Article
Current Situation and Optimization Countermeasures of Cotton Subsidy in China Based on WTO Rules

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Abstract: Cotton plays an important role in China’s agricultural production structure and international trade; therefore, China has implemented a variety of cotton subsidy policies. Since China joined the WTO in 2001, WTO rules have become substantive constraints on its agricultural subsidy policy. Therefore, in order to prevent appeal cases of China’s cotton subsidy, in this article, we investigate the current situation and optimization countermeasures with respect to China’s cotton subsidies based on WTO rules. According to calculation of the level of China’s cotton subsidy support under WTO rules, it currently exceeds 8.5% of the cotton production value. Secondly, we estimate the change in cotton subsidy effect when the support level of China’s cotton subsidy policy is directly reduced to 8.5%; the results show that such a reduction would have a considerable impact on the production scale. However, due to the constraints of the political and economic goals of cotton subsidies, the Chinese government can only “box shift” subsidies by changing the subsidy method and object in order to comply with WTO rules. Finally, from the perspective of how to use cotton subsidies to improve the efficiency of production factors, the Chinese government should focus on optimizing the cotton subsidy policy according to three aspects: improving the Amber Box subsidies, expanding the Green Box subsidies and increasing the Blue Box subsidies so as to maintain the existing level of cotton subsidy support.

Keywords: WTO rules; cotton subsidies; optimization countermeasures

1. Introduction

China is the world’s second largest cotton producer and largest cotton consumer. Cotton is the second most important crop after food crops, and it is also a strategic material related to the national economy and people’s livelihood in China. The period from 1949 to 1960 is the rapid development stage of China’s cotton production. The cotton-planting area increased from 2,770,000 hectares to 5,225,000 hectares, and cotton production increased from 445,000 tons to 1,063,000 tons. However, due to natural disasters and the “Cultural Revolution”, cotton production developed slowly, until the period between 1984 and 1991, when cotton acreage and production reach record highs. The period from 1984 to 2000 was also the period with the largest and most frequent fluctuations in national cotton production. After entering the 21st century, cotton planting area begin to increase in China; coupled with the large-scale promotion of genetically modified, insect-resistant cotton, cotton production reached 7,624,000 tons in 2007, breaking the highest level in history. However, subsequently, affected by many factors, the cotton planting area and production showed a decline and sharp fluctuations (as shown in Figure 1).

Among the 34 administrative divisions in China, there are 21 provinces (municipalities and autonomous regions) in which cotton cultivation takes place, mainly distributed in the northwest inland, the Yellow River and the Yangtze River Basin. Among them, cotton production in Hebei Province, Anhui Province, Jiangxi Province, Hubei Province, Shandong
Province, Hunan Province and Xinjiang Uygur Autonomous Region accounts for more than 90% of China’s total production. The main cotton-producing areas have gradually shifted from the Yangtze River Basin and the Yellow River Basin to the Northwest Region, and the Northwest Cotton Region has shown a trend of continuous expansion, basically forming the industrial layout of China’s cotton production.

![Figure 1. China’s cotton planting area and cotton production from 1949 to 2021.](image)

In terms of cotton export trade, except for a slight decline in the past two years due to the impact of the COVID-19 pandemic, the cotton export value in other years has exceeded USD 14 billion, and China’s cotton export share has remained at about 25% of the world’s exports. However, the proportion of China’s cotton exports as a share of its agricultural exports has continued to decline, from 30% in 2010 to 16% in 2021 (as shown in Figure 2).

![Figure 2. China’s cotton exports from 2010 to 2021.](image)

Due to the important position of cotton in China’s agricultural production structure and world economy and trade, as well as the rising cost of cotton planting in the past two decades, the Chinese government subsidizes cotton production to a certain extent. The main cotton subsidy policies are the temporary cotton purchase and storage policy and the cotton target price subsidy policy. The temporary cotton purchase and storage...
policy has been implemented since 2011. Although it has the effect of stabilizing domestic cotton prices in the short term, it seriously distorts the cotton market price, destroys the cotton market price formation mechanism and increases the financial burden of China. Therefore, in 2014, the policy was cancelled, and the cotton target price subsidy policy was implemented instead. This policy has a positive impact on narrowing the price difference of cotton at home and abroad, protecting the basic interests of cotton farmers and improving the market regulation system. The most important cotton subsidy policy is the cotton seed subsidy, launched in 2007. Although it helps to optimize the structure of cotton varieties, it is subsidized according to the taxable area, and the subsidy amount is relatively small. Other subsidy policies include the high-quality cotton base and county construction fund (from 1994 to the present), the subsidy for the transportation of cotton from Xinjiang (from 2008 to the present) and preferential loans for cotton enterprises (from 1994 to the present), in addition to regulation of cotton imports through tariff quota management and a sliding tax system to play a role in stabilizing domestic cotton prices.

However, with the continuous improvement of globalization and the deepening of agricultural opening to the outside world, especially after China’s entry into the WTO in 2001, the government not only needs to consider domestic issues but also satisfy international requirements when introducing agricultural subsidy policies. Therefore, the No. 1 Central Document has repeatedly emphasized the need to expand the implementation scope and scale of the Green Box policy and adjust and improve the Amber Box support policy in order to speed up the construction of a new agricultural subsidy policy system according to WTO rules and realize a shift from the Amber Box subsidy policy to the Green Box subsidy policy. Nevertheless, WTO rules still impose substantial constraints on China’s agricultural subsidy policy, especially the Xinjiang cotton incident in March 2021, which brought Chinese cotton to international attention. Although the incident did not involve the issue of cotton subsidies, the United States had previously filed a complaint with the WTO with respect to the issue of cotton subsidies in Shandong Province. In order to prevent international disputes caused by cotton subsidies, the Chinese government should pay attention to the requirements of the WTO Agreement on Agriculture with respect to agricultural subsidies and adjust its own cotton subsidy arrangements according to the requirements. Currently in the stage of WTO reform, agriculture has always been a key area of WTO negotiations. The discussion on cotton mainly comprises two aspects. One of them is the trade reform required by cotton subsidies and high trade barriers. In China’s Proposal Document on WTO Reform, China clearly mentioned that it should solve the problem of unfair discipline in the agricultural field and speed up the improvement of cotton subsidy measures under WTO rules.

