized in Table 3.

Category I: High in both RT1 and RT2 (Zhejiang and Jiangsu). Provinces in this group have a high level of RT in both high-value agriculture and rural non-farm employment. In fact, Zhejiang and Jiangsu were ranked as 1st and 2nd in terms of per capita income of rural households among 24 provinces of China in 2018. They had also eliminated rural poverty by 2015 under the current poverty standard – much earlier than other provinces. In the long run, these two provinces should continue their current pathway of RT.

Category II: High in RT1 and medium in RT2. Provinces in this group have a high level of RT in high-value agriculture and a medium level of RT in rural non-farm employment. Of which, Guizhou and Sichuan are low-income provinces with a relatively high rate of rural poverty. The rank of per capita income in the other 4 provinces ranged from 3rd in Fujian to 11th in Hubei, and they had ended rural poverty by 2018. In general, there is more room to expand the share of rural labor engaged in non-farm employment.

Category III: High in RT1 (or RT2) but low in RT2 (or RT1). Provinces in this group have a high level of RT in either high-value agriculture or rural non-farm employment, but a low level in the other RT. Moreover, they (except Liaoning) had a relatively low level of per capita rural income, ranging from 17th in Guangxi to 22th in Qinghai, and a high level of rural poverty. This group has considerable room to speed up either non-farm employment (Yunnan) or high-value agriculture (the other 4 provinces).

Category IV: Medium in both RT1 and RT2 (Chongqing, Hebei, Jiangxi, Hunan, Anhui and Henan). Provinces in this group have a medium level of RT in both high-value agriculture and rural non-farm employment. Their income level and poverty incidence in rural areas have also been about the average in China in recent years (Figures 4 and 5). These provinces still have room to speed up their RT in two major dimensions.

Category V: Medium or low in RT1 and low in RT2. The per capita income in Gansu, Ningxia and Shanxi was ranked between 18th and 24th in 2018, with a high rate of rural poverty. These 3 provinces should make great efforts to accelerate their RT, particularly non-farm employment for rural labors. Heilongjiang and Jilin have maintained a low level of RT in both high-value agriculture and rural non-farm employment, but per capita income in these two provinces is slightly higher than the average. This is mainly because Jilin and Heilongjiang have a greater area of cultivated land of good quality per capita than other provinces, which is more suitable for planting staple crops.

Table 3. The categories of provincial rural transformation in China in 2016-2018

		Share of high-value agriculture (RT_1)		
		High	Medium	Low
Share of rural labor employment in non-farm (RT_2)	High	Zhejiang Jiangsu		Qinghai Guangxi Shaanxi Liaoning
	Medium	Guangdong Fujian Hubei Shandong Sichuan Guizhou	Chongqing Hebei Jiangxi Hunan Anhui Henan	
	Low	Yunnan	Gansu Ningxia Shanxi	Heilongjiang Jilin

6. Major institutions, policies and investments affecting rural transformation

Empirical studies have shown that IPIs are the most important drivers of agricultural growth (for reviews of the literature, see Huang, 2018b; Huang and Rozelle, 2018). This section briefly discusses the likely impacts of the major IPIs on RT.

6.1 Institutional innovations

Ongoing institutional reform has been implemented throughout the four decades of rural reform in China. The Household Responsibility System (HRS) was implemented between 1978 and 1984. The effects of HRS on agricultural productivity have been well documented in the literature (McMillan et al., 1989; Fan, 1991; Lin, 1992; Huang and Rozelle, 1996). Rising agricultural productivity due to HRS made it possible for many farmers to shift their land and labour from grain to cash crop and animal production, which facilitated RT from a grain-dominated agriculture to a more diversified one. Other institutional reforms that have also fostered RT to high-value agriculture and non-farm employment include the reforms of institutions to govern agricultural input and output markets in the 1980s and 1990s, the institutions to support the development of Township and Village Enterprises in the 1990s, the institutions and laws to promote professional farmer cooperatives (Deng et al., 2010) and facilitate labour and land rental market development since the late 1990s (Deiningger et al., 2014; Gao et al. 2012), and the institutional innovation in farm mechanization custom services since the mid-2000s (Yang et al., 2013; Huang and Ding, 2016).

