Assessing the Rationality of Farmland Price Movements

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Land in Agriculture

- Largest portion of assets on the agricultural balance sheet
- Mispricing has severe adverse affects on landowners and financers
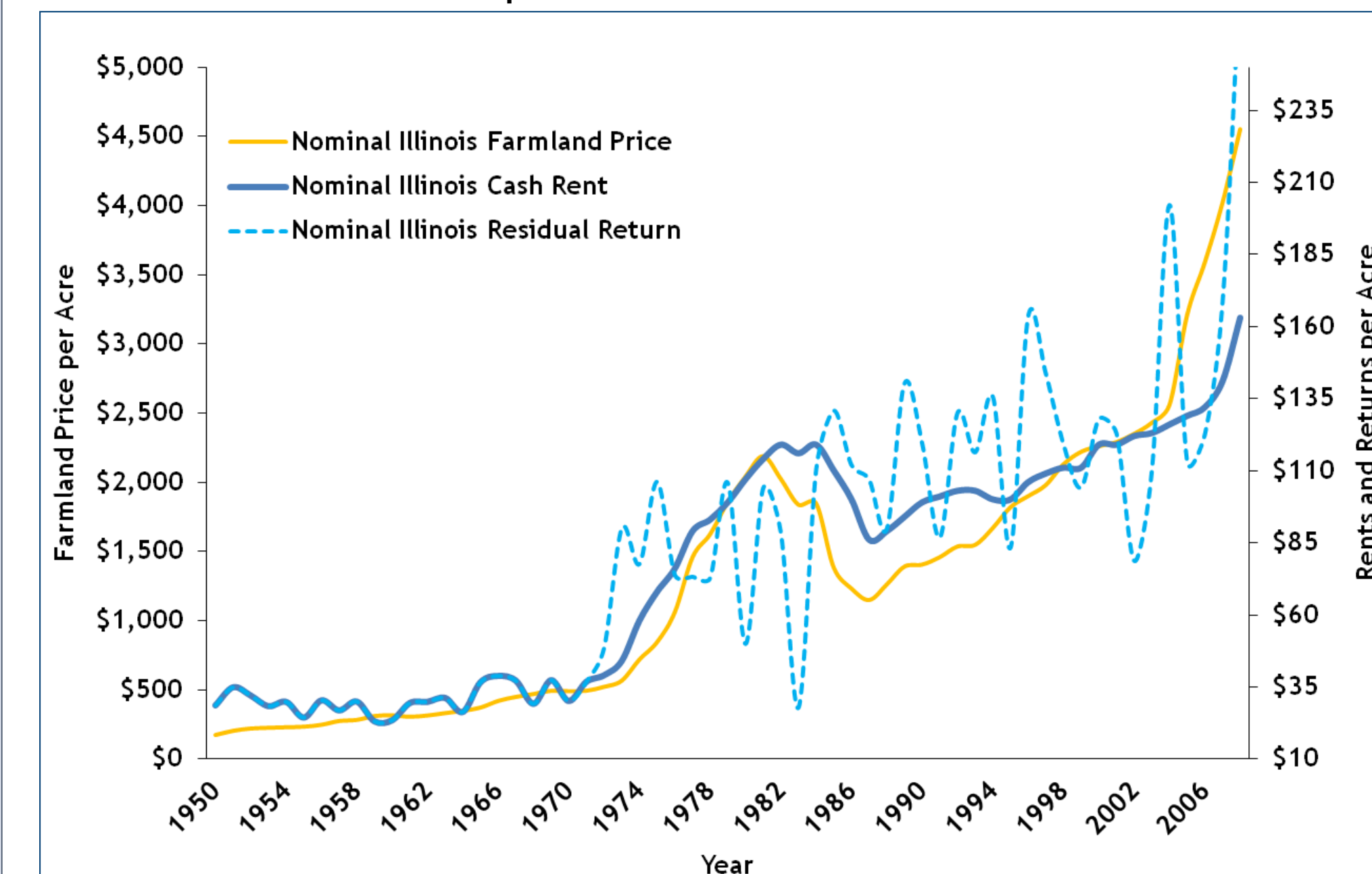- Price should reflect expected future cash flows

Figure 1. Relationship between Illinois Rents, Returns, and Farmland Prices 1959-2008