Therefore, on the basis of determining the support level of China’s cotton subsidy, in this article, we analyze the effect of China’s cotton subsidy and the change in the policy effect after adjusting to the WTO subsidy standard to clarify whether the Chinese government can directly reduce the support level of cotton subsidies.

2. Literature Review

Scholarly research on cotton subsidies can be roughly divided into three categories: the first category is the study of domestic and foreign policy effects of cotton subsidies. For China, the cotton target price subsidy policy can stabilize cotton production, improve cotton quality, ensure an increase in cotton farmers’ income, accelerate the optimization and upgrading of the cotton industry and increase the vitality of the cotton market [1]. Other cotton subsidy policies, such as temporary cotton purchase and storage, improved seed subsidies and crop rotation subsidy policies, also play a role in promoting cotton production but have limited effects on improving production efficiency [2–4]. If domestic cotton subsidies are cancelled, China will increase the number of cotton imports [5]. United States cotton production will drop by 66%, exports will decrease by 40% [6] and the production efficiency of Greek cotton farmers will also decrease [7]. For other countries in the world, because the support of cotton subsidies in developed countries. such as
the United States is too high, it will seriously affect the income-generating capacity of cotton in developing countries [8]. Although reducing cotton subsidies will not have an impact on world cotton prices, it could reduce poverty in countries such as Mali [9,10]. The cancellation of cotton subsidies in the United States will increase world cotton price by 6% to 14%, and the average household expenditure of cotton farmers in C-4 countries (C-4 countries refer to the four cotton countries, namely the four African cotton countries consisting of Benin, Mali, Chad and Burkina Faso. The four cotton countries jointly issued the Joint Press Communiqué on Cotton Field Cooperation under the WTO Framework in Geneva) will increase by 2.3% to 8.8%. Brazil, Australia and African countries will expand their cotton planting area and export volume. The removal of cotton subsidies by the European Union will also positively affect Burkina Faso’s economy [11,12]. However, China, a major cotton importer, it will indirectly affect import demand [13]. The second category is the study of policy effects of the optimized cotton subsidy program. A comparison of 60% area subsidy and 40% yield subsidy with a full subsidy by area and full subsidy by yield shows that a subsidy based on cotton yield has a greater effect of increasing production [14,15]. The decoupling of cotton subsidy policy designed by the United States and the European Union will minimize the input of cotton farmers, reducing the output by 30% and increasing the price by 12% to 21% [16,17]. The third category is the study of the cotton subsidy policy under the WTO framework. The United States–Brazil trade dispute regarding upland cotton determined that the United States subsidies to cotton farmers violated international trade rules, so the United States 2014 Farm Bill introduced the Stacked Income Protection Plan (STAX) and the 2014/2015 Transition Assistance Subsidy for cotton farmers. By changing the subsidy method from price support to income support, the trade disputes brought about by subsidies were resolved by changing to the Green Box [18,19]. The Green Box policy is also recognized as the best choice to resolve the contradiction between agricultural subsidies [20,21]. The enlightenment provided to China by this incident includes strengthening the support and protection of cotton, adhering to the direction of market-oriented reform, improving the agricultural insurance system [22,23] and not violating WTO rules when subsidizing cotton [24]. In contrast to the above studies, Zhu Honghui and Li Congcong (2017) used the WTO Aggregate Measurement of Support (AMS) indicator system to measure China’s cotton price support level for 6 years in order to grasp the adjustment space of China’s cotton subsidy system [25].

In summary, existing cotton subsidy research is mostly carried out from the perspective of impact, using the actual amount of subsidies in the country to conduct empirical analysis. Some scholars have studied the impact of optimized cotton subsidy policies. Although scholars have studied the adjustment space and methods of cotton subsidies, there are still areas to be discussed when estimating the support level of cotton subsidies. For example, if the average market price of cotton in Xinjiang Uygur Autonomous Region from September to November during the policy period is used to represent the fixed external reference price (FERP), the price will be higher than the actual base period price, resulting in a low level of support for the estimated subsidy policy. No research to date have involved an in-depth investigation of the changes with respect to the effect of China’s cotton subsidy policy after adjusting subsidies to WTO rules. Existing studies only analyzed the decoupling of cotton subsidy policies in the United States and the European Union. Therefore, in this article, we refer to existing research and the specific circumstances of the relevant agricultural WTO trade dispute cases to revise the calculation method of the cotton price support level and determine the support level of China’s cotton subsidies under the WTO rules in the past 10 years. By analyzing the effect of China’s cotton subsidies and the changes with respect to each effect after adjusting cotton subsidies according to WTO rules, we propose countermeasures and suggestions for optimization of China’s cotton subsidies to ensure that subsidies are more in line with WTO standards without changing the effect of subsidies.
3. Calculation of the Support Level of China’s Cotton Subsidy Policy under WTO Rules

Annex 3 of the Agreement on Agriculture stipulates that the difference between the fixed external reference price (FERP) and the applicable administrative price (AAP) should be used to calculate the market price support (MPS), multiplied by qualified eligible production (QEP), that is, MPS = (AAP − FERP) × QEP. When determining the relevant indicators, reference is made to DS511, a case in which the United States complained that China’s domestic price support measures for wheat, indica, japonica and corn violated the Agreement on Agriculture. On 26 April 2019, the Dispute Settlement Body passed the expert group report and became the effective ruling, thereby becoming a reference for determination of the level of subsidy policy support for cotton, which is also an agricultural product. The fixed external reference price for determining the comprehensive support of cotton takes 1996–1998 as the base period. The applicable management price is the cotton target reference price, that is, the annual cotton temporary purchase and storage price and the cotton target price. With respect to determining the production volume eligible for the applicable managed price, the WTO expert review groups believe that in addition to the geographic constraints already taken into account by both parties, only quality should be considered. Therefore, they consider that the QEP should be the total production in the relevant designated province minus low-quality grains. Because Xinjiang Uygur Autonomous Region is suitable for cotton growth and high-quality cotton, its production accounts for 87.3% of China’s total cotton production, making it the main cotton producing area in China. Therefore, on the basis of the research of Zhu Honghui and Li Congcong (2017), the cotton production in Xinjiang Uygur Autonomous Region cotton area is determined as the production that is eligible to accept the applicable management price. Because the subsidy level of other policies is small and the scale range is not suitable for measurement, in this article, we mainly analyze the subsidy support level of the cotton temporary purchase and storage policy and the cotton target price policy, ultimately calculating the MPS.