6.2 Policy support: agricultural technology and extension, and agricultural market reform

China has developed a strong agricultural science and technology (S&T) innovation system over the past four decades. China's agricultural research and development system is the largest in the world in terms of the number of staff, covering nearly every discipline in agriculture and related fields (Huang, 2013). China has also developed the world's largest agricultural extension system, with about 700,000 staff members in recent years (Babu et al., 2015). Previous studies have shown that agricultural S&T innovation is a primary source of agricultural productivity growth in the long term and has facilitated China's agricultural transformation over the past several decades (Fan, 1991; Jin et al., 2010). For example, with the successful development of semi-dwarf modern rice varieties in the early 1960s, China has developed several generations of hybrid rice and has significantly increased rice yield since the 1970s. Wheat yield has increased even more than rice yield due to modern varieties and inputs. The national average wheat yield reached 5.63 tons per hectare in 2019, well above the global average (3.5 t/ha). With the rising production of rice and wheat to ensure national food grain security, China has been able to successfully diversify its agriculture over the past four decades.

Market reform is another important reform affecting the process of RT. A series of gradual reforms has facilitated China's smooth transformation from the previous planned economy to a market-oriented economy and helped farmers diversify their farming activities from grain production to the productions of vegetables, fruits, livestock and fishery. Further, farmers have gained from increased allocative efficiency based on market prices and increased their income. In international trade, liberalization in agriculture started in the early 1990s. China also made significant commitments to liberalize its agricultural markets (Anderson et al., 2004). With trade liberalization, exports of labor-intensive products (e.g. horticulture and livestock) and imports of land-intensive commodities (e.g. soybeans, cotton, edible oil and sugar) have been rising, stimulating structural change in agricultural production in China.

6.3 Investment in infrastructure related to agriculture

Investment in infrastructure related to agricultural production establishes a fundamental base for the steady growth of China's agriculture and RT. Some of the most significant investments have been in irrigation since the 1950s, and land improvement and agricultural technology, which have increased agricultural productivity and sped up RT to more high-value agricultural production. Moreover, massive investment in rural roads and agricultural wholesale markets has fostered

market integration across regions and linked hundreds of millions of small farms with retailers and consumers.

7. Concluding remarks

China has achieved successful RT over the past four decades. This process was characterized by both gradually moving from a grain-dominated agriculture to a more diversified and commercialized high-value agriculture, and a significant shift in rural employment from farm to non-farm activities. The rapid transformation within agriculture would not have been possible if China had not achieved steady production growth in grain, particularly cereals. In 2020, China was still nearly self-sufficient in rice and wheat, the country's primary food grains. With rising grain production driven mainly by productivity growth, more land and water resources and other production factors could be allocated to the production of vegetables and fruits, livestock and aquatic commodities to meet growing food demand in China (Huang and Rozelle, 2018). On the other hand, overall structural transformation of the economy driven by urbanization and industrialization has created substantial employment opportunities for rural labor, which, together with the rise in agricultural labor productivity, has enabled rural labors to engage in more non-farm sectors.

Despite the rapid RT that has occurred in China, we also observe that the level of transformation still differs greatly across provinces. In general, provinces in the eastern region have transformed their rural economy faster than many provinces in central, western and northeast China. Our analyses also show that the level of provincial RT is strongly and positively associated with the level of provincial rural income, and negatively correlated with provincial rural poverty incidence. Moreover, the above relationships are non-linear. To be specific, the marginal contribution (if causality exists) of RT either in terms of high-value agriculture or non-farm employment of rural labors to per capita income is increasing. The presence of either the left-hand side of a U-shaped curve or the right-hand side of an inverse U-shaped curve indicates that fostering rapid RT is likely to further reduce rural poverty. Based on the level of RT in terms of high-value agriculture and rural non-farm employment in recent years, five categories of provincial RT in China are identified.

The results presented in this paper have several important policy and research implications for raising rural income and reducing rural poverty during the process of RT. First, accelerating RT either by transforming agriculture from low-value to high-value commodities and shifting rural labor from farm to non-farm employment is crucial. Second, decision makers in central and local government and development agents working in local provinces can use the information on the categories of RT in all provinces, which provides them with a better understanding of where each province currently stands and what direction they should help the province to move towards in the future. Third, to foster faster and more inclusive RT, appropriate IPIs should be explored. While this paper only discusses the likely impacts of IPIs on the pathway and outcomes of transformation, the actual impact and sequence of IPIs in each stage of RT are important issues that should be rigorously examined. Finally, it is worth noting that this study only examines the relationships between RT and rural income and rural poverty at the provincial level. The causality between RT and its outcomes is another important issue that needs further study.

