COTTON PRODUCTION IN XINJIANG PROVINCE AND ITS IMPACT TO COTTON MARKETS IN CHINA

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Abstract

The cotton production is main component of the agricultural income of rural residents and the national economy in Xinjiang. Cotton acreage, total production, and the average yield all rank first. This study analyzed the comparative advantage of Xinjiang cotton. The results showed that the cotton production has a large comparative advantage in Xinjiang from 2005 to 2015. The average of SAI, EAI and AAI are 11.54, 1.48, and 4.11, respectively. Overall, Xinjiang cotton production has a higher planting scale advantage and productivity. In particular, the planted acreages of Xinjiang cotton is much larger than other provinces, and the average cotton yield has a higher efficiency advantage. By using regression to calculate the impact of cotton production on the national economy in Xinjiang, the results showed that increasing the cotton acreages would generate negative effect on Xinjiang GDP.

Introduction

Cotton is the second largest crop in China. It plays an important role in the development of the national economy. China is the largest cotton importer and consumer, and the second largest producer of cotton in the world. Its domestic cotton demand and supply have a significant impact on the world market. Traditionally, cotton production in China was concentrated in the six provinces in the central and northern plains (Yang et al., 2013). In the past decade, cotton production shifted to the Xinjiang province in the west, which became the largest cotton producer in China.

Xinjiang, located in northwest of China, is the largest province in the country, and accounts for one-sixth of China's landmass (Wang et al., 2012). Climate is very dry, a lot of sunshine and big difference between day and night temperatures, which is suitable for production of high-quality cotton.

The cotton production is important to the economic development in Xinjiang. In 2015, Xinjiang's cotton total production accounted for 62.6% of China's total cotton production (Figure 1), followed by Shandong (9.6%), Hebei (6.7%), Hubei (5.3%), and Anhui (4.2%) (National Bureau of Statistics, 1996-2016). From 1995 to 2015, Xinxiang's cotton yield, total production, and quality measurement all ranked No.1 in the country. Cotton production increases farmer's income, and the standard of living in the rural areas, which leads to further improvement of the economy in Xinjiang.

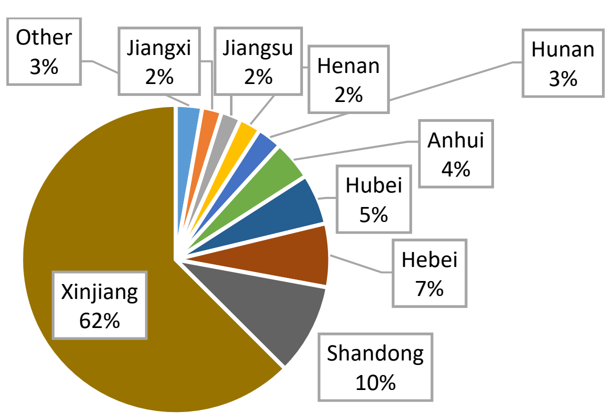

Figure 1. The percentage of major cotton production provinces of China in 2015.

Figure 2 shows the major cotton producer provinces in China. In 2015, Xinjiang cotton planted acres account for 50.16% of China total cotton planted acres, followed by Shandong (13.58%), Hebei (9.46%), Hubei (6.97%), and Anhui (6.12%) (National Bureau of Statistics. 1996-2016).

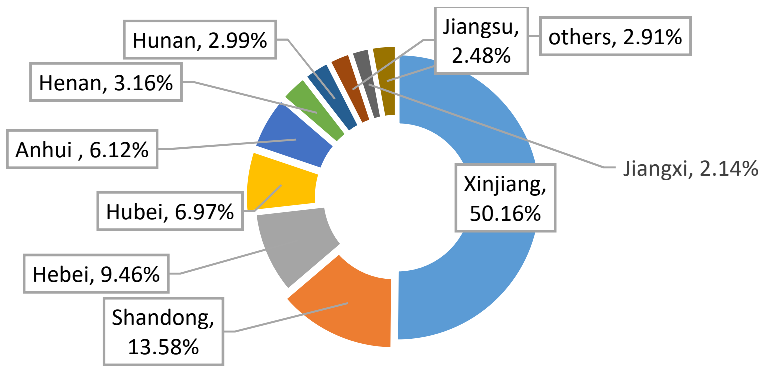

Figure 2. The percentage of planted acreage by provinces in 2015.

