Economic Analysis of Farmland Market: An Introduction

Dr. Wendong Zhang
Assistant Professor of Economics
wdzhang@iastate.edu

FIN 450X, Feb 17th, 2017
A Quick Introduction: Dr. Wendong Zhang

– Grown up in a rural county in NE China
– Attended college in Shanghai and Hong Kong
– Ph.D. in Ag Econ in 2015 from Ohio State
– 2012 summer intern at USDA-ERS on farm economy and farmland values
– Research and extension interests: land value, land ownership, agriculture and the environment, China Ag
Why Care About Farmland Market?

Distribution of U.S. Farm Assets

- Real estate
- Livestock and poultry
- Machinery and motor vehicles
- Crops stored
- Purchased inputs
- Financial assets

Source: USDA ERS
What is the price of corn per bushel now? 2012?

- $ 2.0
- $ 7.0
- $ 3.5
- $ 4
- $ 5
Iowa Corn Prices vs. Costs

Source: Chad Hart
The percentage change in Iowa farmland values since Nov 2015?

- Increased 5%
- Increased 10%
- Did not change
- Decreased 5%
- Decreased 10%
$7,183
As of Nov 16
-5.9%
% Change in Nominal Iowa Farmland Values 1942-2016

IOWA STATE UNIVERSITY
Extension and Outreach

CARD
Center for Agricultural and Rural Development
David Ricardo was an English political economist. He was one of the most influential of the classical economists, along with Thomas Malthus, Adam Smith, and James Mill.
“A” land has lowest production costs = highest rents

“C” land’s rent is 0 because costs are greater than revenue

On fertile land, a farmer can produce same amount of corn with fewer inputs
Market Value of Land – Capitalization Formula

Land Value = net income / interest rate

\[ PV = \sum_{t=0}^{n} \frac{R}{(1+i)^t} \]

- For simplicity, you could think of land value as the present value of all future annual land rental payments a landowner could charge
- \( PV = \frac{R}{i} \)
US Farm Income 1990-2025

Source: USDA OCE
Capitalization Formula and Sources of Income

\[ V_{it} = E_t \sum_{s} \frac{R_{is}}{(1 + \delta_{s})^{s-t}}, \text{where } s = t, t + 1, \ldots \]

\[ R_{it} = \beta' X_{it} + \tau_t + \eta_{it} \]

\[ V_{it} = E_t \sum_{s} f(A_{is}, N_{is}, U_{is}, M_{is}; \delta_t), \text{where } s = t, t + 1, \ldots \]

- Agricultural productivity variables \( A_{it} \) such as soil quality
- Natural amenities variables \( N_{it} \) such as proximity to surface water
- Urban influence variables \( U_{it} \) such as surrounding urban population, access to highway
- Agricultural market influence variables \( M_{it} \) such as proximity to ethanol plants, grain elevators and agricultural output terminals
Hedonic pricing model of farmland values

- Log of arm’s length agricultural land prices per acre
  = parcel characteristics (i.e. parcel size)
- + agricultural productivity variables (e.g. soil quality, slope, distances to ethanol plants, grain elevators)
- + agricultural market influence variables
  (distances to ethanol plants, grain elevators, agricultural terminals)
- + agricultural market influence variables * post 2008 indicator
- + urban influence variables
  (e.g. dist to nearest city + additional dist to 2nd city + surrounding urban population + gravity index of 3 nearest cities)
- + year fixed effects
- + spatial fixed effects at census tract level
### Marginal values of farmland characteristics: Agricultural productivity variables

<table>
<thead>
<tr>
<th><strong>Agricultural Profitability Influence Variables - Marginal Value</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Agricultural productivity index (NCCPI)</td>
<td>+ $77.84/ 10% increase</td>
</tr>
<tr>
<td>Prime soil % of parcel</td>
<td>+ $9.3 / 10% increase</td>
</tr>
<tr>
<td>Steep slope</td>
<td>– $203.11/ from non-steep to steep</td>
</tr>
<tr>
<td>Distance to nearest grain elevator</td>
<td>– $15.87 / 1 mile further</td>
</tr>
<tr>
<td>Distance to other agricultural terminal</td>
<td>– $21.04 / 1 mile further</td>
</tr>
</tbody>
</table>
## Marginal values of farmland characteristics: Urban influence variables

<table>
<thead>
<tr>
<th>Urban Influence Variables – Marginal Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distance to nearest city center</td>
</tr>
<tr>
<td>Incremental distance to 2nd nearest city center</td>
</tr>
<tr>
<td>Total urban population within 25 miles</td>
</tr>
<tr>
<td>Distance to highway ramp</td>
</tr>
<tr>
<td>Distance to railway station</td>
</tr>
</tbody>
</table>
Urban Influence and Farmland Values – Housing Market Bust

