5. Farm Diversification as an Adaptive Capability: Examining the Resilience of Kansas Farms

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Abstract/Summary

The purpose of this study is to examine the impact of diversification on farm resilience. The analysis utilizes an innovative system resilience approach in combination with panel database on Kansas farms. Specifically, resilience index values were computed for more than 1400 farms during three distinct periods of economic and agro-ecological shocks. Additionally, a unique diversification index was computed at the individual farm level accounting for variation in crop selections across acres and across years. The results indicate that the farm size and the level of diversification play an important role in farm's ability to withstand and recover from unexpected economic and agro-ecological shocks.

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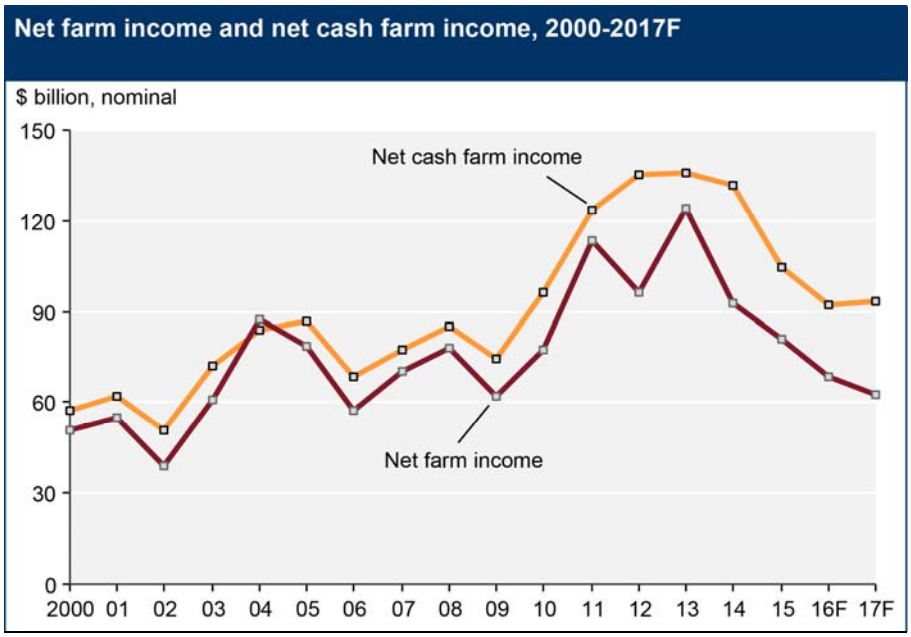
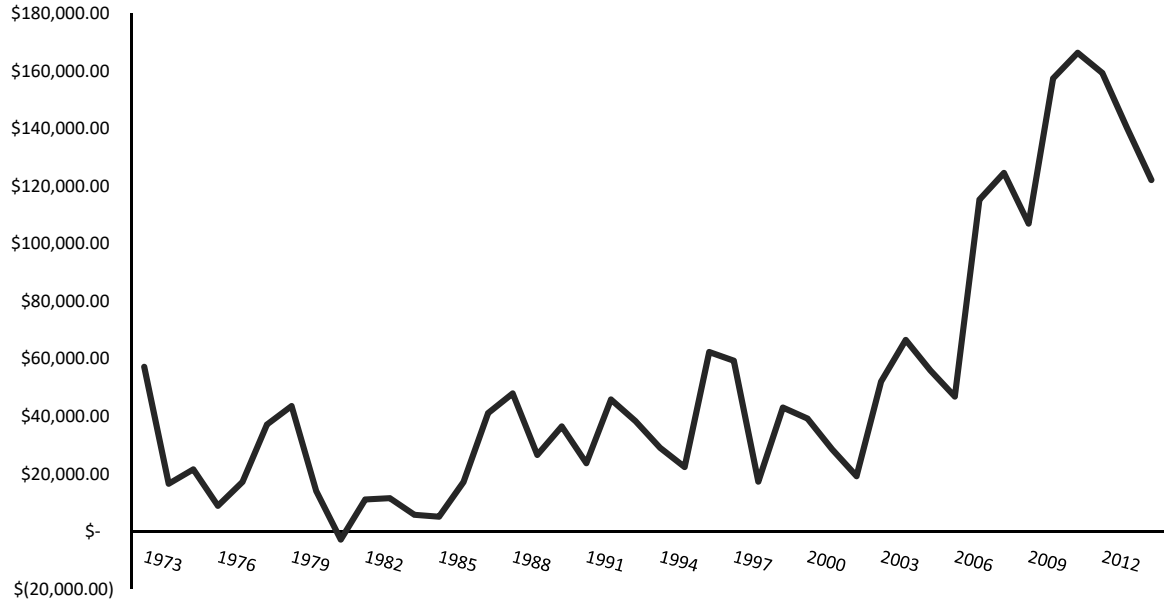


