Agricultural Bankers' Expectations of Farmland Price Changes and Asset Price Bubbles

Todd H. Kuethe

tkuethe@purdue.edu

David Oppedahl

david.oppedahl@chi.frb.org

Todd Hubbs

jhubbs3@illinois.edu

Paper prepared for presentation at the 165. EAAE Seminar
'Agricultural Land Markets –
Recent Developments, Efficiency and Regulation'

Humboldt-Universität zu Berlin, Germany, April 4-5, 2019

Agricultural Bankers' Expectations of Farmland Price Changes and Asset Price Bubbles

Abstract

When the market price of an asset exceeds its fundamental value, rational expectations suggest that agents should expect market prices to fall. This equilibrating relationship is tested using an unbalanced panel of responses from the Federal Reserve Bank of Chicago's quarterly *Land Values and Credit Conditions Survey* from 1993Q1 – 2018Q2. Empirical results suggest that agricultural bankers expect farmland prices to increase, even when current market prices cannot be justified by underlying fundamentals. Thus, agricultural bankers' short-term farmland price expectations are not consistent with efficient farmland markets. This is the first study of direct, disaggregated farmland price expectations.

Keywords: farmland prices, asset price bubbles, survey expectations
JEL Codes: Q14, C83, G12

1 Introduction

Bubbles occur when the market price of an asset deviates from its fundamental value. Sustained periods of overvaluation or undervaluation are inconsistent with efficient markets. Following the 1980s Farm Financial Crisis, a number of studies have examined the degree to which farmland prices can be explained by fundamentals or bubbles. These studies provide conflicting conclusions, yet the lack of a consensus is not surprising. Gürkaynak (2008, pp. 182) surveys a broad literature of empirical tests of asset price bubbles and summarizes, "for every test of bubbles, there is another paper that disputes the particular 'bubble' interpretation."[1] A bubble in farmland prices could have drastic implications for the agricultural sector, as farmland serves as both the primary store of farmers' wealth and the leading source of collateral in agricultural loans (Nickerson et al., 2012).

Econometric tests of asset price bubbles are obfuscated by the fact that asset price bubbles are driven by the expectations of economic agents, which are typically unobserved. That is, prices deviate from fundamental values as a result of the self-fulfilling beliefs of market participants. Case and Shiller (2003, pp. 299) describe bubbles as instances in which "excessive public expectations of future price increases cause prices to be temporarily elevated." Because market participants' farmland price expectations are unobserved, the previous literature is limited to *indirect* tests of bubbles. These empirical tests are "indirect" in the sense that applied economists seek to infer the expectations of marginal or representative agents by examining the empirical relationships between observed farmland prices (or values) and imputed measures of farmland's fundamental value. These empirical tests, however, may yield inaccurate conclusions because applied economists may be unable to distinguish bubbles from time-varying or regime-switching fundamentals (Gürkaynak, 2008). In addition, in an indirect testing framework, a rejection of market efficiency is a joint rejection of both (i) the assumed structural model and (ii) agents' use of the model in forming expectations (Nerlove and Bessler, 2001).

As noted by Pesaran (1987), many of the limitations of indirect tests of expectations can be overcome with *direct* tests of stated expectations collected through surveys.[2] This study develops the first direct test of farmland price expectations. Building on Pesaran and Johnsson (2018), our test examines the degree to which farmland price expectations are related to the difference between market prices and fundamental values. Specifically, when current market prices exceed market fundamentals, rational agents should expect prices to fall. This equilibrating relationship is tested with farmland price expectations obtained from

[1] For an example in the farmland pricing literature, see Falk and Lee (1998),Roche (2001), and Falk et al. (2001).

[2] See Pesaran and Weale (2006) for a review of the relevant literature.

the Federal Reserve Bank of Chicago's quarterly survey of agricultural bankers.

Agricultural bankers' farmland price expectations play a critical role in the agricultural economy. Farm real estate accounts for approximately 82.5% of the value of the U.S. farm sector's asset base (USDA Economic Research Service, 2017) and is the leading source of collateral in agricultural loans (Nickerson et al., 2012). Farmland prices, therefore, influence lenders' ability and willingness to provide credit to the agricultural sector (Briggeman et al., 2009). Farmers rely on credit to finance their capital base, to conduct marketing and production activities, and to provide short-term liquidity. Previous studies have also shown that farmers often cannot access as much credit as they would like or require (Briggeman et al., 2009; Hart and Lence, 2004; Bierlen et al., 1998; Bierlen and Featherstone, 1998). Thus, if agricultural bankers believe that farmland prices are currently driven by bubbles, an expected future "burst" may limit their willingness to accept collateral or extend additional credit to the sector.[3] Economic theory suggests that, because farmland is both a source of collateral and a factor of production, changes in lenders' farmland price expectations may yield large and persistent fluctuations in aggregate productivity (Kiyotaki and Moore, 1997).

The existing literature provides a number of reasons why agricultural bankers may believe that farmland prices are prone to bubbles. First, the observation that farmland prices overreact in the short-run to changes in fundamentals is well documented (Falk and Lee, 1998; Schmitz, 1995; Clark et al., 1993; Irwin and Colling, 1990; Featherstone and Baker, 1988, 1987; Burt, 1986). Second, farmland has been shown to exhibit consistent excess returns (Hanson and Myers, 1995; Falk, 1991; Irwin and Colling, 1990). Third, farmland transactions are subject to short-sale constraints and substantial transaction costs (De Fontnouvelle and Lence, 2002; Lence, 2001; Chavas and Thomas, 1999; Lence and Miller, 1999).

The existing literature, however, provides conflicting evidence on the degree to which farmland prices can be explained by bubbles or fundamentals. A number of studies that examine the time series properties of farmland prices and cash rents conclude that farmland prices cannot be explained by market fundamentals (for example, see Engsted, 1998; Clark et al., 1993; Falk, 1991; Irwin and Colling, 1990). On the other hand, other studies also examine the relationship between farmland prices and cash rents under different assumptions, data sources, or modeling techniques and find no empirical evidence of bubbles (Tegene and Kuchler, 1993; Gutierrez et al., 2007). Lavin and Zorn (2001) find mixed results for the presence of bubbles by examining patterns of abnormal returns. Olsen and Stokes (2015) modify the structural model of Lavin and Zorn (2001) and find only weak evidence of bubbles for low quality farmland. In contrast, Power and Turvey (2010) find strong evidence of

[3]Commercial banks provide roughly 41% of U.S. farm sector debt (USDA Economic Research Service, 2017).

bubbles using empirical real options based tests.

