FARM EFFICIENCY AND VOLATILE COMMODITY MARKETS IN KANSAS

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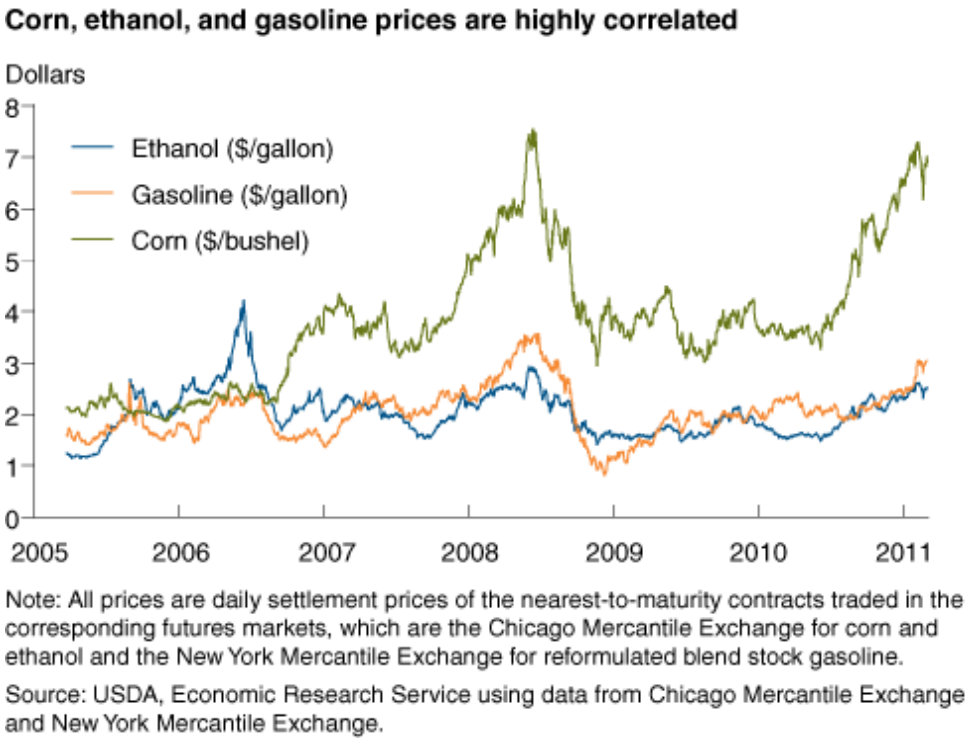
Introduction

- Domestic factors, such as biofuel demand and weather, have increased the demand for crops, resulting in an increase in corn prices, as well as price volatility.



Source: USDA, ERS, 2012

Introduction

- These changes have increased the profitability of the agricultural sector and have affected farm production.

- Incentives to increase agricultural supply:
  - Area cropped
    - Constraints to land availability.
  - Input mix

- Productivity changes have resulted. These changes can be affected by multiple factors as farmers respond to a changing agricultural environment with higher input and output prices.

Previous literature

- Studies have looked at the effect of exogenous factors on productivity change:
  - Yeager and Langemeier (2011): Effect of Input ratios and income shares.
  - Hassanpour et al., 2011): Effect of socio-economic and bio-technical factors.
  - Odeck (2007): Effect of farm size .
  - Zhengfei and Lansink (2006): Effect of capital structure using a dynamic panel data model.
  - Balcombe et al. (2008): Accounted for sample variation using bootstrapping.

Objectives

- To evaluate changes in the total factor productivity of farms in Kansas by using an input-oriented nonparametric approach using a Malmquist index for farm productivity.
  - To evaluate changes in agricultural productivity as a result of changes in commodity prices.
  - To evaluate the persistence of farm behavior as it pertains to productivity changes using the components of the Malmquist index.

Methods

- Productivity change
  - Input Oriented Technical Efficiency and Productivity changes:

Malmquist productivity index: is the product of the technical and efficiency change:

$$\text{Technical Change} = \left[\frac{D_o^t(x_o^t, y_o^t)}{D_o^{t+1}(x_o^t, y_o^t)} \times \frac{D_o^t(x_o^{t+1}, y_o^{t+1})}{D_o^{t+1}(x_o^{t+1}, y_o^{t+1})} \right]^{1/2}, \qquad t = 1,\ldots,T-1$$

$$\text{Efficiency Change} = \frac{D_o^{t+1}(x_o^{t+1}, y_o^{t+1})}{D_o^t(x_o^t, y_o^t)}, \qquad t = 1,\ldots,T-1$$

  - Estimated using Data Envelopment Analysis (DEA) following Färe et al. (1989).

