AN ANALYSIS OF FARMLAND OPTION VALUE: ASCERTAINING THE NATURE OF THE RECENT FARMLAND BUBBLE PHENOMENON

by

BINGBING WANG

(Under the Direction of Cesar Escalante)

ABSTRACT

We conduct models and tests to explore whether there are speculative "bubbles" and which factors contribute to the bubbles if there exits one. In the model, the option value is defined as the investment uncertainty value of farmland. The actual farmland market value and the farmland true value which includes the option value plus the present value are compared to determine whether there is a speculative "bubble". In the test, we conduct robust regression analysis to ascertain the factors that contribute to the "bubble". The result shows that there are two major speculative "bubbles" from 1976 to 1983 and 2003 to 2011 in the State of Iowa with the data from 1950 to 2011. The factors contributing to the "bubble" are corn price value, farm debt to asset ratio, direct government payment, net farm income and its percentage change, farmland market value percentage change, urban land to total land ratio and production cost.

INDEX WORDS: farmland value, speculative bubble, contributing factors, option value

AN ANALYSIS OF FARMLAND OPTION VALUE: ASCERTAINING THE NATURE OF THE RECENT FARMLAND BUBBLE PHENOMENON

by

BINGBIGN WANG

B.A., RENMIN UNIVERSITY, China, 2007

M.S., RENMIN UNIVERSITY, China, 2009

A Dissertation Submitted to the Graduate Faculty of The University of Georgia in Partial Fulfillment of the Requirements for the Degree

MASTER OF SCIENCE

ATHENS, GEORGIA

2013

AN ANALYSIS OF FARMLAND OPTION VALUE: ASCERTAINING THE NATURE OF THE RECENT FARMLAND BUBBLE PHENOMENON

by

BINGBING WANG

Major Professor: Cesar Escalante

Committee: Glenn Ames
Michael E. Wetzstein

Electronic Version Approved:

Maureen Grasso
Dean of the Graduate School
The University of Georgia
August 2013

DEDICATION

Dedicated to my parents, Guohua Feng and Zekun Wang, and my beloved Shi Guo, for their love and support.

ACKNOWLEDGEMENTS

I will thank Dr. Escalante, Dr. Wetzstein and Dr. Ames for their kindly support and contributions to this study.

TABLE OF CONTENTS

Page

LIST OF TABLES

Page

LIST OF FIGURES

Page

CHAPTER 1

INTRODUCTION

1.1 BACKGROUND

The recent unusual appreciation of farmland market values in the central corn-growing region of the United States, including Illinois and Iowa, has drawn considerable interest and concern among both investors and analysts. In Iowa, farmland market values jumped by 18.3% in 2012 compared with a year earlier, according to U.S. Department of Agriculture. Figure 1.1 below presents a longitudinal dataset of Iowa farmland market values from 1930 to 2011 detailing the fluctuation of the inflation adjusted farmland market value and its percentage changes over the time period. The plot trends indicate that the real farmland market values experienced episodes of bust and boom from 1976 to 1983. After 1983, the market values have started to accelerate, a trend that persists until the current year. Interestingly, the current farmland market value has by far surpassed the historical highest level achieved before.

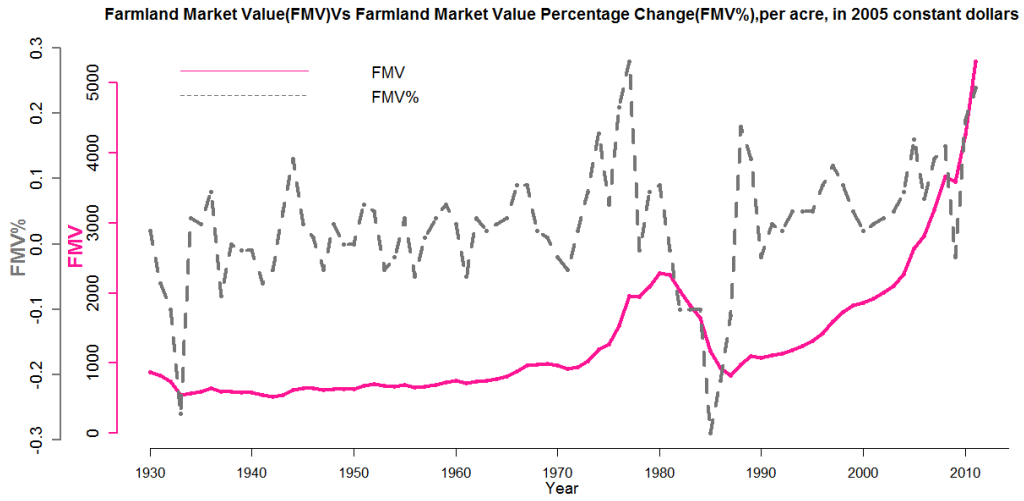

Figure 1.1: Farmland Market Value and Farmland Market Value Percentage Change, Annually, 1930-2011

Source: Economics Research Service, USDA

From the perspective of investors contemplating farmland as an investment, the growth rates in farmland market values have been consistently positive (except in 2009 when the growth rate is -1.97%) since 2001. Apart from that, the annual growth rate is steadily ascending from a level of 3.24% in 2001 to a level of 24.49% in 2011, except for the year 2006 when the rate drops suddenly from 16.20% in 2005 to 6.58%. The average annual growth rate from 2001 to 2011 is 10.25%, which quite surpasses the 4.56% average rate recorded from 1984 to 2011.

The spectacular farmland market value appreciation in recent years has stimulated discussions and debates regarding the possibility of an ensuing farmland price "bubble." Certain analysts are focused on discerning the nature of the price "bubble" – specifically zeroing in on the idea of whether there is a speculative "bubble" or not in the first place. This question relies on whether the appreciation in farmland market values is caused mainly by speculative forces instead of fundamental determinants. According to Murray Wise Associates in Clarion, for the past three years, 91% of the 17,960 acres of land, or 16,340 acres, are sold to investors. Notably,

66% of those acres were leased back to the previous owner (Murray Wise Associates, 2010). Evidence like this would raise the question of whether speculation indeed has been the main driving force for the current appreciation of farmland market values in the Midwest.

Economists' opinions about this speculative bubble issue are quite varied. Mike Duffy of Iowa State University Extension contends that high commodity prices will entice more corn and soybean farmers to increase production. Therefore, there will be a slow decline of the farmland market values in the next several years (Duffy, 2012). In other words, his opinion is that the farmland market value appreciation is driven by the high prices of corn and soybean and thereby its growth rate can be moderated by farmers' decisions to preserve their farmland property holdings in order to continue with their profitable farming operations revolving on the production of the two highly lucrative commodities – corn and soybeans. His general contention is that the "bubble" is not of a speculative nature and is of no harm.

However, Michael Swanson, an agricultural economist at Wells Fargo in Minneapolis, holds a different opinion on this issue. He raises the question "Where does the mania stop?" His views support the idea that all the recent farmland market value appreciation is a mere sudden phenomenon, indicating that the "bubble" is of a speculative nature and can possibly burst just suddenly (Berry, 2012).

1.2 OBJECTIVES AND LITERATURE REVIEW

The purpose of this study is to determine the incidence of speculative "bubbles" in recent farmland market values and further identify factors that significantly perpetuate such speculative "bubble(s)." In order to better understand the nature of a catastrophically speculative "bubble," a basic understanding of the "bubble" phenomenon needs to be clarified at first.

First of all, a "bubble" refers to a situation where the valuation of a certain asset is increasing rapidly at an unsustainable rate such that the expectation is that the asset value will eventually decline at a later point in time. In the literature, there is no commonly accepted method in the characterization of "bubbles." Most economists will characterize a "bubble" by such standards that the market value deviates from the asset fundamental or rational value (Stiglitz, 1990; Malkiel, 2010).

In identifying the usual components of a real property's fundamental value, the first candidate is the property's present value of cash flows. The present value of the future cash flows calculated with the appropriate discount rate is the traditional way of pricing farmland (Baker al., 1991). However, it has been established in several empirical studies that the present value of the cash flows generated from the asset is unable to fully explain the asset market value (Burt, 1986, Featherstone and Baker, 1987, and Hanson and Meyers, 1995). Researchers are unable to show a correlation between present value of cash flows from farm operation and the market value of farmland (Weersink et al., 1999).

Featherstone and Baker (1987) contend that the deviations are heavily dependent on speculative forces. To quantify the speculative forces, farmland price is decomposed into a fundamental value and a speculative value (Featherstone and Baker, 1987; Falk and Lee, 1996). Consequently, a tri-variate vector auto-regression model is employed to analyze the impulse response and to identify the fad component of the price. The vector auto-regression model is also a method for testing the present value model for the valuation of farmland (Campbell and Shiller, 1987). However, this model is more appropriate for estimating the response of farmland prices to non-fundamental shocks rather than measuring the exact numeric farmland market value driven by the speculative forces.

Nevertheless, the exact numeric value is a more direct way for the identification of the speculative "bubble" as well as the analysis of the contributing factors. In addition, the uncertainty value will be introduced into the fundamental value, which already includes the present value of the cash flows. This study contends that the speculative forces stem from the uncertainties of the farmland market value. However, the vector auto-regression model cannot account for the investment uncertainties of the asset. Correspondingly, an option pricing model with an investment perspective is adopted in this paper for the analysis of farmland speculative "bubbles". This method can view the farmland's true value as a sum of the present value of the cash flows and the option value. Additionally, the exact numeric value of the farmland can be provided with the option pricing method.

Dixit and Pindyck (1994) describe the option pricing method for the valuation of the asset investment value in their book, Investment under Uncertainties. It is stated that when investors make their portfolio decisions, there is no certain knowledge on the future appreciation or depreciation of the asset value. Thus, there is an opportunity cost to investing at the time the decision is being made (McDonald and Siegel, 1986; Dixit and Pindyck, 1994; Turvey, 2011; Stokes and Cox, 2012). This opportunity cost can be considered as the value of the uncertainties of investing today and should be included as part of the fundamental values. In a farmland investment decision, therefore, the present value of cash flows plus the uncertainty value is the true value that can be obtained from the investment.