S&P/Case-Shiller Home Price Indices

10-City Composite
U.S. National
20-City Composite

Source: Standard & Poor’s & FiServ

Source: Standard & Poor
Ohio Cropland Sale Prices 2001-2010

Legend:
- Major Roads
- US_State_Border
- US_County
- Urban areas

Real Prices w/o Structures <VALUE>
- < 2,000
- 2,000 - 4,000
- 4,000 - 8,000
- 8,000 - 12,000
- 12,000 - 16,000

2001-2006

2009-2010

Cincinnati

Dayton

Toledo

Columbus
The evolution of urban premium over time

Average Parcel-Level Urban Premium in Ohio 2001-2010

- **2001-2006**
  - Gravity Index of 3 Nearest Cities: 500
  - Incremental Miles to 2nd Nearest City: 1,000
  - Miles to Nearest City: 1,500
  - Surrounding Urban Population: 2,000

- **2008**
  - Gravity Index of 3 Nearest Cities: 500
  - Incremental Miles to 2nd Nearest City: 1,000
  - Miles to Nearest City: 1,500
  - Surrounding Urban Population: 2,000

- **2009-2010**
  - Gravity Index of 3 Nearest Cities: 500
  - Incremental Miles to 2nd Nearest City: 1,000
  - Miles to Nearest City: 1,500
  - Surrounding Urban Population: 2,000

*Source: Iowa State University, Extension and Outreach*
Urban Premium 2001-2006 vs. 2009-2010
## Land Values by District and Land Quality, Nov 2016

<table>
<thead>
<tr>
<th>District</th>
<th>Average Value</th>
<th>% Change</th>
<th>High Quality</th>
<th>% Change</th>
<th>Medium Quality</th>
<th>% Change</th>
<th>Low Quality</th>
<th>% Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Northwest</td>
<td>$9,243</td>
<td>-4.6%</td>
<td>$10,650</td>
<td>-5.2%</td>
<td>$8,468</td>
<td>-4.1%</td>
<td>$6,019</td>
<td>-3.7%</td>
</tr>
<tr>
<td>North Central</td>
<td>$7,562</td>
<td>-5.0%</td>
<td>$8,442</td>
<td>-5.9%</td>
<td>$6,992</td>
<td>-4.9%</td>
<td>$5,164</td>
<td>-3.9%</td>
</tr>
<tr>
<td>Northeast</td>
<td>$7,313</td>
<td>-7.0%</td>
<td>$8,892</td>
<td>-7.1%</td>
<td>$6,994</td>
<td>-6.2%</td>
<td>$4,847</td>
<td>-7.5%</td>
</tr>
<tr>
<td>West Central</td>
<td>$7,358</td>
<td>-8.7%</td>
<td>$8,874</td>
<td>-8.4%</td>
<td>$6,870</td>
<td>-9.4%</td>
<td>$4,577</td>
<td>-9.9%</td>
</tr>
<tr>
<td>Central</td>
<td>$7,841</td>
<td>-7.8%</td>
<td>$9,299</td>
<td>-7.8%</td>
<td>$7,186</td>
<td>-7.4%</td>
<td>$5,158</td>
<td>-2.5%</td>
</tr>
<tr>
<td>East Central</td>
<td>$7,917</td>
<td>-6.9%</td>
<td>$9,502</td>
<td>-7.6%</td>
<td>$7,396</td>
<td>-6.8%</td>
<td>$5,153</td>
<td>-4.0%</td>
</tr>
<tr>
<td>Southwest</td>
<td>$6,060</td>
<td>-4.9%</td>
<td>$7,527</td>
<td>-6.3%</td>
<td>$5,683</td>
<td>-5.9%</td>
<td>$4,189</td>
<td>2.9%</td>
</tr>
<tr>
<td>South Central</td>
<td>$4,241</td>
<td>-3.6%</td>
<td>$5,980</td>
<td>-7.2%</td>
<td>$4,128</td>
<td>-3.6%</td>
<td>$2,892</td>
<td>5.2%</td>
</tr>
<tr>
<td>Southeast</td>
<td>$6,716</td>
<td>-2.6%</td>
<td>$9,265</td>
<td>-2.8%</td>
<td>$6,283</td>
<td>-3.7%</td>
<td>$3,783</td>
<td>-0.4%</td>
</tr>
<tr>
<td>Iowa Avg.</td>
<td>$7,183</td>
<td>-5.9%</td>
<td>$8,758</td>
<td>-6.5%</td>
<td>$6,705</td>
<td>-5.9%</td>
<td>$4,665</td>
<td>-3.5%</td>
</tr>
</tbody>
</table>
## Livestock and Crop Inventory by District