Previous Land Price Analysis

Portfolio Theory and the Analysis of Land Prices
- Capital Asset Pricing Model (Barry 1980)
  - Statistically insignificant betas
  - Statistically significant and positive alpha values
  - Ergo, returns to land overcompensate for systematic risk, but contribute little to a diversified portfolio
- Arbitrage Pricing Theory (Arthur et al. 1988)
  - Four factor model employed
  - No significant reaction to any of the four factors
  - Ergo, farmland investment does not contribute any systematic risk to a diversified portfolio
- Irwin et al. (1988) and Bjorson and Innes (1992) confirm returns to land overcompensate for systematic risk, but contribute little to a diversified portfolio
- Each of the studies implicitly holds constant:
  - the rate of return investors require
  - the sensitivity of investment returns to risk factors
  - the risk premium of investments

Present Value Theory and the Analysis of Land Prices
- Alston (1986) concludes the real growth in net rental income:
  - driven by foreign and not domestic demand
  - inflation had no significant effect
  - Technological change does not significantly impact the price of farmland
- Schmitz (1995) finds that the long run price of land depends on market fundamentals, but the present value model fails to account for short run deviations.
- Falk (1991) "formally" tests the validity of the CDR version of the present value model:
  - rejects the cross-equation restrictions that the present value model implies. Most importantly
  - finds statistically and economically significant predictable excess returns in the Iowa farmland market for the period for the period 1921 to 1968.
  - strongly reject the EMH under the assumptions of a constant discount

Economic Model of Land Prices

A new framework to determine if the price of farmland rationally reflects the expectation of the returns to farmland. Specifically, a full information maximum likelihood estimator with recursive covariance restrictions to estimate simultaneously the following equation system:

$$E\left[R_t | \Phi_{t-1}\right] = \alpha_0 + \alpha_1 R_{t-1} + \alpha_2 EI_{t-1} + \alpha_3 FT_{t-1} + \left[\varepsilon_t^R | \Phi_{t-1}\right] \quad (1)$$

$$E\left[r_t | \Phi_{t-1}\right] = \beta_0 + \beta_1 \left[\frac{E\left[R_t | \Phi_{t-1}\right] - R_{t-1}}{R_{t-1}} + \frac{E\left[R_t | \Phi_{t-1}\right]}{V_{t-1}}\right] + \beta_2 \tilde{r}_{t-1} + \beta_3 \tilde{r}_{t-2} + \left[\varepsilon_t^r | \Phi_{t-1}\right] \quad (2)$$

$$E\left[dV_t | \Phi_{t-1}\right] = \delta_0 + \delta_1 \frac{E\left[R_t | \Phi_{t-1}\right]}{\left(+ E\left[r_t | \Phi_{t-1}\right]\right)} + \delta_2 \frac{E\left[r_t | \Phi_{t-1}\right] V_t}{\left(+ E\left[r_t | \Phi_{t-1}\right]\right)} + \varepsilon_t^{dV} | \Phi_{t-1} \quad (3)$$

The expectation of the return to farmland, $E\left[R_t | \Phi_{t-1}\right]$, is conditional on the information set, Φ_{t-1}, which is a subset of all the information observable at time $t-1$.

In Equation (1), the return to an acre of farmland in a given year is a function of:
- return to farmland in the previous year
- lagged ratio of agricultural exports to agricultural imports
- rate of change in aggregate food price less the rate of return on a 3-month T-bill

In Equation (2), the annual rate of return on farmland capital is a function of:
- expectation of the annual growth rate of returns
- expectation of the annual return yield
- previous two lag values of the rate of return from using land for farming, $\tilde{r}_{t-i}$, where $\tilde{r}_{t-i}$ equals:

$$\tilde{r}_{t-i} = \frac{R_{t-i} - R_{t-i-1}}{R_{t-i-1}} + \frac{R_{t-i}}{V_{t-i-1}} \quad \text{for } i = 1, 2$$

To assess the rationality of land price, we modify the model Schmitz (1995) develops.

In Equation (3), the change in farmland price is a function of:
- present value of the expectation of returns
- present value of the farmland capital accumulation

The fitted values from equations (1) and (2) represent the rational expectation of returns if the error term consists of white noise:
- Presence of information in the error suggests that:
  - market does not make efficient use of available information **or**
  - the information set lacks sufficient information to specify the model correctly
  - The model is not specified correctly
- In either instance, equation (1) does not represent the rational expectation if error does not consist only of white noise

If farmland capital appreciates rationally, the change in farmland price will reflect the rate of return from using farmland capital for agricultural purposes.