Given the conflicting findings of prior research, this study makes a number of important contributions to our understanding of farmland price expectations. First, this is the first study to provide a *direct* test of disaggregated farmland price expectations. We avoid the joint rejection problem of indirect testing by examining an unbalanced panel of bank-level responses to the Federal Reserve Bank of Chicago's *Land Values and Credit Conditions Survey* from the first quarter of 1993 to the second quarter of 2018 (1993Q1 – 2018Q2). Second, individual survey responses allow us to account for unobserved respondent heterogeneity. Using aggregated responses to the *Land Values and Credit Conditions Survey*, Kuethe and Hubbs (2017) found that the respondents' expectations (in aggregate) were unbiased but inefficient, which is inconsistent with rational expectations. The empirical procedures employed by Kuethe and Hubbs (2017), however, assume that respondents are homogeneous, a limitation that has been criticized by a number of researchers (Nardo, 2003; Lahiri and Zhao, 2015). In addition, individual survey responses allow us to test whether agricultural bankers' farmland price expectations are internally consistent with their current information on market fundamentals. Economic theory suggests that bubbles can arise even when investors behave rationally, if the fundamental value of an asset is difficult to determine (Hong and Stein, 1999; Blanchard and Watson, 1982; Tirole, 1982), and our test procedure allows us to control for differences in respondents' view of farmland's fundamental value. Third, the Federal Reserve Bank of Chicago surveys bankers quarterly, and as a result, we are able to examine farmland price dynamics at a finer temporal scale than previous studies. As noted by Olsen and Stokes (2015), previous (indirect) tests of farmland price bubbles rely on annual observations which may limit the statistical power of empirical bubble tests and may not be able to detect short-lived or collapsing bubbles.

The remainder of the paper is organized as follows. Section 2 introduces our conceptual model of farmland expectations as they relate to transaction prices and market fundamentals. Section 3 describes key aspects of the Federal Reserve Bank of Chicago's *Land Values and Credit Conditions Survey*. Section 4 outlines our empirical approach, with a detailed description of our data in Subsection 4.1. Section 5 summarizes our results, and Section 6 discusses the key implications of our findings, as well as important limitations of our study. Section 7 provides concluding remarks, including implications for policy and future research.

2 Conceptual Model

As previously stated, bubbles occur when the market price of an asset deviates from its fundamental value. The fundamental value of an asset is an obviously ambiguous concept,

but in the existing literature, the fundamental value of farmland is typically represented by the present value of discounted future future earnings, such as net farm returns or cash rental rates (Nickerson and Zhang, 2014). The present value (PV) model relates the equilibrium per acre value of farmland L_t, measured at the beginning of the period t, to the expected present value of future returns:

$$L_t = \delta \sum_{j=0}^{\infty} \delta^j \mathrm{E}_t(R_{t+j}) \tag{1}$$

where R_t is the real return received at the end of period t that can be obtained by ownership; $\delta = (1+r)^{-1}$ is the discount rate; r is the constant real interest rate; and $\mathrm{E}_t(\cdot)$ is the expectations operator as it relates to information available at time t.

A number of studies use the PV model framework to test the empirical relationships between farmland prices and cash rental rates (Tegene and Kuchler, 1991; Falk, 1991; Tegene and Kuchler, 1993; Lloyd et al., 1994; Engsted, 1998; Gutierrez et al., 2007). If the equilibrating relationship of (1) fails to hold, the empirical tests suggest that farmland prices may deviate from fundamentals, or alternatively, that farmland prices are prone to bubbles. These empirical tests are classified as *indirect* tests of expectations because they are derived from observed farmland prices and imputed measures of farmland's fundamental value. In contrast, we develop a direct test of expectations of farmland price bubbles based on the testing procedure of Pesaran and Johnsson (2018). Economic theory identifies a number of conditions under which asset price bubbles can exist, including asymmetric information, limited arbitrage, or heterogeneous beliefs (Brunnermeier, 2008). Pesaran and Johnsson's (2018) test procedure is derived from an asset pricing model in which bubbles arise as the result of heterogeneous beliefs and short-sale constraints, following Miller (1977) and Harrison and Kreps (1978). The importance of heterogeneous beliefs and short-sale constraints in farmland pricing was formalized by Brown and Brown (1984). Under short-sale constraints, bubbles can arise even for small differences in beliefs (Scheinkman and Xiong, 2003).

Our test is constructed as follows. Assume that each economic agent i observes the real, per acre prevailing price of farmland in their market area at time t, labeled $P_{i,t}$. Agents also observe prevailing real cash rental rates and real interest rates so that they can construct a measure of the fundamental value of farmland in their area as in (1), labeled $L_{i,t}$. Agents then form expectations of the rate of change for the prevailing real price in their market from the current period t to a later period $t+h$, over some horizon h, expressed $\pi^e_{i,t+h} = \mathrm{E}_{i,t}(\pi_{i,t+h})$ where $\pi_{i,t+h} = h^{-1}(P_{i,t+h} - P_{i,t})/P_{i,t}$. Agents form expectations a function of observed prevailing real market prices $P_{i,t}$, imputed real fundamental values $L_{i,t}$, and individual preferences α_i. The individual fixed effect α_i is a function of independently dis-

tributed agent-specific beliefs regarding individual steady state growth rate of real farmland returns and differences in information sets (as in Brunnermeier, 2001).

Following Pesaran and Johnsson (2018), under rational expectations, agents' expected rate of price change ($\pi^e_{i,t+h}$) should be *negatively* related to the difference between the prevailing real market price ($P_{i,t}$) and the farmland's real fundamental value ($L_{i,t}$). That is, agents who believe that farmland is currently *overvalued* ($P_{i,t} > L_{i,t}$) should expect prices to *fall* ($\pi^e_{i,t+h} < 0$), and agents who believe that the asset is currently *undervalued* ($P_{i,t} < L_{i,t}$) should expect prices to *rise* ($\pi^e_{i,t+h} > 0$). This relationship is formalized by the equilibrating expression:

$$\pi^e_{i,t+h} = \alpha_i + \beta V_{i,t} + u_{i,t}, \tag{2}$$

where $V_{i,t} = (P_{i,t} - L_{i,t})/P_{i,t}$. Thus, when $V_{i,t} > 0$ ($V_{i,t} < 0$), respondent i believes the asset is currently overvalued (undervalued). The equilibrating relationship (2), therefore, yields the testable hypothesis that, under rational expectations, β is expected to be negative ($\beta < 0$).

Pesaran and Johnsson (2018) develop a survey instrument to empirically test the equilibrating relationship of (2). The "double-question" instrument first elicits whether a respondent believes an asset is currently (i) overvalued, (ii) fairly valued, or (iii) undervalued. Then, the instrument collects the respondent's expected value for a given dollar amount of the asset at three separate horizons: one month, three months, or one year. The double-question is an abbreviated version of the bubble expectations survey instrument of Shiller (2000). Pesaran and Johnsson (2018) examine an unbalanced panel of responses to thirteen waves of the monthly RAND American Life Panel between January 2012 and January 2013. The double-question instrument is applied to three assets: US stock market equities, gold, and residential housing in the respondent's metropolitan statistical area. The results suggest that consumers' housing price expectations are equilibrating at all horizons, and equity price expectations are equilibrating at the longest horizon (one year). However, gold price expectations are not equilibrating, implying that respondents believe gold prices are generated by asset price bubbles.

3 *Land Values and Credit Conditions Survey*

We empirically test the equilibrating relationship of (2) using disaggregated survey responses to the Federal Reserve Bank of Chicago's quarterly survey of agricultural bankers. The *Land Values and Credit Conditions Survey* collects information on current and expected credit market conditions and agricultural land values from agricultural bankers throughout the Federal Reserve's Seventh District. As shown in Figure 1, the Seventh District spans

the northern portions of Illinois and Indiana, southern Wisconsin, the lower peninsula of Michigan, and the entire state of Iowa. The survey population includes all member banks at which farm loans as a share of total loans exceeds a threshold that was established in 1972 (Federal Reserve Bank of Kansas City, 2018). A threshold of 25% was applied in all states except Michigan, which uses a threshold of 10%. The Seventh District accounts for approximately 25% of the nation's agricultural banks (Federal Reserve Bank of Kansas City, 2018).

