UNDERSTANDING TEXAS COTTON ABANDONMENT: CLIMATE, WEATHER, AND INSURANCE

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The difference between planted and harvested acres, or abandoned acres, is a variable of key concern to the cotton industry as well as policy makers. Figure 1 shows the abandonment rate (acres harvested as a ratio of planted acres).

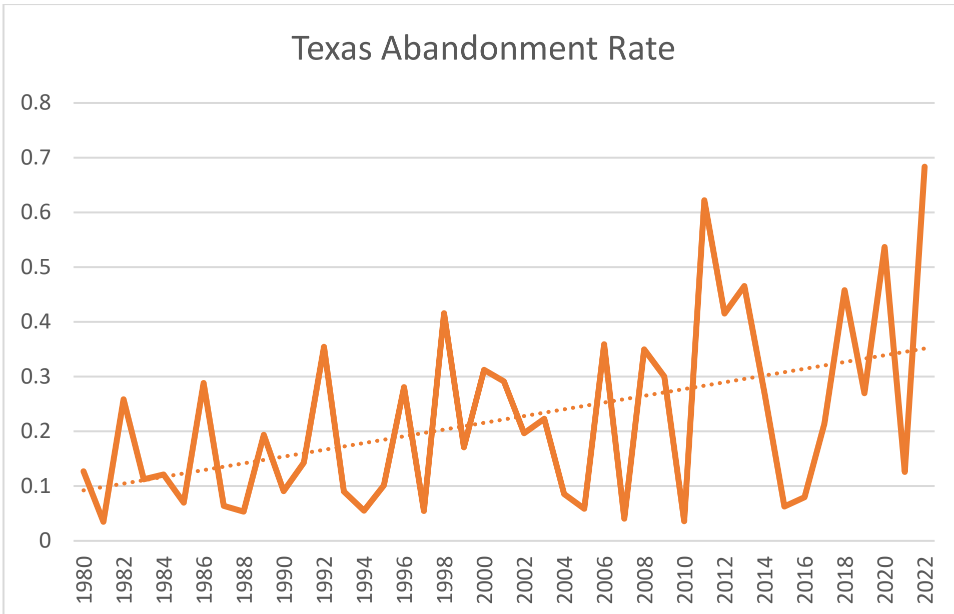

Figure 1. Abandonment Rate in Cotton Acres for Texas, 1980-2022.
Source: USDA, NASS.

Since 1980 Texas has abandoned an average 21% of planted acres, but that trend has been increasing over time. This trend raises some key questions. (1) What are the factors the lead to higher/lower abandonment? (2) Are there factors that can be used to predict abandonment? (3) Are there behavioral factors that influence abandonment? This paper attempts to address these questions to provide insight into abandonment trends in Texas cotton.

ENSO Climate Factor

One of the most often cited reasons for regional weather patterns in Texas is the ENSO (or El Niño-Southern Oscillation). This warming or cooling of the southern Pacific Ocean substantially impacts the general weather patterns across the US. La Niña, or cooling of the central Pacific, is generally associated with cooler and dry conditions across the Plains in the US. El Niño, or warming of the central Pacific, is associated with warmer and wetter conditions across the Plains. These patterns can persist for months or even years, leading to long trends in regional weather patterns.

The ENSO value as produced by the National Oceanic and Atmospheric Administration (NOAA) is used to indicate whether we expect to see a La Niña, Neutral, or El Niño weather pattern. Figure 2 shows the historical ENSO values. Here, the monthly values are averaged from

September of one year to August of the next year to capture the winter moisture/weather pattern and summer growing pattern that is relevant to cotton.

