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Is Investment in Agricultural Research a Good Substitute for Price Support in U.S. Cotton?

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Abstract

This article examines the effects of R&D on cotton yield and relationship between R&D and commodity support programs. The results indicate that yield elasticities with respect to cotton R&D is around 0.2-0.5 based on different regions. It further indicates that R&D increases government expenditures when both commodity programs and R&D funding exist. However, if the future WTO Doha negotiations rules out the possibility of price support programs, increasing R&D funding may provide one of the solutions for farmers to recover their income with 5-6 years lag.

Keywords: cotton, R&D, commodity support programs

Introduction

The nature of agricultural policy has been changing over time. However, the purposes of the agricultural policies are the same, which include supporting farmers' income and increasing domestic agricultural production. As a result, most developed countries set up several programs to support these two objectives. For example, the US has a loan rate, target prices, direct payments and other programs to support farmers' income. At the same time, the US also provides funds to support agricultural research as well as agricultural technology extension. Based on a report from OECD, the US government spent $42.6 billion in producer supports, $2,144 million on research and development, and $423 million in extension in 2005.

Agricultural research in the United States has been shown to be a main determinant of agricultural production. The agricultural sector had, on average, a 1.61% annual growth in real output and 1.63% growth in productivity during the 20th century (Huffman and Evenson 1993). Consequently, agricultural research has boosted yields and reduced costs of production. Examples of these efficiency gains can be seen in more productive varieties, the development of tools to combat pests and disease, and the promotion of agricultural practices that protect and preserve environmental resources. Research programs serve as supply shifters, increasing the level of output for a given price. The real question is how much of a shift in supply do these programs provide.

While policy makers have come to agree that both income support and technology support are important in agriculture, few have attended to the influence of R&D investment on income support programs. Increased productivity due to R&D and extension programs leads producers to produce more, other things equal. Higher yields, in turn, dampen price and, therefore, increase the commodity program payment to producers from the government.

During the last couple years, allegations were levied against the U.S. and other developed countries that their domestic and export subsidies caused significant impacts on world markets by encouraging excess production and trade and depressing world prices. Following these arguments, Brazil, with the support of Australia and the Western and Central African (WCA) countries, filed a petition challenging the U.S. cotton programs at the September, 2002 meeting of the World Trade Organization (WTO) Settlement Body. Brazil alleged that U.S. cotton subsidies were depressing world prices and were injurious to their farmers and the WCA countries [Benin, Burkina Faso, Chad and Mali] also claimed to be losing export earnings of US$ 1 billion a year, including both direct and indirect costs, as a result of the subsidies paid by the US and the EU (BBMC, 2003).

Therefore, the purpose of the paper is to investigate the effects of R&D on cotton yields as well as farmer income. In particular, we are interested whether R&D can provide another income source for farmers if further WTO negotiation rules out the commodity price support programs. To analyze the income support and technology support in the US industry, a time series (VAR) model is used to estimate yield elasticites with respect to the R&D, which then is incorporated into a dynamic simultaneous model to account for the endogeneity between the income support and technology support.

Methods

Basic model structure

A partial equilibrium world fiber model was used to estimate the effects of U.S. cotton subsidy programs on the world market. This model incorporates the regional supply response of cotton, different competing goods in different producing regions, substitutability between cotton and competing fibers, and the linkage between raw fiber and textile sectors (Pan et al., 2004). The China and U. S. textile models include supply, demand, ending stocks, and market equilibrium for cotton and man-made fibers. Cotton A-index, Chinese domestic cotton price, U.S. cotton textile price index, U.S. non-cotton price index, U.S. farm price, and polyester prices are endogenously solved in the models by respectively equalizing world exports and imports, Chinese domestic cotton supply and demand, U.S. cotton and non-cotton textile supply and demand, U.S. domestic cotton supply and demand, and man-made fiber supply and demand.

Chinese cotton mill use was estimated following a two-step process in which total textile fiber mill use is first estimated as a residual of textile fiber consumption and the net trade of textile fiber, followed by allocations among various fibers such as cotton, wool, and man-made fibers (represented by polyester) based on their relative prices. The U. S. cotton and non-cotton textile mill use was solved endogenously with the domestic textile demand and textile net trade (net imports). All these equations were estimated based on the cotton textile price index, non-cotton textile price index, cotton domestic price, and non-cotton domestic price.