In this study, the net rent to the non-operators as the cash flows generated from the farmland is used to represent the present value of farmland. For the uncertainty value, the management of the farm has the option to capitalize on the upside profit or to avoid the downside loss (Trigeorgis, 1993). This option can be materialized by considering farmland as the

underlying asset that generates steady cash flows (Trigeorgis, 1993). The more volatile the value of the underlying asset, the higher the option value is. This volatility leads to the wedge between the present value of expected cash flows and the farmland market value. Equivalently, if uncertainty is factored into the present value calculation of the expected cash flows, there will be no need for the option value. However, the basic thought is obviously of no difference. To this end, this analysis adopts the stance that fundamental values are determined by the present values plus the effect of uncertainty.

The uncertainties or the volatility in the farmland market value can be attributed to the following factors: the volatilities of the crop values and interest rate, the possibility to convert the farmland to urban uses (Isgin and Forster, 2006), new cost-reducing technologies, free trade agreements, biotechnologies and pharmaceuticals, unfound nutritional values (Turvey, 2002), government support such as agricultural insurance program (Goodwin et al., 2003).

Consequently, from the discussions above, the fundamental value and the speculative force-driven value, the irrational value, altogether constitute the whole farmland market value. Speculative forces are construed as the investors' expectation that the price will not fall. The beliefs that the price will not decline and that there will always be a buyer willing to pay a higher price are the only support for the irrational values. This expectation is related or partially caused by investment uncertainties that may drive the asset to appreciate or depreciate. Because the irrational value is purely supported by investors' expectation, the speculative force-driven appreciation is not sustainable and therefore devastatingly destructive when, at a certain point, the speculative "bubbles" could suddenly burst when investors' expectations can unexpectedly disappear or change.

As this study is generally designed to identify the speculative "bubbles," its framework is specifically developed to ascertain whether the irrational component of the farmland market value is positive or not. The framework is based on the efficient market hypothesis (EMH) that claims that financial markets are informationally efficient. Thus, under this assumption, the commodity price will reflect all market information. We take this concept into the farmland market and claim that if the market efficiency holds, the farmland price will reflect the complete market information. Accordingly, the price will represent both the fundamental value and the irrational value so that these components can be decomposed or deducted from the price information and analyze the market value in this manner. The framework we adopt for identifying the bubble is to price the option value first and then calculate the deviation between the farmland market value and the fundamental values. A speculative "bubble" exists if such deviation is positive.

After confirming the incidence of a "bubble," the "bubble's" explanatory factors are then analyzed in terms of the significance of their influence on the "bubble" phenomenon. The contributing factors and their effects on the ratio between the farmland market value and the farmland fundamental value (which shall be referred to as the farmland true value throughout this paper) will be analyzed in this study.

For the contributing factors, the 2012 Farmland Value Survey from Iowa State University (Michael Duffy, 2012) listed several major positive and negative factors associated with farmland valuation. In that list, there are six positive factors identified by over 10% of the respondents.[1] Eighty percent of the respondents mentioned high commodity prices, while 63% mentioned low interest rates. Others cited cash or credit availability (15%), good return to land

[1] The survey is based on reports by licensed real estate brokers and selected individuals considered to be knowledgeable of land market conditions. Respondents were asked to report on more than one county if they were knowledgeable about the land markets. The 2012 survey is based on 486 usable responses, providing 663 county land values estimates.

(14%), lack of other investments (12%), and land availability (10%). The respondents also identified the following negative factors: weather (43%), far too high values or a speculative "bubble" (18%), politics (18%), high input costs (15%), poor yields (14%) and overall economic conditions (13%).

Several empirical studies have already analyzed the importance of some of the factors listed above. Henderson and Gloy (2009) found that the recent high farmland market values are related to the higher crop prices and the translation time from the crop price to the farmland market value is quite short. In terms of the farm income and interest rate, studies have shown that farmland market values rise along with returns to farm and decrease as interest rates increase (Alston, 1986; Burt, 1986; Featherstone and Baker. 1987; Just and Miranowski 1993). The interest rate is considered important due to its effect on the discount rate used in farmland present value calculation (Gloy, 2012). Credit availability has also been found to be an important contributing factor as it has been shown that when the supply of credit to farmers increases, farmland market values will increase faster than if no credit was available (Shalit and Schmitz, 1982). For direct government payment, research has shown that the availability of government support programs tends to be associated with increasing farmland market values (Barnard et al., 1997; Featherstone and Baker, 1988; Herriges, et al., 1992).

While these are interesting and useful findings, most of these studies, however, are focused mostly on the factors' effect on farmland market values. The effects of such factors on farmland price "bubble" remain to be determined.

1.3 ORGANIZATION OF THE STUDY

The initial section of this thesis is devoted to laying the foundation for this study's analytical framework, i.e. to first find the farmland true value with the option pricing method and

then conduct robust regression to analyze the contributing factors. The other sections of this paper will be organized as follows: Chapter 2 will discuss data and method used for pricing the option value of farmland as well as the robust regression; Chapter 3 will present the pricing and regression results that identify periods when speculative "bubbles" are identified and factors that influence the incidence of such speculative "bubbles;" Chapter 4 will present the conclusions and discussions, where implications, limitations, and possible future research are provided.

CHAPTER 2

DATA AND METHOD

2.1 DATA FOR OPTION PRICING

This study utilizes Iowa farmland data since Iowa is one of the states that have one of the highest growth rates in farmland market values, not only in the Midwest but among all states in the country. Moreover, the Iowa farmland market is least influenced by the effect of rural land conversion. Given such consideration, the probable contributors to the "bubble" will be more accurately identified without the influence from urbanization. The Iowa farmland market value data are available at annual state-level on a per acre valuation basis from 1950 to 2011 totaling 62 observations. The farm rent data are the net farm rent to the non-operators per acre from 1950 to 2011. The data are both adjusted by the deflator to the constant 2005 dollars and are obtained from the USDA U.S. and State Farm Income and Wealth Statistics data set.

2.2 METHOD FOR OPTION PRICING

The objective of this thesis is to analyze trends in the actual farmland market values and determine whether the deviation between the market value and the true (fundamental) value is rational or explainable. First, as shown in Figure 2.1, there is a wedge between the actual market value and the present value. In this analysis, the net rent to the non-operators is used to represent cash flows generated from the farm.

At certain time point t, let PV(t) denote the farmland present value of cash flows, R(t) as the net rent of the farm to the non-operators, and δ as the capitalization rate with $\delta = \rho - \alpha$,

where ρ represents the appropriate discount rate and α is the farmland true value (V) growth rate. We will calculate the PV (t) of the farmland from the following:

$$PV(t) = \frac{R(t)}{\delta} \tag{1}$$

After comparing PV (t) with the actual farmland market value, it is expected that a wedge will be observed in most of the years from 1950 to 2011 as illustrated in the plots below:

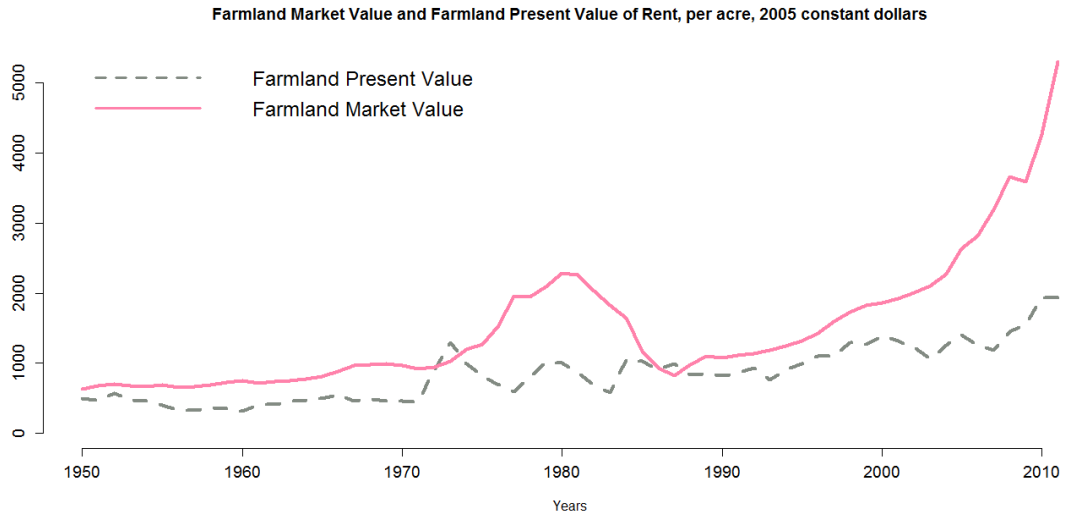

Figure 2.1: Farmland Market Value and Farmland Present Value of Rent, Annually, 1950-2011

Source: Economics Research Service, USDA

The wedge stems from the uncertainty associated with the possibilities for the farmland market value to either appreciate or depreciate in the future. This means that when an investor decides to purchase a farm property, he/she pays the price that includes the present values of the farm rent as well as the uncertainty value with the assumption that the uncertainty values are all assumed by the buyer. Therefore, in order to explain the wedge in this analysis, the uncertainty value will be calculated under the option pricing method. In this way, the actual farmland market value can be construed as being the sum of the irrational value and the farmland true value (V) that includes the present value (PV) and the uncertainty value.

To better understand and calculate this uncertainty value, consider the concept of opportunity cost for the investor. At a certain point of time T_0, the investor is faced with the decision of whether to invest in the farm or not. The traditional decision rule is to weigh the investment cost and the present value of the farmland. The investment cost is the market value of the farmland. The problem for the investor is to maximize the profit obtained, i.e. the farmland true value minus the investment cost. If he/she decides to make the investment at once, there is an opportunity cost for the investor to invest today if the true value of the farmland will increase in the future. Therefore, the simple present value rule will not efficiently solve the problem. The growth in the farmland true value creates an option value for the investor to wait. The option value can be considered as a call option, the right rather than the obligation to invest at some time. If condition permits, the most advantageous scenario for the investor is for him/her to wait until the optimal true value, V*, of the project is reached at time T*. This V* should be larger than V_0 and PV. Therefore, the problem for the investor is to decide the time point at which it is optimal for the investor to invest in the farm.

Assume that the farmland true value V follows the following geometric Brownian motion:

$$d\,V/V = \alpha dt + \sigma dz \qquad (2)$$

Parameters α and σ are the growth rate and volatility of V, respectively. The problem is to find the optimal T* by maximizing the net pay off (V−P), which is equivalent to maximizing (V−PV) since P and PV are known. Additionally, when an investment decision is made, the true value of the farm, V, can be decomposed into PV and the uncertainty value: an option value F (V).