The WTO stipulates that de minimis (WTO defines de minimis as the “minimal amounts of domestic support that are allowed even though they distort trade”) level of China for a given agricultural product is 8.5% of the production value of that agricultural product. However, according to MPS (as shown in Table 1), the price support level of Chinese cotton from 2011 to 2020 was between 11% and 18%, which exceeds the de minimis level. There are two solutions to this problem: one is to directly reduce the support level of cotton subsidies to 8.5% of cotton production value; however, it is necessary to consider the impact of this approach on the effect of cotton subsidies and whether it is in line with the original intention of the government in implementing cotton subsidies—other words, whether there are constraints on directly reducing the level of support for cotton subsidies. The other possible solution is to maintain the existing level of cotton subsidy support. Cotton subsidies are identified as other WTO Box (in WTO terminology, subsidies, in general, are identified by “boxes”, which are assigned the colors of traffic lights: green (permitted), amber (slow down, i.e., needs to be reduced) and red (forbidden). In agriculture, the Agreement on Agriculture has no red box, although domestic support exceeding the reduction commitment levels in the amber box is prohibited; there is also a blue box for subsidies that are tied to programs that limit production) by changing the subsidy method and object. This is a way for “box-shifting” subsidies to comply with the requirements of WTO rules. The ultimate goal is to reduce the risk of being appealed by other countries.
Table 1. Calculation data of China’s cotton subsidy policy support level from 2011 to 2020.

<table>
<thead>
<tr>
<th>Year</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
<th>2014</th>
<th>2015</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total cotton production (ten thousand tons)</td>
<td>658.90</td>
<td>683.60</td>
<td>629.90</td>
<td>617.83</td>
<td>560.34</td>
</tr>
<tr>
<td>FERP (CNY/ton)</td>
<td>14,673</td>
<td>14,673</td>
<td>14,673</td>
<td>14,673</td>
<td>14,673</td>
</tr>
<tr>
<td>AAP (CNY/ton)</td>
<td>19,800</td>
<td>20,400</td>
<td>20,400</td>
<td>19,800</td>
<td>19,100</td>
</tr>
<tr>
<td>QEP (ten thousand tons)</td>
<td>289.78</td>
<td>353.95</td>
<td>351.75</td>
<td>367.72</td>
<td>350.30</td>
</tr>
<tr>
<td>Total production value of cotton (CNY 100 million)</td>
<td>1304.62</td>
<td>1394.54</td>
<td>1285.00</td>
<td>1223.30</td>
<td>1070.25</td>
</tr>
<tr>
<td>De minimis level (8.5% of cotton production value)</td>
<td>101.10</td>
<td>106.00</td>
<td>15.68</td>
<td>15.41</td>
<td>14.49</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Year</th>
<th>2016</th>
<th>2017</th>
<th>2018</th>
<th>2019</th>
<th>2020</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total cotton production (ten thousand tons)</td>
<td>534.28</td>
<td>564.19</td>
<td>610.28</td>
<td>588.90</td>
<td>591.05</td>
</tr>
<tr>
<td>FERP (CNY/ton)</td>
<td>14,673</td>
<td>14,673</td>
<td>14,673</td>
<td>14,673</td>
<td>14,673</td>
</tr>
<tr>
<td>AAP (CNY/ton)</td>
<td>18,600</td>
<td>18,600</td>
<td>18,600</td>
<td>18,600</td>
<td>18,600</td>
</tr>
<tr>
<td>QEP (ten thousand tons)</td>
<td>407.80</td>
<td>456.60</td>
<td>511.09</td>
<td>500.20</td>
<td>516.08</td>
</tr>
<tr>
<td>Total production value of cotton (CNY 100 million)</td>
<td>993.76</td>
<td>1051.25</td>
<td>1135.12</td>
<td>1095.35</td>
<td>1099.35</td>
</tr>
<tr>
<td>De minimis level (8.5% of cotton production value)</td>
<td>67.04</td>
<td>70.79</td>
<td>75.55</td>
<td>71.14</td>
<td>65.99</td>
</tr>
</tbody>
</table>

Data source: Calculated according to the relevant government documents and the China Rural Statistical Yearbook.

4. Analysis of Policy Effects of China’s Existing Cotton Subsidies

In order to consider the impact of directly reducing the support level of cotton subsidies on the effect of cotton subsidies, we analyzed the policy effects of existing cotton subsidies in China. The policy effect of cotton subsidies can be explained as the impact of cotton subsidy measures, means, quantity or structure on cotton yield, planting structure, cotton price, farmer income, cotton demand and social resource allocation efficiency. According to the type of policy effect, it can be divided into production effect, income effect and ecological environment effect. Cotton subsidies have a certain yield-increasing effect, which leads to changes in the prices of input factors of production, causing adjustments in the allocation of factor resources and achieving high output and high returns through the optimal allocation of labor, capital and land factors. As a transfer payment from the government to cotton farmers, cotton subsidies can directly increase the income of cotton farmers. Some cotton subsidy policies can indirectly affect cotton production by affecting the input of labor, fertilizers and agricultural machinery so as to increase the productive income of cotton farmers through the expansion of the cotton planting area, the input of production factors and the progress of production technology. However, in terms of ecological environment, pesticides, fertilizers and other production factors are more widely used, and the improvement of mechanization level and technical level of cotton production will lead to an increase in the proportion of cotton planted and the expansion of the production scale. Ultimately, it will lead to an increase in cotton stalk waste, aggravate non-point source pollution and have a negative impact on the ecological environment in the long run (as shown in Figure 3).