Additionally, if market fundamentals determine the price of farmland, previous changes in farmland capital should have no influence on the expected rate of return on farmland capital.

Results

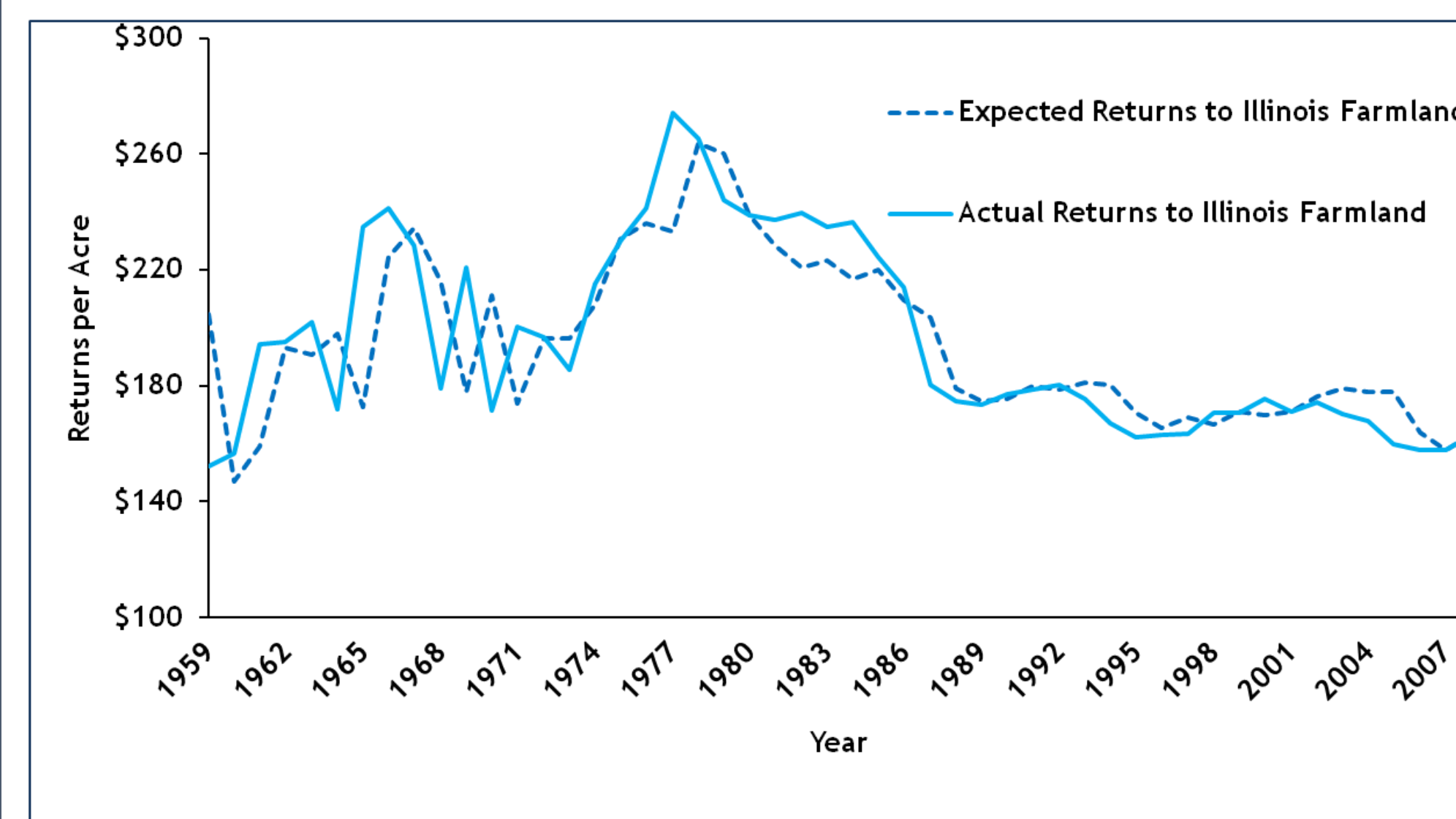Figures 2 to 5 illustrate the fit of the Model