True Value= Present Value + Option Value or Uncertainty Value

$$V = PV + F(V)$$

Then, this calls for the maximization of the option value F(V). F(V) exists because $\alpha > 0$ and $\sigma > 0$ with F(V) an increasing function of α and σ.

At this point, the option value F(V) will be solved. During the continuation region, time period from T_0 till the optimal T*, the Bellman equation is:

$$\rho F(V)dt = E[dF(V)] \tag{3}$$

This equation suggests that during the time interval dt, the total expected return on the farm investment, $\rho F(V)dt$, is equal to its expected rate of capital appreciation.

Using Ito's Lemma, the following result is obtained:

$$dF(V) = F'(V)dV + \frac{1}{2}F''(V)(dV)^2$$

Substituting $dV = V\alpha dt + V\sigma dz$ in the equation above results in the following:

$$E[dF(V)] = \alpha V F'(V)dt + \frac{1}{2}\sigma^2 V^2 F''(V)dt$$

With $E[dz] = 0$

When, the above equation is divided by dt, then the Bellman equation becomes:

$$\frac{1}{2}\sigma^2 V^2 F''(V) + \alpha V F'(V) - \rho F(V) = 0 \tag{4}$$

With $\delta = \rho - \alpha$, equation (4) becomes:

$$\frac{1}{2}\sigma^2 V^2 F''(V) + (\rho - \delta) V F'(V) - \rho F(V) = 0 \tag{5}$$

Before F(V) is obtained, there are three boundary conditions for F(V) to satisfy:

$$F(0) = 0 \tag{6}$$

$$F(V^*) = V^* - PV \tag{7}$$

$$F'(V^*) = 1 \tag{8}$$

Condition (6) is necessary to establish the condition that when the true value of the farmland is zero, the option value is zero as well, meaning there will be no option value for the investment of the farmland. Condition (7) is the value matching condition that captures the condition that when the investment takes place, the true value of the farm V* is equal to the sum of the PV and the option value F(V*). Condition (8) is the "smooth-pasting" condition. It requires F(V) to be continuous and smooth at the critical value V*. Then equation (5) can be solved subject to the conditions (6)-(8).

A solution is of the form:

$$\mathrm{F}(V) = AV^{\beta_1} \tag{9}$$

$$V^* = \frac{\beta_1}{\beta_1 - 1}\mathrm{PV} \tag{10}$$

$$\mathrm{A} = \frac{(V^* - PV)}{(V^*)^{\beta_1}} = \frac{(\beta_1 - 1)^{\beta_1 - 1}}{\beta_1^{\beta_1} PV^{\beta_1 - 1}} \tag{11}$$

$$\beta_1 = \frac{1}{2} - \frac{(\rho - \delta)}{\sigma^2} + \sqrt{[\frac{(\rho - \delta)}{\sigma^2} - \frac{1}{2}]^2 + \frac{2\rho}{\sigma^2}} \tag{12}$$

With this method, the farmland true value (V) will be calculated and compared with the farmland market value to determine whether a speculative "bubble" exists. Below are the numeric values assigned to the parameters in the farmland true value calculation:

Table 2.1: Parameter Values

Parameters	Value	Description
α	Time varying	Calculated as the annual percentage change rate of the actual farmland market value
σ	0.0963	Calculated as the standard deviation of the actual farmland market value
δ	0.0343	Taken from the empirical result
ρ	0.05	Taken from the empirical result

2.3 REGRESSION ANALYSIS

A regression model is developed to identify factors that can explain the deviation between farmland market value and farmland true value. As discussed earlier in Chapter 1, the following contributing factors are considered in this study. Table 2.2 presents the descriptive statistics of these variables:

Table 2.2: Regression Variables Description

Variable	Label	Mean	Standard Deviation
CorPriCha	Corn Price Percentage Change	0.0138	0.1931
CorPriVol	Corn Price Volatility	0.1956	0.1489
CornPri	Corn Price, per bushel, in 2005 dollars	3.0107	0.9431
DGPCha	Direct Government Payment Percentage Change	0.0508	0.7345
Debt_Asset	Debt with Asset Ratio, US	0.1543	0.0265
DirGovPay	Direct Government Payment, per acre, in 2005 dollars	24.0869	18.1493
IntRate	3-Month Treasury Bill: Secondary Market Rate	0.0513	0.0286
NFICha	Net Farm Income Percentage Change	0.0359	0.6413
NetFarInco	Net Farm Income, per acre, in 2005 dollars	79.8382	50.9034
PopCha	Population Percentage Change	0.00224	0.00544
FMVCha	Farmland Market Value Change	0.0382	0.1025
UrbanLand_Tota	Urban Land with Total Land Ratio	0.0166	0.00345
ProCost	Total Production Expenses, per acre, in 2005 dollars	328.2	114.8
Ratio	The Ratio of Farmland Market value Divided by Farmland True Value Minus 1	0.0212	0.3316

Note: there were 52 annual observations in the estimation.

Corn price data are obtained from the USDA Economic Research Service Season-Average Price Forecasts data set. Interest rate represents the possible payoffs of alternative investment opportunities and the data are obtained from the Federal Reserve Bank of St. Louis. Debt to asset ratio, denoting the relative amount of credit available to the farm, is the debt cost divided by the asset value. If the credit is in favor of the farm with a low lending rate, the debt cost will be relatively low compared to the asset value. In this manner, the debt to asset ratio shall be relatively small. The debt-to-asset ratio data are obtained from the USDA Farm Business

Balance Sheet data set. Production cost data come from the USDA Total Production Expenses (including operator dwellings) data set. The population percentage change information is taken from the Federal Reserve Bank of St. Louis. Net farm income values are collected by the USDA, U.S. and State Farm Income and Wealth Statistics data set. The urban land to total land ratio represents the farmland supply and the urbanization trend. This ratio is included in the USDA Economic Research Service Major Land Uses data set. All datasets are collected at the state-level for Iowa except Debt_Asset which is for the U.S. and is used to approximate the debt to asset ratio in Iowa, this study's sample state, and result in 52 annual observations from 1960 to 2011.

In determining the nature of speculative bubbles, the following norm is used: if the dependent variable, Ratio, is positive, then there is a deviation as well as an irrational "bubble," which is not explained by the farmland true value. Below is a plot of the Ratio values from 1960 to 2011. There are two obvious deviations of the farmland market value from the true value: 1976-1983 and 2003-2011. The latter is different from the former one both in size and durations. The former one is larger in size and possibly shorter in length. The exact size and duration time will be provided in the result section.

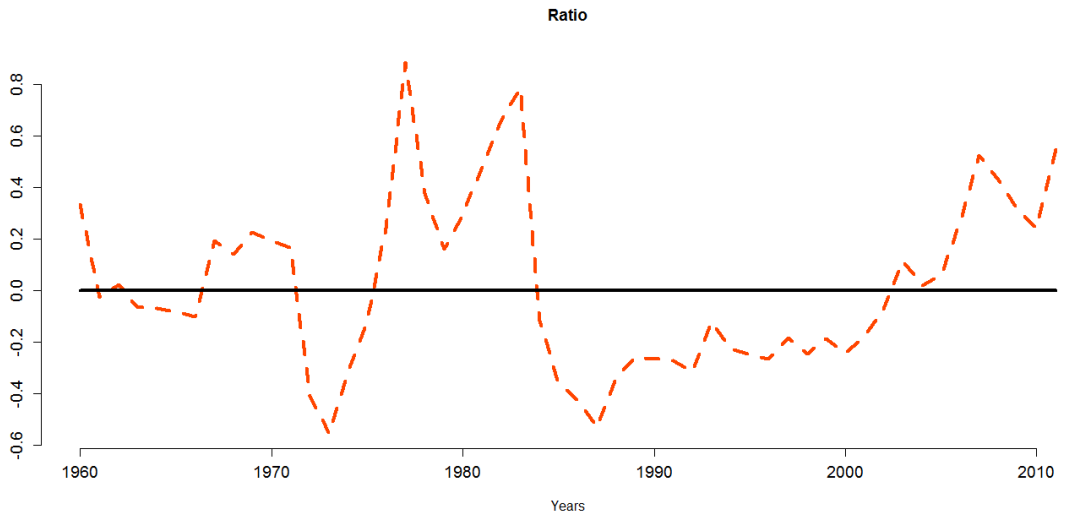

Figure 2.2: Ratio [(Farmland Market Value/Farmland True Value)-1], 1960-2011

As can be gleaned from Figure 2.2, Ratio is larger in the 1980s and in the current years (2005-2011). Thus when Ratio is large, the farmland market value is much higher than the farmland true value. Therefore, the market value is not fully explained by the true value. In other words, there may be a speculative "bubble" in that the farmland market value is larger than the farmland true value and the irrational portion of the farmland market value is positive. Next, we will try to explain which factors may contribute to the deviation between the two values and also to estimate their coefficients on Ratio. The robust regression model is defined as follows[2]:

$$\begin{aligned}\text{Ratio} = {} & \beta_0 + \beta_1 \times \text{CorPriCha} + \beta_2 \times \text{CorPriVol} + \beta_3 \times \text{CornPri} + \beta_4 \times \text{DGPCha} \\ & + \beta_5 \times \text{Debt\_Asset} + \beta_6 \times \text{DirGovPay} + \beta_7 \times \text{IntRate} + \beta_8 \times \text{NFICha} + \beta_9 \times \text{NetFarInco} \\ & + \beta_{10} \times \text{PopCha} + \beta_{11} \times \text{FMVCha} + \beta_{12} \times \text{UrbanLand\_Tota} + \beta_{13} \times \text{ProCost} + \varepsilon\end{aligned}$$

CornPri is the corn price per bushel. CorPriCha reprents the corn price percentage change from last year. CorPriVol is employed to represent the corn price volatility which is calculated as below where P_i is the corn price of period i and n is the total number of periods:

$$u_i = \ln\left(\frac{Pi}{P_{i-1}}\right)$$

$$\sigma = \sqrt{\frac{1}{n-1}\sum\left(u_i - \bar{u}\right)^2}$$

DirGovPay is the direct government payment per acre. DGPCha is used to act as the direct government payment percentage change from the year before. Direct government payment includes payments for commodity programs such as direct payments, counter-cyclical payment, and marketing loan benefits (marketing loan gains, loan deficiency payments, and certificate gains). Other payments included are emergency and disaster payments, tobacco transition payments, and conservation program payments.

