"Cash Rents, Imputed Returns, and the Valuation of U.S. Farmland: A Test of the Present Value Model"

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Abstract

This study uses U.S.-level time-series data (1935-2015) to test the present value model of farmland prices. Following Engle and Granger (1987) we test each individual time-series for non-stationarity. We subject real farmland prices per acre, real returns per acre, and real interest rates (log-log form) to a set of unit root tests designed to test for (weak) stationarity. We find evidence from some of these tests to support stationarity (KPSS test) and also evidence to support non-stationarity. We also find that structural breaks in the data series may at least partly explain why we cannot reject the null that farmland prices and returns/acre are cointegrated. The observed breaks may be due to changes in the required risk premium on farmland investments, such as during the US farm financial crisis of the early 1980s. Also, the standard unit root and cointegration tests may not be powerful enough to detect cointegration.

Introduction

The theory of a stable long-run relationship between farmland and rents is widely accepted. Yet it has been extremely difficult to verify empirically. Does the present value model (PVM) of farmland prices based on capitalization of expected returns to farmland explain long-run changes in farmland values?

Most studies of farmland values are based on the notion of Ricardian rent – the residual return to a fixed factor of production (farmland) after all other factors have been paid their marginal products (Schmitz, 1995). Although there is little disagreement about the basic tenets of Ricardian rent, its empirical definition is still the subject of contention. Some empirical tests of the Ricardian model involved the use of *nonstationary* time series models. Economic theory suggests that if farmland prices and returns are cointegrated, then one can test whether the cointegrating slope is equal to one as predicted by the present value model (PVM) (Gutierrez et al., 2007). Falk(1991) used *cointegration* analysis and found that farmland prices fail to cointegrate with returns to farmland. This finding led to rejection of the traditional present value formulation for farmland values. Falk's result appears to support an infinite disequilibrium between prices and the return to farmland; however, other efforts may be characterized in terms of *rational bubbles* that need not imply permanent disequilibrium. Other recent studies employ panel econometric methods to test the PVM (Falk, 1991; Gutierrez et al., 2007; Lence, 2014; Campbell and Shiller,1988; Lloyd and Rayner,1993 and Lloyd,1994).

Objective

The specific objective of this research is to test the present value model (PVM) of farmland prices. We use US-level estimates of the value of farmland per acre, returns per acre, and interest rates where *net cash flow per acre* is estimated as:

(net cash income + net rent to non-operator landlords +real estate interest)/acres.

Testing the PVM of farmland prices is important for several reasons:

(1) First, historically, farmland has accounted for roughly 70 percent of all agricultural assets since World War II. Therefore the well-being of the agricultural sector is heavily influenced by the value of farmland. http://ers/data-products/farm-income-and-wealth-statistics/balance-sheet.aspx; Nickerson et al., http://ers.usda.gov/media/377487/eib92_2_.pdf.
Also "boom-bust cycles" (Schmitz, A. 1995) can and have resulted in significant changes in farm sector wealth. A boom-bust period (e.g., 1981-86 farm financial crisis) is a period of time in which farmland prices increase(decrease) in value above(below) its fundamental value.

(2) Second, farmland values are not only influenced by returns from farm-based returns but also by the non-farm demand for land. Also, the speculative and consumptive factors influence farmland values (Pope C.A., 1995).

(3) Third, economists still do not fully agree on how to measure “rents”. For example, Ricardo wrote that “rent “arose from the differential profit potential which was inherent to the “indestructible characteristics of the land” How one measures of returns to farmland can affect tests of the present value model (PVM).

Data

We use time series data: USDA estimates of farmland values per acre, returns per acre, and MoodysAAA bond rate, 1948 – 2015. These data are available online using NASS’s QuickStats http://nass.usda.gov/Quick_Stats/ and also at the USDA-ERS web site http://ers.usda.gov/topics/farm-economy/farm-sector-income-finances/2015-farm-sector-income-forecast.aspx

