Analysis on the incentive effect of abolishment of agricultural tax in China staple grain production input

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Abstract: By integrating the process of abolishing the agricultural tax into the empirical analysis of regression discontinuity, this paper studies the incentive effect of the policy on different input types and the production of different food crops. According to research findings, mechanical operating cost is positively stimulated by the abolishment of agricultural tax, while the positive stimulation on fertilizer and labor costs degrades with time. From the perspective of different crops, the abolishment of agricultural tax has incentive effect on the fertilizer input to rice, corn and wheat, the labor input to rice and wheat, and the machinery input to corn. The method of regression discontinuity can determine whether the abolishment of agricultural tax has any incentive effect on crop production, but cannot identify the incentive scale. Therefore, appropriate instrumental variables are introduced in further study to identify the scale of incentives.

1. Introduction

China started agricultural tax and fee reform in 2000 [1-2] when Anhui was determined as the pilot province for rural tax and fee reform and the agricultural tax rate was set no more than 7%. However, the problem of rising agricultural specialty tax rate was derived from the implementation of the reform [3]. In 2001, the Chinese Government took some mitigation measures, including increasing transfer payment and properly dealing with debts, incorporated Jiangsu to the pilot provinces, but slowed down the pilot work in other provinces of China and determined to stop the expansion of provinces with local pilot work. In 2002, the pilot agricultural tax reform was comprehensively implemented in 20 provinces of China on the basis of experience from Anhui and Jiangsu, which drove the rural population in pilot regions up to 620 million and benefited 3/4 of the national rural population. In 2003, China got through the pilot phase of rural tax and fee reform and started to implement it comprehensively across the country. In 2004, the Chinese Government continued the rural tax and fee
reform, by which the agricultural specialty tax was abolished, Heilongjiang and Jilin led in realizing complete exemption of agricultural tax, and the agricultural tax rate was decreased by 3% in 11 provinces including Hebei and by 1% in other provinces. In 2005, the Chinese Government further expanded the scope of agricultural tax exemption and abolished the animal husbandry tax. At that time, there were 28 provinces where agricultural tax was exempted, except Shandong, Hebei and Yunnan. In 2006, China abolished many taxes on agricultural production throughout the country, including agricultural tax, agricultural specialty tax and animal husbandry tax.

2. Status of domestic and foreign research
The research on agricultural tax in European and American countries shows that effective agricultural tax policy is favorable to the protection for national environment, health and land productivity [4-5]. Soliwoda and Paw [6] deem that most EU member states (such as Netherlands, Germany and Austria) take taxes as the policy instrument for influencing sustainable agricultural development. As found by research, taxes have neutral or positive effect on the environmental sustainability. Berendse [7] has proposed that EU should levy progressive tax on such agricultural production activities affecting health and environment, such as farmers’ purchase of pesticides and antibiotics, and import of animal feeds including soybean. Munoz-Zamponi and Mardones-Poblete [8] have simulated the economic and environmental impacts of taxes on CO₂ emissions of the industry by applying the Leontief Price Model. Researches show that the levy of environmental tax on agriculture and animal husbandry will not reduce CO₂ emissions obviously. Both positive and negative effects are reflected in domestic literatures regarding the abolishment of agricultural tax. Yang [9] deem that the abolishment of agricultural tax has positive effect on the change of rural powers, mainly represented by the fact that the initiative of “farmers no longer providing for the government” forces the overall transformation of “rural political” system. However, Zhang [10], Ni et al. [11] deem that the abolishment of agricultural tax has material negative effect on the finance in some regions and eventually makes the supply of rural public goods difficult. Zuo et al.[12] have studied the panel data of 108 county-level administrative units in Henan during 2001-2008 by applying the double difference method, which shows that the abolishment of agricultural tax causes such behavior as allocating more fiscal expenditure by the local government to policy objectives easy to assess, such as infrastructure, ignoring capital input to public services and manpower. Some scholars deem that the abolishment of agricultural tax has positive effect on agricultural production input since it provides real benefits for producers. Wang et al. [13] based on the investigation data of 340 farmer households in 5 counties of Hebei, Henan and Shandong, the abolishment of agricultural tax has incentive effect on the increase of food output.