[2] The model is tested for residue normality and multicollinearity.

Debt_Asset is described as the ratio of debt cost to asset value. This variable is associated with the relative cost of the debt to asset value. The debt source ranges from the farm credit system, farm service agency, commercial banks, life insurance companies, storage facility loans, individuals and others.

IntRate is the 3-month Treasury bill rate of the secondary market. NFICha represents the net farm income percentage change from the last year. NetFarInco is the net farm annual income per acre. PopCha is the Iowa State population percentage change from last year. FMVCha represents the annual farmland market value percentage change. UrbanLand_Tota is the variable specified as the urban land to total land ratio. Finally, ProCost is the production cost per acre associate with the farm operation. All the data for the variables are for the State of Iowa except Debt_Asset which is for the U.S.

CHAPTER 3

RESULT

3.1 THE OPTION PRICING RESULT

The farmland true value is calculated as the sum of the option value and the present value of the farm rent. The option value is calculated using the procedures outlined in the methodology discussion. For the calculation of the present value, the capitalization rate and discount rate are taken from the empirical result (Gloy, Hurt, Boehlje and Dobbins, 2011). Table 3.1 and Figure 3.1 present the results of these calculations:

Table 3.1: Farmland Values and Ratio

Year	Farmland Market Value	Farmland True Value	Ratio
1950	633.3097	868.6778	-0.27095
1951	671.1891	840.0697	-0.20103
1952	701.9514	1008.079	-0.30367
1953	674.8296	824.5838	-0.18161
1954	661.5215	812.9543	-0.18627
1955	690.0303	703.8377	-0.01962
1956	658.5581	577.2219	0.14091
1957	662.5097	582.6578	0.137048
1958	688.9764	638.4356	0.079163
1959	729.9055	620.4955	0.176327
1960	752.9591	565.0076	0.332653
1961	713.107	732.0706	-0.0259
1962	739.5186	722.3772	0.023729
1963	754.3389	808.3624	-0.06683
1964	776.9438	833.7699	-0.06816
1965	808.7425	879.639	-0.0806
1966	885.4107	985.7795	-0.10182
1967	963.7078	807.7646	0.193055
1968	982.0804	860.6772	0.141055
1969	987.0546	806.3527	0.224098
1970	967.1609	811.1124	0.192388
1971	923.7222	792.6433	0.165369
1972	943.6758	1601.34	-0.4107
1973	1022.827	2291.562	-0.55366
1974	1195.004	1750.654	-0.3174

Table 3.1 Continued			
1975	1265.043	1428.321	-0.11431
1976	1533.64	1215.294	0.26195
1977	1964.333	1042.439	0.884363
1978	1946.305	1412.78	0.377642
1979	2096.323	1805.981	0.160767
1980	2286.822	1767.244	0.294005
1981	2265.695	1529.571	0.481262
1982	2029.241	1225.631	0.655671
1983	1825.316	1022.192	0.785689
1984	1649.076	1866.646	-0.11656
1985	1176.055	1820.592	-0.35403
1986	925.3549	1607.792	-0.42446
1987	825.8845	1764.266	-0.53188
1988	973.3285	1475.139	-0.34018
1989	1102.319	1489.522	-0.25995
1990	1076.671	1464.919	-0.26503
1991	1107.934	1520.659	-0.27141
1992	1130.98	1649.325	-0.31428
1993	1187.071	1350.923	-0.12129
1994	1247.661	1614.766	-0.22734
1995	1313.089	1746.763	-0.24827
1996	1426.997	1943.247	-0.26566
1997	1594.801	1957.082	-0.18511
1998	1732.484	2298.633	-0.2463
1999	1819.987	2242.583	-0.18844
2000	1860.465	2454.038	-0.24188
2001	1920.741	2337.536	-0.17831
2002	2002.315	2161.499	-0.07364
2003	2105.351	1886.998	0.115715
2004	2271.859	2226.963	0.02016
2005	2640	2491.898	0.059433
2006	2813.633	2221.276	0.266674
2007	3189.929	2094.121	0.523278
2008	3667.016	2565.334	0.42945
2009	3594.704	2736.623	0.313555
2010	4264.837	3433.3	0.242198
2011	5309.289	3425.046	0.550137

In Table 3.1, the years marked in bold are the years when the farmland market value is larger than the farmland true value. These are the years when a speculative "bubble" is suspected to have occurred.

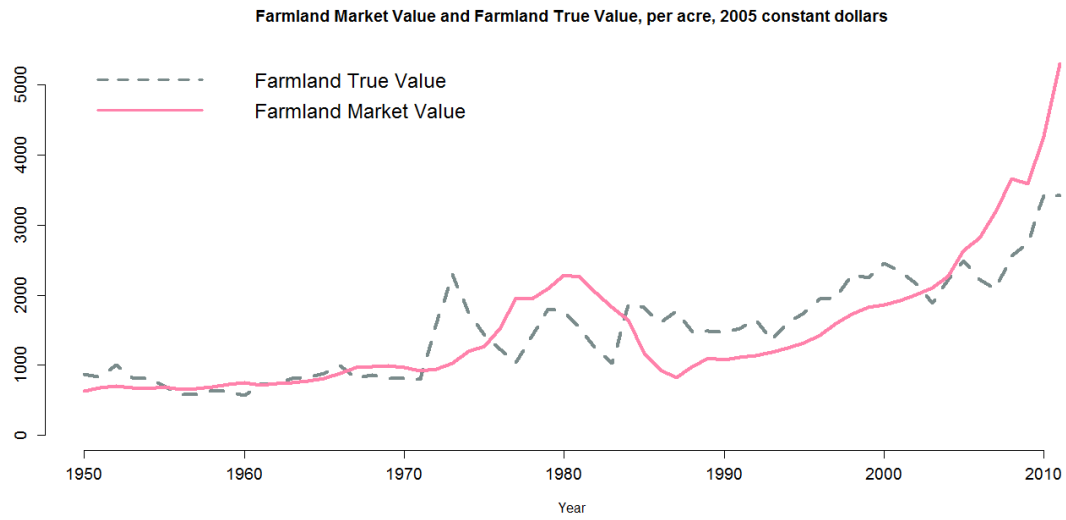

Figure 3.1: Farmland Market Value and Farmland True Value, Annually, 1950-2011

Source: Economics Research Service, USDA

In Figure 3.1, the trends indicate that before 1970, the two values are almost the same. Between 1972 and 1975, however, farmland true values started to exceed the actual market values, followed by the late 1970s farmland "bubble" from 1976 to 1983. During 1972-1975, there was a prospect for the farmland market value to appreciate, expressed by the tick of the farmland true value line. The tick of the farmland true value line indicates that farmland has been undervalued. This prospect seems to have driven the actual farmland market values in 1976 to 1983. During the 1980s "bubble," actual farmland market values are higher than the farmland true values indicating that a part of the actual market value can not be explained by the fundamental value. Speculations may have seemed to dominate the farmland market during the period from 1976 to 1983.

A possible explanation of the phenomenon may lie in the following facts. Before 1971, a relatively fixed exchange rate was adopted by the U.S. and at that time the U.S. was in a trade imbalance with pressures for dollars to depreciate. This fixed exchange rate may have contributed to the stable farmland market and true values prior to 1970. In 1971 and again in

1973, the Nixon Administration started the dollar devaluation by allowing dollar exchange rate to be freely determined. This led to increasing foreign demand for U.S. agricultural products for the decreased price resulted from the devaluation of dollars. The increased export demand, especially from former USSR in mid-1972, drove the agricultural products' domestic price higher than before and increased the farm sector income, which can explain the tick of the farmland true values from 1972 to 1975. However, during the Reagan Administration (1981-1988), in the late 1970s and early 1980s, the dollar was again overvalued. As a result, the U.S. agricultural products were priced out of the international market and the agricultural product price and farm sector income declined. This was one major reason to the U.S. agricultural depression corresponding to the 1976-1983 part of Figure 3.1.

After the peak and fall of market values during the 1980s, From 1985 to 1994, the dollar depreciated again and the farmland market value is on the rise again starting from 1990. With the similar pattern from 1972 to 1975, from 1984 till 2002, the true value is larger than the actual market value. After 2003, the actual market value is larger than the true value similar to the pattern from 1976 to 1983. The prognosis is that there are some portion of the actual market value that cannot be accounted for by the fundamental value. Possibilities are that there may be a speculative "bubble" at the present.

From the results, it is evident that the trends in the levels of market value and true value from 1984 till 2011 are quite similar with that from 1976 to 1983. This supports the contention that there may be a "bubble" currently. The 1980s "bubble," however, is quite different from the current one, in the 1980s, the farmland "bubble" resulted in a large number of bank failures. Moreover, it can be seen that the 1980s "bubble" started in 1976, started bursting in 1983 and lasted for eight years. The current "bubble," on the other hand, started in 2003 and has already

spanned a period of nine years through 2011. For the magnitude of the two "bubbles," the average Ratio during the 1980s is 0.49 compared to 0.28 for the present bubble. Thus, as indicated by the magnitude of the two "bubble(s)," the current one may not be as severe as the 1980s' in terms of the extent to which the farmland market value has deviated from the true value. One of the reasons that leads to this difference might lie in the fact that the credit system has not provided excessive leverage to enlarge the deviation between the market value and the true value at present.

3.2 THE REGRESSION RESULT

The previous set of results has established that there have been noted deviations between the farmland true value and the actual farmland market value. Such deviations correspond to the portion of the farmland market value not explainable by the fundamental value. In determining the fundamental value, the present value depends on the net rent, discount rate, and farmland market value growth rate. The larger the rent, the smaller the discount rate, the larger the growth rate, the larger the present value. Rent is determined by several factors such as the farm net income, which is related to the crop price and production cost. The discount rate is determined by the interest rate as well as the price earning ratio, which is farmland market value divided by rent. The farmland market value is determined by the farmland market demand and supply, which is related to the crop price, direct government payment, and net farm income, among other factors.