<table>
<thead>
<tr>
<th>District</th>
<th>Chickens, Layers</th>
<th>Hogs</th>
<th>Milk Cows</th>
<th>Cattle</th>
<th>Corn</th>
<th>Soybean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Northwest</td>
<td>30%</td>
<td>26%</td>
<td>29%</td>
<td>22%</td>
<td>15%</td>
<td>16%</td>
</tr>
<tr>
<td>North Central</td>
<td>64%</td>
<td>16%</td>
<td>4%</td>
<td>6%</td>
<td>14%</td>
<td>13%</td>
</tr>
<tr>
<td>Northeast</td>
<td>1%</td>
<td>12%</td>
<td>51%</td>
<td>16%</td>
<td>12%</td>
<td>8%</td>
</tr>
<tr>
<td>West Central</td>
<td>0%</td>
<td>13%</td>
<td>1%</td>
<td>13%</td>
<td>15%</td>
<td>16%</td>
</tr>
<tr>
<td>Central</td>
<td>3%</td>
<td>13%</td>
<td>1%</td>
<td>7%</td>
<td>15%</td>
<td>14%</td>
</tr>
<tr>
<td>East Central</td>
<td>1%</td>
<td>5%</td>
<td>10%</td>
<td>11%</td>
<td>10%</td>
<td>10%</td>
</tr>
<tr>
<td>Southwest</td>
<td>0%</td>
<td>2%</td>
<td>0%</td>
<td>9%</td>
<td>7%</td>
<td>9%</td>
</tr>
<tr>
<td>South Central</td>
<td>0%</td>
<td>2%</td>
<td>1%</td>
<td>9%</td>
<td>4%</td>
<td>5%</td>
</tr>
<tr>
<td>Southeast</td>
<td>1%</td>
<td>11%</td>
<td>3%</td>
<td>6%</td>
<td>7%</td>
<td>8%</td>
</tr>
<tr>
<td><strong>State Inventory</strong></td>
<td><strong>20.4 million</strong></td>
<td><strong>20.4 million</strong></td>
<td><strong>0.17 million</strong></td>
<td><strong>2.34 million</strong></td>
<td><strong>13.2 million</strong></td>
<td><strong>9.8 million</strong></td>
</tr>
</tbody>
</table>

Source: USDA Ag Census 2012
Annual Agricultural turnover ratio 2001 - 2010

Farmland Market is Very Thin! → Few Observations

Legend

Ohio County Acres Turnover

Blue: <0.5%
Red: 1.5-2%

Illinois <0-3%>
Farmland supply tends to be tighter in down years

ISU sale activity index and percent change in Iowa land value, 1986-2016 (% reported more sales - % reported less sales) + 100
Figure 2. Farmland P/rent Ratio and S&P 500 P/E Ratio, 1960 to 2015.

Source: Purdue University
Baker et al. 2015
Farmland Values vs. Capitalized Land Values
S&P 500 vs. Farmland Values: A Question of Timing

1960

Value of $1,000 invested in 1960 in thousand dollars

Year


Iowa farmland

Source: Mike Duffy
Ag DM Newsletter June 2014
S&P 500 vs. Farmland Values: A Question of Timing

Source: Zhang and Duffy
Ag DM Newsletter April 2016

Return to S & P Investment Relative to Iowa Farmland Investment

Source: Zhang and Duffy
Ag DM Newsletter April 2016

Figure 4. Return to an investment in the S&P relative to an investment made in Iowa farmland by year of investment and year of selling that investment
A replay of 1920s or 1980s farm crisis?

<table>
<thead>
<tr>
<th>Golden Eras</th>
<th>Land</th>
<th>Gross Income</th>
<th>Net Income</th>
</tr>
</thead>
<tbody>
<tr>
<td>1910-1920</td>
<td>1.2%</td>
<td>0.8%</td>
<td>0.2%</td>
</tr>
<tr>
<td>1973-1981</td>
<td>9.7%</td>
<td>0.9%</td>
<td>-3.2%</td>
</tr>
<tr>
<td>2003-2013</td>
<td>11.1%</td>
<td>4.5%</td>
<td>8.1%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Crises and Declines</th>
<th>Land</th>
<th>Gross Income</th>
<th>Net Income</th>
</tr>
</thead>
<tbody>
<tr>
<td>1921-1933</td>
<td>-5.8%</td>
<td>-1.9%</td>
<td>-1.0%</td>
</tr>
<tr>
<td>1981-1987</td>
<td>-15.0%</td>
<td>-2.5%</td>
<td>2.6%</td>
</tr>
<tr>
<td>2013-2016</td>
<td>-6.0%*</td>
<td>-2.7%</td>
<td>-9.5%</td>
</tr>
</tbody>
</table>

Source: USDA-ERS, Ag DM C2-70
Key Indicators to Watch

Land Value = net income / interest rate

-USDA Farm Income Forecast
  • Price Outlook
  • Ag Exports / Exchange Rate
  • China
  • Ethanol, E-85, RFS