The research objects of this article are the 12 Chinese provinces (autonomous regions) mainly engaged in cotton production, namely Hebei Province, Shanxi Province, Jiangsu Province, Anhui Province, Jiangxi Province, Shandong Province, Henan Province, Hubei Province, Hunan Province, Shaanxi Province, Gansu Province and Xinjiang Uygur Autonomous Region. Previous studies on subsidy effects mostly take the actual amount of subsidies as the core variable. However, in order to consider China’s cotton subsidy support level and compare the changes in subsidies adjusted in accordance with WTO rules, in this article, we use the MPS calculated above as the core variable. The dummy variables of the two subsidy policies, the temporary cotton purchase and storage policy implemented from 2011 to 2013 and the cotton target price subsidy policy implemented since 2014, are introduced to distinguish the effects of the two subsidy policies.
4.1. Production Effect of Cotton Subsidies

When constructing the production effect model of cotton subsidies, cotton production (pro) is selected as the dependent variable, and the core variable is the subsidy policy. On this basis, the interaction terms between subsidy policies (sub₁ and sub₂) and various production factors are introduced. The factors of production variables are land usage amount (acre), fertilizer usage amount (fert), machinery usage amount (mach) and labor usage amount (labor). The interaction term between the temporary cotton purchase and storage policy (sub₁) and land usage amount (acre) is acre₁. The interaction term between the cotton target price subsidy policy (sub₂) and the land usage amount (acre) is acre₂, and the same is true for other variables. The logarithmic form of the variables is used to reduce the probability of collinearity and heteroskedasticity. The data sources are the Cost-Benefit Yearbook of Agricultural Products, the China Agricultural Statistical Yearbook and the China Rural Statistical Yearbook. The source of the following data is the same as here.

The cotton production, production cost and cotton price in the previous period affect the cotton planting situation in the next period, as well as cotton production in the next period. There may also be a certain two-way causal relationship between cotton production (pro) and cotton subsidy (sub), which leads to the simultaneous endogeneity problem of independent variables in the model measurement estimation. In empirical analysis, if conventional random effects or fixed effects are used for ordinary least squares estimation, the estimated coefficients of the model may be biased and inconsistent [26]. In order to solve the above problems, the Generalized Method of Moments (GMM) system proposed by Arellano and Bond (1991) is used. The system GMM solves the problem of weak instrumental variables while improving the estimation efficiency of the econometric model [27]. The empirical results of the static model Ordinary Least Squares (OLS) estimation in Table 2 are for reference only.

As shown in Table 2, the instrumental variables in the GMM system are all valid, and there is no serial correlation in the random error term. According to Table 2, cotton subsidies will have a significant positive effect on production. The implementation of the cotton target price subsidy policy does not significantly affect the use of production factors by cotton farmers, whereas the temporary cotton purchase and storage policy has a greater effect on the use of land and fertilizer production factors to promote cotton production. However, when it acts on the use of machinery and labor production factors, it reduces the production effect. This is mainly because in cotton production, the usage amount of machinery and labor has reached a reasonable input boundary (as shown in Table 3). Excessive subsidies promote the excessive use of production factors, which is not conducive to the activities of cotton farmers and the effect of cotton production. Therefore, a targeted cotton production factor subsidy policy should be adopted.
Table 2. Empirical results with respect to the production effect of cotton subsidies in 12 provinces in China from 2011 to 2020.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Static Model OLS</th>
<th>Dynamic Model GMM</th>
</tr>
</thead>
<tbody>
<tr>
<td>sub1</td>
<td>$-1.8684^{***}$ (0.6293)</td>
<td>0.6650 $^{***}$ (0.1234)</td>
</tr>
<tr>
<td>sub2</td>
<td>$-1.4751^{**}$ (0.5932)</td>
<td>1.0944 $^{***}$ (0.3626)</td>
</tr>
<tr>
<td>lnpro$_{-1}$</td>
<td>0.9230 $^{***}$ (0.0374)</td>
<td>$-0.0479^{*}$ (0.0219)</td>
</tr>
<tr>
<td>lncost$_{-1}$</td>
<td>0.2154 (0.1848)</td>
<td>0.3233 $^{***}$ (0.0541)</td>
</tr>
<tr>
<td>lnprice$_{-1}$</td>
<td>0.5330 $^{***}$ (0.1387)</td>
<td>$-0.3250^{***}$ (0.0209)</td>
</tr>
<tr>
<td>lnacre</td>
<td>0.6650 $^{***}$ (0.1234)</td>
<td>0.0166 $^{***}$ (0.0062)</td>
</tr>
<tr>
<td>lnacre$_{1}$</td>
<td>0.1288 $^{**}$ (0.0596)</td>
<td>1.7613 $^{*}$ (1.053)</td>
</tr>
<tr>
<td>lnacre$_{2}$</td>
<td>0.1358 $^{**}$ (0.0580)</td>
<td>0.4554 (0.3473)</td>
</tr>
<tr>
<td>lnfert$_{1}$</td>
<td>0.0052 (0.0046)</td>
<td>0.2803 $^{***}$ (0.1011)</td>
</tr>
<tr>
<td>lnfert$_{2}$</td>
<td>0.0016 (0.0053)</td>
<td>$-0.3541$ (0.2474)</td>
</tr>
<tr>
<td>lnmach$_{1}$</td>
<td>$-0.0155$ (0.0430)</td>
<td>$-0.6117$ (0.4376)</td>
</tr>
<tr>
<td>lnmach$_{2}$</td>
<td>$-0.0296$ (0.0513)</td>
<td>$-1.7585^{*}$ (1.1489)</td>
</tr>
<tr>
<td>lnlabor$_{1}$</td>
<td>$-0.0056$ (0.0075)</td>
<td>$-0.4933^{***}$ (0.1815)</td>
</tr>
<tr>
<td>lnlabor$_{2}$</td>
<td>$-0.0207^{**}$ (0.0088)</td>
<td>0.0391 (0.0804)</td>
</tr>
<tr>
<td>Constant</td>
<td>3.6624 $^{**}$ (2.1732)</td>
<td>$-0.0226$ (0.4224)</td>
</tr>
</tbody>
</table>

AR (1) 0.012 0.091
AR (2) 0.441 0.732
Hansen 0.966 1.000
N 108 84 108

Note: $^{***}$, $^{**}$ and $^{*}$ indicate that they passed the 1%, 5% and 10% significance tests, respectively, with standard errors in brackets. AR (1) and AR (2) are the first-order and second-order serial autocorrelation, respectively, and the Hansen value is an overidentification test for instrumental variables.