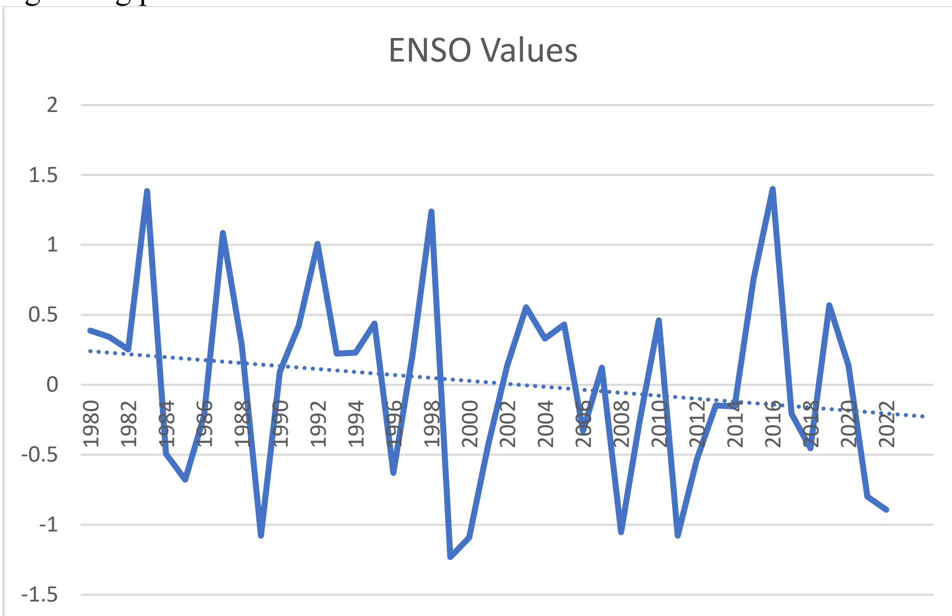

Figure 2. Average Annual (SEP-AUG) ENSO Values, 1980-2022.
Source: NOAA.

In Figure 2, positive values are associated with El Niño patterns and negative values are associate with La Niña patterns. There is clearly variability in this pattern, which likely leads to climate changes that impact growing conditions and that relationship has been trending more toward La Niña, on average, but what is the relationship to abandonment? Figure 3 shows that unconditional relationship between the ENSO value and Texas cotton abandonment rate.

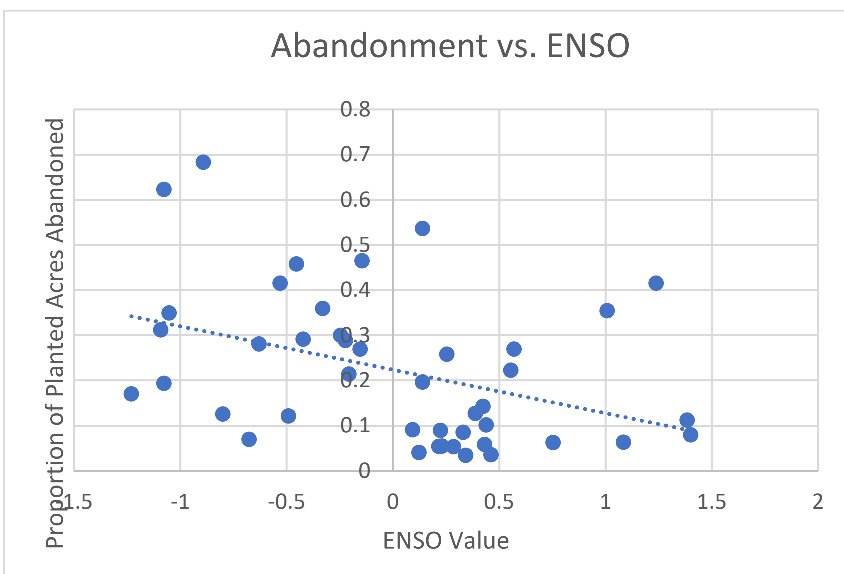

Figure 3. Texas Cotton Abandonment Rate vs. Annual Average ENSO value.
Sources: USDA, NASS and NOAA.

The data indicate that there is a negative relationship between ENSO values and abandonment. Specifically, as the ENSO value moves toward El Niño abandonment decreases, which is not surprising given that El Niño is associated with warmer, wetter conditions for the region.