3. Comparison of food production inputs before and after abolishment of agricultural tax in china
The original intention of reduction and exemption in agricultural tax by Chinese Government is to increase farmers’ confidence in national support for “agriculture, farmer and rural area”, arouse the enthusiasm of farmers for food growing, guide farmers to input more resources to production and therefore promote food production. To verify the authenticity of such incentive effect, the process of abolishment of agricultural tax is divided into three stages (see Table 1): I- before abolishment of
agricultural tax (1995-2000), II- during abolishment of agricultural tax (2000-2005) and III- after abolishment of agricultural tax (2005-2010), with attention to various agricultural production inputs and the average annual growth rate of food output at different stages.

Table 1. Comparison of agricultural production factors and average annual growth rate of food product output before and after abolishment of agricultural tax in China.

| Stage                                      | Year      | Cultivated area (1,000 hectares) | Total sowing area of crops (1,000 hectares) | Gross power of agricultural machinery (10,000 KW) | Irrigated area (1,000 hectares) | Converted application of fertilizer (10,000t) |
|--------------------------------------------|-----------|---------------------------------|---------------------------------------------|-----------------------------------------------|---------------------------------|---------------------------------------------|
| I before abolishment of agricultural tax   | 1995-2000 | 0.86%                           | 0.70%                                       | 6.46%                                         | 1.48%                           | 2.41%                                       |
| II during abolishment of agricultural tax  | 2000-2005 | 0.81%                           | -0.09%                                      | 4.48%                                         | 0.37%                           | 2.35%                                       |
| III after abolishment of agricultural tax  | 2005-2010 | 2.92%                           | 0.55%                                       | 5.21%                                         | 1.55%                           | 2.61%                                       |

| Stage                                      | Year      | Food (10,000t)                  | Cereal (10,000t)                           | Rice (10,000t)                               | Wheat (10,000t)                | Corn (10,000t)                            |
|--------------------------------------------|-----------|---------------------------------|---------------------------------------------|---------------------------------------------|---------------------------------|---------------------------------|
| I before abolishment of agricultural tax   | 1995-2000 | -0.16%                          | -0.44%                                      | 0.24%                                       | -0.42%                         | -0.91%                                       |
| II during abolishment of agricultural tax  | 2000-2005 | 0.77%                           | 0.91%                                       | -0.66%                                      | -0.37%                         | 4.67%                                       |
| III after abolishment of agricultural tax  | 2005-2010 | 2.04%                           | 2.51%                                       | 1.35%                                       | 2.83%                          | 4.09%                                       |

Data source: Hexun macro data (http://mac.hexun.com/)

From the perspective of production factors, the growth rate was in recession during transition from stage I to stage II, which was specifically reflected by the great decrease in the average annual growth rate of agricultural land scale and mechanization, and mainly caused by ecological restoration and construction occupation [2]. However, such situation was reversed from stage II to stage III when the growth rate of several production factors, including cultivated area, sowing area of crops, gross power of machinery, irrigated area and fertilizer application, was increased compared with that at stage II. At the early stage of reduction and exemption in agricultural tax during 2000-2003, China carried out pilot tax reduction and exemption gradually, but local governments put focus on settlement of owing taxes since they were under the time pressure regarding to the agricultural tax exemption imposed by the Central Government (China Taxation Yearbook 2005). This explains, to some degree, why the agricultural tax reached the peak-peak in 2002 and 2003 as shown in Table 1, and such situation was gradually mitigated in 2004 and 2005. In other words, during implementation of the tax reduction at
stage II, the policy effect of “alleviating burden” had not been fully developed, and the effect of abolishment of agricultural tax was observed after 2004. From the perspective of food output, the average annual growth rate declined slightly at stage I, but such declining was restrained at stage II, and then the average annual growth rate rose greatly at stage III. The average annual growth rate of rice and wheat was negative at stage II and positive at stage III, while that of corn was maintained above 4.0% at both stage II and stage III. It can be preliminarily inferred from above that the incentive effect of abolishment of agricultural tax in China on food production cannot be underestimated.