Source: USDA, Economic Research Service, Farm Income and Wealth Statistics, February 7, 2017

Net Farm Income (All Kansas Farms 1973 – 2014)



1. Introduction

- Many advances in risk management for agricultural production
- Embraces the fact that every system will always be subject to some level of unpredictable vulnerabilities

1. Introduction

- **System Resilience:** The ability of a system to experience a shock (ecological or economic) and then recover to a similar or improved state of existence
- Embraces the fact that every system will always be subject to some level of unpredictable vulnerabilities

1. Introduction

- Resilience has two components:
  1. Time to recovery
  2. Magnitude of impact
- In order to return to full performance levels, the resilient system develops adaptive capabilities

1. Introduction

- Adaptability: The capacity of actors in a system to influence resilience
- Adaptive Capabilities Examples:
  - Drought resistance
  - Migratory patterns
  - Technology adoption

1. Introduction

- Resilience does not mean adherence to a fixed steady state
- Resilience is the continuation of the fundamental system relationship
- Analogy of the tree

1. Introduction

- **Farm Resilience:** The ability of a farm to return to similar or improved states of existence following an economic or ecological shock
- Uses the two components:
  1. Time to recovery
  2. Magnitude of impact

1. Introduction

- Fundamental relationship:
  - Farmer engaging in productive activities
- Many existing adaptive capabilities

2. Motivation and Objective

- Motivation
  - Why are some farms more resilient than others?
  - No existing empirical measure of resilience in this context
  - Resilience measures will help identify most impactful adaptive capabilities

2. Motivation and Objective

- Motivation
  - Help farmers improve system resilience
  - Minimize impacts of low probability/high impact events like the current farm crisis

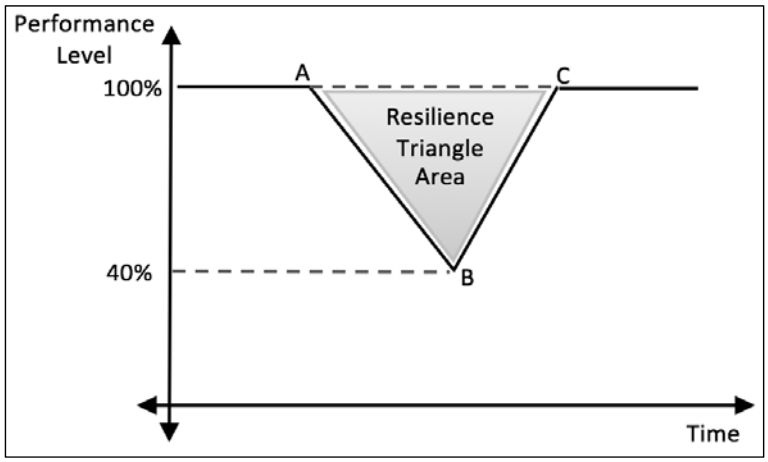
2. Motivation and Objective

- Objective
  - Determine farm characteristics and adaptive capabilities that influence farm resilience
  - Look specifically at the role of diversification as an adaptive capability on farm resilience
  - Elicit policy and production implications from the resilience/diversification relationship