Other Factors

There are other factors likely to be of importance in determining abandoned acres as well. Agronomically, moisture (in particular, pre-plant moisture which impacts whether planted cotton emerges) and temperature (as measured by growing degree days or GDD) impact the potential yield of cotton during the growing season. For this analysis, the pre-plant moisture was calculated as the total inches of moisture received from September-May averaged across the Texas High Plains from the National Oceanic and Atmospheric Administration (NOAA). Additionally, the growing degree days from May-September of each year was also collected from the Lubbock station.[2] Figure 4 below shows the trend in pre-season moisture over the study period.

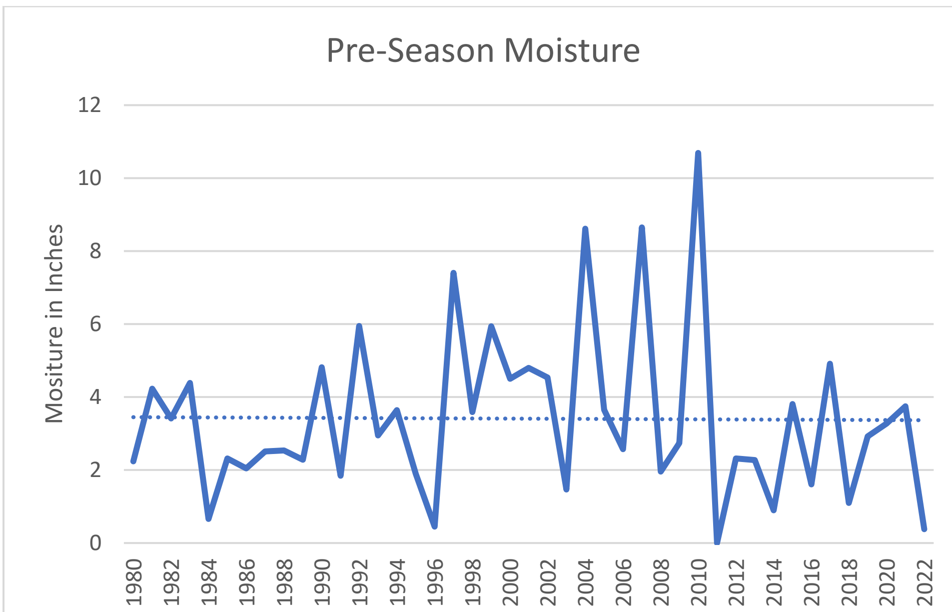

Figure 4. Pre-Season (September-May) Moisture in the Texas High Plains.
Source: Texas High Plains Average, NOAA.

The data show little trend in the pre-season moisture, though the pre-season moisture has been at or below the trend (mean) since 2011. Figure 5 shows the trend in growing degree days (GDDs).[3]

[2] The abandonment measure in this analysis is for the whole of Texas. The Texas High Plains was used for simplicity and also represents the center point for the largest concentration of cotton production in Texas.
[3] Other variables such as in-season moisture and percentage of irrigated acres were considered with no success. GDD appears to subsume several environmental variables together that jointly explain production better than individual variables alone.