Methodology

- Two potentially serious problems in testing the PVM: *endogeneity* (Livanis, G., Moss, C., Breneman, V. and R. Nehring, 2006) and *spurious regression*. Stationarity or otherwise of a series can strongly influence its behavior and properties – e.g. persistence of shocks will be infinite for nonstationary series. If the variables in the regression model are not stationary, then the usual “*t*-ratios” will not follow a *t*-distribution, so we cannot validly undertake hypothesis tests about the regression parameters.
- Following Engle and Granger (1987) we test each individual time-series for non-stationarity. In this paper we refer to the weak form or *covariance stationarity*.
- Unit root tests are not valid unless real rents evolve as a difference stationary process (Falk, 1991). Then the theory implies that land prices will also evolve as a difference stationary process. So we are testing whether land prices and rents evolve as ***difference stationary*** processes rather than ***trend stationary*** processes.
- *Trend stationary* (TS) models are suitable for models that have a deterministic trend and fluctuations about that deterministic trend. *Difference stationary* (DS) models are models having a stochastic trend. Unit root in the AR polynomial means that the trend part in the series cannot be represented by a simple linear trend with time (a + bt). The correct representation is $(1\text{-}B)z_t$ where e_t iis i.i.d.
- Lloyd and Rayner 1993 note some important caveats that should be considered when testing for stationarity and cointegration.
- We subject real farmland prices per acre, real returns per acre, and real interest rates (log-log) to a set of unit root tests designed to test for (weak) stationarity. (Table 1).

Table 1. Unit Root Tests: Real Farmland Value Per Acre, Real Returns per Acre, and Real Interest Rate

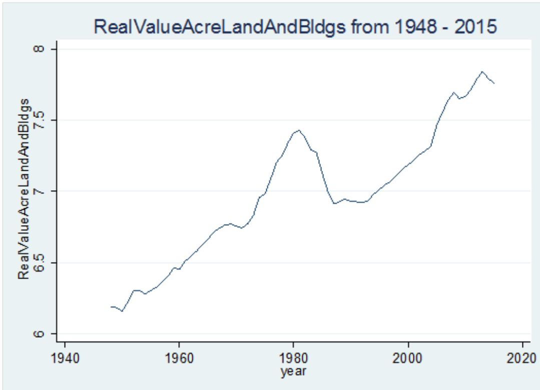
Unit root test	Farmland value per acre	Returns per acre	Interest rate
Dickey-Fuller tests: accommodates general ARMA(*p,q*) models with unknown orders of integration			
ADF[1] unit root, drift, trend	NS[2]	NS	NS
Dickey-Fuller GLS no trend	NS	S *	S *
Phillips-Perron tests: no IID assumption on disturbances; allows autocorrelated residuals			
Phillips-Perron unit root	NS	S **	S *
Phillips-Perron trend	NS	S **	S**
KPSS test[2]: near unit root series; higher power than ADF; transposition of the null hypothesis			
KPSS	S[2] trend stationary	S trend stationary	S trend stationary
Clemente-Montanes-Reyes unit root tests including structural breaks[3]:			
Clemente-Montanes-Reyes single mean shift AO model	NS	Break 1971	Break 1981
Clemente-Montanes-Reyes double mean shift IO model	NS	Break 1971, 2007	Break 1981, 2001
Clemente-Montanes-Reyes double mean shift IO model	NS	Break 1972, 2008	Break 1979
Zivot-Andrews tests[4]: structural change, break estimated at unknown point			
Zivot-Andrews test break intercept	Intercept break at 1985	Intercept break at 1980	Intercept break at 1981
Zivot-Andrews test break in trend	Trend break at 1974	Trend break at 2002	Trend break at 1995
Zivot-Andrews test break in intercept and trend	Intercept and trend break at 1985	Intercept and trend break at 1980	Trend and intercept break at 1981
*** = significant at 1% ** = significant at 5% * = significant at 10%. S = stationary NS = nonstationary			

[1]ADF = Augmented Dickey-Fuller. A well-known weakness of the Dickey–Fuller style unit-root test with I(1) as a null hypothesis is its potential confusion of structural breaks in the series as evidence of nonstationarity.

[2] The KPSS is a test where the null hypothesis is that a series is stationary against an alternative hypothesis that it is not. It is also often used (in conjunction with, e.g., dfgls) to detect "long memory" or fractional integration.

[3] Clemente, Montanes, and Reyes test allows for two events within the observed history of a time series, either additive outliers (the AO model, which captures a sudden change in a series) or innovational outliers (the IO model, allowing for a gradual shift in the mean of the series).

[4] One weakness of the Zivot–Andrews strategy is its inability to deal with more than one break in a time series.



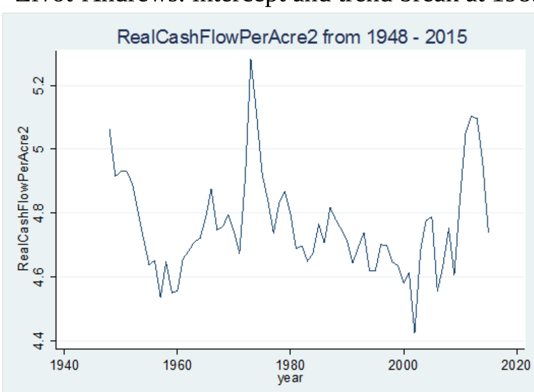
--Zivot-Andrews: intercept break in 1985 (post-farm crisis recovery)