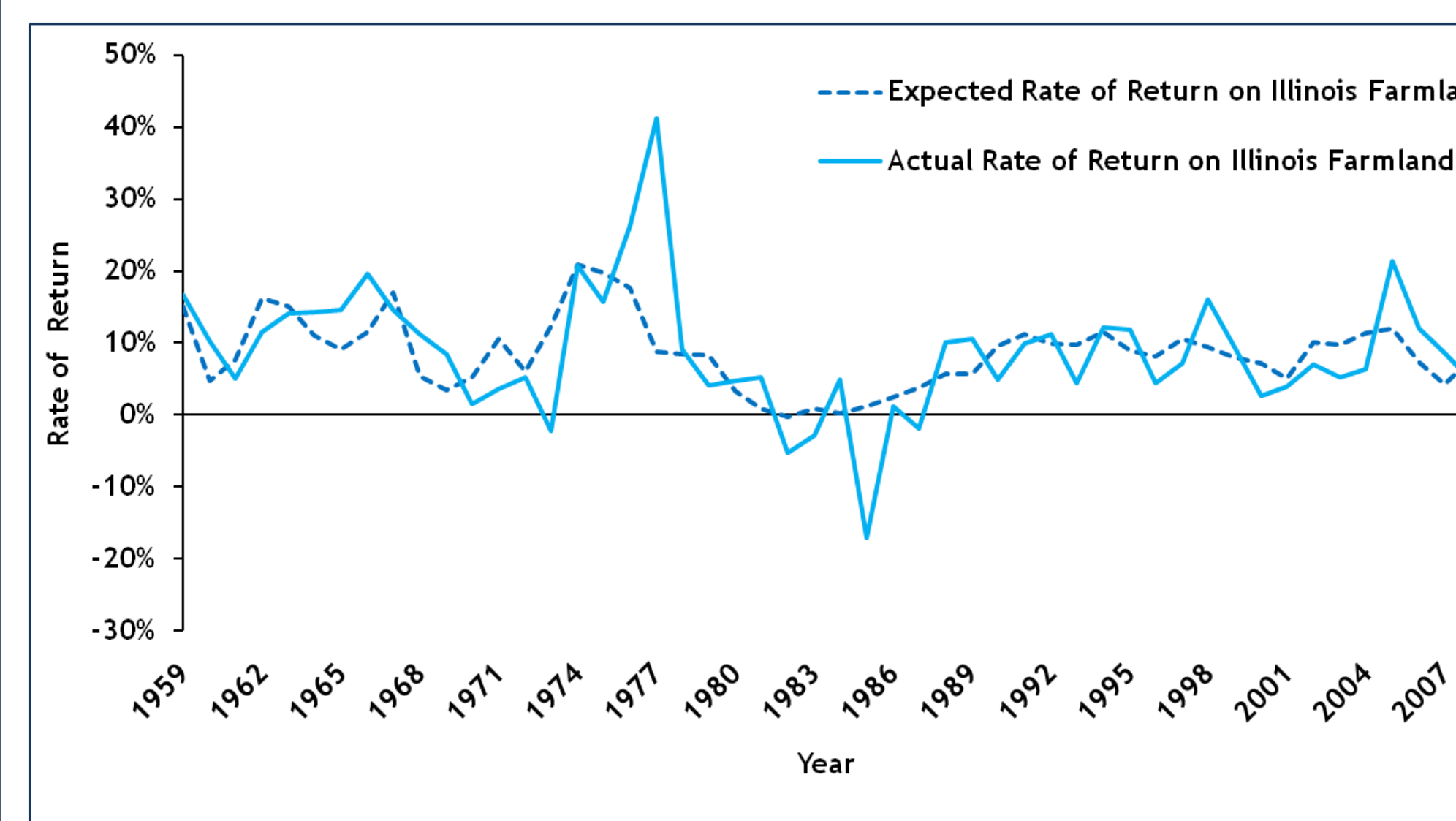Figure 2. Realized and Estimated Returns to Farmland 1959-2008