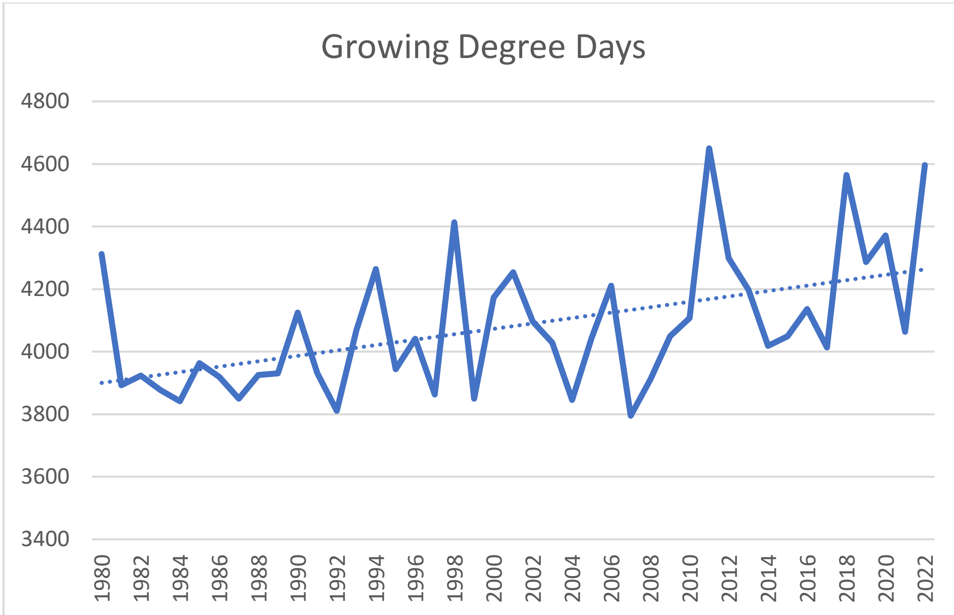

Figure 5. Growing Degree Days (May-September), Lubbock, TX.
Source: National Weather Service, Lubbock, TX.

Average annual GDD has been on an upward trend since 1980. Although not shown here, the upward trend is most likely tied to warmer nighttime lows than higher daytime high temperatures.

But there are also behavioral variables that are likely to impact abandonment decisions as well. The existence of crop insurance protects producers from losses when crops fail. Because the insurance premium is subsidized it can incentivize producers to abandon crops that, at the margin, could have covered harvest costs and would have otherwise been harvested (Wu, Goodwin, and Coble). While there is an incentive (called moral hazard), actual behavior may not be observed. Or, alternatively, the moral hazard behavior may be mitigated by other factors present in the decision. For example, in years where the harvest price is high, producers may harvest a smaller crop because the financial payoff would be higher than abandoning the crop and taking an insurance indemnity payment. Additionally, good weather conditions that are favorable to yield would be expected to reduce the impact of insurance on abandonment.

To control for the insurance effect, a variable was included that represented the number of Texas acres that were insured with a coverage level of 65% or higher. This restriction eliminated the acres in Texas that were simply covered with the required catastrophic coverage insurance required for participation in farm programs. Figure 6 shows the proportion of Texas cotton acres insured over time.

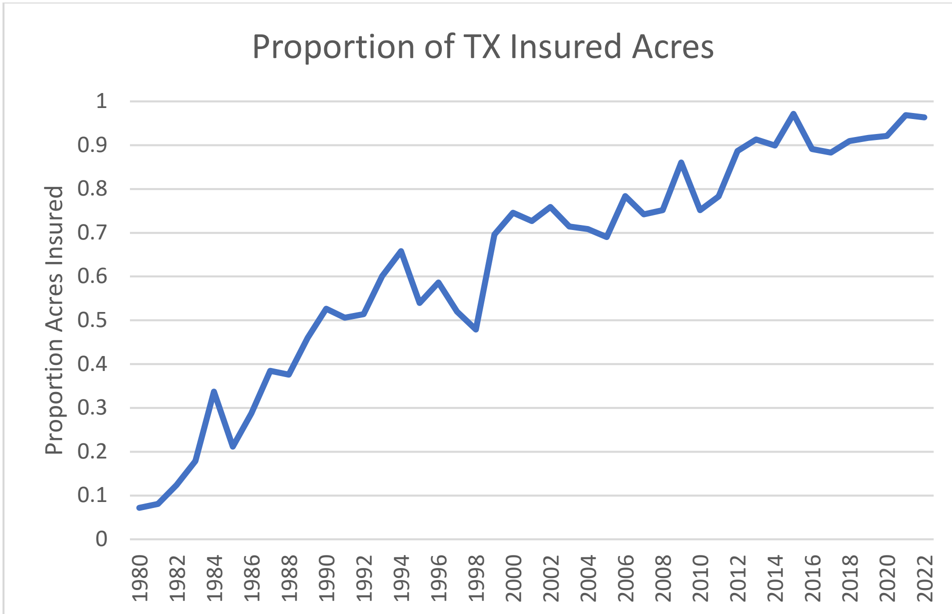

Figure 6. Proportion of Texas Cotton Acres Insured at the 65% Coverage Level or Higher, All Types of Insurance.
Source: Risk Management Agency, USDA.