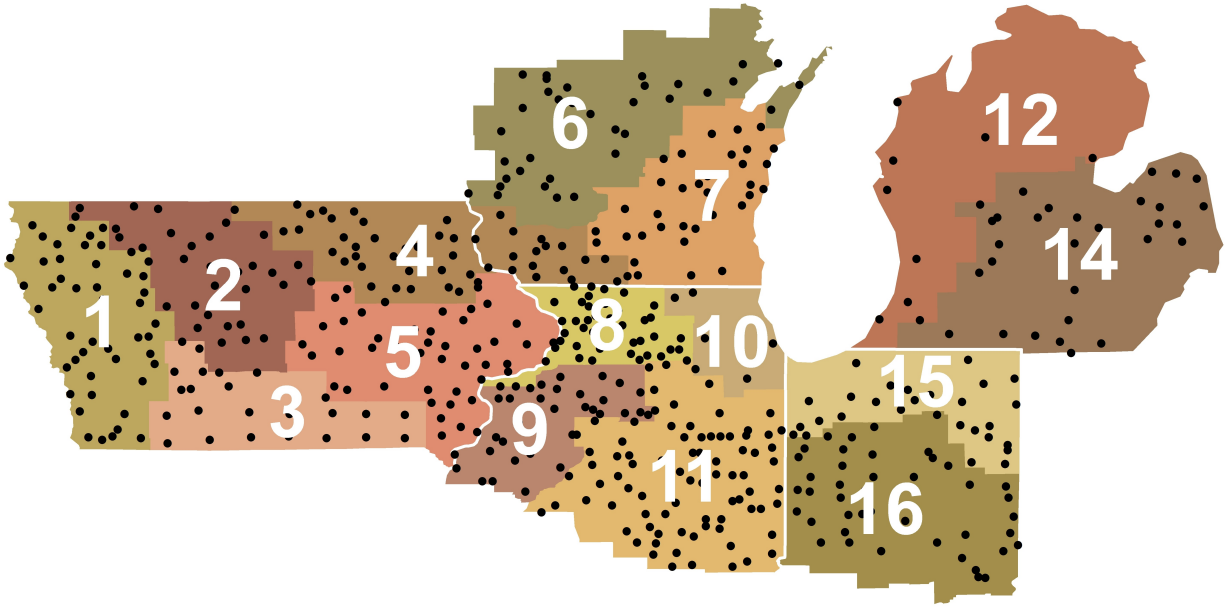

Figure 1: *Land Values and Credit Conditions Survey* Market Areas and Respondent Banks

Our empirical test of (2) uses information collected from the following survey questions. A two-part survey question elicits (i) the per acre prevailing market price of farmland in each respondent's area and (ii) the respondent's expectation of farmland price changes over the coming quarter.

> I. A. What is the present market value of good farmland in your area? Exclude the best farmland as well as that of below average productivity from your consideration.
>
> $\_\_\_\_\_$ per acre.

> I. B. What trend in farmland values do you expect in your area in the next three months?
>
> Up (1) _____; Down (2) _____; Stable (3) _____.

The respondents' subjective beliefs of current farmland values are one of the key pieces of information collected by the *Land Values and Credit Conditions Survey*. Prior research

shows that, in aggregate, these values are highly correlated with values reported by similar, annual surveys conducted by the U.S. Department of Agriculture (USDA) and Iowa State University (Kuethe and Ifft, 2013). In addition, Zakrzewicz et al. (2012) find that individual responses from a related survey conducted by the Federal Reserve Bank of Kansas City are consistent with Oklahoma farmland transaction prices.

The fundamental value of farmland is imputed for each respondent given the responses to two survey questions. The first question collects the bank's current discount rate on farm mortgage loans:

> IV. What is the typical interest rate your bank currently charges on farm real estate loans? _____%.

The second question collects the current cash rental rate:

> VII. What is the typical cash rental rate per acre for good farmland in your area this year? $_____.

Questions I.A, I.B, and IV are included in the survey in every quarter. However, the cash rental rate information (question VII) is collected only once a year, given the annual nature of cash rental agreements in the District. It is collected at the end of the first quarter (April), and we assume rental rates are constant in the remaining quarters of the reference year.

4 Empirical Strategy

Following Pesaran and Johnsson (2018), the "double-question" survey instrument is used to test the equilibrating relationship of (2) using the following two-way fixed effects (or fixed effects, time effects) regression:

$$\pi^{e}_{i,t+h} = \alpha_i + \beta V_{i,t} + \tau_t + \varepsilon_{i,t}, \quad i = 1, ..., N; t = 1, ..., T, \tag{3}$$

where τ_t are a set of time period fixed effects that control for common, economy-wide shocks to expectations. As previously stated, the individual fixed effects α_i control for independently distributed agent-specific beliefs regarding individual steady state growth rate of real farmland returns and differences in information sets. Empirically, α_i also controls for inter-individual differences in scaling and anchoring of responses, intrinsic differences in expectations, and unobserved explanatory variables, as long as these differences are constant through time (Winkelmann and Winkelmann, 1998). As previously described, β in (3) is expected to be statistically significant and negative.

In contrast to Pesaran and Johnsson (2018), we do not observe $\pi^{e}_{i,t+h}$ directly. Instead, the *Land Values and Credit Conditions Survey* collects ordered qualitative farmland price

expectations. Specifically, respondents express whether they expect farmland prices in the next quarter to be "down," "stable," or "up."[4] This form of elicitation is common in many economic surveys of expectations (Pesaran and Weale, 2006). This form of elicitation was first developed because it was believed that respondents would be unlikely to complete a survey that requires exact cardinal responses (Theil, 1955). In addition, it is believed that ordinal responses are less likely to be subject to measurement error than attempts at direct cardinal measurement (Pesaran, 1984, pp. 34).

The ordered qualitative farmland price expectations collected by the *Land Values and Credit Conditions Survey*, however, can be considered a discrete representation of respondents' unobserved continuous expectations. As first proposed by Theil (1952) and later formalized by Carlson and Parkin (1975), when respondents believe that the expected change in farmland prices is small or close to zero, they provide a categorical response of "stable." In order for respondents to report a directional change ("down" or "up"), their expectations must exceed some threshold value. For example, agricultural bankers answer "up" when they expect farmland prices to increase by some value greater than a nonzero threshold or breakpoint.

Lahiri and Zhao (2015) demonstrate that the unobserved continuous distribution of expectations can be approximated through ordered choice regression of the observed ordered farmland price expectations. However, the formulation of the conceptual model (2), as developed by Pesaran and Johnsson (2018), requires that agents are allowed to possess independently distributed agent-specific beliefs. This form of respondent heterogeneity is captured in our regression model (3) with the respondent fixed effects α_i, and there is no consistent estimator for an ordered logit or probit model that can explicitly incorporate individual fixed effects. The existing literature, however, provides a number of potential estimation strategies that address this shortcoming of ordered regression in panels. Through a series of Monte Carlo simulations, Riedl and Geishecker (2014) demonstrate that simple binary re-coding schemes deliver parameter estimates with very low bias and high efficiency. Following Riedl and Geishecker (2014), we convert the ordinal expectations into a dummy variable, $U_{i,t}$, that takes the value of 1 if respondent i answered "up" in period t and 0 otherwise. While the dummy variable approach does not use all the available information efficiently, it enables us to make use of a relatively well developed class of limited dependent variable panel models (Winkelmann and Winkelmann, 1998). Further, the resulting binary logit estimator is consistent as it does not depend on the choice of breakpoints or thresholds between "down," "stable," and "up" (Crouchley, 1995).