The cotton production in Xinjiang includes three regions: southern, northern, and eastern. The southern and northern regions account for most of the cotton production in Xinjiang. The Southern region accounts for about 55% of the total planting acreage and about 56% of the total cotton production. The Northern region accounts for about 42% the total planting acreage and about 41% of the total production. The Eastern region only accounts for about 3% of the total production (Huang, et al., 2006).

Figure 3 shows trend of planting acres and production in Xinjiang cotton from 1995 to 2015. The cotton production in Xinjiang shows a clear upward stage, and the trend of policy-oriented changes is remarkable. From 1995 to 2002, the cotton production was in a slow development period. Since 1999, due to the reform of China's cotton circulation system, the price of cotton has been gradually liberalized. From 2003 to 2008, Xinjiang cotton production was in a rapid and stable development period. With the effect of China's accession to the WTO, the demand for cotton in the textile industry is growing continuously and the cotton production in Xinjiang is developing rapidly. The production of cotton increased from 140.8 (10,000 tons) in 2003 to 301.6 (10,000 tons) in 2008, an increase of 114.3%. In 2008, planting acres reached 166.8 (10,000 hm^2), an increase of 67.5% compare to 1999. Due to the international financial crisis in 2008, cotton prices plunged and the entire cotton industry was influenced, causing cotton production and planting acres start to decline. However, with the introduction of corresponding national control policies, the cotton production began to recover gradually. In 2011, cotton planting area reached 168.3 (10,000 hm^2) and the output was 289.8 (10,000 tons), comparable to the level of 2008. From 2011 to 2015, Xinjiang cotton production experienced a period of rapid development (Yang, et al., 2013).

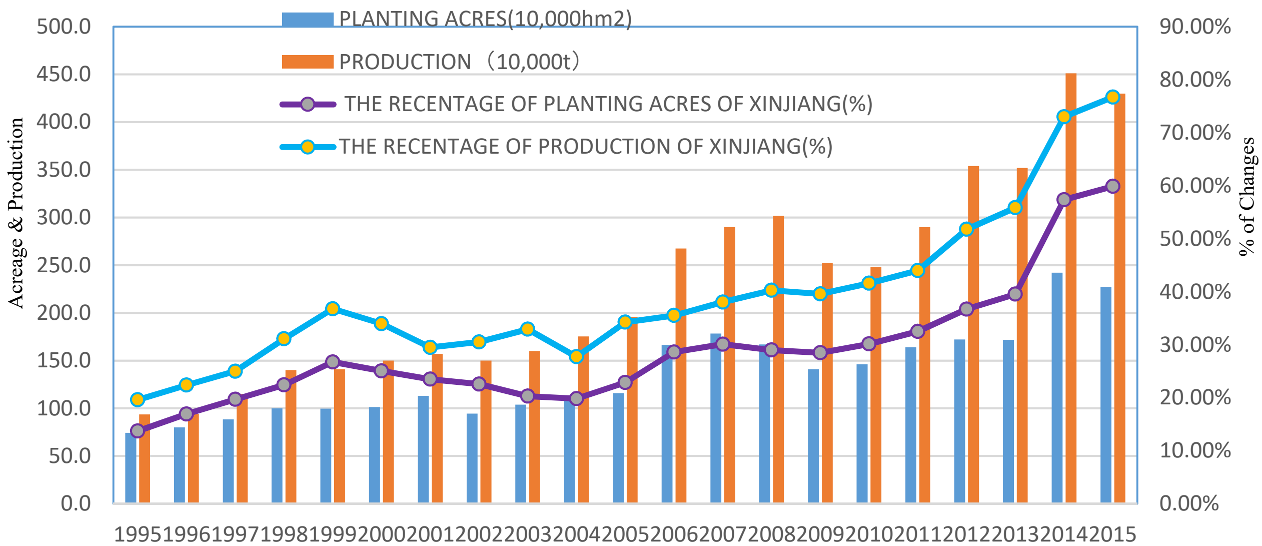

Figure 3. Xinjiang Cotton Planting Acreage and Total Production in 1995-2015.

Figure 4 shows the comparison of cotton yield in Xinjiang and China. From 1995 to 2015, the average of Xinjiang cotton yield is 428.71 kg/hm^2 higher than the average of China cotton yield and the trend of Xinjiang yield is upward. (Statistical Bureau of Xinjiang Uygur Autonomous Region, 1996-2016). In 2012, the cotton yield of Xinjiang is 2054 kg/hm^2, the highest yield level in recent years. Compared with Xinjiang cotton yield, China's cotton yield has shown a little change from 2012 to 2015. However, Xinjiang cotton yield has a decline in 2014, due to some disastrous weather, which led to a decline in production, and resulted in a decrease in cotton farmers' income. Some cotton farmers reduced cotton acreage to lower losses and switched to planting other crops since 2014.