Methods

Regression Analysis:

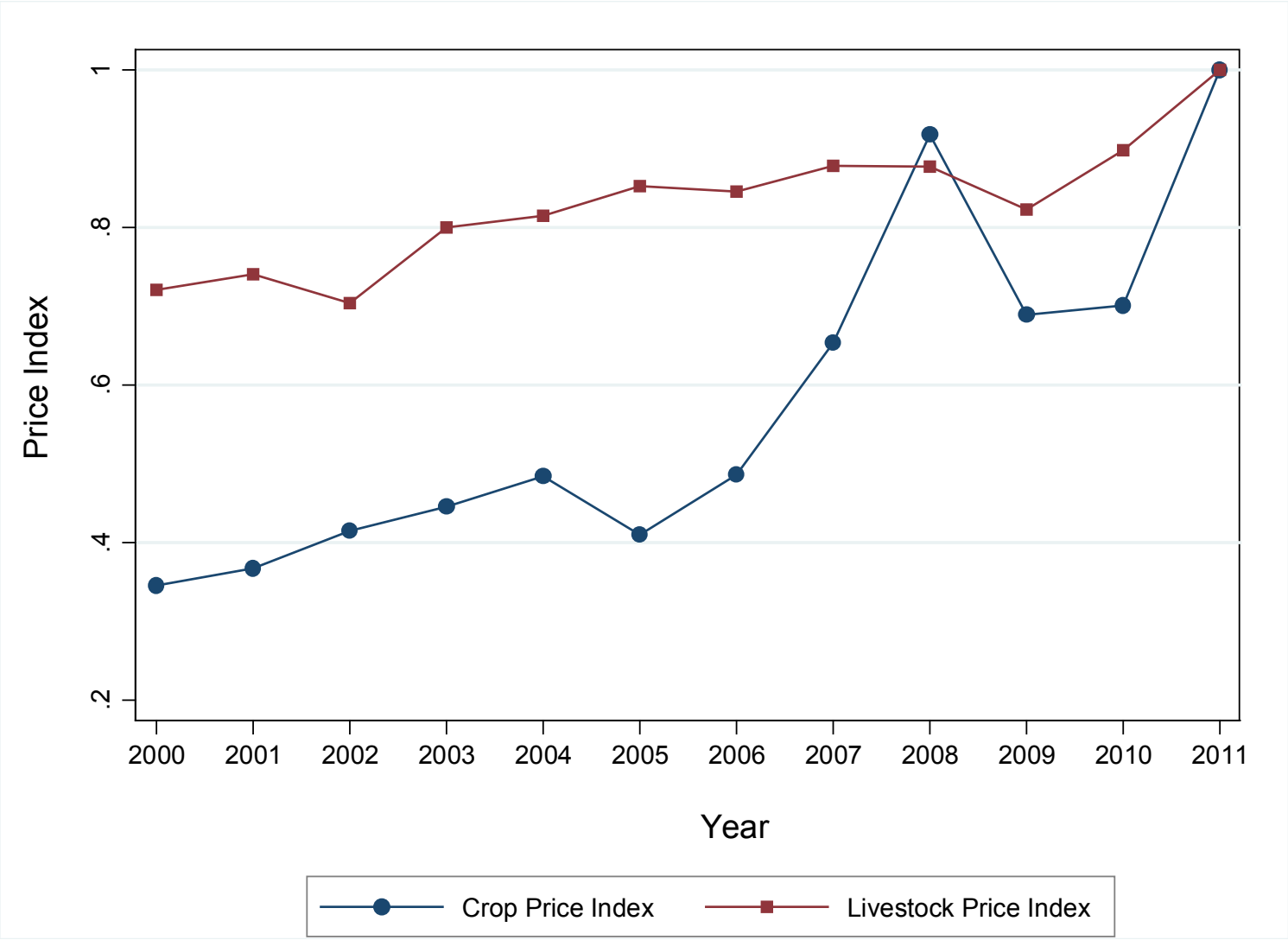
- Farm efficiency performance.
  - Dynamic probit model: probability that a farm was in the upper quartile of the distribution.
    - Effect of past performance
    - Other socio-economic factors.

- Productivity change and its components.
  - Dynamic panel data model.
    - Effect of past performance.
    - Effect of output and input prices.

Data

- Data obtained from Kansas Farm Management Association
  - 331 Kansas farms
  - Years 2000-2011
- Input oriented technical efficiency and productivity indexes:
  - Two outputs: crops and livestock.
  - Five inputs: crop inputs, livestock inputs, labor, fuel, and other inputs.
- Variables in second stage estimation:
  - Output and input price indexes, size, debt to asset ratio, investment, government payments, crop land, rented land, farmer's age, region.