Chamberlain (1980) shows that such a fixed-effects logit model can be estimated by

[4]Note: the expectations responses are re-coded from the original survey to be ordinal.

conditional maximum likelihood. For $\varepsilon_{i,t}$ independently logistic,

$$\Pr(U_{i,t} = 1|V_{i,t}, \alpha_i, \tau_i) = \frac{e^{(\alpha_i + \beta V_{i,t} + \tau_t)}}{1 + e^{(\alpha_i + \beta V_{i,t} + \tau_t)}}. \tag{4}$$

Riedl and Geishecker (2014) demonstrate that the estimation is efficient with very small bias in large samples.

4.1 Data

We construct an unbalanced panel of agricultural bankers using responses from the Federal Reserve Bank of Chicago's *Land Values and Credit Conditions Survey*. The unbalanced panel spans 102 quarters from the first quarter of 1993 (1993Q1) to the second quarter of 2018 (2018Q2). The panel is unbalanced because participation is voluntary and the number of agricultural banks in the Seventh District declined during the observation period. The panel retains all observations with complete responses for the four questions outlined previously. In sum, the panel consists of 729 agricultural banks and 22,530 responses. Figure 1 shows the approximate locations of the respondent banks.

Figure 2 plots the number of complete survey responses per quarter from 1993Q1 through 2018Q2 (dashed line), along with the number of agricultural banks (solid line) in the Federal Reserve's Seventh District, according the *Agricultural Finance Databook* (Federal Reserve Bank of Kansas City, 2018). The *Agricultural Finance Databook* uses a slightly different definition of an agricultural bank, but Figure 2 suggests that the panel represents an average of 34.5% of agricultural banks in the District per quarter, with a range of 23.7% – 53.0%.[5]

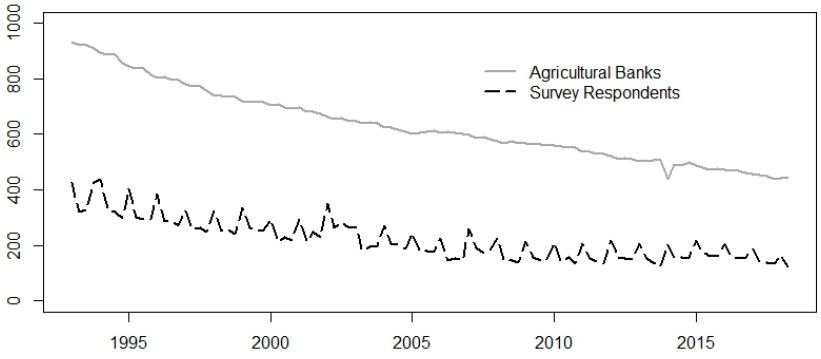

Figure 2: Complete *Land Values and Credit Conditions Survey* Responses and Seventh District Agricultural Banks, 1993Q1 – 2018Q2

[5]The *Agricultural Finance Databook* defines an agricultural bank as a bank where the share of farm loans to total loans exceeds the national average at all banks.

The dependent variable in our regression model is a dummy variable that takes the value of 1 when respondents report a farmland price expectation of "up." Figure 3 shows the share of respondents each quarter who report an expectation of "up." Over the observation period, 25.6% of respondents expect farmland prices to increase in the following quarter. Figure 3 demonstrates, that the share of respondents who report "up" fluctuates greatly across the observation period, with as few as 0% in several quarters in 2016 to as high as 71.2% in 1996Q1.

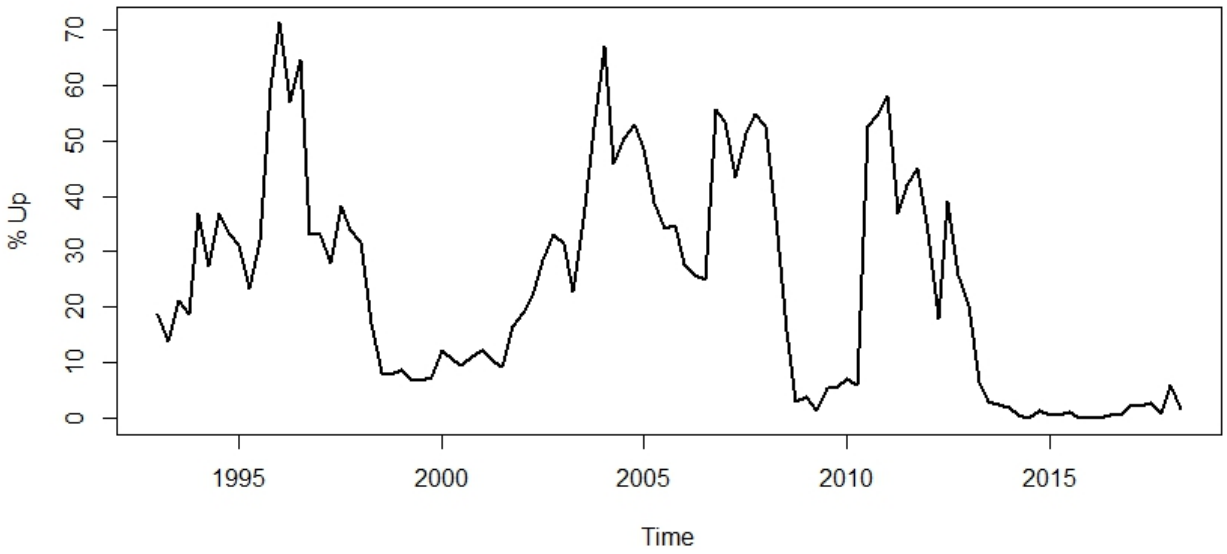

Figure 3: Share of Respondents with Farmland Price Expectations of "Up," 1993Q1 – 2018Q2

Our regression model estimates the relationship between the probability that a respondent believes that farmland prices will increase in the next quarter and the degree to which market prices reflect fundamentals. The deviation between market prices and fundamentals is captured by the independent variable $V_{i,t} = (P_{i,t} - L_{i,t})/P_{i,t}$. The prevailing price of farmland $P_{i,t}$ is obtained directly from the survey responses, and the fundamental value $L_{i,t}$ is computed using a simplified version of the PV model (1). The fundamental value is imputed by dividing the cash rental rate $R_{i,t}$ by the interest rate the bank currently charges on farm real estate loans $r_{i,t}$:

$$L_{i,t} = \frac{R_{i,t}}{r_{i,t}}. \tag{5}$$

This expression of the fundamental value is often referred to as the traditional capitalization formula or capitalized rental rate (Weersink et al., 1999). Following (1), $P_{i,t}$, $R_{i,t}$, and $r_{i,t}$ are expressed in real terms using the quarterly Personal Consumption Expenditures Price Index (2018Q2 = 1) (Bureau of Economic Analysis, 2018).