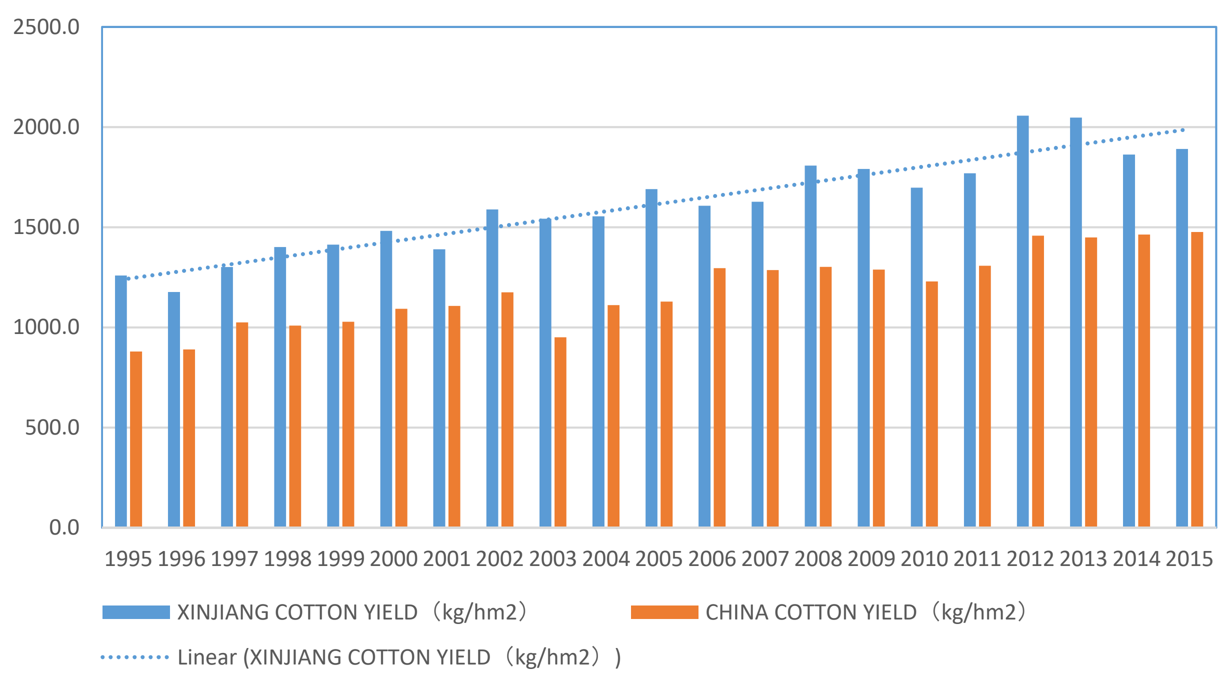

Figure 4. Comparison of Cotton Yield in Xinjiang and China in 1995-2015.

Figure 5 is the major crops planting structure in Xinjiang. Obviously, the food crops account for 41.9 % in total crops planting. Since Xinjiang is a major agricultural province, food crops have always been an important guarantee for food security. In addition, cotton play a principle role in crops planted, accounting for 32.2%. Food crops and cotton are the most important crops in Xinjiang (Zhang and Huang, 2010; Statistical Bureau of Xinjiang Uygur Autonomous Region,1996-2016).

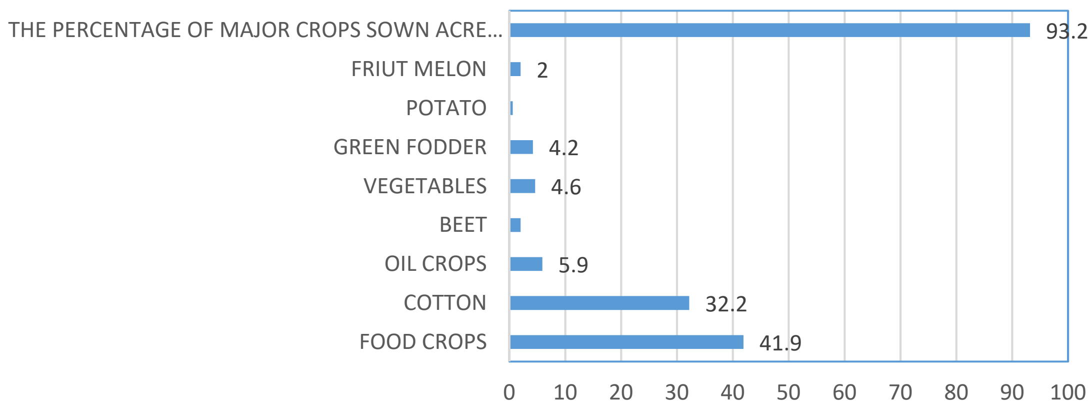

Figure 5. Xinjiang major crops planting structure.

