Economic Analysis of Farmland Market: An Introduction

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

FIN 450X, October 4th, 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
China’s Provinces

My Hometown
Why Care About Farmland Market?

Note: F = forecast; data for 2016 and 2017 are forecasts. The GDP chain-type price index is used to convert the nominal (current-dollar) statistics to real (inflation adjusted) amounts (2009=100).
Data as of February 7, 2017.
ISU Land Value Survey – Iowa average farmland value
all farmland 1941–2016

$7,183
As of Nov 16
-5.9% since one year ago
% Change in Nominal Iowa Farmland Values 1942-2016
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.
Ricardo model

“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

• \( PV = \frac{R}{i} \)
Guiding Framework

Land Value = localized net income / universal interest rate
US Farm Income 1990-2026

U.S. farm income indicators

Billion dollars

140
120
100
80
60
40
20
0


Net cash income

Net farm income

Source: USDA OCE 2016
Percent change in dollar value of “good” farmland

* Top: April 1, 2017 to July 1, 2017
* Bottom: July 1, 2016 to July 1, 2017

<table>
<thead>
<tr>
<th>State</th>
<th>April 1, 2017 to July 1, 2017</th>
<th>July 1, 2016 to July 1, 2017</th>
</tr>
</thead>
<tbody>
<tr>
<td>Illinois</td>
<td>0</td>
<td>-3</td>
</tr>
<tr>
<td>Indiana</td>
<td>+2</td>
<td>-1</td>
</tr>
<tr>
<td>Iowa</td>
<td>+2</td>
<td>*</td>
</tr>
<tr>
<td>Michigan</td>
<td>+1</td>
<td>+1</td>
</tr>
<tr>
<td>Wisconsin</td>
<td>+1</td>
<td>+1</td>
</tr>
<tr>
<td>Seventh District</td>
<td>+1</td>
<td>+1</td>
</tr>
</tbody>
</table>

**REALTORS® Land Institute- Iowa Chapter**

September 1, 2017

September 2016– September 2017

- **Iowa**
  - 3.2%
  - 1.9%
  - 5.1%
  - -0.5%
  - 0.8%
  - 2.6%
  - 0.3%
  - 3.1%
  - 5.7%
  - -2.0%
  - 1.1%
  - -0.9%
  - -3.0%
  - 2.6%
  - -0.5%
  - 1.3%
  - 1.3%
  - 1.8%
  - 2.6%

*STATE’S FARMLAND VALUES ON THE RISE*

But experts say it’s unlikely ag downturn has turned a corner

**CARD**

Center for Agricultural and Rural Development

Federal Reserve Bank of Chicago, July 2017

Ag Letter

Realtor Land Institute
The “temporary break” in continued declines results from **limited land supply**.
The “temporary break” in continued declines results from limited land supply.
Annual Agricultural turnover ratio 2001 - 2010

Blue: <0.5%
Red: 1.5-2%

Illinois <0-3%>

Farmland Market is Very Thin! → Few Observations
Capitalization Formula and Sources of Income

\[ V_{it} = E_t \sum_s \frac{R_{is}}{(1 + \delta_t)^{s-t}}, \text{where } s = t, t + 1, ... \]

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

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

- **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

#### Agricultural Profitability Influence Variables - Marginal Value

<table>
<thead>
<tr>
<th>Variable</th>
<th>Marginal Value</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>
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

- **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
## 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></th>
<th>Inventory 2012</th>
<th>Harvested Acres 2015</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Chickens, Layers</td>
<td>Hogs</td>
</tr>
<tr>
<td><strong>Northwest</strong></td>
<td>30%</td>
<td>26%</td>
</tr>
<tr>
<td><strong>North Central</strong></td>
<td>64%</td>
<td>16%</td>
</tr>
<tr>
<td><strong>Northeast</strong></td>
<td>1%</td>
<td>12%</td>
</tr>
<tr>
<td><strong>West Central</strong></td>
<td>0%</td>
<td>13%</td>
</tr>
<tr>
<td><strong>Central</strong></td>
<td>3%</td>
<td>13%</td>
</tr>
<tr>
<td><strong>East Central</strong></td>
<td>1%</td>
<td>5%</td>
</tr>
<tr>
<td><strong>Southwest</strong></td>
<td>0%</td>
<td>2%</td>
</tr>
<tr>
<td><strong>South Central</strong></td>
<td>0%</td>
<td>2%</td>
</tr>
<tr>
<td><strong>Southeast</strong></td>
<td>1%</td>
<td>11%</td>
</tr>
<tr>
<td><strong>State Inventory</strong></td>
<td><strong>20.4 million</strong></td>
<td><strong>60.5 million</strong></td>
</tr>
</tbody>
</table>

Source: USDA Ag Census 2012
Capitalization Rate (Cap Rate)
Rent to Value Ratio

Year: 1950 to 2014

- Interest Rate
- Rent to Value_NASS
- Rent to Value_ISU
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

Actual Farmland Values vs. Rent/Interest Rates

- Actual Farmland Values
- Predicted Land Values by Dividing Land Rent over Interest Rate
- Predicted Land Values by Dividing Land Rent over (Interest Rate+0.5%)
- Predicted Land Values by Dividing Land Rent over (Interest Rate+1%)
- Predicted Land Values by Dividing Land Rent over (Interest Rate+2%)

IOWA STATE UNIVERSITY
Extension and Outreach

CARD
Center for Agricultural and Rural Development
S&P 500 vs. Farmland Values: A Question of Timing

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

Year

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

Value of $1,000 invested in 1980 in dollars

Year


Source: Zhang and Duffy
Ag DM Newsletter April 2016

Source: Zhang and Duffy
Ag DM Newsletter April 2016
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>2013-2017</td>
<td>-4.5%*</td>
<td>-4.5%</td>
<td>-9.8%</td>
</tr>
</tbody>
</table>

Note: The average land value change from 2013 to 2017 is approximate because 2017 land values are unknown. The 1910–1933 gross and net farm income changes are for the whole United States due to limited data at the state level. Land values are based on USDA Census of Agriculture and USDA NASS Land Value and Cash Rent Survey, while the data on farm income is from the USDA Economic Research Service Farm Income and Wealth Statistics database.

Source: USDA-ERS, Ag DM C2-70
Farmland Price Expectations, 12 months from now

<table>
<thead>
<tr>
<th>Percentage of Respondents</th>
<th>Higher Farmland Prices</th>
<th>Lower Farmland Prices</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nov '15</td>
<td>40%</td>
<td>60%</td>
</tr>
<tr>
<td>Feb '16</td>
<td>30%</td>
<td>70%</td>
</tr>
<tr>
<td>March '16</td>
<td>25%</td>
<td>75%</td>
</tr>
<tr>
<td>May '16</td>
<td>20%</td>
<td>80%</td>
</tr>
<tr>
<td>July '16</td>
<td>15%</td>
<td>85%</td>
</tr>
<tr>
<td>Nov '16</td>
<td>10%</td>
<td>90%</td>
</tr>
<tr>
<td>Feb '17</td>
<td>5%</td>
<td>95%</td>
</tr>
<tr>
<td>May '17</td>
<td>0%</td>
<td>100%</td>
</tr>
<tr>
<td>Aug '17</td>
<td>0%</td>
<td>100%</td>
</tr>
</tbody>
</table>

Most Recent Observation: Aug. 2017

Source: Purdue Ag Barometer
http://card.iastate.edu/farmland

Iowa Farmland Value Portal

twitter #ISUland value
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/