Data


Price Index
.2
.4
.6
.8
1
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
Year
Crop Price Index
Livestock Price Index

Results

Input Oriented Technical Efficiency Scores and Productivity Indexes across farms in Kansas, 2000-2011

Year	Technical Efficiency		Productivity Change (a) X (b)		Efficiency Change (a)		Technical Change (b)	
2000	0.691	(0.178)						
2001	0.757	(0.159)	0.926	(0.255)	1.156	(0.358)	0.816	(0.128)
2002	0.763	(0.172)	0.924	(0.241)	1.031	(0.240)	0.898	(0.122)
2003	0.692	(0.177)	1.111	(0.333)	0.941	(0.302)	1.198	(0.182)
2004	0.769	(0.156)	1.077	(0.361)	1.177	(0.364)	0.934	(0.215)
2005	0.749	(0.175)	1.18	(0.599)	1.003	(0.276)	1.188	(0.441)
2006	0.756	(0.172)	0.955	(0.262)	1.05	(0.309)	0.929	(0.179)
2007	0.772	(0.174)	1.015	(0.301)	1.055	(0.281)	0.969	(0.173)
2008	0.773	(0.171)	0.961	(0.295)	1.04	(0.286)	0.924	(0.115)
2009	0.758	(0.170)	1.191	(0.524)	1.027	(0.405)	1.156	(0.150)
2010	0.707	(0.181)	1.083	(0.399)	0.974	(0.334)	1.115	(0.140)
2011	0.74	(0.184)	0.855	(0.453)	1.093	(0.342)	0.778	(0.271)
Mean	0.744		1.025		1.049		0.991	
Maximum	0.773		1.191		1.177		1.198	
Minimum	0.691		0.855		0.941		0.778	

Numbers in parenthesis are standard errors.

The Malmquist Productivity Index is the product of column (a) and (b).

Results

- Factors affecting the probability of farmers in the upper quartile of the efficiency distribution of farms in Kansas (only statistically significant variables are included here).

	Parameter estimate	Standard Error
y(-1)	0.117*	(0.066)
Age	-0.0107*	(0.005)
Crop share	-0.820***	(0.165)
Investment in crop machinery	0.963***	(0.259)
Government Payments	-1.836***	(0.553)
Size	0.0001***	0.000
Western Kansas	0.319**	(0.156)
Central Kansas	-0.268**	-0.106

Results

- Factors affecting the efficiency, technical and productivity growth of farms in Kansas (only statistically significant variables are included here).

	Efficiency Change		Technical change	
y(-1)	-0.473***	(0.013)	-0.331***	(0.013)
Crop price index	-0.511***	(0.064)	-0.482***	(0.044)
Livestock price index	-0.119*	(0.054)	0.378***	(0.037)
Crop price index *Year>2008			-0.391***	(0.045)
Livestock price index *Year>2008	-0.187***	(0.054)	0.466***	(0.038)
Crop input price	0.273***	(0.048)	0.218***	(0.035)
Fuel price	0.119*	(0.047)	0.318***	(0.033)
Livestock input price	0.820***	(0.111)	-0.806***	(0.074)
Investment in crop machinery	0.142*	(0.060)		
Government payments	-0.708***	(0.053)	0.308***	(0.034)
Crop share	-0.141***	(0.034)	-0.0894***	(0.022)
Debt to asset ratio			-0.184***	(0.038)

Conclusions

- While it was expected that increases in commodity prices would have resulted in a push to increase efficiency, the results from this study did not find evidence for an increase in efficiency on average. Increases in the crop price index had a negative effect on efficiency and technical growth.
  - It could be that farmers adjust their production to take advantage of increases in commodity prices, but those changes in production might be geared towards yield increases and not necessarily optimization of input usage and technology. improvements.
- Input prices have a positive effect on efficiency and technical growth.
  - Higher input prices may represent an incentive to invest and adopt input saving technologies.

Conclusions

- Farms that are efficient in the past are more likely to perform well in the future which could be attributable to the stock of knowledge, know–how, and farms available technology which builds upon existing technology. Farmers' learning from their previous experiences affects the dynamics and interrelation of previous and future performance.

- Lower efficiency and technical growth was found with high past growth rates.
  - Productivity grows less rapidly for farmer with larger initial productivities.
  - Importance of agricultural innovation : new technologies allow farmers to shift up their efficiency frontier.