U.S. cotton production was modeled using separate acreage and yield equations. Cotton production is a function of last year's cotton net returns and the relative net return(s) of competing crops. As part of the total U.S. cotton supply, imports and exports are functions of domestic price, international price (A-index)[1], exchange rates, tariff rates, and quota restrictions. Similarly, the U.S. man-made fiber model is modeled using capacity and utilization. The capacity and utilization equations are estimated by the man-made fiber price and petroleum spot price.

Western and Central African countries and other countries were assumed to be price takers in the cotton market. The elastcties used in the study are presented in Table 1 (Pan et al., 2004). The short run elasticities of cotton acreage response range from 0.10 to 0.54, with Mexico having the highest value. The long-run acreage response elasticities range from 0.21 to 1.15, with the highest in Australia. These elasticties have been used in several studies such as Chinese currency valuation (Pan et al., 2007b) and cotton in a free trade scenario (Pan et al., 2007a).

Scenarios

To analyze the scenarios, we adjusted the model to include the R&D elasticites based on a VAR model in the US cotton yield equation. A 10 year baseline was created following the assumption that current R&D cotton funding and income support programs continue. Three scenarios were examined under different assumption: first, under the assumption that cotton commodity programs such as target price, counter cycle payments, and loan rate are removed and R&D funding is kept at the current level (Scenario 1); second, R&D funding increases by 100% and commodity programs still exist (Scenario 2); third, R&D funding increases by 100% and there are no commodity support programs (Scenario 3). The results based on the three scenarios are used to compare with baseline number.

[1] The A-Index is a measure of world cotton fiber prices.

Results

Effects of R&D on cotton yields

Table 1 presents the stationary tests for regional yields and R&D funding and Table 2 presents the lag selection for VAR model. The results indicate that all the yield and R&D funding are stationary in the level. The lag tests indicate that the effects of R&D on cotton yields are between 5-8 year lags based on different regions. Table 3 presents the VAR results based on lags found in Table 2. Long term regional cotton yield elasticites with respect to cotton R&D are presented in Table 4. These results indicate that elasticities are between 0.2 and 0.5, which are consistent with the R&D literature (Huffman and Evenson 1993).

Simulation Results

Table 5 presents the percentage changes on the baseline in the world US farm price, yield, production, exports, net farm income, and government commodity programs (Target price, direct payments, and loan rate) under the three different scenarios mentioned above. The numbers under baseline are derived from the assumption that US keeps its own policies and R&D investment in the next 10 years. The percentage changes under the various scenarios are derived from a comparison with the baseline.

It indicates that, if cotton R&D increases 100% and farm programs are eliminated (scenario 2 in the table), farm price would decrease (around 20% over 10 years) due to an average yield increase of 31% average over the 10 years (averaged across all U.S. growth regions). However, net farm income would increase 46% over the 10 years at the cost of an 86% increase in government commodity program expenditures.

Although net farm income would decrease over the next 10 years in scenario 3 (double R&D and without commodity programs), the decline happens in the first 5-6 years and the lagged effects are felt, production increases would begin to cover lost revenue. Net farm income would be higher than base number under scenario 3 beginning with 2016/17. At the same time, government commodity program expenditure would be reduced by 31% over the next 10 years.

Conclusion

The effects of cotton commodity programs have been a topic during the last several years. Those programs have provided a great income safety net for cotton producers. However, farmers would be lost if future WTO negotiations eliminate price support programs. This study indicates that R&D funding increases may provide one way for cotton farmers to alleviate income losses from lost price supports should those arise.

Reference

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Table 1. Dickey Fuller Unit Root Test

	Delta Yield	Southeast Yield	Southwest irrigated yield	Southwest dryland yield	West yield	R&D
Test statistics	-3.59*	-5.47*	-6.76*	-2.85*	-3.63*	-2.07*

* indicate the data set is stationary.