Market prices and capitalized rents are, therefore, unique to each respondent i and time

period t, based on current rental and interest rates. Thus, $V_{i,t}$ represents the degree to which current real market prices $P_{i,t}$ can be justified according to current real market fundamentals (5). The traditional capitalization formula assumes that rental and interest rates are held constant at current levels. The independent variable $V_{i,t}$, therefore, captures the degree to which current farmland market prices can be justified by fundamentals, controlling for inflation, and the regression model tests whether agricultural bankers' expectations are internally consistent with the equilibrating relationship (2). This relationship can be evaluated empirically by testing the restriction $\beta < 0$.

Figure 4 plots the relationship between the prevailing real market price of farmland ($P_{i,t}$) and real capitalized rental rates ($L_{i,t} = R_{i,t}/r_{i,t}$) for each survey response. The dashed line represents price levels at which $P_{i,t} = L_{i,t}$. Thus, for points above the dashed line, the respondent believes that farmland is currently overvalued, or alternatively, the market prices cannot be fully justified by current rental rates and interest rates. The equilibrating relationship (2) implies that the respondents above the dashed line *should not* expect prices to rise. Similarly, for points below the dashed line, the respondent believes that farmland is currently undervalued, and (2) implies that the respondents below the dashed line *should* expect prices rise.

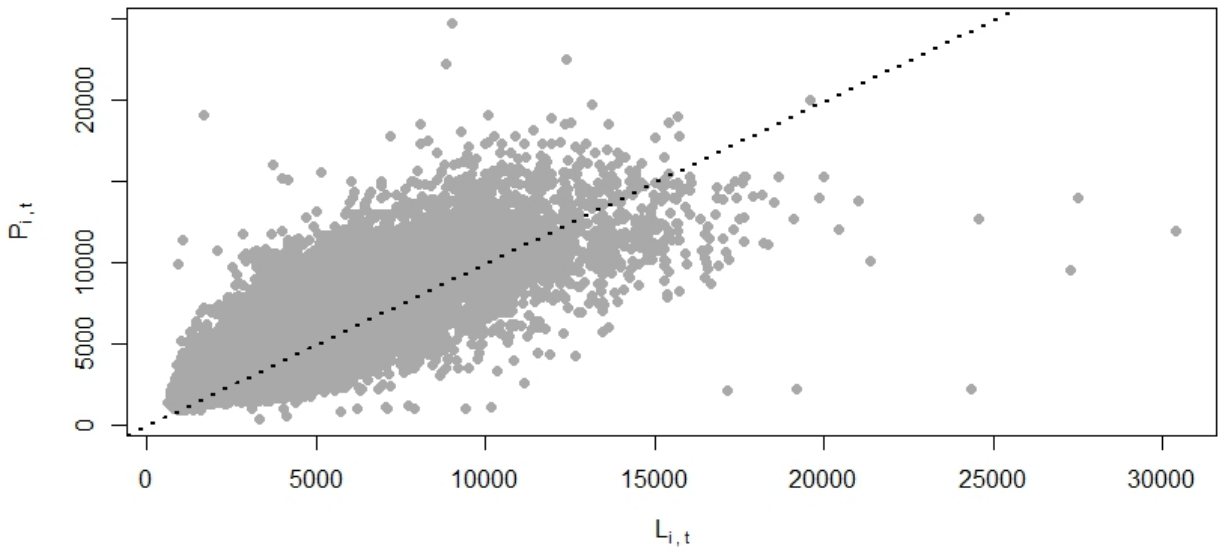

Figure 4: Relationship between P_t and L_t

5 Results

Our regression results are reported in Table 1. The results reported in the first column are those of the standard logit regression, with all observations pooled over time. The remaining columns report the results of the conditional panel logit model with different sets of fixed effects: individual, time, and individual and time, respectively. The standard errors, in parentheses, are clustered at survey market area, as shown in Figure 1, and robust to serial correlation (Driscoll and Kraay, 1998).

Table 1: Regression Results

			Fixed-Effects					
	Pooled		**Individual**		**Time**		**Individual & Time**	
Constant	0.254	***						
	(0.035)							
$V_{i,t}$	0.024		0.016		0.043	***	0.029	**
	(0.041)		(0.055)		(0.015)		(0.015)	
Fixed-effects								
Individual			yes				yes	
Time					yes		yes	
Pseudo-R^2	0.0004		0.3413		0.3993		0.4754	
AIC	4,291.29		5,256.15		3,667.72		4,685.03	
LR Test (degrees of freedom)								
vs. Pooled			2,741.10	***	4,819.00	***	7,871.90	***
			728		101		829	
vs. FE					2,077.80	***	5,130.70	***
					–627		101	
vs. TE							3,052.90	***
							728	

Regression results for unbalanced panel of 729 agricultural banks from 1993Q1 to 2018Q2, with 22,530 observations. *, **, and *** denote statistical significance at 10%, 5%, and 1%, respectively. Standard errors (in parentheses) are clustered at the survey market area level and robust to serial correlation (Driscoll and Kraay, 1998).

The primary result of the equilibrating relationship (2) is that agricultural bankers' farmland price expectations should be *negatively* related to the difference between the prevailing real price of farmland and real capitalized cash rents. Specifically, (4) implies that when the prevailing market price of farmland exceeds its capitalized rental rate, the probability that

agricultural bankers expect farmland prices to increase should decline. Thus, the estimated coefficient on $V_{i,t}$ is expected to be negative.

In both the pooled and individual fixed effects models (columns 1 and 2), the estimated coefficient on $V_{i,t}$ is statistically indistinguishable from zero which implies that agricultural bankers' farmland price expectations are unrelated to the difference between prevailing market prices and market fundamentals. In contrast, for both the time and two-way fixed effects models, the estimated coefficient on $V_{i,t}$ is statistically significant and *positive*. Thus, when controlling for common movements shocks to farmland price expectations across time, agricultural bankers' farmland price expectations are not equilibrating. This finding implies that agricultural bankers do not believe farmland markets are efficient.

It is important to note that the fixed effects estimator does not use information provided by inter-individual comparisons of farmland price expectations. As a result, the expectations effect is identified by individuals who change expectations from "down" or "stable" to "up" during the observation period. In the fixed effect logit model, all respondents with unchanged expectations drop out of the conditional likelihood function. In our sample, we observed 620 respondents (or approximately 85% of the 729 observed) who change their expectations to "up" at least once during the 1993Q1 to 2018Q2 observation period. Hence, the number of informative observations is lower than the total sample size, and the theoretical motivation for individual and time fixed effects have to be traded off for less precise estimates. Pesaran and Johnsson (2018), however, outline the theoretical justification for both time and individual fixed effects. Further, a series of pairwise likelihood ratio tests are used to compare the goodness of fit of the various models. As reported at the bottom of Table 1, the likelihood ratio tests suggests that the inclusion of time and individual fixed effects improves the fit of the models. In addition, the pseudo-R^2 suggests that the two-way fixed effect specification explains the greatest amount of variation in agricultural bankers' farmland price expectations.