Appendix Table. The relationships between the path and outcome of rural transformation based on alternative specifications of RT in terms of RT and inverse-RT.

	Rural income		Rural poverty incidence					
	1978-2018		1978-1999		2000-2010		2011-2018	
	OLS	FE	OLS	FE	OLS	FE	OLS	FE
RT_1	115.74***	74.76***	0.18	0.53***	-1.17***	-0.09	-1.50***	-3.03***
	(21.26)	(23.39)	(0.16)	(0.14)	(0.25)	(0.27)	(0.33)	(0.27)
$1/RT_1$	427,951.60***	271,203.00***	1,367.79***	2,769.84***	-6,223.62***	765.05	-9,161.84***	-11,250.85***
	(74,564.13)	(73,754.46)	(514.52)	(442.21)	(1,298.35)	(1,327.63)	(1,934.06)	(1,438.44)
RT_2	199.52***	228.46***	-0.32***	-0.23***	-0.15**	-0.00	-0.22**	-0.05
	(7.28)	(9.13)	(0.06)	(0.07)	(0.08)	(0.05)	(0.11)	(0.24)
$1/RT_2$	9,886.66***	12,553.42***	122.06***	117.75***	394.93***	607.70***	210.97	1,185.62***
	(1,225.16)	(1,181.85)	(10.73)	(8.23)	(84.44)	(59.08)	(245.84)	(381.24)
Constant	-16,511.77***	-12,317.62***	-21.52	-68.13***	175.42***	-11.46	249.81***	373.77***
	(2,468.51)	(2,523.55)	(18.08)	(15.59)	(35.60)	(38.31)	(49.01)	(40.97)
Sample	984	984	377	377	264	264	192	192
R^2	0.725	0.753	0.629	0.679	0.520	0.649	0.331	0.758

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

References

Anderson, K., Huang, J. and Ianchovichina, E. 2004. Will China's WTO accession worsen farm household income? *China Economic Review* 15(4): 443-456.

Babu, S., Huang, J., Venkatesh, P. and Zhang, Y. 2015. A comparative analysis of agricultural research and extension reforms in China and India. *China Agricultural Economic Review* 7(4): 541-572.

Cai, F. and Wang, M. 2010. Growth and structural changes in employment in transition China. *Journal of Comparative Economics* 38: 71-81.

Deiningger, K., Jin, S., Xia, F. and Huang, J. 2014. Moving off the farm: land institutions to facilitate structural transformation and agricultural productivity growth in China. *World Development* 59: 505-520.

Deng, H., Huang, J., Xu, Z. and Rozelle, S. 2010. Policy support and emerging farmer professional cooperatives in rural China. *China Economic Review* 21(4): 495-507.

Fan. S. 1991. Effects of technological change and institutional reform on production growth in Chinese agriculture. *American Journal of Agricultural Economics* 73(2): 266-275.

FAO. 2017. *The State of Food and Agriculture: leveraging food system for inclusive rural transformation*. Rome: Food and Agriculture Organization of the United Nations.

Gao, L., Huang, J. and Rozelle, S. 2012. Rental markets for cultivated land and agricultural investments in China. *Agricultural Economics* 43(4): 391-403.

Gao, S., Huang, X., Zhong, T. and Chen, Z. 2014. The influence of agricultural product commercialization on rural household planting structure in Shanghai, Jiangsu and Anhui. *Resources Science* 36(11): 2370-2378.

Haggblade, S., Hazell, P. and Reardon, T. 2010. The rural non-farm economy: prospects for growth and poverty reduction. *World Development* 38(10): 1429-1441.

Huang, J. 2013. Deepening agricultural science and technology system reform and improving its innovation capacity. *Agricultural Economics and Management* 2: 5-8.

Huang, J. 2018a. Facilitating inclusive rural transformation in the Asian countries. World Food Policy 4(2): 31-55.

Huang, J. 2018b. Forty years of China's agricultural development and reform and the way forward in the future. Journal of *Agrotechnical Economics* 3: 4-15.

Huang, J. and Ding, J. 2016. Institutional innovation and policy support to facilitate small-scale farming transformation in China. *Agricultural Economics* 47: 227-237.

Huang, J. and Rozelle, S. 1996. Technological change: the re-discovery of the engine of productivity growth in China's rice economy. *Journal of Development Economics* 49: 337-369.

Huang, J. and Rozelle, S. 2018. China's 40 years of agricultural development and reform. *In China's 40 Years of Reform and Development: 1978-2018, China Update*, edited by R. Garnaut, L. Song and F. Cai. Canberra: Australian National University Press.