Figure 6 shows the importance of cotton-related productions to Xinjiang's export trade. (Zhu and Yue, 2012). From 2007 to 2013, Xinjiang cotton-related exports are upward, especially from 2010 (10457 10 thousand dollars) up to 2011(25631 10 thousand dollars). However, in 2014, cotton experienced a great decline from bad weather and low-price reasons. Corresponding cotton-related exports as a percentage of total exports had a steep decline (Cotton-related productions: Raw Cotton, cotton Yam, Cotton Woven Fabrics, Cotton Clothing).

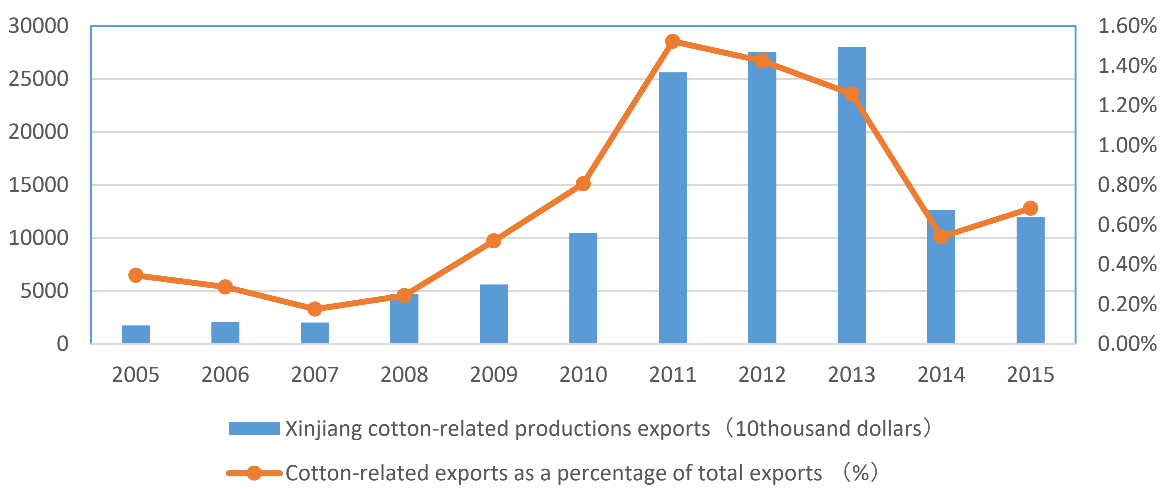

Figure 6. The Percentage of Cotton-Related Products and Its Contribution to Total Export in Xinjiang.

The main objective of this study is to evaluate the influence of cotton production on regional GDP in Xinjiang by using a linear regression statistical analysis model. More specifically, the purpose of the study is: (1) to evaluate the comparative advantage of Xinjiang cotton production from 2005 to 2015, and (2) to analyze the impact of cotton production on GDP.

The successful accomplishment of the objectives of this study will be significant for future research dealing with the influence of Xinjiang cotton production on the China cotton market to: (1) helping Xinjiang cotton farmers to make better choices in cotton production decisions; (2) helping policymakers identify the suitable cotton policy for Xinjiang province; and (3) assisting interested parties in better understanding the important of Xinjiang cotton production in China.

The remainder of the paper proceeds in the following manner. Next section provides the materials and method used in the present analysis, followed by the presentation and discussion of the results. Conclusions and discussion are presented in the last section.

Methods

The China Statistics Yearbook and Xinjiang Statistics Yearbook are used to collect all the data for the study, including cotton yield, planted acres, production, harvest acres, etc. in Xinjiang in 1995-2015.

Comparative Advantage

This study will quantify the comparative advantage of Xinjiang cotton production from 2005 to 2015, by using three different indices: Efficiency Advantage Indices (EAI), Scale Advantage Indices (SAI), and Aggregate Advantage Indices (AAI) (Yu, et al., 2006; Hong and Zhou, 2007; Wang, et al., 2012).