Table 3. Empirical results of the resource allocation effect of cotton subsidies in 12 provinces in China from 2011 to 2020.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Inpro Marginal Output of Resources</th>
<th>Input–Output Price Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Before the Subsidies</td>
<td>After the Subsidies</td>
</tr>
<tr>
<td>lnfert</td>
<td>0.0736 (0.4569)</td>
<td>$-0.0226$ (0.4224)</td>
</tr>
<tr>
<td>lnmach</td>
<td>0.8922 $^{***}$ (0.0672)</td>
<td>0.7572 $^{***}$ (0.0713)</td>
</tr>
<tr>
<td>lnlabor</td>
<td>1.1758 $^{***}$ (0.4641)</td>
<td>1.3799 $^{***}$ (0.4277)</td>
</tr>
<tr>
<td>seed</td>
<td>0.0770 (0.0625)</td>
<td>0.0577 (0.0586)</td>
</tr>
<tr>
<td>sub</td>
<td>0.0132 $^{**}$ (0.0034)</td>
<td>0.0132 $^{**}$ (0.0034)</td>
</tr>
<tr>
<td>Constant</td>
<td>3.6624 $^{*}$ (2.1732)</td>
<td>3.7227 $^{*}$ (2.0132)</td>
</tr>
</tbody>
</table>

Note: $^{***}$, $^{**}$ and $^{*}$ indicate passing the significance test of 1%, 5% and 10%, respectively, with the standard error included in parentheses.

In order to further consider the relationship between input and output in cotton production based on the cotton subsidy policy, the Cobb–Douglas model was used to fit cotton input and output production functions, and the impact of production factor input on cotton output was analyzed. The input production factors include seed usage amount (seed) (because this variable is mostly 0, it is not logarithmized), fertilizer usage amount (fert), machine usage amount (mach) and labor usage amount (labor). The data source is the same as above. The formula $\text{MPP}x_i = \beta_i \times y/x_i$ is used to calculate the marginal product of each production factor, where $\beta_i$ is the production elasticity coefficient of resource $i$, $x_i$ is the input of the $i$-th resource and $y$ is the theoretical output.

Table 3 shows that after receiving the subsidy, with the exception of the marginal product of labor input, which increased, the marginal product of other production factors decreased, indicating that the cotton subsidy did not promote the allocation and adjustment of factor resources, which is consistent with the previous results. Therefore, it is necessary to optimize the cotton subsidy policy from the perspective of production factor allocation to make it more targeted. The marginal yield of seed input shown in Table 3 is greater than the input–output ratio, indicating that the marginal net income profit is greater than 0, that is, the amount of seed input has not reached the reasonable input limit. Therefore, it is
essential to focus on increasing the input of high-quality cotton seeds to achieve optimal allocation of resources and ensure increased production and income; it is also necessary to solve the problems of unfair subsidies and lack of supporting administrative funds in the current cotton seed subsidy policy.

4.2. Income Effect of Cotton Subsidies

In order to clarify the income effect of cotton subsidy, a cotton subsidy income model was constructed. In this model, the dependent variable is the income of cotton farmers (income); however, because the income of cotton farmers cannot be obtained directly and their main source of income is cotton sales—that is, the income of cotton per mu directly determines the income level of cotton farmers—the net profit of cotton per mu is used to represent the income of cotton farmers. The core explanatory variable is the subsidy policy, including two dummy variables representing the implementation of the temporary cotton purchase and storage policy (sub$_1$) and the cotton target price subsidy policy (sub$_2$), as well as the cotton subsidy level calculated according to WTO rules (sub). Other explanatory variables include cotton price (price), cotton production cost (cost), cotton production (pro), gross agricultural production (gdp), land usage amount (acre), fertilizer usage amount (fert), machine usage amount (mach) and labor usage amount (labor). All variable data sources are the same as above. Due to the obvious intertemporal correlation of farmers’ income, it is not only affected by current factors but also related to past factors to a certain extent. It is necessary to add the first-order lag term of farmers’ income to the independent variables of the model [28] and use the GMM system to solve the endogeneity problem caused by the lag of dependent variables and missing variables [29]. When using the GMM system to estimate the dynamic panel model, a serial correlation test and a Hansen test are needed to judge the applicability of the GMM system. As shown in Table 4, the instrumental variables in the GMM system are all valid, and the random error term has no serial correlation, so the GMM system model is used to estimate the impact of subsidies on the income of cotton farmers.

Table 4. Empirical results of the income effect of cotton subsidies in 12 provinces in China from 2011 to 2020.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Static Model OLS</th>
<th>Dynamic Model GMM</th>
</tr>
</thead>
<tbody>
<tr>
<td>sub$_1$</td>
<td>0.1988 *** (0.0776)</td>
<td>0.4557 *** (0.1009)</td>
</tr>
<tr>
<td>sub$_2$</td>
<td>-0.1131 (0.1079)</td>
<td>0.9523 *** (0.2236)</td>
</tr>
<tr>
<td>sub</td>
<td></td>
<td>0.8844 *** (0.0685)</td>
</tr>
<tr>
<td>lnincome$_t-1$</td>
<td></td>
<td>0.2124 *** (0.0679)</td>
</tr>
<tr>
<td>lngdp</td>
<td>-0.0549 (0.0581)</td>
<td>-0.0183 (0.0327)</td>
</tr>
<tr>
<td>lnacre</td>
<td>0.9589 *** (0.0369)</td>
<td>0.1197 * (0.0742)</td>
</tr>
<tr>
<td>lnfert</td>
<td>0.2488 ** (0.1238)</td>
<td>-0.1267 * (0.0773)</td>
</tr>
<tr>
<td>lnmach</td>
<td>-0.0267 (0.0356)</td>
<td>-0.0318 (0.0215)</td>
</tr>
<tr>
<td>lnlabor</td>
<td>-0.3507 ** (0.1668)</td>
<td>-0.1267 * (0.0773)</td>
</tr>
<tr>
<td>lnprice</td>
<td></td>
<td>2.0818 *** (0.3207)</td>
</tr>
<tr>
<td>lncost</td>
<td></td>
<td>-0.9489 *** (0.2167)</td>
</tr>
<tr>
<td>lnpro</td>
<td></td>
<td>0.0932 (0.0852)</td>
</tr>
<tr>
<td>Constant</td>
<td>4.9998 *** (0.7360)</td>
<td>6.3173 (0.7229)</td>
</tr>
<tr>
<td>Constant (AR 1)</td>
<td></td>
<td>-4.1575 (3.8327)</td>
</tr>
<tr>
<td>Constant (AR 2)</td>
<td></td>
<td>0.006</td>
</tr>
<tr>
<td>Hansen</td>
<td></td>
<td>0.116</td>
</tr>
<tr>
<td>N</td>
<td>120</td>
<td>84</td>
</tr>
</tbody>
</table>

Note: ***, ** and * indicate that they passed the 1%, 5% and 10% significance tests, respectively, with the standard errors in brackets. AR (1) and AR (2) are the first-order and second-order serial autocorrelation, respectively, and the Hansen value is an overidentification test for instrumental variables.