The harvest price for each year was also included to control for potential crop value at the end of the growing season. Finally, a dummy variable (indicator variable) was included for the 2014 farm bill which included some revisions to the crop insurance program that made it more favorable for the producer to file insurance claims when losses occurred.

Data and Methods

Table 1 shows the descriptive statistics of all the variables used in this analysis.

Table 1. Descriptive Statistics of Key Variables in Analysis.

Variable	Mean	Standard Deviation	Maximum	Minimum
Abandonment Rate	0.222	0.167	0.684	0.035
ENSO Value	0.018	0.689	1.400	-1.231
Growing Degree Days	4081.442	216.366	4596.000	3795.000
% Acres Insured	0.634	0.260	0.972	0.072
Pre-Season Moisture (In.)	3.408	2.294	10.690	0.000
Harvest Price	0.628	0.127	1.010	0.350

A simple linear regression was used to estimate the relationships between key variables and the Texas cotton abandonment rate. The estimated coefficients and relevant statistics are shown in Table 2.

Table 2. Regression Results of Texas Cotton Abandonment Rate.

Variable	Coefficient	Standard Error	t-value	p-value
Intercept	12.609	6.103	2.066	0.047
ENSO	-0.053	0.027	-1.937	0.061
GDD	-0.006	0.003	-2.187	0.036
GDD^2	0.000	0.000	2.316	0.027
Insurance	0.339	0.187	1.815	0.079
Pre-Season Moisture	0.037	0.375	1.001	0.324
Farm Bill	0.779	0.955	0.812	0.422
Harvest Price	-0.169	0.163	-1.042	0.304
In*Pre	-0.075	0.052	-1.433	0.161
In*FB	-0.824	1.038	-0.794	0.432
F-value = 8.051, Adjusted R^2 = 0.602				

The results show, consistent with Figure 2, that there is an inverse relationship between ENSO and abandonment. So, even when controlling for other factors, the ENSO effect remains important to understanding abandoned acres in Texas. The growing degree days (GDD) show a curvilinear relationship. That is, as GDDs increase, abandonment initially decreases. But after some value (around 3900-degree days) abandonment begins to increase. This result seems consistent with the idea that cotton responds to warmer temperatures positively, but that it can become too warm which negatively affects yields and crop survival. As an interesting note, the overall mean GDD is 4081 which suggests, holding other factors constant, that average abandonment would be about 17%. But the mean GDD for the past 5 years has been 4376, suggesting a predicted abandonment of 32.6%. This result would suggest that a large factor in the more recent increase in abandonment would be the increase in average GDDs. One may be tempted to think that GDD and ENSO are correlated, but the actual correlation is r = -0.20, so those variables are not highly correlated.

From a behavioral point of view, insurance does have some impact on acres abandoned, signaling that the subsidized program does result in moral hazard behavior. However, two items should be noted. First, while the coefficient is significantly different than zero at the 7.9% level, that level of precision indicates that the insurance effect is present (and numerically large) but with less confidence than we would prefer. Second, the insurance effect, when interacted with pre-season moisture, reduces substantially. The effect of pre-season moisture on the insurance effect can be visualized in Figure 7 below.