EAI is an indication of how efficiently a crop grows in one specific region. It is calculated by using the relative yield of one crop in one region related to the average yield of all crops in the same region to the yield of same crop in the nation related to the average yield of all crops in the nation. EAI can be expressed following:

$$EAI_{ij} = \frac{Y_{ij}/Y_i}{Y_{nj}/Y_n} \quad (1)$$

where, EAI_{ij} represents the Efficiency Advantage Index of the *j*th crop growing in the *i*th region; Y_{ij} is the yield of the *j*th crop in the *i*th region; Y_i represents the average yield of all crops in the *i*th region; Y_{nj} is the national average yield of the *j*th crop; and Y_n is the national average yield of all crops. If $EAI_{ij} > 1$, then the yield of the *j*th crop in the *i*th region, relative to all other crops' yield growing in the same region is higher than that of the national average. It can be interpreted as in the *i*th region; there is a yield or an efficiency advantage in growing the *j*th crop. If $EAI_{ij} < 1$, then the yield of the *j*th crop in the *i*th region, relative to all other crops' yield growing in the same region, is lower than that of the national average. It can be interpreted as in the *i*th region; there is no yield or efficiency advantage in growing the *i*th crop. By assuming a competitive market structure and no significant barriers for technology diffusion and adoption in agricultural production in the country, the EAI_{ij} can be taken as an indicator of relative efficiency due to natural resource endowments and other local economic, social and cultural factors.

The SAI indicates the extent of concentration of a certain crop growing in a region, relative to that ratio of same crop growing in the nation. It can be expressed as following.

$$SAI_{ij} = \frac{S_{ij}/S_i}{S_{nj}/S_n} \quad (2)$$

Where, SAI_{ij} is the Scale Advantage Index of the *j*th crop in the *i*th region.S_{ij} represents the planted area of the *j*th crop in the *i*th region. S_i is the total planted area of all crops in the *i*th region.S_{nj} is the total planted area of the *j*th crop in the nation. And S_n represents the total planted area of all crops in the nation. If $SAI_{ij} > 1$, it implies the degree of concentration of the *j*th crop growing in the *i*th region is higher than average concentration ratio in the nation. It also indicates that producers in the *i*th region prefer to grow more *j*th crop, compared to other producers in the nation. If $SAI_{ij} < 1$, the degree of concentration of the *j*th crop growing in the *i*th region is lower than that average ratio in the nation. It indicates that producers in the *i*th region prefer to grow less *j*th crop, compared to other producers in the nation.

Assuming a competitive market structure and that producer can quickly adjust the crop mix by responding to the market price and cost changes. Economic factors or the profit level of certain crop growth in the region determines the concentration level. For example, a low value of SAI implies producers do not want to increase the share of that crop production in the region because it is less profitable or restricted by natural (or other) conditions, while a high value of SAI implies producers want to increase the share of that crop production in the region.

The AAI is an aggregate indication of the overall comparative advantage of a certain crop in one region relative to the national average. It can be calculated as the geometric average of the EAI and SAI.

$$AAI_{ij} = \sqrt{EAI_{ij} * SAI_{ij}} \quad (3)$$

If $AAI_{ij} > 1$, then the *j*th crop in the *i*th region is considered to have a overall comparative advantage over the national average, while $AAI_{ij} < 1$ indicates *j*th crop in the *i*th region does not have a overall comparative advantage over the national average.

Regression Model

Xinjiang cotton production is closely related to the economic development and rural residents' income. Linear regression is used to analyze the comprehensive effect of cotton production on Xinjiang GDP from 1995 to 2015. This analysis will use SAS 9.4 software for statistical regression analysis of the collected data. Xinjiang GDP is the dependent variable, and rural households' agricultural income (Inc), total cotton planting acres (Pla), total cotton production (Prod), and cotton average yield (Yield) as the independent variables analysis.

Linear regression attempts to model the relationship between two variables by fitting a linear equation to observed data. One variable is considered to be an explanatory variable, and the other is considered a dependent variable. A linear regression line has an equation (Zhu and Cui, 2012):

$$\text{GDP} = \beta_0 + \beta_1\, Inc + \beta_2\, Pla + \beta_3\, Prod + \beta_4\, Yield + \varepsilon \quad (4)$$

where, β_0, β_1, β_2, β_3, and β_4 are regression coefficients; ε represents random error; and *Inc* represents rural household's agricultural income; *Pla* are planted acres; *Prod* represents total production in tons; and *Yield* is the average cotton yield.