Table 2. VAR lag test

	AIC	BIC	Lag
Delta (Difference) R&D	-89.90*	-88.49*	7
Southeast (Difference) R&D	-92.72*	-91.30*	6
Southwest Irrigated R&D	-93.61*	-92.06*	8
Southwest Dryland R&D	-96.58*	-95.04*	8
West (Difference) R&D	-91.24*	-89.83*	6

Table 3. VAR Results (only yield equations are reported here)

	Delta		Southeast		Southwest Irrigated		Southwest Dryland		West	
	Par	t	Par	t	Par	t	Par	t	Par	t
Constant	-282.54*	-6.11	-64.38	-1.81	1774.79*	21.13	-47670.41*	-5.45	107.42	1.71
Yield										
Lag1	-0.92*	-6.43	-0.97*	-9.40	-1.09*	-15.23	32.45*	5.47	-1.31*	-6.20
Lag2	-0.53*	-4.71	-0.48*	-4.03	-1.08*	-18.97	47.34*	8.73	-0.70	0.24
Lag3	0.55*	3.12	-0.24*	-2.16	-0.93*	-11.45	36.96*	5.54	-0.688	-2.70
Lag4	0.79*	3.43	-0.72*	-5.56	-0.92*	-18.92	15.40*	5.52	-0.33	-1.37
Lag5	0.92*	3.52	-0.81*	-6.84	-0.56*	-7.61	12.46*	5.61	0.40*	2.16
Lag6	0.52*	2.15	-0.66*	8.38	0.61*	7.87	7.15*	5.15	-0.18	1.00
Lag7	0.66*	4.89			1.38*	12.71	-5.45*	-5.16		
Lag8					0.31*	3.90	-17.83*	-5.49		
R&D fund										
Lag1	0.004	0.14	0.01*	6.81	0.009*	7.78	-0.23*	-5.46	-0.002	-0.43
Lag2	0.0016	0.33	-0.01*	-4.21	-0.02*	-11.17	0.54*	5.39	-0.24*	-3.22
Lag3	0.01*	2.42	0.007*	2.43	0.02*	0.002	-0.18*	-5.18	0.02*	3.71
Lag4	-0.01*	-4.19	-0.01*	-3.83	-0.01*	-10.25	0.02*	4.89	0.004	0.56
Lag5	0.002	0.67	0.005	1.81	0.006*	5.74	0.03*	5.39	-0.01*	-2.30
Lag6	-0.006	1.79	0.0005	0.311	-0.002*	-2.19	-0.24*	-5.50	0.02*	3.81
Lag7	0.01*	4.51			-0.04*	-23.87	0.60*	5.38		
Lag8					0.04*	30.05	-0.52*	-5.34		

Table 4. Long Term Yield Elasticties with Respect to R&D

Delta	Southeast	Southwest Irrigated	Southwest Dryland	West
0.23	0.30	0.45	0.16	0.37

Table 5. Effects of R&D on U.S. cotton market

		2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17	2017/18	2019/20	average
					Cents per Pound						
Farm price	base	60.53	61.26	61.44	61.42	62.29	61.78	63.09	63.34	63.99	62.13
	scenario 1	3.79%	2.28%	1.56%	1.31%	1.35%	0.89%	1.02%	0.40%	0.64%	1.47%
	scenario 2	-36.83%	-27.37%	-27.00%	-21.87%	-22.16%	-20.24%	-19.74%	-18.72%	-18.65%	-23.62%
	scenario 3	-30.00%	-17.23%	-20.37%	-16.56%	-17.74%	-16.22%	-16.23%	-15.72%	-15.79%	-18.43%
Yield					Bales per Acre						
Delta	base	1.88	1.89	1.90	1.92	1.93	1.95	1.97	1.97	1.97	1.93
	scenario 1	0.00%	-1.48%	-0.73%	-0.64%	-0.63%	-0.63%	-0.48%	-0.50%	-0.31%	-0.60%
	scenario 2	21.86%	22.99%	22.03%	21.88%	21.45%	21.29%	21.02%	21.03%	20.97%	21.61%
	scenario 3	21.86%	20.29%	18.32%	19.33%	19.01%	19.16%	19.06%	19.20%	19.36%	19.51%
Southeast	base	1.64	1.64	1.65	1.66	1.67	1.68	1.69	1.68	1.68	1.66
	scenario 1	0.00%	-2.12%	-1.04%	-0.92%	-0.91%	-0.91%	-0.69%	-0.73%	-0.46%	-0.86%
	scenario 2	33.26%	35.14%	33.96%	33.80%	33.23%	33.04%	32.73%	32.75%	32.67%	33.40%
	scenario 3	33.26%	31.27%	28.50%	30.01%	29.59%	29.84%	29.75%	29.97%	30.21%	30.26%
southwest irrigated	base	1.82	1.84	1.86	1.89	1.91	1.94	1.96	1.96	1.96	1.90
	scenario 1	0.00%	-1.26%	-2.56%	-3.81%	-5.04%	-6.24%	-7.42%	-7.46%	-7.50%	-4.59%
	scenario 2	43.22%	42.86%	42.19%	41.65%	41.08%	40.56%	40.04%	40.02%	40.00%	41.29%
	scenario 3	43.22%	42.45%	41.62%	41.26%	40.71%	40.24%	39.74%	39.74%	39.75%	40.97%
southwest dryland	base	0.70	0.70	0.70	0.71	0.71	0.72	0.72	0.72	0.73	0.71
	scenario 1	0.00%	-0.43%	-1.10%	-1.77%	-2.48%	-3.21%	-3.93%	-4.02%	-4.13%	-2.34%
	scenario 2	23.27%	23.89%	23.32%	23.16%	22.85%	22.69%	22.47%	22.45%	22.38%	22.94%
	scenario 3	23.27%	22.30%	21.11%	21.64%	21.39%	21.41%	21.28%	21.33%	21.40%	21.68%
West	base	3.08	3.09	3.12	3.15	3.17	3.20	3.23	3.24	3.25	3.17
	scenario 1	0.00%	-0.52%	-1.33%	-2.16%	-3.03%	-3.92%	-4.78%	-5.03%	-5.30%	-2.90%
	scenario 2	25.50%	26.22%	24.77%	24.72%	24.36%	24.40%	24.16%	24.15%	24.15%	24.72%
	scenario 3	25.50%	24.33%	22.96%	23.54%	23.22%	23.21%	23.03%	23.06%	23.10%	23.55%

