Analysis on Factors Influencing Supply of Rapeseed in Provinces of China

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Abstract From the perspective of micro-subjects of rapeseed planting, namely, the rape seed planting farmers, this paper made an analysis on factors influencing supply of rapeseed in provinces of China on the basis of panel data of 14 provinces producing rapeseed. Analysis indicates that decision of rapeseed planting area is influenced by planting area of the previous year and comparative benefits of rapeseed and the substitute crop wheat, while the local non-agricultural employment level exerts little influence on decision of rapeseed planting area. Finally, it came up with pertinent policy recommendations: since lagging influence of previous planting decisions and selection of planting decisions are a long period, formulation and implementation of any policy should consider long-term subsequent effect, instead of excessively focusing on policy objectives; strengthening new technological researches of new rapeseed varieties relying on scientific and technological innovation, enhancing construction of rapeseed production infrastructure, and improving integrated rapeseed production capacity, so as to increase relative income of rapeseed planting.

Key words Rapeseed supply, Influence factors, Decisions, Comparative benefits, Non-agricultural employment opportunities

1 Introduction

Rapeseed is important oil crop, major raw material for processing rapeseed oil, and also major source of China's edible vegetable oil (Zhu Zaiqing, *et al*, 2014). In 1993, the rapeseed planting area of China was 5.3 million hectare; in 2013, it reached 7.531 million hectare, accounting for 54% of total planting area of oil crops in China and 20% of rapeseed planting area in the world; the per unit area yield rose from 1309 kg/ha in 1993 to 1920 kg/ha in 2013. Since the 1990s, expansion of rapeseed planting area promoted constant increase of per unit area yield. For a long time, total rapeseed yield of China accounted for more than 25% of total rapeseed yield of the world, and China has become the largest rapeseed producer in the world. In the meantime, China is also the largest rapeseed consumer of the world. China's rapeseed production keeps certain growth trend, but the total yield fluctuates frequently due to influence of natural environment and planting income. It fails to satisfy domestic demands for rapeseed, and the rapeseed supply remains short for a long term. In 1993, China became a net importer of rapeseed; after 1995, China successively opened oil and oilseed market, the domestic oil and oilseed consumption rapidly increases, them the unbalance of rapeseed supply and demand becomes more and more prominent and takes on significant expansion trend. In the opinion of Wang Hanzhong (2010), domestic oil crops only supply about 40% of total vegetable oil consumption, and about 60% needs import, and the reliance on foreign countries becomes more and more high. It is estimated that there will still be the situation of serious short of supply and increase of import pressure, prominent conflict between production and demand, and severe hidden troubles. In this context, China's soybean industry is losing original vitality and position due to extravagant expansion of foreign capitals, and excessive soybean oil. Some scholars think that soybean becomes the first crop sacrificed in the condition of open economy (Wang Lu, 2014). With the highest oil production efficiency, rapeseed is the largest source of edible vegetable oil and plays an essential position in China's edible oil market. Facing with outside threat of the edible oil industry and tragedy of soybean, it is of great significance to raising self-sufficiency of China's rapeseed and ensuring China's rapeseed industry safety, and safety of the whole edible oil market. Just on the basis of the above background, we analyzed factors influencing rapeseed supply of China from the perspective of micro-subjects of China's rapeseed planting, to provide references for prediction about rapeseed supply changes and relevant policy implications.

2 Literature review

The issue of crop production and supply is always a hot spot of academic circle. Many scholars have made extensive studies on this issue. With the aid of Theil Model, Du Weizhang and Coleman (1997) estimated response of crops to price in 4 northern provinces, and the conclusion indicates that price rise will lead to increase of sown area. Tan Yanwen and Li Zhaohui (2005) measured cotton producer supply response function of China and the United States using adaptive expectation model and cointegration test, and results indicate that China's cotton producers' decision is mainly influenced by price and cost, while cotton producers of the United States take on anti-market reverse action. Zhong Funing and Hu Xuemei (2008) analyzed factors influencing China's rapeseed supply from the perspective of cotton growers, and found that planting area of cotton growers is mainly influenced by their expectation of relative gains and previous decisions. Ma Wenjei and Feng Zhongchao (2009) and Qian Wenrong and Wang Dazhe