6 Implications and Limitations

Our results suggest that, when controlling for common shocks to farmland price expectations, the probability that agricultural bankers expect farmland prices to rise *increases* as the current market price of farmland exceeds its fundamental value. Thus, even though current market prices cannot be justified by current cash rental and interest rates, agricultural bankers expect farmland prices to increase over a one-quarter horizon. This finding suggest that agricultural bankers' farmland price expectations are in direct conflict with efficient farmland markets or that agricultural bankers believe that farmland prices are prone to

asset price bubbles.

In their study of responses from the RAND American Life Panel, Pesaran and Johnsson (2018) demonstrate that the share of respondents with non-equilibrating expectations can explain cross sectional variation in house price appreciation rates across metropolitan statistical areas. The survey responses examined by Pesaran and Johnsson (2018) have a large cross sectional dimension ($n = 4,971$) and short time dimension ($T = 13$). Our panel of *Land Values and Credit Conditions Survey* responses, by contrast, has a relatively small cross sectional dimension ($n = 729$) and relatively large time dimension ($T = 102$). We can, therefore, exploit the large time dimension of our dataset to examine the impact of agricultural bankers' non-equilibrating expectations on observed farmland price changes.

Following Pesaran and Johnsson (2018), we classify respondents who have non-equilibrating or "bubble" expectations as those who believe farmland is currently over valued ($P_{i,t} > L_{i,t}$) *and* also expect farmland prices to increase in the next quarter ($U_{i,t} = 1$). We construct and indicator variable $B_{i,t} = 1$ if $P_{i,t} > L_{i,t} \ \cap U_{i,t} = 1$ for respondent i at time t. The indicator variable is used to construct an index of the share of respondents with "bubble" expectations:

$$B_t = \left(\frac{\sum_i B_{i,t}}{N_t} \right) \times 100 \tag{6}$$

where N_t is the number of respondents at time t. The bubble expectations index is plotted in Figure 5. The bubbles expectations index fluctuates greatly over the observation period, reaching its maximum value of 54.2% in 2006Q4.

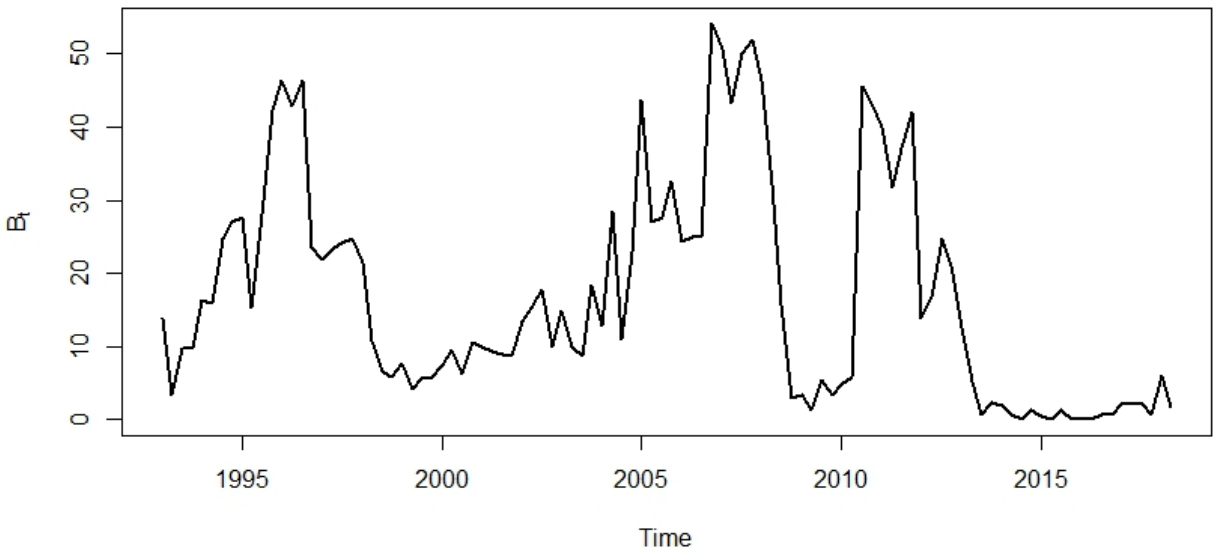

Figure 5: Bubble Expectations Index, 1993Q1 – 2018Q2

The impact of bubble expectations B_t on observed farmland price changes can be tested

empirically as follows. Let, $\bar{P}_t$ be mean of the reported farmland prices reported by each respondent across the District in quarter t and $\triangle\bar{P}_t = [(\bar{P}_t - \bar{P}_{t-1})/\bar{P}_t] \times 100$ be the quarterly change between quarter t and the previous quarter $t-1$. The degree to which aggregate farmland price changes can be explained by the bubble expectations index can be evaluated by the regression:

$$\triangle\bar{P}_t = \lambda_0 + \lambda_1 B_{t-1} + \lambda_2 \triangle\bar{P}_{t-1} + \eta_t. \tag{7}$$

The regression results of (7) are reported in Table 2. The table reports the coefficient estimates using four alternative specifications, and standard errors, in parentheses, are robust to heteroskedasticity and autocorrelation following Newey and West (1987). The coefficient estimates for the bubble expectations index B_{t-1} is statistically significant and positive across all specifications. Thus, the results provide robust evidence that farmland prices tend to increase at a faster rate when the portion of respondents with bubble expectations increases. Alternatively, the regression tests suggest that bubble expectations are not entirely unfounded, as increases in B_t are positively associated with $\triangle\bar{P}_t$.

Table 2: Bubble Expectations and Farmland Price Changes

	(1)		(2)		(3)		(4)	
Constant	-0.887	***	-1.065	***	0.042		-0.157	
	0.315		0.388		0.498		0.570	
B_{t-1}	0.084	***	0.101	***	0.083	***	0.095	***
	0.015		0.021		0.014		0.020	
$\triangle\bar{P}_{t-1}$			-0.175				-0.121	
			0.116				0.132	
Quarter FE					yes		yes	
R^2	0.218		0.240		0.273		0.278	

*, **, and *** denote statistical significance at 10%, 5%, and 1%, respectively. Standard errors (in parentheses) are heteroskedasticity and autocorrelation consistent (Newey and West, 1987).

While our empirical tests suggest that agricultural bankers' farmland price expectations are not consistent with efficient farmland markets, the findings should be considered with the following limitations in mind. First, farmland market prices (and agricultural bankers' expectations) may be driven by more than capitalized cash rental rates. Previous research suggests that farmland prices are determined by a complex set of factors beyond cash rental rates (Borchers et al., 2014). This is particularly true in areas where farmland prices are influenced by conversion potential or natural amenities. Second, the simple capitalization formula (5) assumes that current cash rental rates and interest rates will hold in perpetuity.

However, as Gürkaynak (2008) notes, the fundamental drivers of asset prices likely change over time. If agricultural bankers believe that current rental rates or interest rates are not sustainable, they will likely adjust their expectations. Expectations of future farmland price increases can be easily justified if returns are expected to grow substantially over time. Third, as Pesaran and Johnsson (2018) demonstrate, the equilibrating relationship between price expectations and fundamentals can vary by horizon. The *Land Values and Credit Conditions Survey* only collects price expectations over the coming quarter (three months). Further, prior studies suggest that farmland prices are determined by market fundamentals in the long-run, but in the short-run, prices exhibit significant deviations from the present value formulation (Schmitz, 1995; Falk and Lee, 1998). Thus, future studies may explore whether the equilibrating relationship holds at longer horizons.