The option value represents the uncertainty value for investment or the opportunity cost of not waiting till the optimal value of the farmland is reached. Therefore, it is the value of the call option that the buyer pays for the uncertainty or possibility that the farmland can appreciate in the future. The value of the call option is related to the discount rate, capitalization rate and

farmland market value volatility. The discount rate and farmland growth rate will determine the capitalization rate. In conclusion, the present value and the option value of farmland are dependent of the farmland market value, farmland market value growth rate, net rent and farmland market value volatility, which are the variables through which the chosen independent variables influence the dependent variable, Ratio, in the robust regression. The following table presents the results of the robust regression estimation procedure:

Table 3.2 : Robust Regression Result

Parameter Estimates

Parameter	**Estimate**	**Standard Error**	**Chi-Square**	**Pr > ChiSq**
Intercept	1.9933	0.2787	51.14	<.0001
CorPriCha	0.1249	0.1241	1.01	0.3142
CorPriVol	-0.2186	0.1386	2.49	0.1147
CornPri	**-0.2019**	**0.0401**	**25.35**	**<.0001**
DGPCha	0.0298	0.0253	1.39	0.2382
Debt_Asset	**-3.0537**	**1.3681**	**4.98**	**0.0256**
DirGovPay	**-0.0057**	**0.0015**	**14.26**	**0.0002**
IntRate	1.4062	0.91	2.39	0.1223
NFICha	**0.1063**	**0.0329**	**10.43**	**0.0012**
NetFarInco	**-0.004**	**0.0007**	**36.49**	**<.0001**
PopCha	-0.0124	4.1882	0	0.9976
FMVCha	**0.511**	**0.2545**	**4.03**	**0.0447**
UrbanLand_Tota	**-67.7338**	**7.1974**	**88.56**	**<.0001**

Table 3.2 Continued

ProCost	**0.0018**	**0.0002**	**54.65**	**<.0001**
R-Square	68.43%			

3.3 CORN PRICE

The variables CorPriCha, CorPriVol and CornPri are chosen to represent the crop price effect on Ratio. Corn is the major crop product in midwest, including Iowa, and the corn price is expected to have a direct effect on the demand of farmland because the corn farmland demand is derived from the demand on corns. This effect is strengthened by the fact that the legislation requires minimum and increasing amount of domestic consumption of biofuels starting from the 1980s and a large portion of the requirement has been met by corn-based ethanol. The effect of the CorPriCha on Ratio is expected to be positive in that if the corn price increases, the demand for the farmland is likely to increase as well, leading to the increase of farmland market value and maybe resulting in a larger deviation or possibly a "bubble." However, the CorPriVol may have a negative effect on Ratio. In other words, if the corn price is very volatile, investors in farmland may wait till the corn market is stablized, therefore dragging down the farmland market value and, thus, Ratio will decrease accordingly.

Interestingly, the CorPriCha and CorPriVol variables are not significant. This may be due to the fact that when farm investors consider the investment, the volatility or percentage change of the corn price may not influence the decisions. The variable CornPri is statistically significant and its effect on Ratio is negative. On one hand, the farmland market value will increase when the corn price increases. On the other hand, for the farmland true value the investor may also price the option value of investment higher when the corn price increases. In this sense, if the effect on farmland true value outweigh that on farmland market value, the farmland market value

will be more explainable and the possibility of a "bubble" may be slim when the corn price is high. For the magnitude of the effects, the coefficient is -0.2019 for the corn price which means that when the real corn price increases by $1 (in 2005 dollars) per bushel, Ratio will decrease by 0.2019. Then if the crop price is higher, the possibility that the high farmland market value is a "bubble" is lower.

Figure 3.2 below shows the fluctuations of the corn price and Ratio. For corn price, before the early 1970s, it is relatively stable. After the early 1970s, the corn price started to ascend rapidly due to the high export demand stemmed from the dollar devalution. After the corn price peaked in 1974, it started to drop significantly and this trend is carried through to 1982, after which year the corn price increased. Several reasons may have contributed to this corn price drop. One reason is the overvaluation of the dollars in the early 1980s followed by the agricultural depression. Another reason may lie in the release of the production controls in the 1970s. Grain surplus may have contributed to the corn price decrease also. While for Ratio, when the corn price was increasing from 1972 to 1974, it was decreasing. The farmland market value had not responded correspondingly with the corn price increase instantly. Similarly, when the corn price dropped in 1974, the farmland market value was still on the rise fueled by overly optimistic expectations on the farmland future appreciation. While at the same time, the farmland true value decreased, which explains the 1976 to 1983 farmland "bubble."

As can be seen in Figure 3.2, Ratio and corn price move in opposite directions for most of the time. However, after 2004, they seem to move in the same directions. Given that the translation time between the corn price and farmland market value is short, that may be a signal that the corn price increase leads to more market value increase than the true value increase and

maybe a possible "bubble" exists then. The crop price and Ratio are moving in the same directions (see figure below) after 2004.

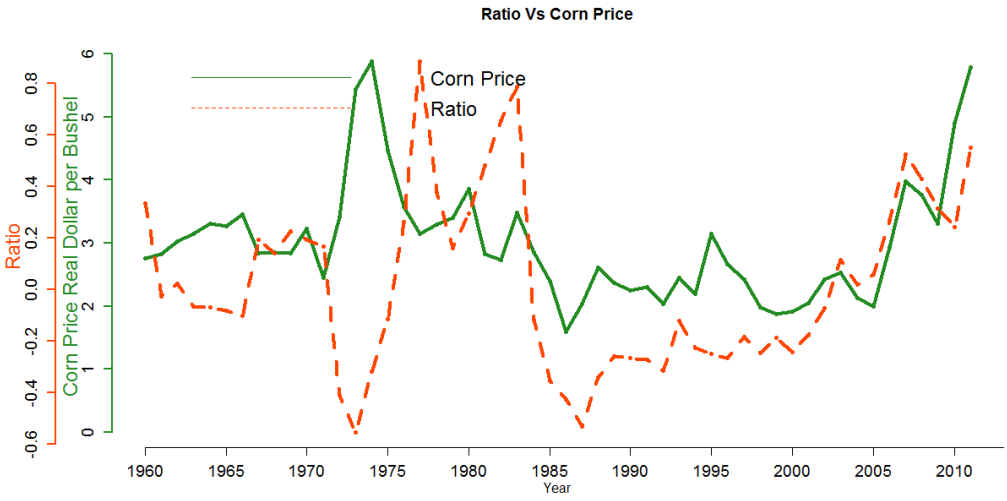

Figure 3.2: Ratio and Corn Price, Annually, 1960-2011

Source: Economics Research Service, USDA

3.4 DIRECT GOVERNMENT PAYEMNT

For the government subsidies, the variables of DirGovPay and DGPCha are chosen. As can be seen from the figure below, the government direct payment is quite volatile. Direct government payment changes are closely related to the crop price changes. When the crop price is low, there would be a payment for market-loss assistance from the government. Based on Figure 3.3, the direct government payment and corn price move in opposite directions for most of the time.

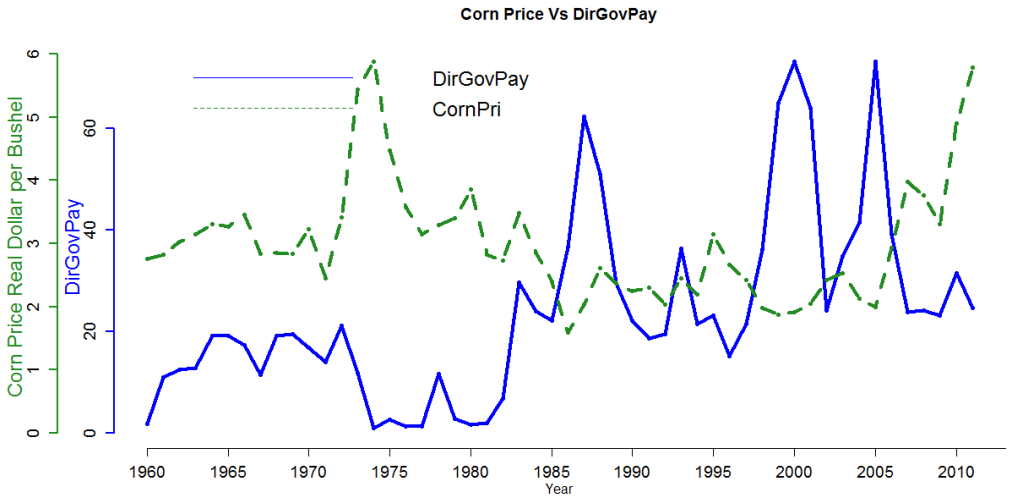

Figure 3.3: Corn Price and Direct Government Payment, Annually, 1960-2011

Source: Economics Research Service, USDA

It is not clear, however, if the increase of the direct government payment will increase the farmland market value instantly or over a lag as demonstrated by Figure 3.4 below. From previous studies, government support programs increase farmland market values and, conversely, the absence of such programs would tend to be associated with lowering farmland market values (Barnard et al., 1997; Featherstone and Baker, 1988; Herriges et al., 1992). In this case, direct government payment may be a side effect of the corn price on farmland market value and it may complicate the effect of corn price on farmland market value.