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(2015) made related studies with the aid of Nerlove supply response model. On the basis of time series data of China's wheat sown area, price and production cost in 1981-2006, Ma Wenjei and Feng Zhongchao measured response degree of China's wheat sown area to price and cost. Using Nerlove supply response model and 2SLS method, Qian Wenrong and Wang Dazhe measured response elasticity of per unit area yield and planting area of 12 corn production provinces to price in 1999 – 2012, and measured impact of grain marketization policy, urbanization, and technological progress to corn supply. Researches about crop production and supply provide many helpful references for study of rapeseed supply response. Based on Nerlove partial adjustment model, Lu Wencong and Yejian (2004) made an empirical analysis on influence of agricultural product price, state grain purchasing and agricultural operating risk on production of planting industry (including rapeseed) in Zhejiang Province in the process of grain policy reform since 1991. Lin Dayan and Zhujing (2015) established Nerlove model and analyzed major factors and reasons for planting structure changes of 6 major crops in China, and found that previous supply and previous price are major factors influencing planting structure of major crops.

Summing up findings of scholars, we know that grain crops are major objects of researches of crop supply response. However, there are few researches about rapeseed supply response, and even existing researches of rapeseed supply fail to give prominence to important position of rapeseed in China's edible oil industry. In addition, there are few researches about rapeseed production and supply response from the perspective of rapeseed farmers. Based on the above factors, we selected China's rapeseed production provinces as research entirety from the perspective of micro-subjects of rapeseed supply, and analyzed factors influencing rapeseed supply from the supply decision action of farmers in major rapeseed production provinces.

3 Theoretical analysis and variable selection

3.1 Theoretical analysis Typical scholar of neoclassical economics, Schultz put forward the hypothesis of "rational farmers", believed that farmers are sufficiently rational to optimize resource allocation and maximize benefit; even the poor small peasant method also has the characteristic of penny capitalist (Qian Wenrong and Wang Dazhe, 2015). Formation and adjustment of farmers' planting decision is an important manifestation of their rational production, while their planting action adjustment will be influenced by comparative benefits of crops, and the ultimate purpose is to realize maximum relative benefit of crop planting. Therefore, comparative benefit is the basic driving force promoting flow and allocation of production resources between different industries and projects. Since farmers' income consists of agricultural production income and non-agricultural production income, when purchasing maximum benefits, farmers' planting decision is influenced by comparative benefits of different crops, but also influenced by non-agricultural employment opportunities (Lu Chao and Zhou Yingheng, 2011). On the other hand, formation and change of farmers' planting decision are a process of constant learning and adaptation. Farmers' planting decision is also influenced by previous decisions. In addition, since the formation and adjustment of farmers' planting decision are a complicated process, their planting decision may be influenced by other factors such as natural conditions and technological progress. However, in the condition of commodity economy, adjustment of farmers' planting action submits to the principle of maximum economic benefits, economic factor is the most direct factor influencing planting area, while natural, policy, and geographical factors give full play only through economic factors (Zhu Qirong, 2005). In sum, according to the above theoretical analysis, we believe that farmers' planting decision is not only influenced by comparative benefits, but also influenced by non-agricultural employment opportunities, and adaptive adjustment of previous decisions.

3.2 Selection of variables

3.2.1 Explained variables. We selected crop planting area to characterize farmers' planting decision, but this has certain limitation. Based on previous researches and convenience of economic analysis, and data availability, it is still very effective to check rapeseed production and supply through rapeseed planting area. Therefore, we took the rapeseed planting area as explained variables.

3.2.2 Explanatory variables. (i) Relative comparative benefits of rapeseed and substitute crop. Comparative benefits will give rise to flow of production resources in different projects. In the restraint of given market environment and production technologies, farmers will take use of comparative advantages and reasonably use the most rare elements through comparing relative benefits of different crops. When there are changes in relative benefits of agricultural products, farmers need increasing production of certain crop, it may change planting structure; in other words, increasing production of a certain crop will inevitably reduce production of another crop (Zhong Funing and Hu Xuemei, 2008). Therefore, changes in relative benefits of rapeseed and substitute crop will lead to changes in rapeseed planting area. According to difference in growth period of rapeseed, China's rapeseed planting is divided into winter rapeseed and spring rapeseed, winter rapeseed accounts for more than 85% of total sown area in the whole country; in winter, the major crop competing for land is wheat. Therefore, we selected relative comparative benefits of rapeseed and substitute (wheat) as an explanatory variable. (ii) Non-agricultural employment opportunities. Comparative benefits will give rise to flow of production resources in different industries. Since the market-oriented reform, China's economy has been developing rapidly and secondary and tertiary industries also develop rapidly, non-agricultural employment opportunities of farmers are constantly increasing. Thus, development of non-agricultural industries significantly increases opportunity cost of farmers planting rapeseed. In the meantime, previous researches also proved that non-agricultural employment opportunities will exert influence on production and