3. Conceptual Framework

- Resilience Triangle Approach

1. Time to recovery
2. Magnitude of impact



3. Conceptual Framework

- Resilience Triangle Approach

1. Time to recovery
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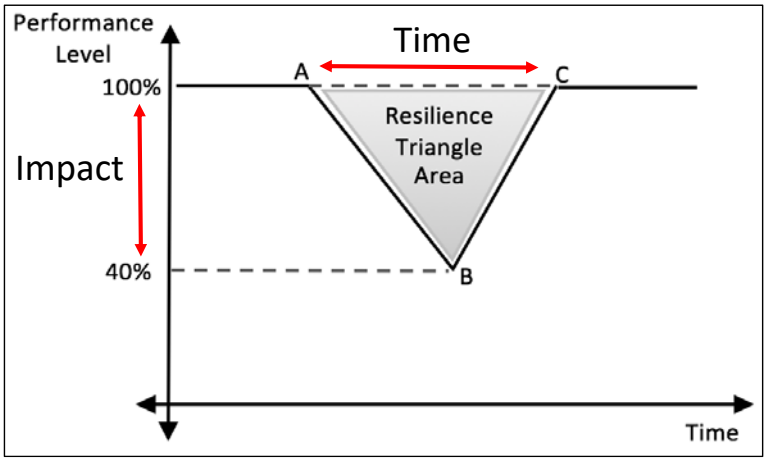
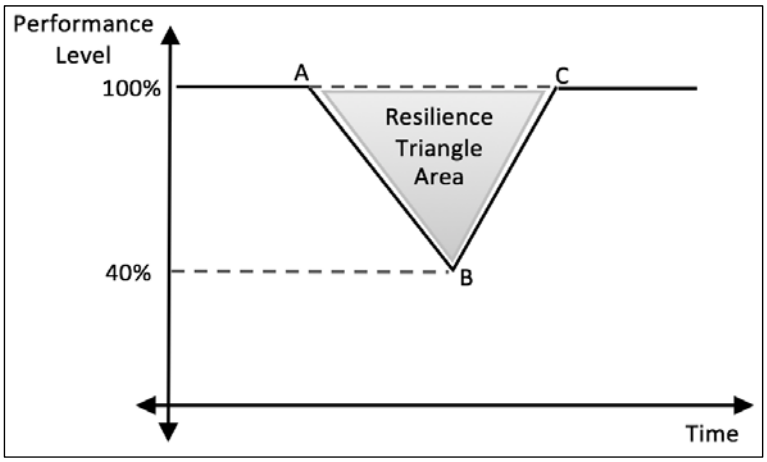


3. Conceptual Framework

- Resilience Triangle Approach
- Large triangle = Low Resilience
- Small Triangle = High Resilience



3. Conceptual Framework

- Existing Applications:
  - Automotive Supply Chains
  - Chinese grain market supply chains
  - Emergency services infrastructure

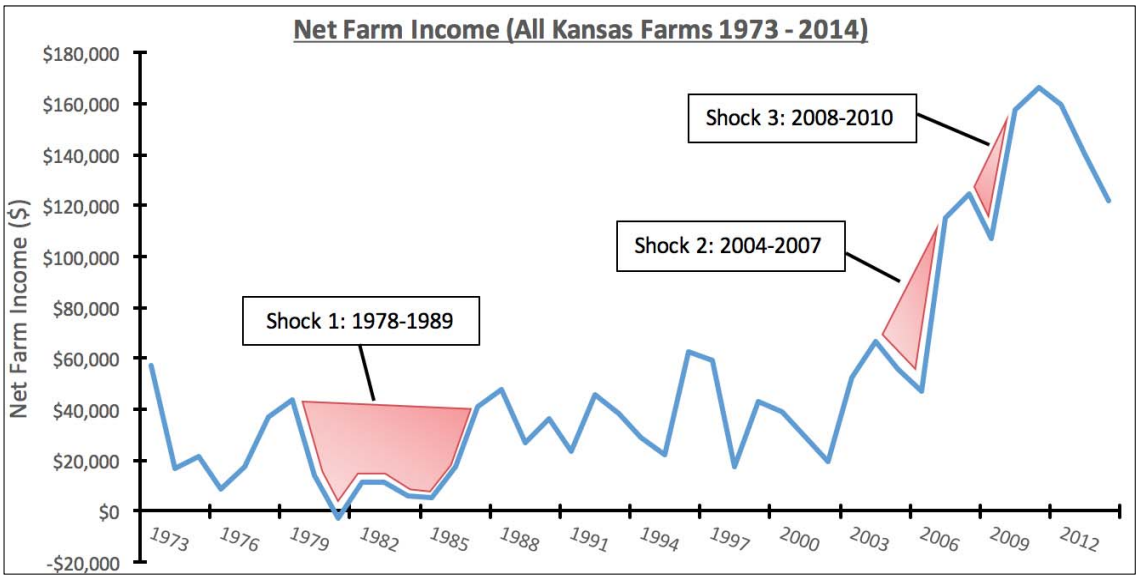
3. Conceptual Framework: Diversification

- **Method 1:**
  - Herfindahl-Hirschman Index applied to acreage allocation
  - $D_i = \sum(PAP_m)^2 = \sum\left(\frac{Sum\ of\ acres\ planted\ to\ crop\ m\ across\ all\ shock\ years}{Sum\ of\ total\ crop\ acres\ across\ all\ shock\ years}\right)^2$
- **Method 2:**
  - Crop/Livestock integrated vs Crop only
- **Method 3:**
  - HH Index applied to revenue sources
  - $D_i = \sum\left(\frac{A_i^m}{TR_i}\right)^2$