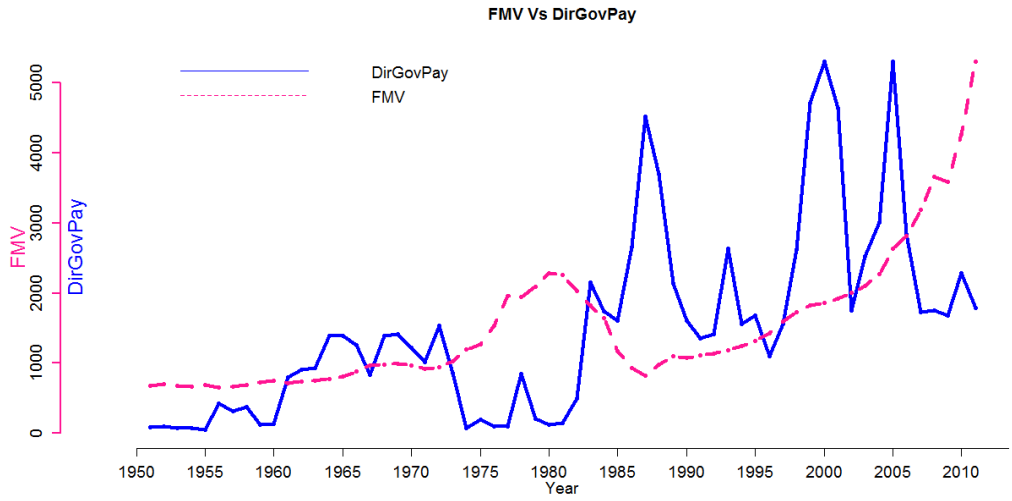

Figure 3.4: Farmland Market Value and Direct Government Payment, Annually, 1950-2011

Source: Economics Research Service, USDA

With the acknowledgement that the direct government payment (DirGovPay) may increase the farmland market value, the effect of direct government payment on the farmland true value is, however, unclear. The estimation results show that DirGovPay is significant and the effect is negative with a magnitude of -0.0057 indicating that the farmland market value is more explainable and a speculative "bubble" is less probable. When the crop price is higher, the direct government payment will decrease, and Ratio will increase. This indicates a speculative 'bubble." Then from Figure 3.5, it can be seen that at present, DGP is quite low possibly indicating a speculative "bubble." The fact that DGPCha is not statistically significant implies that the investment considerations may not be based on the direct government payment percentage change.

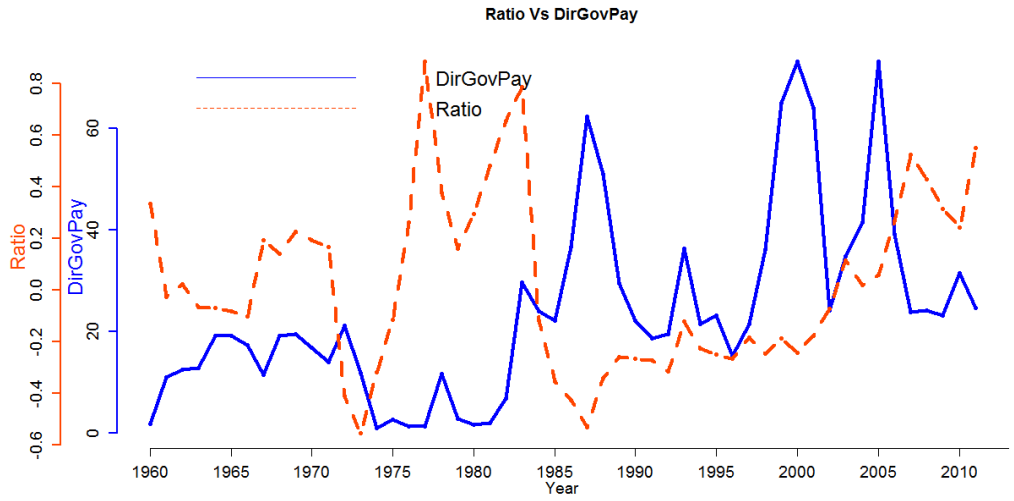

Figure 3.5: Ratio and Direct Government Payment, Annually, 1960-2011

Source: Economics Research Service, USDA

3.5 DEBT TO ASSET RATIO

The Debt_Asset variable represents the cost of farm credit. This variable will test whether the cost of debt relative to asset value will affect Ratio. The estimation results show that the coefficient is -3.0537 and significant at the 5% significance level. The negative effect suggests that when the debt to asset ratio increases, Ratio declines. Therefore, it is less possible that an irrational "bubble" exists. In other words, when the credit is expensive, the debt to asset ratio will increase and Ratio will decrease. Then the availability of the credit leads to a lower debt to asset ratio and this has a positive effect on the deviation between the farmland market value and the farmland true value. The coefficient for debt to asset ratio is -3.0537, which means that when debt to asset ratio decreases by 1%, Ratio will increase by 0.030537.

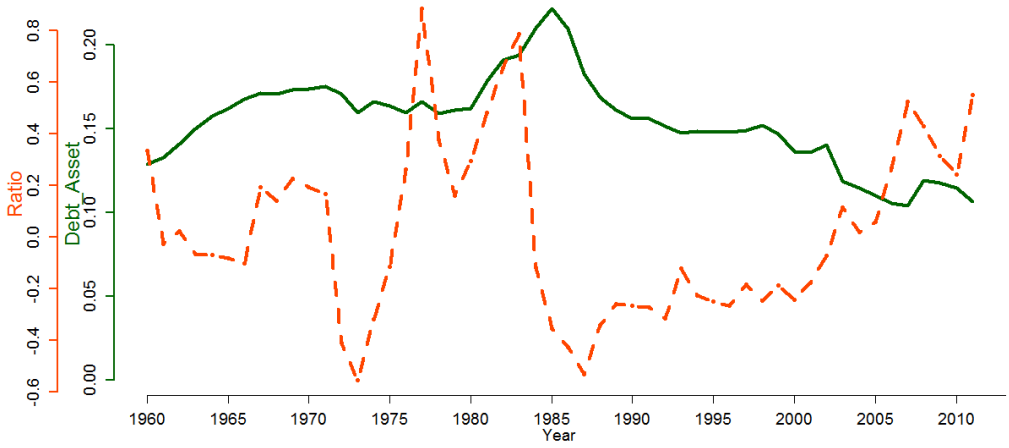

Figure 3.6: Ratio and Debt to Asset Ratio, Annually, 1960-2011

Source: Economics Research Service, USDA

Figure 3.6 shows that during the 1980s "bubble," the debt to asset ratio was initially low and then grew gradually to a peak after the "bubble" burst. In the 1980s, the "bubble" was fueled by excessive credit and as a result, the burst of the "bubble" resulted in bankruptcies of the credit agencies. At present, the debt to asset ratio is farely low indicating cheap credit. Nevertheless, this may not be as serious a problem as in the 1980s. The lending system does not seem to provide excessive leverage to the farm sector this time. However, it may still be true that cheaper credit is also fueling the current "bubble." As can be seen from Figure 3.7 below, the gross loan volume is increasing in constant 2005 dollars through the years despite registering a small decrease in 2011.

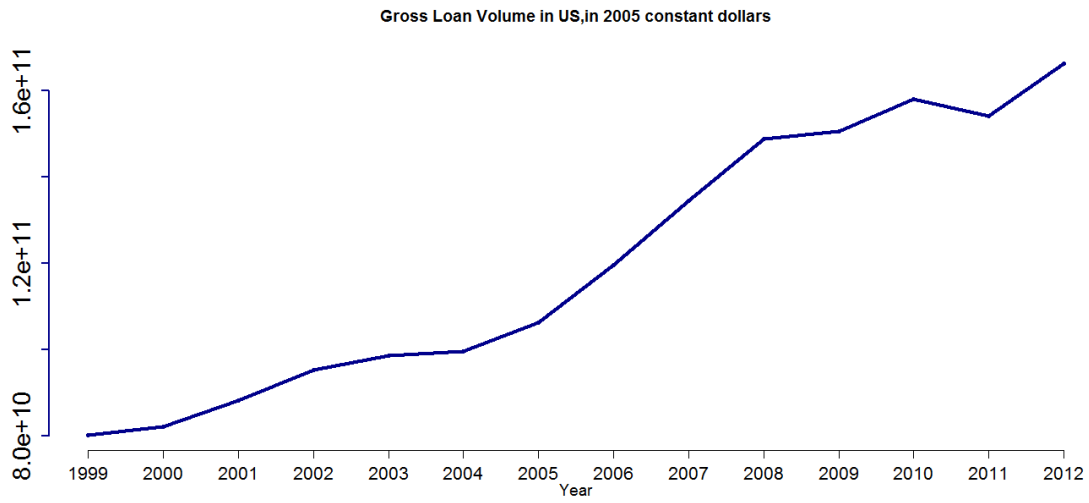

Figure 3.7: Gross Loan Volume, Annually, 1999-2012

Data Source: Annual Report on the Farm Credit System by the Farm Credit Administration

3.6 NET FARM INCOME

Both net farm income and net farm income percentage change represent the demand side of the farmland and both variables are significant. The negative effect of net farm income (NFI) suggests that when NFI increases, Ratio decreases. Then, when NFI increases, the market value is more explainable and the possibility of a "bubble" is lower.

Figure 3.8 shows the variations of the net farm income and Ratio. Net farm income experienced a local peak from 1972 to 1975 which might be attributed to the devaluation of dollars during this period. After 1975, the net farm income dropped further and continuted to drop until 1983. This significant decrease is closely related to the agriculture depression of the U.S. in this period. Further, the production control is lifted at that time which caused a surplus of the agricultural products, as in 1976, 1981 and 1982 of grain. Moreover, due to the tight monetary policy and overvaluation of the dollars, export and domestic demand were not enough to sustain a stable level of income. The oil embargo-cartel also worsened the situation.

In Figure 3.8 below, we can see that in 1980s, the net farm income is low, Ratio is high and there is a "bubble" during that period. Between 1972 and 1975, the net farm income is quite high and this may possibly lead to the "bubble" afterwards, and during the "bubble," the net farm income drops, which may be a signal that the farmland market value will decline.

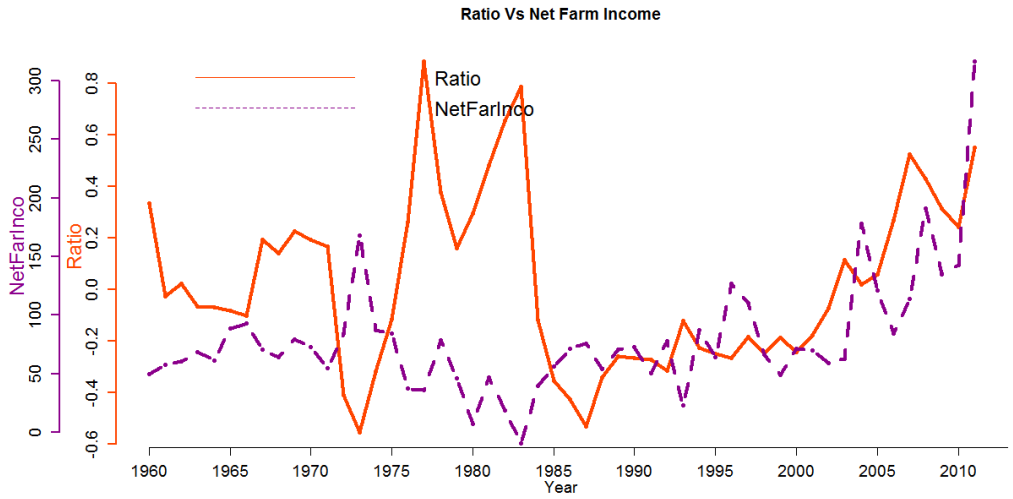

Figure 3.8: Ratio and Net Farm Income, Annually, 1999-2012

Source: Economics Research Service, USDA

Since 2000, on average, the net farm income is increasing in spite of some variations during the last few years. This effect may drive the farmland market value a little close to the farmland true value by a magnitude of -0.004 even though Ratio is high. Based on Figure 3.9, the variable net farm income percentage change has a positive effect. When an investor is considering a farm investment, the net farm income percentage increase may play a positive role on the farm demand, thus leading to the farmland market value increase. This may possibly contribute to a "bubble."