Table 5. (*Continued*)

		2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17	2017/18	2019/20	average
					000 Bales						
Production	base	14468.80	14751.76	15056.88	15381.47	15700.64	15946.40	16117.44	16176.84	16219.06	15535.48
	scenario 1	-3.10%	-4.95%	-6.88%	-8.85%	-10.70%	-12.07%	-13.01%	-13.33%	-13.55%	-9.60%
	scenario 2	35.71%	34.01%	33.24%	32.28%	31.93%	31.42%	31.07%	30.90%	30.84%	32.38%
	scenario 3	28.07%	21.55%	23.45%	23.52%	24.08%	24.15%	24.28%	24.72%	25.02%	24.31%
Export	base	11686.09	11832.23	12173.63	12519.62	12942.42	13684.98	13676.91	13901.50	14042.14	12939.95
	scenario 1	-3.2%	-4.4%	-7.1%	-9.7%	-12.6%	-17.4%	-17.3%	-18.7%	-19.5%	-12.21%
	scenario 2	38.41%	42.62%	40.64%	39.80%	38.23%	36.23%	35.95%	35.35%	34.91%	38.02%
	scenario 3	30.03%	27.82%	28.26%	28.96%	28.69%	27.82%	28.03%	28.23%	28.30%	28.46%
					000000 $						
Farm net income	base	2737.24	2755.13	2762.10	2826.89	2893.63	2756.48	2813.81	2798.31	2813.47	2795.23
	scenario 1	-24.22%	-24.32%	-21.47%	-20.83%	-17.54%	-13.12%	-8.77%	-8.09%	-5.63%	-16.00%
	scenario 2	44.40%	49.60%	50.07%	52.02%	53.43%	40.03%	41.52%	42.87%	43.71%	46.41%
	scenario 3	-42.30%	-15.53%	-19.69%	-10.13%	-9.53%	-0.54%	3.25%	6.56%	8.49%	-8.83%
government expenditure	base	1740.54	1659.66	1582.83	1579.55	1511.80	1349.47	1256.23	1211.21	1167.12	1450.93
	scenario 1	-46.16%	-43.09%	-39.83%	-39.11%	-35.56%	-27.65%	-21.30%	-18.21%	-14.59%	-31.72%
	scenario 2	109.77%	91.83%	97.62%	84.82%	95.39%	66.00%	74.00%	73.94%	78.74%	85.79%
	scenario 3	-48.20%	-42.91%	-40.13%	-38.32%	-34.96%	-26.41%	-19.94%	-16.40%	-12.75%	-31.11%