INVESTING IN UNITED STATES FARMLAND: A CAPITAL ASSET PRICING MODEL ANALYSIS

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The Supervisory Committee certifies that this ***disquisition*** complies with North Dakota State University's regulations and meets the accepted standards for the degree of

MASTER OF SCIENCE

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ABSTRACT

This study examines the risk and returns to owning United States farmland. State, regional, and national farmland returns from 1998 to 2018 are analyzed via the capital asset pricing model. Results show that farmland may be an effective route of investment portfolio diversification due to its favorable returns and low correlation with other commonly held assets. This study's findings are generally consistent with similar research conducted in the past.

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1. INTRODUCTION

United States farmland has emerged as an increasingly popular investment opportunity in recent years. Although farmland is not as well-known as traditional asset classes like stocks or bonds, farmland provides specific traits attractive to those seeking a diversified investment portfolio. Farmland may be a useful addition to many portfolios because it carries very little systematic, or undiversifiable, risk when paired with an array of diverse investments (Barry 1979). Furthermore, because farmland accounts for roughly 82 percent of farm assets in the United States, the returns to farmland ownership are critically important to the wealth and savings of agricultural operators (USDA 2014). Because farmland is the dominant asset in the agricultural sector and an intriguing investment for those outside agriculture, it is important to understand the opportunities that farmland ownership provides to both operators and investors.

1.1. Purpose and Contribution

Agricultural economics is an evolving discipline. Technology and production practices are constantly reinventing standards for America's farmers. In recent years, the U.S. economy and U.S. agriculture have each experienced unique events. The financial crisis of 2008 led to a dramatic downfall in stock prices and sent the national economy into a recession. In contrast, farmers experienced record high commodity prices, especially from 2010 through 2013. This extremely profitable period was swiftly followed by a decline in prices received and slowed appreciation in farmland values.

American farmland owners routinely make important decisions regarding the use of their primary asset. Specifically, farmland owners must decide between operating the land themselves or renting the land to another operator. This decision is now particularly critical because input prices have continued to rise in recent years, while commodity prices have declined from record highs earlier in the decade. Understanding farmland's returns and associated risks will help landowners make better decisions regarding the future use of their farmland. It is also useful to study farmland's interplay with other assets, such as stocks and bonds.

Because U.S. farmland is spread across several different topographies, this study will examine farmland investment at the state, regional, and national levels. The capital asset pricing model (CAPM) is used to analyze risk and returns associated with holding farmland. Data from 1998 to 2018 are considered. This CAPM perspective provides insight on farmland values and returns through an investment point of view. CAPM is considered to be a foundational method for portfolio evaluation. This study applies CAPM to agricultural land, thereby offering information on the model's consistency and dependability through time. It is important to analyze the characteristics of farmland as an investment because of its relevance to the industry in the past, present, and future.

This study compares farmland returns to those of other investments. In these comparisons, the correlations between different assets are used to examine farmland's capabilities for diversifying a market portfolio. As demonstrated in Chapter 2, farmland carries a low or negative correlation with several commonly held assets. The correlation between farmland values and interest rates is also analyzed, which is one way of determining how farmland values are related to outside factors.

1.2. Overview

This study is divided into six chapters. Following this introductory chapter, Chapter 2 offers insights into historical farmland trends and characteristics. Chapter 3 outlines previous literature relevant to farmland investment and applications of the CAPM. Chapter 4 explores this study's theoretical model and explains the rationale behind the variables used to estimate the empirical model. Chapter 5 provides detailed regression results from the model detailed in Chapter 4. Lastly, Chapter 6 summarizes this study's results and proposes possibilities for future research.

2. BACKGROUND

2.1. United States Agricultural History

This study analyzes farmland's risks and returns by examining three categories of farmland throughout the fifty states, ten separate agricultural regions, and the United States as a whole. The three categories of farmland are general agricultural land including buildings, cropland, and pastureland. This study places particular emphasis on North Dakota and several other Midwest states. These other states are emphasized because of their geographic proximity to North Dakota and the high importance of agriculture in each state.

It is undeniable that the price of agricultural real estate has risen dramatically over time. The value of North Dakota's agricultural land including buildings was just $29 per acre in 1950, but in 2018 it was $1,830 per acre (USDA, NASS). These asset values are statewide averages, which may discount the prices commanded by parcels with the highest quality soil. Much like other states, North Dakota's variety of soil and topography creates major differences in value per acre in various locations. For example, the average value including buildings for Richland County in the southeast corner of North Dakota reached $2,970 per acre in 2012, while values in Divide County in the northwest corner of North Dakota were $646 per acre (USDA, NASS).

In recent years, the scale of agricultural operations has increased to sizes that would have been unimaginable several generations ago. For example, an 80 acre farm may have provided for a family at the beginning of the twentieth century, but in today's agricultural environment a typical farming operation cannot collect sufficient returns without being much larger in size. Moreover, the cost of renting or buying equipment and machinery cannot be justified without controlling a substantial amount of land. The average farm size in North Dakota was 1,492 acres in 2017, compared to just 529 acres in 1950 (USDA Census of Agriculture). Along with equipment and machinery needs, input costs create difficulties for small farms. This has also shifted the industry towards large or corporate farms across the country.