-Fed’s move on Interest Rate

-Ag Loan Delinquency; Vendor Credit
US Farm Income 1990-2025

Source: USDA OCE
Federal Reserve raises interest rates for second time in a decade, expects 3 hikes in 2017

By Jim Tankersley  December 14 at 3:30 PM
Iowa Farmland Value Portal

http://card.iastate.edu/farmland

Iowa Farmland Value Portal BETA

Your One-Stop Web-Portal for Everything You Need to Know about Iowa’s Farmland Value

2015 Results  Charts  Interactive County Maps  Downloads  Resources  Archive

Select a county or district: State of Iowa

Select result format:  dollar value  annual percentage change  farmland value indexes (state only)

Select data sources:  ISU Iowa Land Value Survey  USDA National Agricultural Statistics Service  REALTORS Land Institute  Federal Reserve Bank of Chicago

Years: 1951 through 2014

Show Values

Show Iowa Average  Show District Average
Iowa Farmland Value Portal

http://card.iastate.edu/farmland
Iowa Farmland Value Portal
www.card.iastate.edu/farmland

twitter #ISUlandvalue
If you only remember one thing

- PV = R/I
- Land Values = Net Income/Discount Rate

Land Value Depends on the Source of Income
Thank You!

Wendong Zhang
Assistant Professor and Extension Economist
478C Heady Hall
Iowa State University
515-294-2536
wdzhang@iastate.edu
http://www2.econ.iastate.edu/faculty/zhang/
http://card.iastate.edu/farmland/
Additional Information
Zillow for Farmers: Acre Value

Report Preview

Select a plot to view the report preview and order a report.

ACREVALUE

$9,814/ac

AVG SLOPE
1.9%

AVG CSR2
83

STATE
Iowa

COUNTY
Pocahontas

TOWNSHIP/SECTION
90N 34W - 5

ACRES
58.7

CROPS

- 95.5% Soybeans
- 3.4% Grass/Pasture
- 0.9% Corn
- 0.1% Non-Agricultural

2014

Get Report
WHAT'S MY FARM WORTH?

Zillow for Farmers

Source: Peoples Company
Iowa Farmland Purchases by Buyer Types 1989-2016

- Existing Farmers
- Investors
- New Farmers
- Other
Iowa Landowners tend to hold the farmland

<table>
<thead>
<tr>
<th>Years of ownership</th>
<th>% of Iowa Farmland</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 10 years</td>
<td>24%</td>
</tr>
<tr>
<td>10-20 Years</td>
<td>21%</td>
</tr>
<tr>
<td>20-30 Years</td>
<td>19%</td>
</tr>
<tr>
<td>30-40 Years</td>
<td>15%</td>
</tr>
<tr>
<td>&gt; 40 Years</td>
<td>20%</td>
</tr>
</tbody>
</table>

Source: Ag DM PM1980
2012 Iowa Farmland Ownership and Tenure Survey
## Iowa Farmland Purchases by Seller Types, 2016

<table>
<thead>
<tr>
<th>Region</th>
<th>Active Farmers</th>
<th>Retired Farmers</th>
<th>Estate Sales</th>
<th>Investors</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PERCENT</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Northwest</td>
<td>12</td>
<td>17</td>
<td>64</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>North Central</td>
<td>8</td>
<td>17</td>
<td>61</td>
<td>10</td>
<td>4</td>
</tr>
<tr>
<td>Northeast</td>
<td>14</td>
<td>34</td>
<td>43</td>
<td>6</td>
<td>5</td>
</tr>
<tr>
<td>West Central</td>
<td>12</td>
<td>25</td>
<td>57</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>Central</td>
<td>13</td>
<td>22</td>
<td>53</td>
<td>8</td>
<td>4</td>
</tr>
<tr>
<td>East Central</td>
<td>11</td>
<td>24</td>
<td>53</td>
<td>9</td>
<td>2</td>
</tr>
<tr>
<td>Southwest</td>
<td>15</td>
<td>24</td>
<td>47</td>
<td>13</td>
<td>1</td>
</tr>
<tr>
<td>South Central</td>
<td>17</td>
<td>24</td>
<td>37</td>
<td>19</td>
<td>3</td>
</tr>
<tr>
<td>Southeast</td>
<td>11</td>
<td>24</td>
<td>57</td>
<td>10</td>
<td>2</td>
</tr>
<tr>
<td><strong>STATE</strong></td>
<td><strong>12</strong></td>
<td><strong>23</strong></td>
<td><strong>53</strong></td>
<td><strong>9</strong></td>
<td><strong>3</strong></td>
</tr>
</tbody>
</table>

*Source: Iowa State University Extension and Outreach, Center for Agricultural and Rural Development*