The Ethanol Mandate and Downside Risk in Agriculture

Levi A. Russell
Assistant Professor and Extension Economist
Department of Agricultural Economics
Texas A&M University
lrussell@tamu.edu

Michael R. Langemeier
Director of Cropping Systems
Center for Commercial Agriculture
Purdue University
mlangeme@purdue.edu

Gregory Ibendahl
Associate Professor
Department of Agricultural Economics
Kansas State University
ibendahl@k-state.edu

Jon T. Biermacher
Associate Professor
Center for Economic Information and Analysis
The Samuel Roberts Noble Foundation
jtbiermacher@noble.org

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Introduction and Motivation

The Energy Independence and Security Act of 2007 was passed with the intention of increasing production of clean renewable fuels. As a result, U.S. ethanol production increased dramatically from 6.5 billion gallons in 2007 to 14.3 billion gallons in 2014. The effect of the policy is demonstrated by an empirical study by Akinfenwa and Qasmi (2014) who identified structural breaks in ethanol production in 2002 and 2007. Though production of ethanol increased, the literature suggests that the increase in production has had a moderate impact on the level of corn prices and a more dramatic impact on corn price volatility ~~.~~ (McPhail and Babcock, 2008). ~~Theoretical~~ R~~r~~esearch also indicates that ethanol policy has likely increased planted acreage ~~as well.~~ (Feng and Babcock, 2008). Further, there is evidence that fuel ethanol subsidies can be substitutes at the margin for other agricultural subsidies to producers~~.~~ (Gardner, 2007).

Many studies over the past few years have evaluated the impacts of ethanol policy on profitability, planted acres, environmental factors, and other issues. However, the authors are not aware of any effort to examine the effect of ethanol policy on downside risk at the farm level. Downside risk is an important factor in agricultural production because it focuses on the probability of loss rather than simply the variability of returns. While modeling risk as variance generates analytically tractable models, the probability of loss is a more intuitive conception of risk.

Langemeier and Jones (2001) used the percentage of years with negative return on equity as a proxy for downside risk. They reported that farms with relatively low downside risk “had a higher current ratio, a lower debt to asset ratio, a lower total expense ratio, represented younger operators, were more specialized, received a smaller percent of their income from livestock, and

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were larger than farms in the high downside risk category.” This paper examines downside risk of a sample of Kansas farms before and after the Energy Independence and Security Act of 2007. Specifically, we examine the extent to which the relationships between downside risk and its determinants shift after the ethanol mandate. We extend the model used by Langemeier and Jones (2001) by including the percentage of revenue from government payments and dummy variables that account for farming regions within the state.

Data and Methods

Data for this paper are taken from the Kansas Farm Management Association (KFMA) database. The KFMA dataset includes data on 300 crop and livestock farms over the 1997-2014 time frame. These data include detailed income statements and balance sheets for each farm in each of 6 farming regions across the state of Kansas, as well as several other characteristics such as the age of operator, and the total acres operated.

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The probability of a negative return on equity is used as a measure of downside risk in this study. In contrast to Langemeier and Jones (2001), we use the probability of a negative return on equity rather than the percentage of years with a negative return on equity so we can examine effects of ethanol policy over time. A positive (negative) return on equity indicates that the farm operator is able to cover all (some of) cash costs plus an opportunity charge for unpaid operator labor and management. This is consistent with the concept of a target net farm income which, in this case, is set at a level which covers all of the costs described above.

A logit model is used to estimate the effects of several factors on downside risk. The dependent variable y is equal to 1 if the return on equity of farm i in year t is negative and is equal to 0 otherwise. We follow Langemeier and Jones (2001) and Purdy, Langemeier, and Featherstone (1997) in our choice of our explanatory variables which are the inverse current ratio, the debt to asset ratio, the total expense ratio, the operator's age, an index of specialization, the percentage of gross farm income from government payments, a measure of farm type, controls for regional and size effects, the marketing year average corn price, and the ethanol policy variable. The logit regression model is specified as follows:

$$Pr[y = 1|\boldsymbol{x}] = \frac{e^{x'\beta}}{1+e^{x'\beta}} \quad (1)$$

where $\boldsymbol{x}$ is a vector of explanatory variables listed above.

The inverse current ratio is used instead of the current ratio to avoid dividing by zero in the case of a farm with zero average short-term liabilities for the year. Since farms that are more liquid tend to be more profitable, we expect that farms with a higher inverse current ratio will be more likely to have a negative return on equity.

Higher total debt-to-asset ratios are generally associated with higher business risk. Thus, we expect that farms with higher debt-to-asset ratios will be more likely to have a negative return on equity in a given year.

A farm with higher a total expense ratio (total expenses divided by value of farm productiongross farm income) is expected to have a higher probability of a negative return on equity. This is because the total expense ratio is inversely related to profitability. Higher cash costs relative to value of farm production gross farm income make it less likely that a farmer will be able to cover opportunity costs of unpaid labor and management.

Operator age captures the effects of technology adoption and experience. Younger operators are, *ceteris paribus*, more likely to adopt new technologies while older operators have the advantage of more experience. We use linear and quadratic terms to capture this potential nonlinearity in the effect of age on downside risk.

To capture the effects of specialization on downside risk, we use a Herfindahl-Hirschman index across income sources. Specifically, we compute income shares across major crop types (feed grains, oilseeds, small grains) and livestock (beef cattle, hogs, dairy) for each farm in each year. The shares are squared and added together to calculate the Herfindahl-Hirschman index, which ranges in value from 1/6 to 1. A value close to zero indicates very little specialization while a value of 1 indicates that the farm is specialized in the production of one commodity. Specialization is expected to be positively related to downside risk. That is, operations which are more diverse are expected to be less risky.

The percentage of income from government payments is expected to be negatively related to downside risk. Farm support from the federal government is designed to assist producers when yields and/or prices are low.

The percentage of labor dedicated to crop production is used to measure farm type. This measure is used to determine whether crop production is more or less risky than livestock production.

Dummy variables for KFMA region (six regions in the state) and value of farm production gross farm income are included to control for regional and size effects on downside risk. Kansas is generally more arid in the west and has higher rainfall in the east and such climate conditions may affect downside risk. Larger farms may be subject to more or less downside risk than smaller farms. Both linear and quadratic terms are included to account for any nonlinearity in the effect of farm size on downside risk. This specification allows for medium-sized farms to be more or less risky than their larger or smaller counterparts.

We use two measures of ethanol policy to examine its effect on downside risk: (1) a time dummy variable for before and after the Energy Independence and Security Act of 2007 and (2) the marketing-year total bushels of domestically-produced corn used in fuel ethanol production in the U.S. The use of the first measure is supported by Akinfenwa and Qasmi (2014), who find a structural break in U.S. fuel ethanol production in 2007. This indicates that the passage of the Energy Independence and Security Act of 2007 likely had a significant effect on ethanol production in the U.S. The time dummy variable measures the state of federal ethanol policy. The second measure of ethanol policy is intended to provide a robustness check on the first specification. The marketing year average corn price is included in the model to control for other factors at play in the corn markets that might affect downside risk. We include an interaction term to account for the effect of ethanol policy on corn prices.

We expect that either measure of ethanol policy is likely to be negatively related with downside risk. That is, we expect that farms in general experienced less downside risk after the Energy Independence and Security Act of 2007 was passed. Ethanol policy significantly increased planted acres of corn and significantly strengthened a source of demand for corn that was previously small relative to other uses such as exports and feed.

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