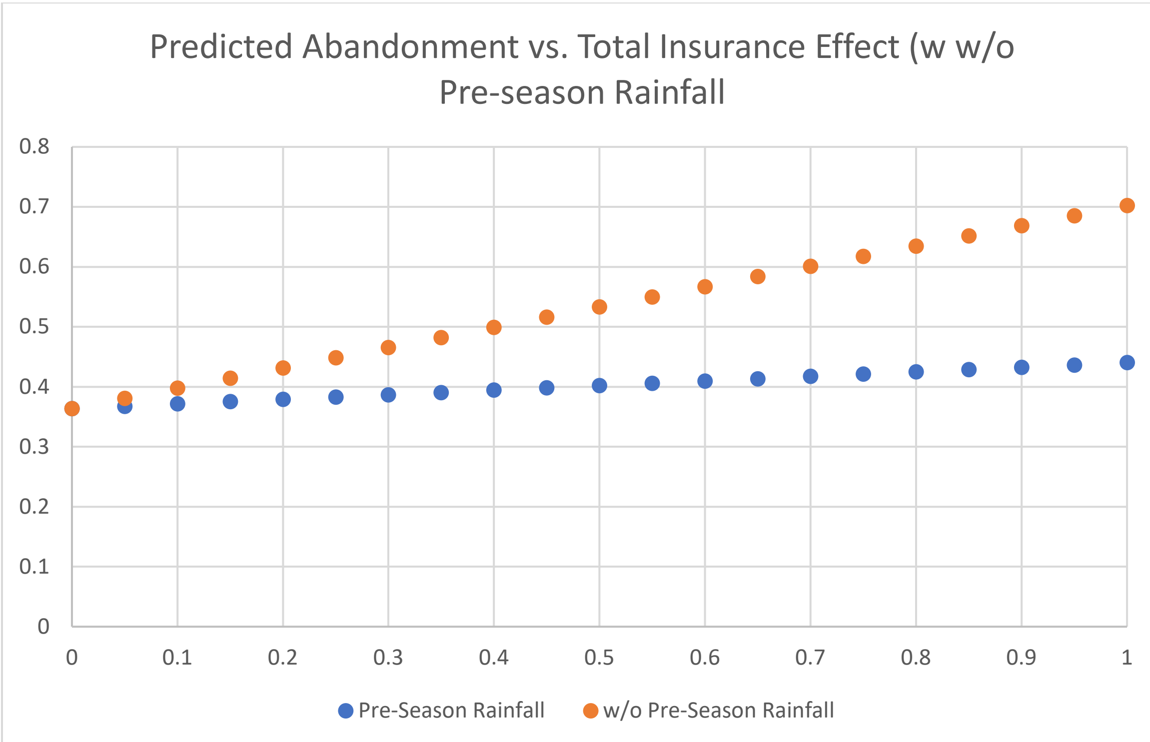

Figure 7. Predicted Texas Cotton Abandonment vs. The Impact of Insured Acres With and Without the Inclusion of Pre-Season Moisture Impacts.

The orange line in Figure 7 shows the predicted abandonment rate (holding all other variables at their mean levels) without considering the impact of pre-season moisture (that is, ignoring the interaction effect in the regression). The blue line depicts the impact of insured acres when considering the interaction with pre-season moisture. Choosing two arbitrary insured acres level (0.50 and 0.90), without the consideration of pre-plant moisture, the predicted abandonment rate would be 0.53 and 0.67, respectively. When considering pre-plant moisture, those same predicted values would be 0.40 and 0.43. This result indicates that the impact of pre-plant moisture is to lower the overall predicted abandonment as well as the change in abandonment with a change in insured acres.

Also from a behavioral standpoint, the farm bill indicator variable is not statistically significant, although it is numerically large. The interpretation here is that the 2014 farm bill did not significantly increase abandonment even though it contained provisions that were more favorable to producer filing of insurance claims.

Discussion

Overall, this analysis indicates that weather variables (and climate trends like ENSO) impact abandonment in expected ways. At the margin, it appears that growing degree days (GDDs) have the largest potential impact on abandoned acres. As an explanatory variable, this makes sense. But as a predictive variable, it is less useful because it would require forecasting GDDs ahead in time to predict abandonment. That may be a useful exercise but was not pursued here. A forecaster would have a good idea about the ENSO value, pre-season moisture, a predicted harvest price (futures prices), and insured acres. So, the key missing variable here would be a forecast of GDD.