Increasing farm sizes have reduced the number of farm operations in the United States. Figure 2.1 shows that the number of farms that are 500 to 999 acres decreased from 203,925 to 133,321 from 1982 to 2017. At the same time, the number of farms in the next tier of farm size, 1,000 to 1,999 acres, decreased slightly, while the number of large farms with over 2,000 acres increased from 64,577 to 85,127.

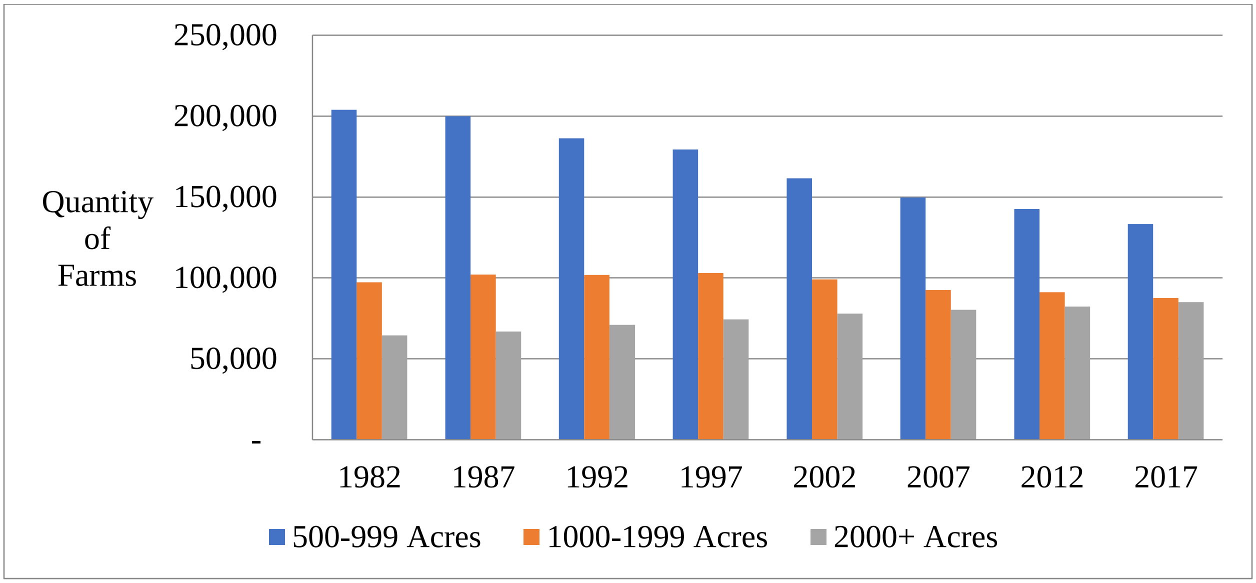

Figure 2.1. United States Farms by Size, 1982 to 2017
Source: USDA

Interestingly, the number of small farms that are 1 to 499 acres, which are not pictured in Figure 2.1, decreased only slightly during this same time period. Figure 2.2 displays trends in the number of small farms in the United States. Small farms may not provide a large income, but oftentimes provide a desirable hobby or lifestyle for operators. These operators are often willing to pay higher prices for small parcels of land. Many operations that grow high value crops can profitably operate on a small scale, providing additional strength in the small farm category. The USDA Economic Research Service (USDA ERS) defines a farm as "any place from which

$1,000 or more of agricultural products were produced and sold, or normally would have been sold, during the year." Because of this definition, it is very easy for a small, rural residence to classify as a farm.