7 Conclusion

This study examines the degree to which farmland price expectations of agricultural bankers are consistent with asset price bubbles. Asset price bubbles are defined as periods in which the market price of an asset deviates from its fundamental value, a clear violation of efficient markets. Previous *indirect* tests of observed farmland prices and fundamentals provide conflicting information on the degree to which farmland prices are subject to bubbles. Our analysis, by contrast, examines the stated expectations of agricultural bankers using a rich panel of responses from the Federal Reserve Bank of Chicago's *Land Values and Credit Conditions Survey*. We develop a *direct* test of the equilibrating relationship between expectations and the difference between farmland market prices and market fundamentals. The equilibrating relationship implies that respondents who believe that farmland is currently overvalued (undervalued) should expect farmland prices to fall (rise). This relationship is tested using fixed-effect conditional logit model, and the results suggest that, when controlling for common shocks to expectations, agricultural bankers' farmland price expectations are not equilibrating. Additional tests, however, suggest that this view is not unfounded, as farmland prices tend to appreciate at higher rates as the share of respondents with non-equilibrating expectations increases.

We must be cautious about some of the underlying assumptions of the study. First, we assume that farmland's fundamental value can be captured by the simple capitalization formula derived from cash rental rates and typical interest rates on farm mortgages. Previous research suggests that farmland prices are driven by a complex set of factors beyond cash rental rates (Borchers et al., 2014). Second, the simple capitalization formula assumes that current cash rental rates and interest rates will hold in perpetuity. However, non-

equilibrating expectations can be justified by large changes in the growth rate of returns or changes in discount rates.

Our findings have important implications for agricultural policy. As previously noted, lenders' expectations of farmland price changes may influence their ability and willingness to extend credit to the agricultural sector (Briggeman et al., 2009), and prior studies have consistently shown that farmers often cannot access as much credit as they would like or require (Briggeman et al., 2009; Hart and Lence, 2004; Bierlen et al., 1998; Bierlen and Featherstone, 1998). Our findings suggest that agricultural bankers, on average, expect farmland prices to rise, even when current market prices cannot be justified by market fundamentals. When farmland market prices exceed market fundamentals, some of the more productive producers may be driven out of the sector, as efficient producers tend to borrow more heavily against farmland to acquire productive assets, such as equipment (Bierlen et al., 1998). This process results in higher business risk in the sector. In addition, lenders may view farmland price bubbles as an indication of an increase in the risk of default among farm borrowers, given a potential "burst" in farmland prices. Thus, if agricultural bankers make lending decisions according to their expectations of farmland's collateral value, their non-equilibrating expectations may reduce their willingness or ability to extend credit in the sector. Lenders may respond to the perceived increase in a downside price correction by decreasing the flow of credit, increasing the price of credit, or tightening the terms of borrowing. This limits farmers' ability to borrow against farmland when farmland markets are inefficient (Schmitz, 1995).

Our findings also have important implications for future research. The existing literature suggests that farmland prices may exhibit significant deviations from the fundamental value in the short-run but are generally determined by market fundamentals in the long-run (Schmitz, 1995; Falk and Lee, 1998). The *Land Values and Credit Conditions Survey*, however, only collects price expectations for the next quarter (three month horizon). Pesaran and Johnsson (2018) demonstrate that expectations of bubbles can vary as a function of forecast horizon. Although our analysis suggests that agricultural bankers expectations are not equilibrating in the short-run, we are unable to examine their longer-run expectations. The relatively short length of our single horizon may be particularly important for farmland price expectations given the thinness and periodicity of farmland market transactions. The relationship between expectation horizon and expectations formation is left for future research.

References

Bierlen, R., B. L. Dixon, B. L. Ahrendsen, and P. J. Barry (1998). Credit constraints, farm characteristics, and the farm economy: differential impacts on feeder cattle and beef cow inventories. *American Journal of Agricultural Economics 80*(4), 708–723.

Bierlen, R. and A. M. Featherstone (1998). Fundamental q, cash flow, and investment: Evidence from farm panel data. *The Review of Economics and Statistics 80*(3), 427–435.

Blanchard, O. J. and M. W. Watson (1982). Bubbles, rational expectations and financial markets.

Borchers, A., J. Ifft, and T. Kuethe (2014). Linking the price of agricultural land to use values and amenities. *American journal of agricultural economics 96*(5), 1307–1320.

Briggeman, B. C., M. A. Gunderson, and B. A. Gloy (2009). The financial health of agricultural lenders. *American Journal of Agricultural Economics 91*(5), 1406–1413.

Briggeman, B. C., C. A. Towe, and M. J. Morehart (2009). Credit constraints: their existence, determinants, and implications for us farm and nonfarm sole proprietorships. *American Journal of Agricultural Economics 91*(1), 275–289.

Brown, K. C. and D. J. Brown (1984). Heterogenous expectations and farmland prices. *American Journal of Agricultural Economics 66*(2), 164–169.

Brunnermeier, M. K. (2001). *Asset pricing under asymmetric information: Bubbles, crashes, technical analysis, and herding*. Oxford University Press on Demand.

Brunnermeier, M. K. (2008). Bubbles. In S. N. Durlauf and L. Blume (Eds.), *The new Palgrave dictionary of economics*. Palgrave Macmillan Basingstoke.

Bureau of Economic Analysis (2018). Personal Consumption Expenditures Price Index. Bureau of Economic Analysis, U.S. Department of Commerce, Washington DC.

Burt, O. R. (1986). Econometric modeling of the capitalization formula for farmland prices. *American journal of agricultural economics 68*(1), 10–26.

Carlson, J. A. and M. Parkin (1975). Inflation expectations. *Economica 42*(166), 123–138.

Case, K. E. and R. J. Shiller (2003). Is there a bubble in the housing market? *Brookings papers on economic activity 2003*(2), 299–362.

Chamberlain, G. (1980). Analysis of covariance with qualitative data. *Review of Economic Studies*, 225–238.

Chavas, J.-P. and A. Thomas (1999). A dynamic analysis of land prices. *American Journal of Agricultural Economics 81*(4), 772–784.

Clark, J. S., M. Fulton, and J. T. Scott Jr (1993). The inconsistency of land values, land rents, and capitalization formulas. *American Journal of Agricultural Economics 75*(1), 147–155.

Crouchley, R. (1995). A random-effects model for ordered categorical data. *Journal of the American Statistical Association 90*(430), 489–498.

De Fontnouvelle, P. and S. H. Lence (2002). Transaction costs and the present value "puzzle" of farmland prices. *Southern Economic Journal*, 549–565.

Driscoll, J. C. and A. C. Kraay (1998). Consistent covariance matrix estimation with spatially dependent panel data. *Review of economics and statistics 80*(4), 549–560.

Engsted, T. (1998). Do farmland prices reflect rationally expected future rents? *Applied Economics Letters 5*(2), 75–79.

Falk, B. (1991). Formally testing the present value model of farmland prices. *American Journal of Agricultural Economics 73*(1), 1–10.

Falk, B. and B.-S. Lee (1998). Fads versus fundamentals in farmland prices. *American Journal of Agricultural Economics 80*(4), 696–707.