Importantly for the debate about cotton abandonment, however, the analysis does provide evidence that crop insurance has shaped abandonment decisions to some extent. However, it appears to be far from the most important variable at the margin, especially when considering the interaction effects of other variables that mitigate the impact of crop insurance. Further, provisions in the 2014 farm bill appear to have had little impact on abandonment decisions holding other things constant.

There are many other issues and considerations here that lead to concerns about endogeneity (simultaneous decisions) that certainly lead to questions about causality. For example, the correlation between the percentage of the total cost of production that is incurred at or before planting and insured acres is quite high. Figure 8 shows the trend in the cost of production variable.

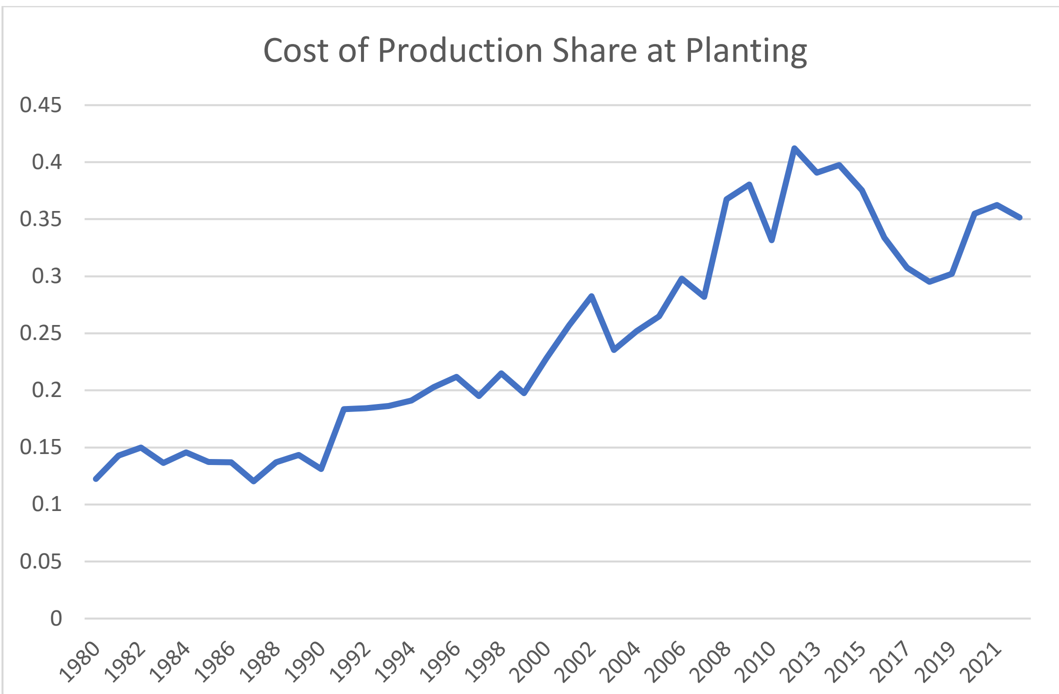

Figure 8. Share of the Total Cost of Production for Cotton that is Incurred At or Before Planting, Prairie Gateway Region.
Source: Economic Research Service, USDA.

So, has abandonment increased over time because producers have more of their cost of production incurred at planting (necessitating a decision about abandonment sooner)? Has insured acres increased because of this cost of production phenomenon? The correlation between insured acres and this cost of production measure is r = 0.88. But correlation is not causation. The above model does not address this issue, but the relationships here seem quite important from a policy perspective.

References

Wu, S., B. Goodwin, and K. Coble. 2020. "Moral Hazard and Subsidized Crop Insurance." *Agricultural Economics*, 51: 131-142.