Results

Table 1 indicates cotton production in Xinjiang has obvious comprehensive advantages from 2005 to 2015. The average of SAI is 11.54, which means Xinjiang cotton has a higher Scale Advantage than other crops, and the planting acres are big in the region. The mean of EAI is 1.48 (greater than 1), which means Xinjiang cotton has Efficiency Advantage, the yield of Xinjiang cotton is higher than the average yield of China. The mean of AAI is 4.11, which means Xinjiang cotton has an overall comparative advantage over the national average. By calculate the AAI, SAI and EAI, the results show that whether it is the yield or planting scale, Xinjiang cotton has the absolute comprehensive advantages.

Table 1. Comparative Advantage of Xinjiang Cotton Production in 2005-2015.

	SAI	EAI	AAI
2005	9.54	1.55	3.85
2006	10.35	1.47	3.91
2007	10.51	1.39	3.82
2008	9.98	1.56	3.95
2009	9.59	1.43	3.71
2010	10.17	1.48	3.88
2011	10.59	1.44	3.90
2012	11.68	1.54	4.24
2013	12.49	1.52	4.36
2014	15.83	1.41	4.72
2015	16.26	1.46	4.88
Mean	**11.54**	**1.48**	**4.11**

Table 2 shows the descriptive statistics (minimum, maximum and Std. Deviation) of the variables for 21 years (1995-2015). According to the results of descriptive statistics (Std. Dev. = 2915.458), Xinjiang GDP changes considerably with a mean of 3705.72.

Table 2. Descriptive Statistics of Variables.

Variable	Unit	N	Min	Max	Mean	Std. Dev.
GDP	100 million yuan	21	815	9325	3705.72	2915.458
Income (Inc)	yuan	21	724	3903	1840.82	941.903
Planting (Pla)	10,000 hm^2	21	74	242	136.12	46.929
Production (Prod)	10,000 tons	21	94	451	228.90	106.551
Average yield(Yield)	kg/hm^2	21	1177	2057	1616.92	245.578

Table 3 shows the correlation coefficients among variables, the independent variables are highly correlated with the dependent variable and with each other. The correlation coefficients are 0.88 or above. In particular, the correlation coefficient between the cotton planting acres and cotton production is 0.9839. The independent variables that are highly correlated with one another, such cause multi-collinearity limits the value of those coefficients.

Table 3. Correlation.

Variable	Income (Inc)	Planting (Pla)	Production (Prod)	Yield	GDP
Income (Inc)	1.0000	0.9064	0.9472	0.8852	0.9863
Planting (Pla)	0.9064	1.0000	0.9839	0.8018	0.9073
Production	0.9472	0.9839	1.0000	0.8844	0.9535
Yield	0.8852	0.8018	0.8844	1.0000	0.8808
GDP	0.9863	0.9073	0.9535	0.8808	1.0000

Thus, the independent variables require collinear diagnosis before using the model (4) for regression analysis. The results are shown in Tables 4 and 5. The variance inflation factor (VIF) is a measure of multi-collinearity. 0<VIF<10 indicates that multi-collinearity is weak, while VIF≥10 indicates a serious multi-collinearity (NCSS software, Ridge Regression, 2017). In Table 4, all VIF are greater than 10, which means the variables have significant multi-collinearity, and require further statistical analysis. (Table 5)

Table 4. Parameter Estimates.

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|	Variance Inflation
Intercept	**1**	4912.72286	1977.86344	2.48	0.0245	**0**
Income (Inc)	**1**	2.10789	0.29821	7.07	<.0001	**12.27109**
Planting (Pla)	**1**	-69.44593	17.75809	-3.91	0.0012	**108.01406**
Production	**1**	46.42653	10.83202	4.29	0.0006	**207.17485**
Yield	**1**	-3.87234	1.22510	-3.16	0.0061	**14.07757**

Table 5 gives an eigenvalue analysis of the independent variables, eigenvalue near 0 indicate a multi-collinearity problem in the data. Obviously, in the Table 5, there is a small eigenvalue (0.0003022), which indicates directions in which there is no spread. Since regression analysis seeks to find trends across values, when there is not a spread, the trends cannot be compute.

Table 5. Collinearity Diagnostics.