supply of crops. For example, based on simple unary regression model analysis results, Wu Shanlin (2000) held that employment pulling force of non-agricultural industry development is a key factor promoting regional changes of China's grain production. Based on this, we believed that non-agricultural industry development of different regions will exert influence on farmers' decision of rapeseed planting area. Considering this study was based on farmers and rapeseed production belongs to labor intensive industry, we selected the proportion of non-agricultural labor forces to total labor forces to measure non-agricultural employment opportunities. Total labor forces are indicated by rural employment personnel, while non-agricultural labor forces are calculated through rural employment personnel deducting employment personnel of agriculture, forestry, animal husbandry and fishery. (iii) Previous rapeseed planting area of farmers. Formation and change of farmers' planting decision are a process of constant learning and adaptation. In this long production process, farmers will adjust their planting action through constantly accumulating agricultural production experience. Current planting area decision may be the enhancement of previous decision in the same direction, and also may be constant correction of previous decisions. In this situation, it is believed that existing planting area of rapeseed farmers may be influenced by previous planting area decisions. We selected previous rapeseed planting area to characterize the influence of previous planting decisions of farmers on existing planting area of farmers.

4 Empirical analysis

4.1 Model building

4.1.1 Theoretical model. Theoretical model for influential factors of rapeseed supply is as follows:

$$Rarea_{i,t} = f(Rarea_{i,t-1}, Rincome_{i,t}, Nain_{i,t} \quad (1)$$

where i and t signify the t – th year of the i – th province; $Rarea_{i,t}$ denotes rapeseed planting area of the i – th province in the t – th year; $Rarea_{i,t-1}$ denotes rapeseed planting area of the i – th province in the $(t-1)$ th year; $Rincome_{i,t}$ denotes relative comparative benefits of rapeseed of the i – th province in the t – th year, namely, the ratio of per mu benefit of rapeseed to wheat; $Nain_{i,t}$ denotes the non-agricultural employment opportunities of i – th province in the t – th year, namely, the ratio of non – agricultural labor forces to total labor forces in the same year.

4.1.2 Calculation model. Analysis of panel data often adopts fixed effect model or random effect model: (i) fixed effect model. This model takes intercept as a fixed unknown parameter and assigns different intercepts to different regions in the following form:

$$Rarea_{i,t} = a_{i,t} + bRrea_{i,t-1} + cRincome_{i,t} + dNain_{i,t} + \varepsilon_{i,t} \quad (2)$$

(ii) Random effect model. This model takes intercept as a random variable ($a_{i,t} = a + v_i$) in the form of:

$$Rarea_{i,t} = a + bRea_{i,t-1} + cRincome_{i,t} + dNain_{i,t} + v_i + \varepsilon_{i,t} \quad (3)$$

where $\alpha_{i,t} = a + v_i$ and v_i is the special disturbance term of the i – th province.

For selection of fixed effect and random effect models, the general method is using fixed effect model when taking observed individual as random sampling result from a big whole (Luo Wanchun and Chen Yongfu, 2005). Since this study focuses on planting decision of farmers in major rapeseed production provinces, we adopted the fixed effect model. However, this selection method is still not very reliable, we usually apply Hausman test introduced by Li Zinai (2000) in practice. After estimating two results, we selected proper model using Hausman test.

4.2 Data description Data used in estimation model were time series and cross-sectional data of provinces in 1993 – 2013. In 1993, China became a net importer of rapeseed; after 1995, China successively opened oil and oilseed market, and there have been significant changes in rapeseed production. In this situation, we selected time period of 1993 – 2013, and research objects include Jiangsu, Zhejiang, Anhui, Jiangxi, Henan, Hubei, Hunan, Sichuan, Guizhou, Yunnan, Shaanxi, Gansu, Qinghai, and Inner Mongolia. Besides, considering consistency of spatial unit, Chongqing was included into Sichuan Province after 1997. These provinces are major rapeseed production provinces. In the new century, the sum of rapeseed planting area of these provinces accounts for more than 95% of total rapeseed planting area in China. Thus, research findings of these provinces will be highly representative. Data mainly come from *China Rural Statistical Yearbook* (over the years). Data of per mu income of rapeseed and substitute (wheat) come from *Compilation of National Cost Benefit Data of Agricultural Products*. Because some provinces lack data, we applied data of adjacent provinces to replace. The data of non-agricultural employment data come from China *Rural Statistical Yearbook*.