As shown in Table 4, the empirical results indicate that both the temporary cotton purchase and storage policy and the cotton target price subsidy policy have a significant positive impact on the income of cotton farmers. That is, cotton subsidies increase the income of cotton farmers; the income effect caused by the cotton price subsidy policy is
more obvious, which indirectly confirms that China’s current cotton price subsidy policy is an improvement relative to the previous subsidy policy. On this basis, the mediation effect is used to analyze the factors affecting the income of cotton farmers. Cotton subsidies ultimately affected the income of cotton farmers by affecting the planting area of cotton farmers, and this mediation effect accounted for 25.22% of the total effect (due to limited space, the empirical results of the mediation effect of cotton farmers’ planting area with respect to the relationship between cotton subsidies and cotton farmer income is omitted but available upon request). However, the influence of other factors of production is not obvious, which indirectly shows that cotton subsidies as a transfer payment from the government to cotton farmers to promotes an increase in cotton farmers’ income rather than promoting such an increase through productive income. At present, the most important transfer payment method is agricultural insurance.

4.3. Ecological Environment Effect of Cotton Subsidies

In response to climate change, all countries in the world are paying more attention to protection of the ecological environment. Among them, China’s “dual carbon” goal means that it is gradually inclined to green development while attaching importance to economic development. Therefore, when analyzing the effect level of cotton subsidies, the ecological environment effects should also be considered in order to satisfy the realistic background and objective needs of China’s development at this stage.

Referring to a study by Sun (2020), the agricultural non-point source pollution index (poll) is used to measure the ecological environment effect, and the inventory analysis method commonly used in environmental analysis is introduced to calculate the amount of non-point source pollutants produced by cotton planting [30]. Inventory analysis quantifies environmental pollution by identifying pollution-producing units (such as fertilizers and straw) and combining the pollution-producing coefficients of the pollution-producing units. Because pesticides are only sprayed on the leaves of cotton and the pesticide loss content is lower than the detection limit of the instrument, there is no valid detection result under the current instrument accuracy, so the non-point source pollution caused by the loss of pesticides is ignored when calculating the non-point source pollutants of cotton. Because the main chemical fertilizers used in cotton production are nitrogen fertilizers, the amount of nitrogen fertilizer pollutants produced can be obtained based on the Handbook of Pesticide Loss Coefficients for the First National Pollution Source Census. The specific formula can be expressed as follows:

\[
\text{Amount of nitrogen fertilizer pollutants} = \text{nitrogen fertilizer application pure volume} \times \text{loss coefficient.}
\]

Among them, the loss coefficient is 0.561%. In addition to nitrogen fertilizer, compound fertilizer is also applied in the cotton production process. According to the actual situation, the proportion of nitrogen in compound fertilizer is 43.48%. It is also necessary to calculate the amount of straw pollutants. The specific formula can be expressed as follows:

\[
\text{Amount of straw pollutants} = \text{total cotton production} \times \text{straw yield ratio} \times (1 - \text{comprehensive utilization rate of straw}) \times \text{straw nutrient content.}
\]

According to existing research, the cotton stalk yield ratio is 5, the comprehensive utilization rate of cotton stalk is not high and it is mainly returned to the field or used as fuel, accounting for about 75%, with a nutrient content of cotton stalk of 90.9%; therefore, the amount of cotton stalk pollutants is 1.13625 times the total cotton production. The cotton non-point source pollution index is calculated by principal component analysis; the specific formula can be expressed as:

\[
\text{Cotton non-point source pollution index} = 0.3628 \times \text{amount of nitrogen fertilizer pollutants} + 0.3430 \times \text{amount of compound fertilizer pollutants} + 0.3422 \times \text{amount of straw pollutants.}
\]

The calculated cotton non-point source pollution index (poll) is used as a dependent variable to measure the ecological and environmental effects of cotton subsidies. The core explanatory variable is the subsidy policy, and the specific settings are the same
as the previous ones. Other explanatory variables include cotton planting land usage amount (acre), gross agricultural production (gdp), the amount of machinery used in cotton production (mach), which represents the level of mechanization as a proxy variable for the application of cotton production technology and uses the price of alternative crops (re-price) to represent the agricultural planting structure in the region, among which alternative crops include corn, wheat, soybean, peanut, rapeseed and rice. Due to the hysteresis of non-point source pollution and the endogenous problem of cotton subsidies, the dynamic panel GMM system method is used to estimate the impact of subsidies on the local ecological environment [30].

As shown in Table 5, the empirical results indicate that both the temporary cotton purchase and storage policy and the cotton target price subsidy policy lead to environmental pollution problems, although the impact of the cotton target price subsidy policy is small. This demonstrates that the current cotton subsidy policy has alleviated the environmental pollution caused by cotton production. Furthermore, the cotton planting area and the mechanical production area significantly aggravate non-point source pollution, showing that cotton subsidies increase the proportion of cotton planting; increase the input of cotton farmers in production factors, such as machinery and fertilizers; increase the production area and scale; distort the market mechanism of cotton; cause market failure; and increase the amount of waste, such as straw, exacerbating non-point source pollution. In addition, the empirical results fully confirm that non-point source pollution seriously affects the ecological environment in the following year.