Number	**Eigenvalue**	**Condition Index**	**Proportion of Variation**				
			Intercept	**Income**	**Planting**	**Production**	**Yield**
1	4.83006	1.00000	0.00006246	0.00066657	0.00004001	0.00003444	0.00006405
2	0.14969	5.68045	0.00478	0.02621	0.00010311	0.00088289	0.00128
3	0.01596	17.39378	0.00019377	0.47334	0.02033	0.00686	0.00537
4	0.00399	34.80552	0.06632	0.38379	0.03043	0.03196	0.17379
5	0.00030227	126.40825	0.92864	0.11599	0.94910	0.96027	0.81950

Ridge Regression is a technique for analyzing multiple regression data with multi-collinearity. When multi-collinearity occurs, least squares estimates are unbiased, but their variances are large so they may be far from the true value. By adding a degree of bias to the regression estimates, ridge regression reduces the standard errors. To eliminate the influence of multi-collinearity among the variables in equation (1), the ridge regression results are shown in Table 6 and Figure 7 for four variables.

Figure 7 shows the ridge trace. It can be seen that when $k \geq 0.02$, the ridge trace curve tends to be stable, and $0 < VIF \leq 10$, then after ridge regression analyzes, the multi-collinearity between variables is eliminate.

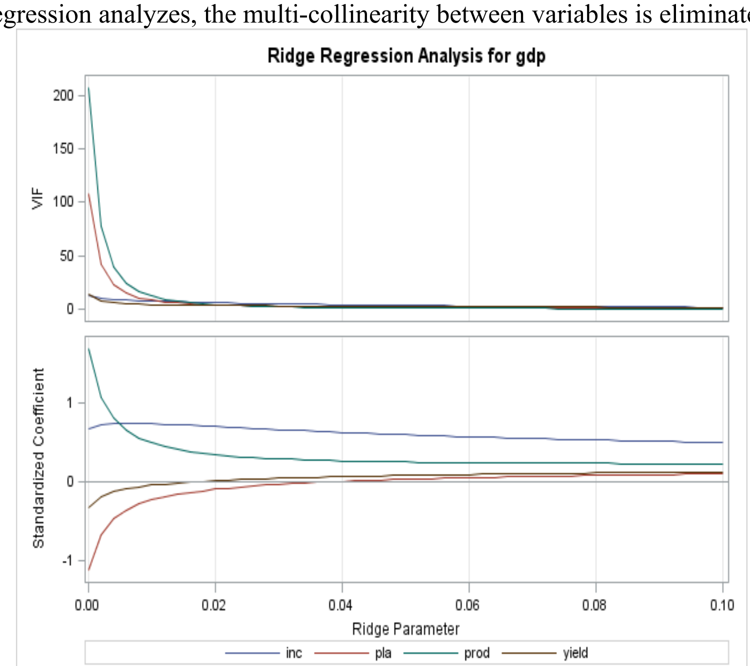

Figure 7. Ridge trace for GDP.

Table 6 shows the parameter estimates for the ridge regression parameter k. ($0 \leq k \leq 0.03$).In table 6, constants the ridge parameter estimate of the ridge regression equation.

$$\text{GDP} = -2092.03 + 2.18369\ \text{Inc} - 5.5702\ \text{Pla} + 9.5989\ \text{Prod} + 0.20963\ \text{Yield} \qquad (5)$$

The regression coefficients of the independent variables in model (5) reflect that for every additional unit of income of rural households in Xinjiang, its GDP will increase by an average of 2.18369 units while the other conditions remain unchanged. For every increase in total cotton production 1 unit, Xinjiang GDP will increase by an average of 9.5989 units. For each additional unit of cotton planting area, Its GDP will reduced by an average of 5.5702 units. For each additional unit of cotton yield, Its GDP will increase by an average of 0.20963 units.

Table 6. The parameter estimates for the ridge regression.

_TYPE	_RID	_RMSE_	Intercept	Income	Planting	Production	Yield
RIDGE	0	358.602	4912.72	2.10789	-69.4459	46.4265	-
RIDGE	0.002	385.875	1988.87	2.27206	-41.4318	29.4593	-
RIDGE	0.004	413.428	665.04	2.31882	-29.0351	22.1132	-
RIDGE	0.006	432.804	-111.67	2.32706	-21.96	18.036	-
RIDGE	0.008	447.009	-634.98	2.31866	-17.3359	15.4572	-
RIDGE	0.01	458.067	-1019.32	2.30205	-14.0454	13.6883	-
RIDGE	0.012	467.129	-1318.59	2.28111	-11.5632	12.406	-
RIDGE	0.014	474.866	-1561.57	2.25789	-9.6094	11.4384	-
RIDGE	0.016	481.686	-1765.07	2.2335	-8.021	10.6857	0.00319
RIDGE	0.018	487.846	-1939.58	2.20863	-6.6968	10.086	0.11284
RIDGE	**0.02**	**493.516**	**-2092.03**	**2.18369**	**-5.5702**	**9.5989**	**0.20963**
RIDGE	0.022	498.808	-2227.17	2.15893	-4.5958	9.1971	0.29626
RIDGE	0.024	503.803	-2348.4	2.13453	-3.7415	8.861	0.37466
RIDGE	0.026	508.556	-2458.2	2.11059	-2.9839	8.5769	0.44628
RIDGE	0.028	513.108	-2558.47	2.08717	-2.3055	8.3343	0.51217
RIDGE	0.03	517.489	-2650.63	2.06432	-1.6929	8.1255	0.57319