- Increased uncertainty about expected returns on farmland investments
- High interest rates, and relatively low commodity prices

--Zivot-Andrews: trend break at 1974 (pre-farm crisis "boom")

- Unusually large farm income following the growth of ag exports due to devaluation of the dollar and bad weather conditions overseas

--Zivot-Andrews: intercept and trend break at 1985 (post-farm crisis recovery)



--Clemente-Montanes-Reyes single mean shift break in1971
--Clemente-Montanes-Reyes double mean shift breaks in1971, 2007
--Clemente-Montanes-Reyes double mean shift IO model breaks in1972, 2008

- Net farm income, net cash income and NVA declined significantly; increased volatility of commodity prices, energy/input prices and in financial markets
- QE2 initiated in the fourth quarter of 2010

--Zivot-Andrews intercept break at 1980

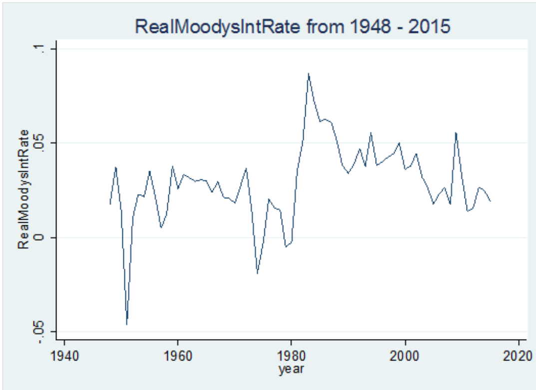
- Farm financial crisis

--Zivot-Andrews trend break at 2002

- Growth in returns

--Zivot-Andrews intercept and trend break at 1980

- Farm financial crisis



--Clemente-Montanes-Reyes single mean shift break in1981

- Major FED policy shift; fed funds rate reached 20 percent in late 1980.

--Clemente-Montanes-Reyes double mean shift breaks in1981, 2001

--Clemente-Montanes-Reyes double mean shift IO model breaks in1979

- Beginning of farm financial crisis; sector lost near $250 billion in equity between 1979-1985

--Zivot-Andrews intercept break at 1981

- Farm financial crisis

--Zivot-Andrews trend break at 1995

- Lehman Brothers collapse September 1998

--Zivot-Andrews intercept and trend break at 1981

- Farm financial crisis

Results

- There is evidence from some of these tests to support stationarity (KPSS test) and there is also evidence of non-stationarity. The results of this study using US-level data from 1935-2015 are inconclusive since some unit root tests suggest stationarity (KPSS) while others non-stationarity (Table 1).
- We find that ***structural breaks*** **(**Table 1**)** in the data series (farmland values/acre, returns/acre, and interest rates) may at least partly explain why we cannot (at this point) reject the null that farmland prices and returns/acre are cointegrated. The observed breaks may be due to changes in the required risk premium on farmland investments, such as during the US farm financial crisis of the early 1980s. Also, the standard unit root test and cointegration tests may not be powerful enough to detect cointegration.
- We are pursuing three options: (Hamilton, 1994, pp. 651-52):

(1) Ignore nonstationarity altogether and simply *estimate the VAR in levels*, relying on stand t and F distributions for testing any hypotheses. (For example, the KPSS test suggests trend stationarity, so we can estimate a farmland value model without resorting to estimating an error-correction model (ECM). This model would incorporate dummy variables to reflect the structural breaks identified by running both the Clemente-Montanes-Reyes test and the Zivot-Andrews tests (Table 1) with intercept and trend dummy variables to capture the impacts of ***structural breaks*** in the series.

(2) *Difference any apparently nonstationary variables before estimating the VAR*. The alternative to (1) is to continue the unit root testing and estimate an ECM – a model constructed using variables that are employed in stationary, first-differenced forms together with a term that captures movements back towards long-run equilibrium. Following the Johansen approach the π matrix can be interpreted as a long-run coefficient matrix. The test for cointegration between the y*s* is calculated by looking at the rank of the π matrix via its eigenvalues taken from rank-restricted product moments matrices. (Brooks, *Introductory Econometrics for Finance*, Cambridge University Press, 2014)[1].

(3) Future research will use a third approach: investigating carefully *the nature of the nonstationarity, testing each series for unit roots and then testing for possible cointegration among the series*. Once the nature of the nonstationarity is understood, a stationary representation for the system can be estimated.

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[1]The drawback to this approach is that the true process may not be a *VAR* in differences. Some of the series may in fact have been stationary, or perhaps some linear combination of the series are stationary, as in a cointegrated *VAR*. In such cases a *VAR* in differenced form is misspecified.

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