Huang, J. and Shi, P. 2021. Regional rural and structural transformations and farmer's income in the past four decades in China. *China Agricultural Economic Review* 13(2): 278-301.

Huang, M. and Li, X. 2019. The impacts of rural labour price rising on crop structure among provinces. *Economic Geography* 39(6): 172-183.

IFAD. 2016. *Rural Development Report 2016: fostering inclusive rural transformation*. Rome: International Fund for Agricultural Development.

IFPRI. 2019. *Global Food Security Report 2019*. Washington, D.C.: International Food Policy Research Institute.

Jin, S., Ma, H., Huang, J., Hu, R. and Rozelle, S. 2010. Productivity, efficiency and technical change: measuring the performance of China's transforming agriculture. *Journal of Productivity Analysis* 33(3): 191-207.

Li, H., Li, L., Wu, B. and Xiong, Y. 2012. The end of cheap Chinese labor. *Journal of Economic Perspectives* 26(4): 57-74.

Li, S., Dong, Y., Zhang, L. and Liu, C. 2021. Off-farm employment and poverty alleviation in rural China. *Journal of Integrative Agriculture* 20(4): 943-952.

Li, Y., Zhang, Z., Hans, W. and Liu, Y. 2015. Rural household income in transitional China: spatio-temporal disparity and its interpretation. *China: An International Journal* 13(2): 151-168.

Lin, J. 1992. Rural reforms and agricultural growth in China. *American Economic Review* 82(1): 34-51.

Liu, S., Wang, R. and Shi, G. 2018. Historical transformation of China's agriculture: productivity changes and other key features. *China & World Economy* 26(1): 42-65.

Liu, Y., Guo, Y. and Zhou Y. 2018. Poverty alleviation in rural China: policy changes, future challenges and policy implications. *China Agricultural Economic Review* 10(2): 241-259.

Liu, Z., Yang, P., Wu, W., Li, Z. and You, L. 2016. Spatiotemporal changes in Chinese crop patterns over the past three decades. *Acta Geographica Sinica* 71(5): 840-851.

Long, H., Zou, J., Li, T. and Liu, Y. 2012. Study on the characteristics and territorial types of rural transformation development: the case of 'Southern Jiangsu-Northern Shaanxi' transect. *Geographical Research* 31(3): 495-506.

McMillan, J., Walley, J. and Zhu, L. 1989. The impacts of China's economic reforms on agricultural productivity growth. *Journal of Political Economy* 97(4): 781-807.

Meng, H., Li, T., Yu, Z. and Li, F. 2013. Rurality and a correlation analysis of the county economy in Anhui province. *Economic Geography* 33(4): 144-148, 185.

NBSC. 2020. *China Statistical Yearbook 2020*. Beijing: China Statistical Press.

Otsuka, K. and Fan, S. 2021. Agricultural Development: new perspective in a changing world. Washington, D.C.: International Food Policy Research Institute.

Reardon, T., Berdegue, J., Barrett, C. and Stamoulis, K. 2007. Household income diversification into rural nonfarm activities. In *Transforming the rural nonfarm economy*, edited by S. Haggblade, P. Hazell and T. Reardon, 115-140. Baltimore: Johns Hopkins University Press.

Timmer, C. 2009. *A World Without Agriculture: the structural transformation in historical perspective*. Washington, D.C.: AEI Press.

Timmer, C. 2017. Food security, structural transformation, markets and government policy. *Asia & the Pacific Policy Studies* 4(1): 4-19.

Timmer, C. and Akkus, S. 2008. The structural transformation as a pathway out of poverty: analytics, empirics and politics. Center for Global Development Working Paper No. 150. Washington, D.C.: Center for Global Development.

Yang, J., Huang, Z., Zhang, X. and Thomas, R. 2013. The rapid rise of cross-regional agricultural mechanization services in China. *American Journal of Agricultural Economics* 95(5): 1245-1251.

Zhang, L., Dong, Y., Liu, C. and Bai, Y. 2018. Off-farm employment over the past four decades in rural China. *China Agricultural Economic Review* 10(2): 190-214.

Zhao, T., Ma, X. and Zhou, Y. 2014. The regional differentiation of rural economic transformation development in Jiangsu province. *Economic Geography* 34(1): 128-132, 107.

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ISBN 978-92-9266-325-4
9 789292 663254