Table 1 Estimation results of models

Explanatory variables	Estimation coefficient	t value	P value
$Rarea_{i,t-1}$	0.8770***	33.43	0.000
$Rincome_{i,t}$	0.3630***	10.99	0.000
$Nain_{i,t}$	-1.7768	-0.04	0.968
R^2	-	0.7539	-
F statistics	-	376.38	-
Prob (F)	0.0000	-	-

Note: ***, **, and * denote significance different from zero at 1%, 5%, and 10% level.

4.3 Analysis of estimation results Using Stata 12.0, through Hausman test, P value was 0.0008, so we strongly rejected the original hypothesis that fixed effect model is better than random effect model. Therefore, we made analysis on factors influencing China's rapeseed planting area using estimation results of fixed effect model as basis, and estimation results are listed in Table 1. In this study, we focused on rapeseed planting area, relative comparative benefits of rapeseed, and non-agricultural employment opportunity coefficient estimation and their significance level of the previous year. From Table 1 estimation results, explanatory variable coefficient is consistent with our expectation. The coefficient estimation value of rapeseed planting area of the previous year was

0.8770, and it was significantly different from zero at 1% confidence level, indicating that in the condition of other conditions not changed, planting area decision of China's rapeseed farmers was highly influenced by previous decisions. If the rapeseed planting area of previous year increases 1%, planting area increase in the next year will increase about 0.877%.

The coefficient estimation value of relative comparative benefits of rapeseed was 0.3630 and it was significantly different from zero at 1% confidence level, indicating that when other conditions are not changed, if relative income of rapeseed and substitute wheat increases 1%, the rapeseed planting area will increase about 0.363%. These show that relative benefits of rapeseed and wheat will significantly influence rapeseed planting decision of farmers. If rapeseed income is higher than wheat income, rapeseed planting area will increase; otherwise, it will decrease. The coefficient estimation value of non-agricultural employment opportunities was −1.7768, but even at 10% confidence level, it was still not significantly different from zero. This indicates that non-agricultural employment opportunities exert little influence on rapeseed planting decision. The possible reason: Jiangsu, Zhejiang, Anhui, Jiangxi, Henan, Hubei, Hunan, Sichuan, Guizhou, Yunnan, Shaanxi, Gansu, Qinghai, and Inner Mongolia, as traditional rapeseed production provinces, have traditional rapeseed planting custom. In addition to support of national science and technologies, and policies for rapeseed industry, non-agricultural employment pulling force fails to significantly influence rapeseed production and supply. On the whole, previous rapeseed planting decision of farmers, relative comparative benefits of rapeseed and wheat, and non-agricultural employment opportunities are factors influencing rapeseed planting area of rapeseed farmers. As to the influence degree, previous rapeseed planting decision of farmers and relative comparative benefits of rapeseed and wheat have significant influence on rapeseed planting area, while non-agricultural employment opportunity exerts little influence on rapeseed planting area.

5 Conclusions and policy recommendations

Combining panel data of 1993 − 2013, we made an empirical analysis on factors influencing rapeseed supply in major rapeseed production provinces of China and we arrived at following conclusions. Firstly, an essential factor influencing rapeseed supply is evaluation and correction of previous decisions, namely, their constant learning and adaptation ability. In this study, we proved that decision of rapeseed planting area is influenced by planting area of the previous year. Secondly, another essential factor influencing rapeseed supply is relative comparative benefits of rapeseed and substitute crop. In this study, we took wheat as major substitute crop of rapeseed and took relative benefits of rapeseed and wheat as explanatory variables. The results indicate that relative comparative benefits of rapeseed and substitute crop wheat will significantly influence rapeseed planting decision. If rapeseed income is higher than wheat income, rapeseed planting area will increase; otherwise, it will decrease. Thirdly, local non-agricultural employment opportunities exert little influence on rapeseed planting decision. The possible reasons: research objects are traditional rapeseed planting custom, in addition to support of national science and technologies, and policies for rapeseed industry, non-agricultural employment pulling force fails to significantly influence rapeseed production and supply. Combining these conclusions, formation and change of farmers' planting decision are a process of constant learning and adaptation, so government should reduce unreasonable intervention and make optimum resource allocation through market forces. Besides, it is recommended to reinforce effort of new technology research of rapeseed, strengthen construction of rapeseed production infrastructure, raise integrated rapeseed production capacity, and increase relative benefits of rapeseed planting relying on scientific and technological innovation.

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