4. Data

- Kansas Farm Management Association (KFMA) Data set
  - Farm level data ranging from 1973-2014
  - Variables Include:
    - Net Farm Income
    - Acreage allocations and farm size
    - Production practices
    - Farm production values
    - Production costs
    - Socio-demographic characteristics

4. Data



4. Data: Descriptive Statistics

	1978-1989 Shock	2004-2007 Shock	2008-2010 Shock
Observations	471	1060	1042
Avg. Acres Managed	715	1257	1463
	(416)	1009	1159
Avg. Value Farm Prod.	$158,757	$329,454	$516,887
	112,346	304,597	448,851
Avg. Age of Producer	51	55	56
	9.45	11.58	11.77
Avg. Net Farm Income	$29,159	$66,135	$150,426
	24,860	82,262	156,422

5. Analysis

1. Calculate resilience index values for each farm
2. Calculate diversification index for each farm
3. Estimate impact of diversification on resilience

5. Analysis: State and regional resilience values

Shock	State-wide	North Central	South Central	Southwest	Northeast	Northwest	Southeast
1978-1989	0.297	0.415	0.400	0.528	0.362	0.537	0.269
2004-2007	0.849	0.895	0.829	0.769	0.852	0.969	0.748
2008-2010	0.929	0.930	0.812	0.992	1.000	0.938	0.937

5. Analysis: Average farm-level resilience index values

	1978-1989 Shock	2004-2007 Shock	2008-2010 Shock
Mean	0.283	0.629	0.728
Standard Deviation	0.243	0.290	0.275
Range	0.785	0.992	0.998
Minimum	0	0.008	0.002
Maximum	0.785	1	1

5. Analysis: Diversification index values

Method 1: Diversification of Acres

	Shock Period 1978-1989	Shock period 2004-2007	Shock Period 2008-2010
Mean	0.390	0.393	0.390
Std. Dev.	0.194	0.189	0.171
Range	0.865	0.891	0.891
Min	0.135	0.109	0.109
Max	1.000	1.000	1.000
# Observations	471	1060	1042

5. Analysis: Diversification index values

Method 3: Diversification based on revenue source

	Shock Period 2004-2007	Shock period 2008-2010
Mean	0.328	0.324
Std. Dev.	0.811	0.132
Range	26.184	0.858
Min	0.105	0.142
Max	26.289	1.000
# Observations	1060	1042

6. Model Specification

Estimating the impact of diversification on resilience:

$$R_i = \beta_0 + \beta_1 D_i^k + \beta_2 1989 + \beta_3 2007 + \sum_{j=1}^{n} \beta_j X_i + \varepsilon_i$$

R_i: Resilience index value for Farm i

D_i^k: Diversification index k (methods 1-3) for Farm i

1989 & 2007: Time control variables

X_i: Vector of Control variables (farm size, age of producer, location, value farm production)

β: Parameter estimates

7. Results

	Div. Method 1	Div. Method 2	Div. Method 3
LHS Variables:	Resilience Index	Resilience Index	Resilience Index
RHS Variables			
Intercept	0.727*	0.749*	0.682*
	(20.46)	(22.47)	(37.91)
Diversification	0.039	-0.02	0.0003
	(1.24)	(-1.51)	(0.027)
Age	-0.001*	-0.001*	-0.0003
	(-2.17)	(-2.08)	(-0.33)
Farm size	3.9E-05*	3.4E-05*	3.5E-05*
	(3.14)	(2.75)	(2.69)
1989	-0.430*	-0.430*	-
	(-26.26)	(-26.25)	-
2007	-0.092*	-0.092*	-0.078
	(-7.68)	(-7.69)	(-1.82)
South Central	-0.065*	-0.066*	-0.072*
	(-4.09)	(-4.14)	(-3.99)
$(\text{Farm size})^2$	-4.3E-09*	-3.7E-09	-3.6E-09
	(-1.99)	(-1.74)	(-1.601)

8. Key Implications

- Resilience has increased significantly over time, at all levels, across all regions
- Impact of Diversification?
  - Resilience on Value of Farm Production: Significant
  - Value of Farm Production on Diversification: Significant
  - Diversification on Resilience: Insignificant
- Insights for Stakeholders (policy makers & ag producers)
  - Diversification can play a role in improving resilience

9. Further Research

- Explore alternative model and index specifications
- Examine changes in resilience over time (panel vs. pooled)
- Explore differences in resilience across shocks

Thank you for your attention.

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