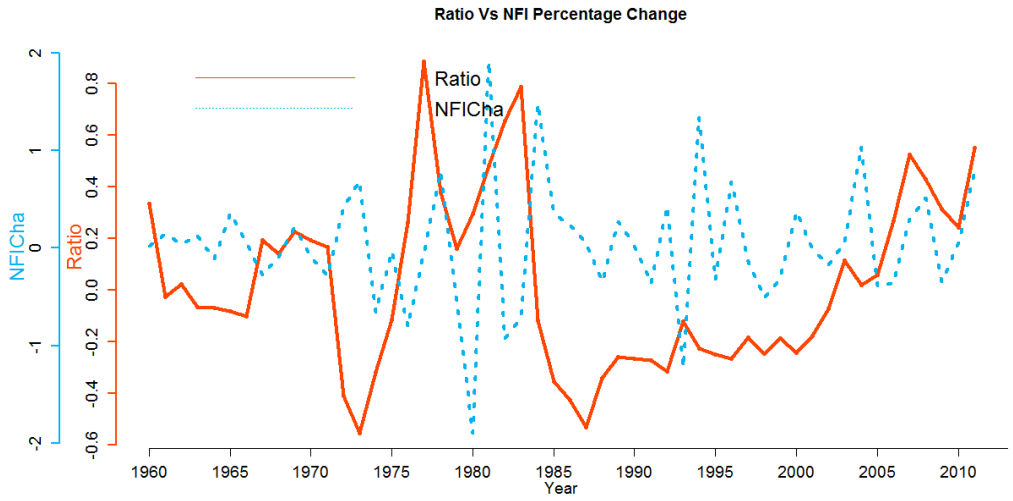

Figure 3.9: Ratio and Net Farm Income Percentage Change, Annually, 1999-2012

Source: Economics Research Service, USDA

3.7 FARMLAND MARKET VALUE PERCENTAGE CHANGE

The next significant variable is the farmland market value percentage change. This variable's effect is positive, which means that an increase of the farmland market value percentage change is likely to contribute to a "bubble." As can be seen from Figure 3.10 below, the current farmland market value percentage change is on a rise and this may indicate that there may be a "bubble."

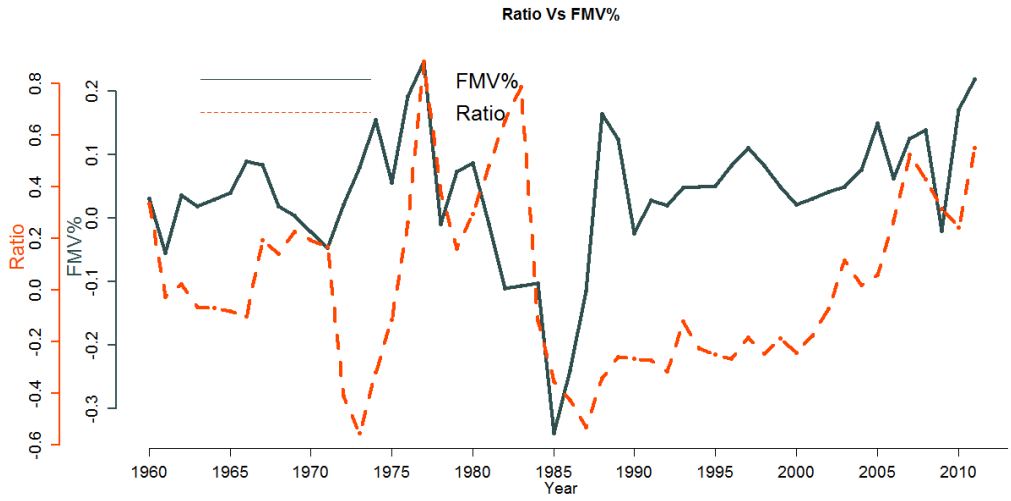

Figure 3.10: Ratio and Farmland Market Value Percentage Change, Annually, 1960-2011

Source: Economics Research Service, USDA

3.8 URBAN LAND TO TOTAL LAND RATIO

Urban land to total land ratio represents the supply of farmland change as well as the change of urbanization. The negative effect implies that urban land to total land ratio and Ratio move in opposite directions. Therefore, if urbanization is on the rise, the market value is less likely to deviate from the true value. In Figure 3.11 below, we can see that Urban land to total land ratio is decreasing in the current years, possibly resulting in increases in Ratio. The reason for this negative correlation may be that when the supply of farmland increases, the farmland market value and the farmland true value will both decrease. However, the translation time of the effect from the farmland supply to the farmland market value may be longer than that from the farmland supply to the farmland true value. Then the overall effect of increasing farmland supply on Ratio is positive. Consequently, the decrease in the urban land to total land ratio may have contributed to the "bubble."

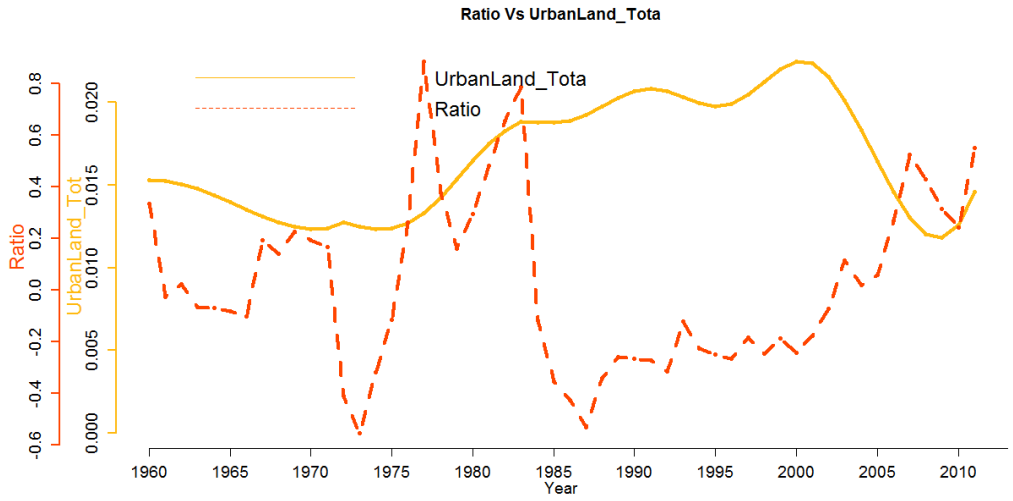

Figure 3.11: Ratio and Urban to Total Land Ratio, Annually, 1960-2011

Source: Economics Research Service, USDA

3.9 PRODUCTION COST

The last significant variable is the production cost shown in Figure 3.12 below. This variable's positive effect means that when production cost increases, Ratio will increase as well. However, this may be due to the fact that when the production cost increases, the market value will decrease as well as the true value. Therefore, the overall effect on Ratio is positive in that the decrease in the true value is even more. Investors may be more worried than they should be when the production cost increases.

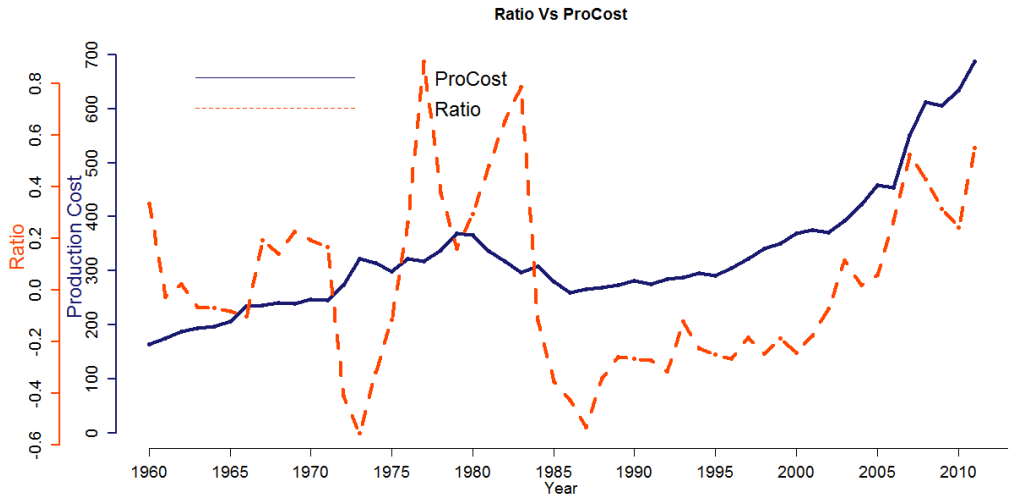

Figure 3.12: Ratio and Production Cost, Annually, 1960-2011

Source: Economics Research Service, USDA

3.10 VARIABLES INFLUENCE MAGNITUDE

The significant variables explain which factors may contribute to a "bubble." Their effects on the "bubble" vary in terms of the magnitude. Below is a graph of their elasticities on Ratio (elasticities calculated based on the year of 2011): Seen from the table, corn price, net farm income and production cost are the three most influential variables. If the three variables change by 1%, then Ratio will change by more than 2%.