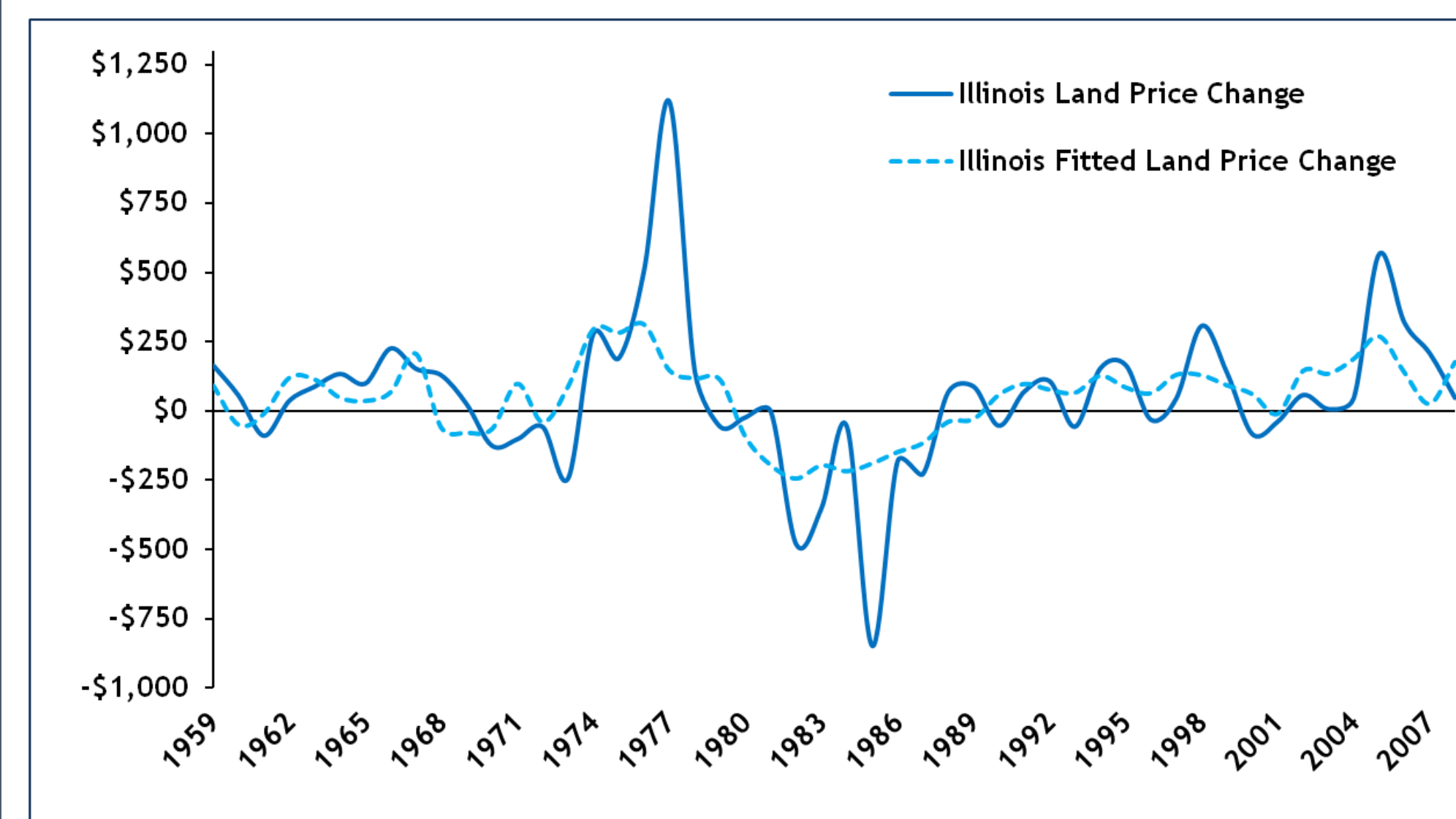Figure 3. Expected and Actual Rate of Return to Farmland 1959-2007