4. Empirical analysis on incentive effect of abolishment of agricultural tax in China on food production input

4.1. Research idea and method
It is the most reasonable to take 2004, 2005 and 2006 as the observation nodes since the abolishment of agricultural tax is a process and policy effect is with hysteretic nature in general. In addition, such incentive may vary depending on different food crops. If the years 2003, 2004, 2005, 2006 and 2007 are taken as the breakpoints to observe the time of showing policy effect, the policy effect on different products can be observed more clearly by using the data of production inputs to such four food varieties as rice, corn and wheat. It is necessary to compare the agricultural situation at stages with and without effect of agricultural tax and take the time (year) as grouping variable in order to reflect the effects of abolishment of agricultural tax on agriculture in a more objective and clearer way. To obtain the estimates by applying the accurate regression discontinuity, this study applies the local linear regression, namely to obtain the required estimates by minimizing the following objective function:

\[
\frac{m}{n} \sum_{i=1}^{n} K \left[ \frac{x_i - c}{h} \right] (y_i - \alpha - \beta(x_i - c) - \delta D_i - \gamma(x_i - c)D_i)^2
\]

\[
D_i = \begin{cases} 
1 & \text{if } x_i \geq 2006 \\
0 & \text{if } x_i < 2006
\end{cases}
\]

In the formula, \(K\) represents kernel function, \(h\) represents bandwidth, \(y_i\) represents mechanical operating cost, \(x_i\) represents year and \(c\) is 2006 (2006 as the breakpoint). The essence of local linear regression is to estimate by weighted least square method in a small neighborhood, where the weight is calculated by the kernel function and the weight of the point closer to the point is larger. With hysteretic nature between agricultural production decision and actual production, food farmers may have not made the decision to increase production input in the year of tax exemption, and farmers always make fixed asset input until the year after they obtain increased income. Therefore, it is necessary to take 2004, 2005 and 2006 as the potential jump points and the discontinuity occurring in these three years can be regarded as the incentive effect of abolishment of agricultural tax.

4.2. Data description
The data used in this study is from the Data Compilation of Costs and Benefits of Agricultural Products in China 1980-2016 and China Statistical Yearbook 2016, covering the material and manpower inputs to three food crops (rice, corn and wheat) in 31 provinces of China during 1979-2016. This study puts emphasis on analyzing whether the abolishment of agricultural tax is
incentive to food farmers’ material and labor inputs, where the representative variables are fertilizer cost per mu, mechanical operating cost per mu and labor cost per mu. Control variables involved in the calculation include seed and seedling cost, farmyard manure cost and pesticide cost per mu (Table 2), which are all converted to the constant price in 1978 based on the CPI over the years.

**Table 2.** Key variables and control variables.

| variable                        | mean  | sd   | p50   |
|---------------------------------|-------|------|-------|
| Key variable                    |       |      |       |
| X3 fertilizer cost              | 272.4 | 281.7| 197.0 |
| X7 mechanical operating cost    | 174.6 | 287.6| 40.63 |
| X13 labor cost                  | 144   | 169.7| 86.12 |
| Other control variables         |       |      |       |
| X1 seed and seedling cost       | 123.9 | 507.1| 60.37 |
| X2 farmyard manure cost         | 37.07 | 56.22| 19.87 |
| X5 pesticide cost               | 59.53 | 100.4| 20.25 |
| X8 irrigation and drainage cost | 62.83 | 98.75| 21.61 |
| X9 fuel and power cost          | 14.29 | 45.54| 3.720 |
| X11 other direct costs          | 9.800 | 25.76| 2.480 |
| X12 indirect production costs   | 39.25 | 48.21| 23.94 |

4.3. Calculation results

STATA15 is used for accurate regression discontinuity analysis. 3 key variables are taken as dependent variables in sequence and the years 2004, 2005 and 2006 are taken as independent variables for operation (Table 3).