Table 3.3: Variable Elasticities

Parameter Estimates			
Parameter	**Estimate**	**Pr > ChiSq**	**Elasticity**
Intercept	1.9933	<.0001	
CorPriCha	0.1249	0.3142	0.039
CorPriVol	-0.2186	0.1147	-0.162
CornPri	**-0.2019**	**<.0001**	**-2.185**
DGPCha	0.0298	0.2382	234.720
Debt_Asset	**-3.0537**	**0.0256**	**-0.608**
DirGovPay	**-0.0057**	**0.0002**	**-0.262**
IntRate	1.4062	0.1223	0.001
NFICha	**0.1063**	**0.0012**	**0.158**
NetFarInco	**-0.004**	**<.0001**	**-2.366**
PopCha	-0.0124	0.9976	0.000
FMVCha	**0.511**	**0.0447**	**0.209**
UrbanLand_Tota	**-67.7338**	**<.0001**	**-1.845**
ProCost	**0.0018**	**<.0001**	**2.311**

CHAPTER 4

CONCLUSION

In this thesis, we discussed that the dangerous "bubbles" are costly and should be avoided. For "bubble" detection, however, we can only observe the actual farmland market value from which we are unable to identify a "bubble." Then, for the fact that "bubbles" are created by the expectations on future farmland market value appreciation, this analysis priced the option value of the farmland, and theoretically calculated the farmland true value obtained when making farmland investment decisions. Consequently, if the actual market value is larger than the true value, we conclude that there may possibly be a speculative "bubble." This "bubble" is not explained by the farmland true value calculated. Therefore, it is not explained by the cash flows or the expectations regarding the farmland market value appreciation. In other words, this "bubble" is an irrational one. Consequently, this analysis has uncovered a speculative "bubble" deduced from a longitudinal dataset of Iowa farmland data in the period from 1976 to 1983 as well as the period from 2003 to 2011. For the magnitude of the two "bubbles," the average Ratio for the first one is 0.49 while it is 0.28 for the second one. To that end, it is indicated that the current "bubble" may be less severe than the one in the 1980s. Further, the two "bubbles" vary greatly in terms of their background and formulation. In the 1980s, the major cause of the "bubble" might be the overvaluation of the dollars caused by the excessive credit support and the afterwards agriculture depression as well as the. However, currently, there is no sign of an agriculture crisis or excessive leverage. The high demand of corn both domestically and internationally may be a key issue with the "bubble".

In analyzing the contributing factors that perpetuate such "bubble(s)," a robust regression analysis is conducted. The estimation results show that corn price, debt to asset ratio, direct government payment, net farm income and net farm income percentage change, farmland market value percentage change, urban land to total land ratio, and production cost are statistically significant factors that can explain the incidence of the bubbles.

Among these factors, corn price, debt to asset ratio and direct government payment may be the three fundamental reasons for the speculative "bubble" currently. The real corn price is ascending and high in levels; the debt to asset ratio is decreasing and low in levels; the direct government payment is declining and low in levels currently. Therefore, the increase of supply from the corn market, or less speculation in the corn market may relieve the driving force on the "bubble." In addition, more prudent borrowing behaviors of farmers as well as more cautious and strict supervision of farm lenders in the farm lending market may help to bring the farmland market value close to its true value. The direct government payment is closely related to crop price change thus complicating the effect of the crop price on the "bubble." It may need long-term reform on the government support programs to alleviate the programs' negative effect on the "bubble."

In addition, there are several implications and limitations of the result:

First, the parameters we hypothesized to calculate the present value and the option value, such as capitalization rate, discount rate and farmland market value volatilities, are fundamental to the calculation of farmland true values. Those parameters should be time varying instead of being constant as we specified in the thesis. Therefore, the result may be different if we allow the parameters to vary.

Second, the uncertainty value or the option value stems from the fact that there is opportunity cost to investing now than later. This uncertainty value leads to the wedge between the farmland market value and the present value. Also, this is the reason leading to the "bubbles." The full opportunity cost is assumed by the buyer by assumption. If not, the option value should be smaller than calculated. Further, in order to calculate the option value, we modeled the farmland true value with the geometric Brownian motion. However, the farmland true value is more likely to follow a Jump Diffusion process. In both cases, the conclusion that we might be experiencing a "bubble" may vary.

Third, with the statistically significant variables, we might be able to predict the "bubble" with the level of the variables value. This may aid the government and agencies in their decision making. On the other hand, even if those variables are significant, the adjusted R square is 68.43% meaning that we may be able to include more effective variables in the regression to better explain Ratio. Additionally, for the insignificant variable, interest rate, it may be insignificant because the discount rate used is specified as a constant instead of time-varying with the interest rate. Normally, the interest rate should be different in different time periods. It will vary as the economic condition changes. Thus, the interest rate should be varying according to different time periods. However, in this paper, we take interest rate as a constant. Therefore, even if the interest rate is insignificant, the result might be different if we model the interest rate as a function of time periods.

Finally, for the effect of the urbanization on the farmland market values, the result will be more convincing if the data is by parcel. The data we have is macro-level thus lacking the ability to explain the urbanization effect accurately.

To conclude, unlike the former research concentrating on explaining farmland "bubble(s)" mainly through the correspondence among the related longitudinal variables, this thesis analyzed the speculative "bubble(s)" from the perspective of the investment decision making process. This perspective is utilized to calculate the farmland true values (fundamental values) including the present value and uncertainty values. In this manner, not only can the speculative "bubble(s)" be identified, but also the direct effect of the explanatory variables on the speculative "bubble(s)" can be analyzed with the framework provided in this thesis, given that previous research generally emphasized on analyzing the variables' effect on the farmland market values instead of the "bubble(s)."

REFERENCES

Alston, J.M. 1986. “An Analysis of Growth of U.S. Farmland Prices.” *Amer. J. Agr. Econ*. 68:1-9.

Baker T.G., E.H. Ketchabaw and C.G. Turvey. 1991. "An Income Capitalization Model for Land Values with Provisions for Ordinary Income and Long-Term Capital Gains Taxation." *Canadian Journal of Agricultural Economics* 39(1):69-82.

Barry Falk and Bong-Soo Lee. 1996. “Fads Versus Fundamentals in Farmland Prices.” *Staff Paper* No. 281, August 1996.

Berry, I., 2012. “Farmland Prices Rise Despite Drought” Available at: http://online.wsj.com/article/SB10001424127887324595904578121344140378274.html

Blas, J. 2012. “Fears of US Farmland Bubble Echo History.” Financial Times, May 16, available on line at: http://www.ft.com/intl/cms/s/0/a37bbc74-9f32-11e1 a45500144feabdc0.html#axzz2HhifILjVBurt, O.R. 1986. “Econometric Modeling of the Capitalization Formula for Farmland Prices,” *American Journal of Agricultural Economics* 68: 10-26

Campbell, John Y., and Robert J. Shiller. 1987. “Co-integration and Tests of Present Value Models.” *J. Polit. Econ* 95: 1062-88.

Drummond H. E. and J. W. Goodwin. 2003. *Agricultural Economics,* 2nd. ed. Upper Saddle River NJ: Prentice Hall.

Duffy, M. 2012. “2012 Farmland Value Survey Iowa State University” Available on line at: https://www.extension.iastate.edu/agdm/wholefarm/html/c2-70.html

Gloy, B. A. 2012. "Farmland Values: Will the Boom Turn Bust?" Paper Prepared 2012 Agricultural Symposium Federal Reserve Bank of Kansas City, July 16 - 17, 2012.

Gloy, B. A., Hurt, Boehlje, and Dobbins. 2011. "Farmland Values: Current and Future Prospects." Working paper, Dept. of Agr. Econ., Purdue University.

Goodwin, B.K., Ashok K. Mishra and François N. Ortalo-Magné. 2003. "What's Wrong with Our Models of Agricultural Land Values?" *American Journal of Agricultural Economics* 85(3): 744-752.

Featherstone, A.M. and T.G. Baker. 1987. "An Examination of Farm Sector Real Asset Dynamics," *American Journal of Agricultural Economics* 69: 532-546

Halcrow H. G. 1984. *Agricultural Policy Analysis*. New York: Mcgraw-Hill Book Co.

Hanson, S.D. and R.J. Meyers. 1995. "Testing for A Time-varying Risk Premium in the Returns to U.S. Farmland," *Journal of Empirical Finance* 2: 265-276.

Isgin, T. and D. Lynn Forster. 2006. "A Hedonic Price Analysis of Farmland Option Premiums under Urban Influences." *Canadian Journal of Agricultural Economics* 54(3): 327–340.

Just, R. E. and J. A. Miranowski. 1993. "Understanding Farmland Price Changes." *American Journal of Agricultural Economics* 75(1): 156-168

Malkiel, B.G. 2010. "Bubbles in Asset Prices." CEPS Working Paper, Center for Economic Policy Studies, Princeton University, No. 200, January 2010.

McDonald, R. and D. Siegel. 1986. "The Value of Waiting to Invest." *The Quarterly Journal of Economics* 1(4): 707-728.

Murray Wise Associates. 2010. "Ag expert: Investor demand exceeds current supply of quality farmland" Available at: http://www.murraywiseassociates.com/news/ag-expert-investor-demand-exceeds-current-supply-quality-farmland

Power, G. J. and Calum G. Turvey. 2010. "US Rural Land Value Bubbles.*" Applied Economics Letters* 17: 649–656.

Quigg, L. 1993. "Empirical Testing of Real Option-pricing Models." *Journal of Finance* 48: 621 – 40.

Shalit, H. and A. Schmitz. 1982. "Farmland Accumulation and Prices." *American Journal of Agricultural Economics* 64(4): 710-719.

Stiglitz, J.E.1990. "Symposium on Bubbles." *Journal of Economic Perspectives* 4:2: 13 – 18.

Titman, S. 1985. "Urban Land Prices under Uncertainty." *American Economic Review* 75: 505 – 514.

Trigeorgis, L. 1993. "Real Options and Interactions with Financial Flexibility." *Financial Management* 3: 202-224.

Turvey, C. G. 2002. "Can Hysteresis and Real Options Explain the Farmland Valuation Puzzle?" Working Paper, Dept. of Food, Agri. and Resource Econ., University of Guelph.Tweeten, L. G. 1979. *Foundations of farm policy*. 2nd ed. University of Nebraska Press.

Weersink, A.J., J.S. Clark, C.G. Turvey and R. Sarkar. 1999. "The Effects of Agricultural Policy on Farmland Values." *Land Economics* 75(3): 425-439.