Table 5. Empirical results of the ecological and environmental effect of cotton subsidies in 12 provinces in China from 2011 to 2020.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Static Model OLS</th>
<th>Dynamic Model GMM</th>
</tr>
</thead>
<tbody>
<tr>
<td>sub1</td>
<td>0.1535 *** (0.0297)</td>
<td>0.1587 *** (0.0435)</td>
</tr>
<tr>
<td>sub2</td>
<td>0.1718 *** (0.0375)</td>
<td>0.1364 * (0.0842)</td>
</tr>
<tr>
<td>sub</td>
<td>0.4146 *** (0.0624)</td>
<td>0.0642 * (0.0362)</td>
</tr>
<tr>
<td>lnpoll</td>
<td>0.0642 * (0.0362)</td>
<td>0.0660 *** (0.0235)</td>
</tr>
<tr>
<td>lngdp</td>
<td>−0.0299 (0.0368)</td>
<td>0.0599 *** (0.0709)</td>
</tr>
<tr>
<td>lnacre</td>
<td>1.0132 *** (0.0211)</td>
<td>0.9448 *** (0.1062)</td>
</tr>
<tr>
<td>lnmach</td>
<td>−0.0350 ** (0.0178)</td>
<td>−0.0219 (0.0135)</td>
</tr>
<tr>
<td>re-price</td>
<td>−0.0138 *** (0.0021)</td>
<td>−0.0125 *** (0.0015)</td>
</tr>
<tr>
<td>Constant</td>
<td>6.9841 *** (0.3207)</td>
<td>3.42107 *** (0.5185)</td>
</tr>
<tr>
<td>AR (1)</td>
<td>0.039</td>
<td></td>
</tr>
<tr>
<td>AR (2)</td>
<td>0.101</td>
<td></td>
</tr>
<tr>
<td>Hansen</td>
<td>1.000</td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>120</td>
<td>84</td>
</tr>
</tbody>
</table>

Note: ***, ** and * indicate that they passed the 1%, 5% and 10% significance tests, respectively, with the standard errors in brackets. AR (1) and AR (2) are the first-order and second-order serial autocorrelation, respectively, and the Hansen value is an overidentification test for instrumental variables.

5. Changes to China’s Cotton Subsidy Effect under WTO Rules

There are two ways to solve the cotton subsidy policy support level being higher than 8.5%; one is to directly reduce the support level of cotton subsidies. Therefore, based on the policy effect of China’s existing cotton subsidies, we considered the impact on China’s cotton production, cotton farmers’ income and cotton non-point source pollution when the support level of the cotton subsidy policy is controlled at the allowable upper limit of 8.5% of the production value required by WTO rules, especially in the main cotton producing areas of Xinjiang Uygur Autonomous Region. Table 6 shows the change in cotton subsidy effect when China’s cotton subsidy policy support level is 8.5% of the cotton output value stipulated by the WTO according to the relationship between the variables obtained above.
As shown in Table 6, if the cotton subsidy policy support level is reduced to 8.5%, it will have a serious impact on the scale of cotton production, with the scale of cotton production reduced by about 70%. However, for cotton farmers in Xinjiang Uygur Autonomous Region or all cotton-producing areas, the adverse impact on income is relatively low, with an income reduction of about 20%. Regarding the ecological environmental impact of cotton cultivation, when the subsidy is reduced to the level required by the WTO, it is basically the same as the situation before the subsidy. However, the non-point source pollution in Xinjiang Uygur Autonomous Region will show signs of improvement, which is in line with the conclusion of Munasinghe and Cruz (1995) that the elimination of subsidies will have a positive effect on environmental protection [31].

Because the essence of China’s cotton subsidy is the state’s preference and transfer of the interests of cotton farmers, the cotton subsidy policy is the result of the combined effect of the national economic development strategy, constraints and the social environment. The Chinese government also claims that cotton subsidies are only aimed at promoting its own rural development. When the cotton subsidy level is reduced to 8.5%, the impact on the scale of cotton production and the income of cotton farmers will be detrimental to rural development and the interests of cotton farmers, not meeting the economic goals of the national cotton subsidy policy. In addition, Xinjiang Uygur Autonomous Region is the most important commercial cotton production base in China. The issue of farmers’ income is not only related to the stability of the cotton industry and rural development but also directly affects the long-term stability of Xinjiang Uygur Autonomous Region and the stable development of the national economy. A reduction in the cotton subsidy level is also not conducive to national political needs. Therefore, the political and economic goals of cotton subsidies will restrict the Chinese government from simply reducing the support level to 8.5%, forcing the government to adopt another solution, i.e., to maintain the existing cotton subsidy support level and optimize the subsidy method to make the cotton subsidy support level consistent with WTO rules.

6. Discussion

The approach to reducing the cotton subsidy support level to 8.5% discussed in this article is similar to the decoupling cotton subsidy policy, both of which aim to bring the subsidy into line with WTO rules. The decoupling cotton subsidy policies designed by the United States and the European Union will reduce cotton production by 30% and increase prices by 12% to 21%. Similar results were also obtained in the present study, i.e., cotton production is also reduced. However, the production reduction effect is more obvious, and the cotton production scale would be reduced by about 70%. The reason for this difference is that the intention of the subsidy decoupling policy implemented by developed countries is not to blindly reduce the level of subsidies but to subsidize farmers through other means, such as loans for cotton farmers, insurance premium subsidies, etc., in order to avoid direct
subsidies for indicators such as cotton price and production. This also indirectly confirms
the research conclusion presented this article, that is, there is an optimal way that the
subsidy is identified as other WTO Box by changing the subsidy method and object. The
STAX and the 2014/2015 Cotton Farmer Transition Assistance Subsidy for cotton farmers
in the United States both resolved trade disputes caused by subsidies by shifting to the
Green Box. Therefore, there is a certain feasibility of “box-shifting” subsidies. However,
given that Green Box subsidies have continued to increase significantly since 2000, they
are not conducive to the development of developing countries and the least developed
countries [32]. There may be a tendency to restrict Green Box subsidies in the future, so
multichannel “box-shifting” subsidies are required, involving the transfer of more than
8.5% of the product-specific Amber Box subsidies into non-product-specific Amber Box
subsidies, Green Box subsidies and Blue Box subsidies.

The level of cotton subsidies in China is relatively high, and they have not exerted a
positive subsidy effect, except with respect to the promotion of increased production. The
increase in production is mainly due to the use of land and fertilizers. However, the input
of production factors, especially the use of seeds, has not reached the reasonable input
limit, and the cotton subsidy efficiency is not high. Therefore, with respect to the three
aspects of improving Amber Box subsidies, expanding Green Box subsidies and increasing
Blue Box subsidies and focusing on how to use cotton subsidies to improve the efficiency
of production factors, specific optimization strategies are proposed.