Summary

Xinjiang cotton production makes a main role in China cotton market. Its planting acres, total production and the average of yield are number1 in China. This study caculated three different indices: Efficiency Advantage Indices (EAI), Scale Advantage Indices (SAI), and Aggregate Advantage Indices (AAI) to evaluate the comparative advantage of cotton production in Xinjiang. Secondly, the study applies linear regression, a statistical analysis method to analyze the comprehensive effect of cotton production on Xinjiang's GDP.

The evaluation results showed that the cotton production has a huge comparative advantage in Xinjiang from 2005 to 2015. The mean of SAI, EAI and AAI is11.54, 1.48 and 4.11 respectively in 16 years. This results means Xinjiang cotton has a higher planting scale advantage and the average of yield. In particular, the planting acres of Xinjiang cotton is much larger than other provinces, and the average of yield is far higher than the China cotton yield.

Using the regression statistics method to analyze the effect of cotton production on Xinjiang GDP, the results showed that GDP and cotton production have a high correlation. Due to high multi-collinearity between cotton production variables, ridge regression was used to reduce multi-collinearity and improve the accuracy of regression results. The regression analysis reveals that the total production of cotton, the independent variable, has a greater positive impact on Xinjiang GDP. Rural householder's agriculture income and the average of yield has a positive influence also. The regression coefficients of the average of cotton yield (0.20963), which means the average of cotton yield, has a less positive impact on GDP. The regression coefficient of the cotton planting areas is (-5.5702), means this variable is a negative impacts on GDP, and continued increases in cotton planting acres in Xinjiang will decrease its GDP. This result is important for policymakers, who should formulate a more optimized cotton planting scale in Xinjiang to promote economic development.

A few recommendations for future research follow: First, additional data encompassing a larger region and covering multiple years would enhance the representativeness of the findings. Second, the study would use more variables to analyze the impact on Xinjiang GDP (cost, mechanization, modern technology etc.). Third, future research should in-depth analysis the influence of Xinjiang cotton on China and the world cotton market. Nonetheless, despite the foregoing recommendations for future research, the present analysis is a solid contribution to studying the impact of Xinjiang cotton production on its GDP.

References

Huang, L., H. Li, and Z. Sun. 2006. Cotton Industry in Xinjiang's Regional Economic Status. *Xinjiang Agricultural Sciences*. 6:38-41.

Li, H., and S. Zhou. 2007. Cotton production in Xinjiang market competitive advantage analysis. Agricultural economy. 3: 96-101.

National Bureau of Statistics. 1996-2016. China Statistical Yearbook. Beijing, China Statistics Press.

NCSS software, Ridge Regression. 2017. www.NCSS.com\NCSS statistics Software Ridge Regression.

Statistical Bureau of Xinjiang Uygur Autonomous Region. 1996-2016. Statistical Yearbook of Xinjiang.

Wang, X., C. Pi, and J. Ding. 2012. Comparative Analysis of Xinjiang Cotton Production. *China Cotton*. 39: 4-6.

Yang, Z., J. Tang, and X. Yu .2013. Xinjiang Cotton Industry Present Situation and Countermeasure Research. *Agricultural Modernization Research*.

Yu, X., M. Yu, and F. Ewell. 2006. The Comparative Advantage of Upland Cotton Production in Texas. *The Texas Journal of Agriculture and Natural Resource*, 19:31-38.

Zhang, R., and M. Huang. 2010. Effect of Agricultural Structure Adjustment on Farmers' Income-Taking Xinjiang as an Example. *Journal of Economic Research*. 11: 27-28.

Zhu, H., and H. Yue. 2012. Analysis on the Import and Export Trade Situation and International Competitiveness of Chinese Cotton. *China Cotton*. 39:1-4.

Zhu, J., and D. Cui. 2012. Xinjiang Corps cotton buying and selling system evolution and the main interests of the behavior and countermeasures. *Agricultural Modernization Research*. 33: 603-606.