**Table 3.** Regression discontinuity results of different inputs in years.

| Variables             | (1)  | (2)  | (3)  | (4)  | (5)  |
|-----------------------|------|------|------|------|------|
|                       | -1   | 2004 | 2005 | 2006 | +1   |
| Fertilizer cost       | 5.978** | 15.37*** | -3.360 | -10.35* | 6.713 |
| (2.792)               | (3.464) | (4.304) | (5.649) | (4.622) |
| Mechanical operating cost | 1.273 | 2.416 | 4.430* | 5.036 | 3.260 |
| (2.876)               | (2.738) | (2.646) | (3.286) | (4.060) |
| Labor cost            | -2.006 | 27.15** | 0.0962 | -13.98 | -23.89** |
| (11.17)               | (10.96) | (11.33) | (12.14) | (10.37) |
Notes: 1. The optimum bandwidth is selected for regression and we try to use 75% and 125% of the optimum bandwidth for stability test. Similar results are obtained.

2. The table shows the results without control variable, which are slightly different from the results obtained by adding control variables for regression, but they still back up the opinions in this paper.

3. The content in the bracket is standard error, *** p<0.01, ** p<0.05, * p<0.1.

The incentive effect of abolishment of agricultural tax on the production inputs to 3 food crops is observed for the year when a positive jump occurs as mentioned above. The results are shown in Table 4:

**Table 4. Regression discontinuity results of different material inputs to three food crops.**

| Variables                        | (1)         | (2)         | (3)         |
|----------------------------------|-------------|-------------|-------------|
|                                  | Rice        | Corn        | Wheat       |
| Fertilizer cost (2004)           | 16.15***    | 20.68**     | 14.89***    |
|                                  | (4.541)     | (8.536)     | (5.506)     |
| Mechanical operating cost (2005) | 6.430       | 13.37**     | 4.866       |
|                                  | (5.201)     | (6.040)     | (4.543)     |
| Labor cost (2004)                | 30.63**     | 21.83       | 25.67*      |
|                                  | (11.94)     | (17.94)     | (19.20)     |

Notes: 1. The optimum bandwidth is selected for regression and we try to use 75% and 125% of the optimum bandwidth for stability test. Similar results are obtained.

2. The table shows the results without control variable, which are slightly different from the results obtained by adding control variables for regression, but they still back up the opinions in this paper.

3. The content in the bracket is standard error, *** p<0.01, ** p<0.05, * p<0.1.

4.4. Test

A series of tests are required after regression discontinuity: the first is to test whether the covariate condition at the breakpoint shows a jump [2], and the second is to test whether the density function of grouping variable is discontinuous at the breakpoint. The above statistical significant results are verified respectively in Table 6 to observe whether the covariates show a jump at the breakpoint. The results are not reliable if there are many jumps. It can be seen that only a few covariates in 5 regression functions show a jump, which means the results are acceptable.

**Table 5. Test of covariate condition and density.**

|               | Fertilizer cost (2004) | Fertilizer cost (2006) | Mechanical operating cost (2005) | Labor cost (2004) | Labor cost (2007) |
|---------------|------------------------|------------------------|----------------------------------|-------------------|-------------------|
| X1            | -2.8712 (6.1054)       | -4.2739 (6.6948)       | -4.5369 (5.4224)                 | -0.1849 (10.3256) | -5.5709 (6.5942)  |
| X2            | 0.7019                 | -0.1753                | 0.2714                           | 0.2934            | -0.1601           |
5. Main study conclusions

By integrating the process of abolishment of agricultural tax into the empirical analysis of regression discontinuity, this paper studies the incentive effect of the policy on different input types and the production of different food crops. According to research findings, mechanical operating cost is positively stimulated by the abolishment of agricultural tax, while the positive stimulation on fertilizer and labor costs degrades with time. From the perspective of different crops, the abolishment of agricultural tax has incentive effect on the fertilizer input to rice, corn and wheat, the labor input to rice and wheat, and only the machinery input to corn. The method of regression discontinuity can determine whether the abolishment of agricultural tax has any incentive effect on crop production, but cannot identify the incentive scale. Therefore, appropriate instrumental variables are introduced in further study to identify the scale of incentives.

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