Falk, B., B.-S. Lee, and R. Susmel (2001). Fads versus fundamentals in farmland prices: Reply. *American Journal of Agricultural Economics 83*(4), 1078–1081.

Featherstone, A. M. and T. G. Baker (1987). An examination of farm sector real asset dynamics: 1910–85. *American Journal of Agricultural Economics 69*(3), 532–546.

Featherstone, A. M. and T. G. Baker (1988). Effects of reduced price and income supports on farmland rent and value. *North Central Journal of Agricultural Economics 10*(2), 177–189.

Federal Reserve Bank of Kansas City (2018). Agricultural finance databook. Technical report.

Gürkaynak, R. S. (2008). Econometric tests of asset price bubbles: taking stock. *Journal of Economic surveys 22*(1), 166–186.

Gutierrez, L., J. Westerlund, and K. Erickson (2007). Farmland prices, structural breaks and panel data. *European Review of Agricultural Economics 34*(2), 161–179.

Hanson, S. D. and R. J. Myers (1995). Testing for a time-varying risk premium in the returns to us farmland. *Journal of Empirical Finance 2*(3), 265–276.

Harrison, J. M. and D. M. Kreps (1978). Speculative investor behavior in a stock market with heterogeneous expectations. *The Quarterly Journal of Economics 92*(2), 323–336.

Hart, C. E. and S. H. Lence (2004). Financial constraints and farm investment: A bayesian examination. *Journal of Business & Economic Statistics 22*(1), 51–63.

Hong, H. and J. C. Stein (1999). Differences of opinion, rational arbitrage and market crashes. Technical report, National bureau of economic research.

Irwin, S. H. and P. L. Colling (1990). Are farm asset values too volatile? *Agricultural Finance Review 50*, 58–65.

Kiyotaki, N. and J. Moore (1997). Credit cycles. *Journal of political economy 105*(2),

211–248.

Kuethe, T. H. and T. Hubbs (2017). Bankers' forecasts of farmland values: a qualitative and quantitative evaluation. *Journal of Agricultural and Applied Economics 49*(4), 617–633.

Kuethe, T. H. and J. Ifft (2013). The information content of farmland value surveys. *Agricultural Finance Review 73*(1), 45–57.

Lahiri, K. and Y. Zhao (2015). Quantifying survey expectations: A critical review and generalization of the carlson–parkin method. *International Journal of Forecasting 31*(1), 51–62.

Lavin, A. M. and T. S. Zorn (2001). Empirical tests of the fundamental-value hypothesis in land markets. *The Journal of Real Estate Finance and Economics 22*(1), 99–116.

Lence, S. H. (2001). Farmland prices in the presence of transaction costs: A cautionary note. *American Journal of Agricultural Economics 83*(4), 985–992.

Lence, S. H. and D. J. Miller (1999). Transaction costs and the present value model of farmland: Iowa, 1900–1994. *American Journal of Agricultural Economics 81*(2), 257–272.

Lloyd, T. et al. (1994). Testing a present value model of agricultural land values. *Oxford Bulletin of economics and statistics 56*(2), 209–223.

Miller, E. M. (1977). Risk, uncertainty, and divergence of opinion. *The Journal of finance 32*(4), 1151–1168.

Nardo, M. (2003). The quantification of qualitative survey data: a critical assessment. *Journal of economic surveys 17*(5), 645–668.

Nerlove, M. and D. A. Bessler (2001). Expectations, information and dynamics. In B. L. Gardner and G. C. Rausser (Eds.), *Handbook of agricultural economics*, Volume 1, pp. 155–206. Elsevier.

Newey, W. K. and K. D. West (1987). A simple, positive semi-definite, heteroskedasticity and autocorrelationconsistent covariance matrix. *Econometrica 55*(3), 703.

Nickerson, C., M. Morehart, T. Kuethe, J. Beckman, J. Ifft, and R. Williams (2012). Trends in us farmland values and ownership. Technical report, Economic Information Bulletin Number 92, United States Department of Agriculture, Economic Research Service, Washington, DC.

Nickerson, C. J. and W. Zhang (2014). Modeling the determinants of farmland values in the united states. In J. Duke and J. Wu (Eds.), *The Oxford Handbook of Land Economics*. Oxford: Oxford University Press.

Olsen, B. C. and J. R. Stokes (2015). Is farm real estate the next bubble? *The Journal of Real Estate Finance and Economics 50*(3), 355–376.

Pesaran, M. H. (1984). Expectations formations and macroeconomic modelling. In P.-A. Muet and P. Malgrange (Eds.), *Contemporary Macroeconomic Modelling*. Blackwell.

Pesaran, M. H. (1987). *The limits to rational expectations*. Basil Blackwell.

Pesaran, M. H. and I. Johnsson (2018). Double-question survey measures for the analysis of financial bubbles and crashes. *Journal of Business & Economic Statistics* (just-accepted).

Pesaran, M. H. and M. Weale (2006). Survey expectations. In G. Elliott, C. Granger, and A. Timmermann (Eds.), *Handbook of economic forecasting*, Volume 1, pp. 715–776. Elsevier.

Power, G. J. and C. G. Turvey (2010). U.S. rural land value bubbles. *Applied Economics Letters 17*(7), 649–656.

Riedl, M. and I. Geishecker (2014). Keep it simple: estimation strategies for ordered response models with fixed effects. *Journal of Applied Statistics 41*(11), 2358–2374.

Roche, M. J. (2001). Fads versus fundamentals in farmland prices: comment. *American Journal of Agricultural Economics 83*(4), 1074–1077.

Scheinkman, J. A. and W. Xiong (2003). Overconfidence and speculative bubbles. *Journal of Political Economy 111*(6), 1183–1220.

Schmitz, A. (1995). Boom/bust cycles and ricardian rent. *American Journal of Agricultural Economics 77*(5), 1110–1125.

Shiller, R. J. (2000). Measuring bubble expectations and investor confidence. *The Journal of Psychology and Financial Markets 1*(1), 49–60.

Tegene, A. and F. R. Kuchler (1991). A description of farmland investor expectations. *The Journal of Real Estate Finance and Economics 4*(3), 283–296.

Tegene, A. and F. R. Kuchler (1993). Evidence on the existence of speculative bubbles in farmland prices. *The Journal of Real Estate Finance and Economics 6*(3), 223–236.

Theil, H. (1952). On the time shape of economic microvariables and the munich business test. *Revue de l'Institut International de Statistique*, 105–120.

Theil, H. (1955). Recent experiences with the munich business test: An expository article. *Econometrica*, 184–192.

Tirole, J. (1982). On the possibility of speculation under rational expectations. *Econometrica: Journal of the Econometric Society*, 1163–1181.

USDA Economic Research Service (2017). 2017 Farm Sector Balance Sheet. United States Department of Agriculture, Economic Research Service, Washington, DC.

Weersink, A., S. Clark, C. G. Turvey, and R. Sarker (1999). The effect of agricultural policy on farmland values. *Land Economics*, 425–439.

Winkelmann, L. and R. Winkelmann (1998). Why are the unemployed so unhappy? evidence from panel data. *Economica 65*(257), 1–15.

Zakrzewicz, C., B. Wade Brorsen, and B. C. Briggeman (2012). Comparison of alternative sources of farmland values. *Agricultural Finance Review 72*(1), 68–86.