Figure 4. Realized and Predicted Changes in Farmland Prices 1959-2008
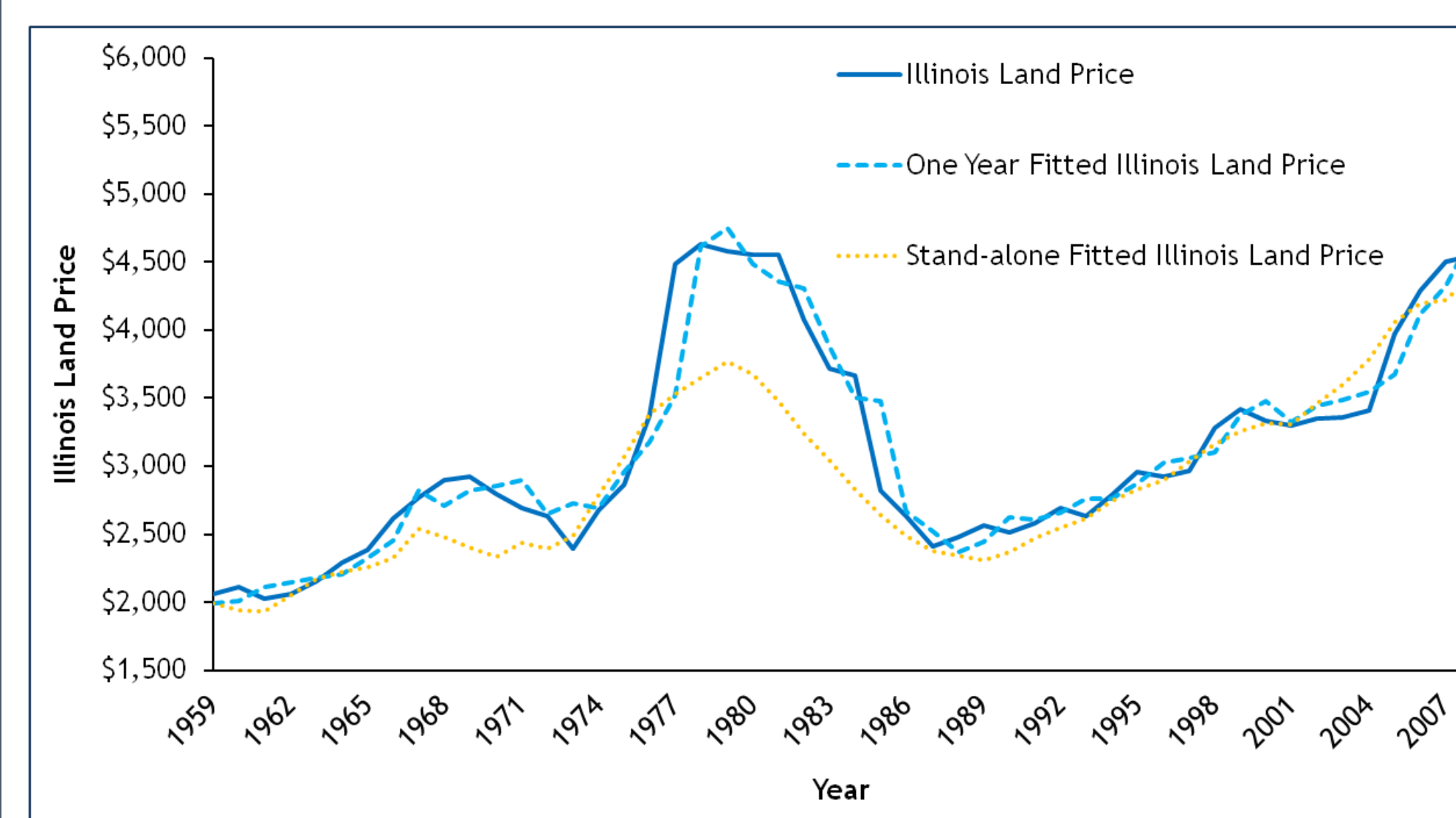

Figure 5. Realized and Predicted Farmland Prices 1959-2008

Conclusions

- Throughout 63% of the sample, the standard score of the estimated change in farmland capital lies below the standard score of the estimated rate of return that rational individuals expect to earn from farming land.
- Throughout 95% of the sample, the 95% confidence interval for the standard score of the estimated rate of return encompasses the standard score of the estimated change in farmland capital.
- The expected rate of return was never negative
- The estimators generate white noise residuals
- The parameter estimates in all three equations accord to present value theory:
  - β_0 and δ_0 do not statistically differ from zero
  - β_1 and δ_2 do not statistically differ from one and statistically differs from zero
  - δ_1 does not statistically differ from negative one and statistically differs from zero
- Transaction costs prevent the rate of return on farmland from equaling the rate of return on government securities:
  - make interest rates a function of return expectations instead of an exogenous discount rate
- Results suggest that changes in the value of Illinois farmland occur as a result of return expectations
- We find no evidence of bubbles or fads. Any downward reversal in the price of farmland will follow a downward adjustment in return expectations

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