In terms of improving Amber Box subsidies, non-product-specific Amber Box subsi-
dies should be increased, for example, increasing interest subsidies for agricultural loans,
subsidies for agricultural production materials and subsidies for agricultural inputs, espe-
cially subsidies for the purchase of agricultural machinery and equipment. The Chinese
government can change the existing subsidy method by subsidizing the production factors
of non-specific agricultural products. On the one hand, it is conducive to the effective use of
various production factors in cotton production. On the other hand, it can boost production
and mitigate the loss of cotton planting scale due to lower levels of price support. In
addition, China can refer to the practice of the United States in implementing target price
subsidy policies for agricultural products at different historical stages, that is, adopting a
more flexible subsidy notification.

In terms of expanding Green Box (Green Box refers to support policies with no or a
minimal distortive effect on trade. Annex 2 of the Agreement on Agriculture sets out a
number of general and measure-specific criteria, which, when all satisfied, allow measures
to be placed in the Green Box) subsidies, the Chinese government should focus on agri-
cultural insurance policies. Agricultural insurance conforms with the Green Box of the
WTO rules when certain conditions are met and can not only protect farmers from natural
disasters and agricultural product market fluctuations but also optimize the allocation
of production factors and stabilize agricultural production efficiency. Although China’s
agricultural insurance has developed rapidly and has the basic conditions to provide policy
support for cotton production, the WTO case focuses on the new scrutiny of insurance
subsidies in countries with large insurance programs, such as the United States [33] and
China [34]. Therefore, in order to make cotton subsidy declarations be smoothly placed
in the box, it is necessary for China to optimize agricultural insurance in accordance with
the following three practices: first, improve cotton income insurance. China’s existing crop
income insurance does not conform to the Green Box policy in terms of insurance subject
matter, payment conditions and insurance deductibles and belongs to the product-specific
Amber Box policy. There is no fundamental solution to the problem of excessive subsidies
for China’s Amber Box, so attention should be paid to compliance when designing income
insurance. Secondly, it is necessary to improve cotton “Insurance + Futures”. Although
the “Insurance + Futures” model has achieved fully market-oriented price regulation, it is
related to the total output scale of the target, so whether it belongs to the Green Box policy
requires further discussion. Differences with respect to the source of subsidy funds lead to
considerable differences in identified box categories. Only when insurance companies and
new agricultural business entities sign insurance contracts and these business entities have purchase agreements with cotton farmers does it belong to the Green Box policy. Thirdly, optimize cotton price insurance. With reference to China Changzhou Rice Target Price Insurance, the target price is the japonica rice futures delivery price in November of the first two years of the Zhengzhou Commodity Exchange. When the market price is lower than the target price, the claim is settled based on the average yield of paddy in the first three years of the field, resulting in double decoupling from the price and actual production, thus satisfying the requirements of the Green Box policy.

In terms of increasing Blue Box subsidies, subsidies to be classified as Blue Box must be based on fixed area and output, in addition to direct payments under the production restriction plan. Because the WTO has basically no restrictions on the Blue Box, China can shift the Amber Box to the Blue Box in terms of cotton subsidies. Drawing on the newly created price loss guarantee (PLC) and agricultural risk guarantee (ARC) projects in the 2014 Agricultural Reform Act of the United States, although it is also subsidized based on the price difference, its production standard is based on 85% of the area of the historical base period. Therefore, subsidies will be decoupled from the actual production of specific products in the current period so as to comply with the new Blue Box rules of the Draft Amendment to the Agricultural Concession Model (Fourth Draft), which can be categorized as Blue Box subsidies. In the cotton target price reform carried out in China from 2017 to 2019, the upper limit of the cotton subsidy quantity in Xinjiang Uygur Autonomous Region was at 85% of the national average cotton production in the base period (2012–2014), which also paved the way for the categorization as Blue Box subsidies.

7. Conclusions

According to WTO rules, we calculated that China’s cotton subsidy support level far exceeds the upper limit of 8.5% of cotton output value. According to the estimated change in cotton subsidy effect before and after compliance with WTO rules, we found that when the subsidy support level is simply reduced to 8.5%, first, this will inhibit China’s cotton production to a large extent, which is not conducive to expanding the scale of cotton production; the scale of cotton production will be reduced by about 70%. Secondly, this will have a certain impact on the income of cotton farmers in China, reducing the income of cotton farmers by about 20%. Thirdly, this will have little impact on the environmental pollution caused by cotton cultivation in China, which is basically consistent with the ecological environment under the current subsidy conditions. Therefore, the Chinese government cannot directly reduce the support level of cotton subsidies. Instead, it is necessary to “box shift” subsidies by changing the subsidy method and object.

This article clarifies the status quo of China’s cotton subsidies from the perspective of WTO rules, suggesting innovations with respect to the research perspective. Based on the cotton subsidy effect, we propose future subsidy trends and optimization countermeasures that are conducive to the stable and sustainable development of China’s cotton industry. However, this article is subject to two limitations: First, due to limited data sources, the cotton subsidy policy cannot be better studied for a long time. Furthermore, the sample size was small, which may result in deviations with respect to the estimated results. Secondly, this article only considers the subsidy status and effects of the temporary cotton purchase and storage policy and the cotton target price subsidy policy. Although these are the two main cotton policies implemented in China, in order to optimize the Green Box subsidies and the non-product-specific Amber Box subsidies, further consideration should be given to other subsidy policies, such as fine cotton seed subsidies.

Given that the aim of this article was to determine the optimization trend of China’s cotton subsidies under the WTO rules, we only considered the situation of simply reducing the subsidy level. Therefore, the pertinence of the subsidy optimization strategy still needs to be improved. In the future, the impact of specific subsidy methods on China’s cotton production, cotton farmers’ income and ecological environment should be simulated in order to form the best cotton subsidy method in line with WTO rules. In addition, it
is possible to conduct field research to grasp specific subsidy practices, understand the subsidy situation at the micro level and make the optimized subsidy method more practical.

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**References**