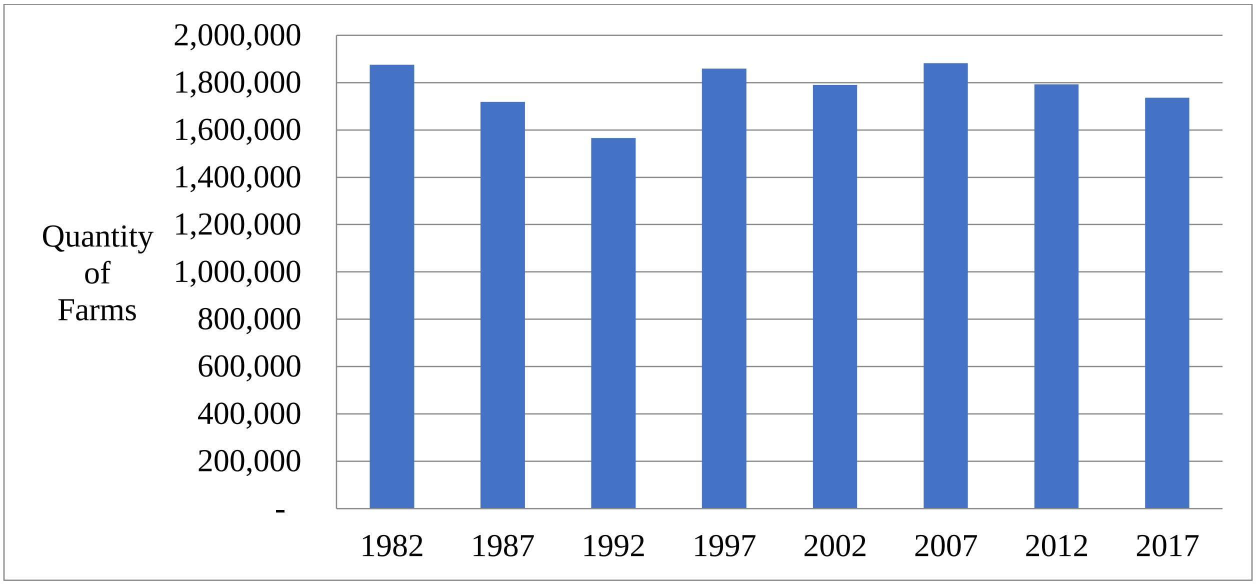

Figure 2.2. Quantity of Small United States Farms (1 to 499 Acres), 1982 to 2017
Source: USDA

Along with the number of farm operations declining during the recent past, the average age of farm operators has increased. The average age of a North Dakota principal farm operator increased from 44.6 years in 1950 to 53.6 in 2017. This trend of increasing age could be caused by several factors. For example, some young farmers may be entering the industry later because they pursued higher education after high school. Perhaps more importantly, beginning farmers need large amounts of capital to enter the industry, and this can be a difficult process without assistance from family or friends. Heightened input costs, along with the costs of buying or leasing land and equipment, have contributed to most new farmers being those that inherit land or start up with the help of a relative.

Figures 2.3 and 2.4 illustrate the estimated market value of land and buildings in per farm and per acre measurements. In the U.S., the average market value per farm has increased nearly four-fold since 1982, growing from $345,869 to $1,311,808 in 2017. This change reflects increasing farm sizes and increasing per-acre values. The estimated market value per acre has increased at nearly the exact same rate, reaching $2,976 in 2017. These increasing values have attracted non-individual owners that view agricultural land as an investment vehicle rather than solely a production necessity. For instance, a Farmland Real Estate Investment Trust (FREIT) is comprised of several owners, so the amount of capital needed is less burdensome for one owner. These trusts take investors' collective assets and target farmland fitting the trust's criteria. A FREIT also allows owners to earn the capital gains of their land without having to pay those large costs associated with operating the land themselves.

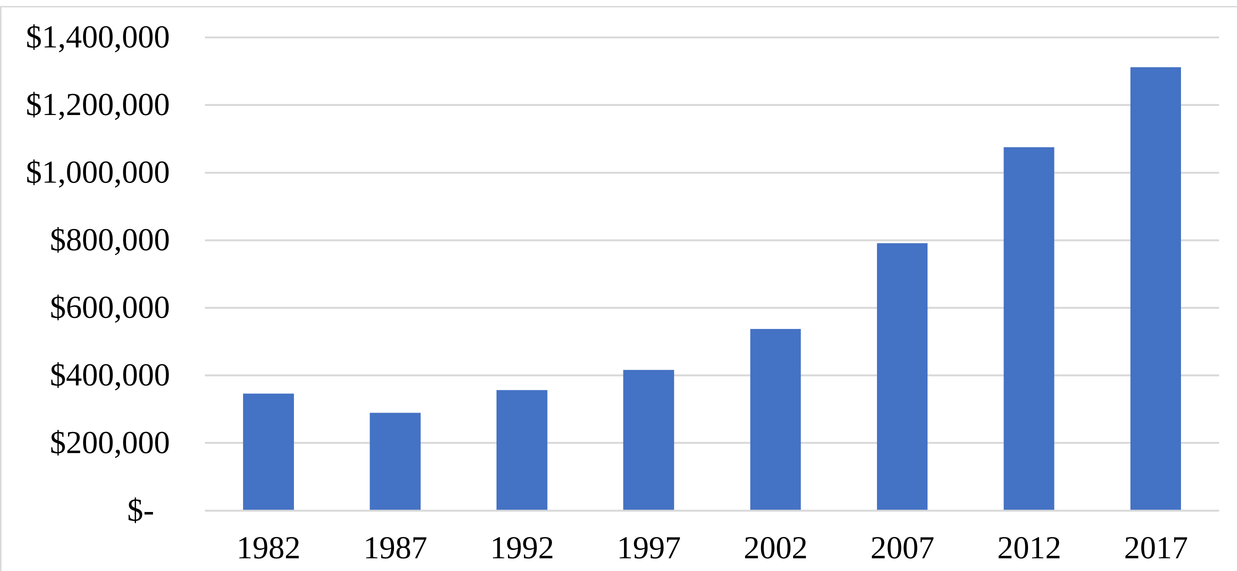

Figure 2.3. Value of United States Agricultural Land and Buildings per Farm, 1982 to 2017
Source: USDA

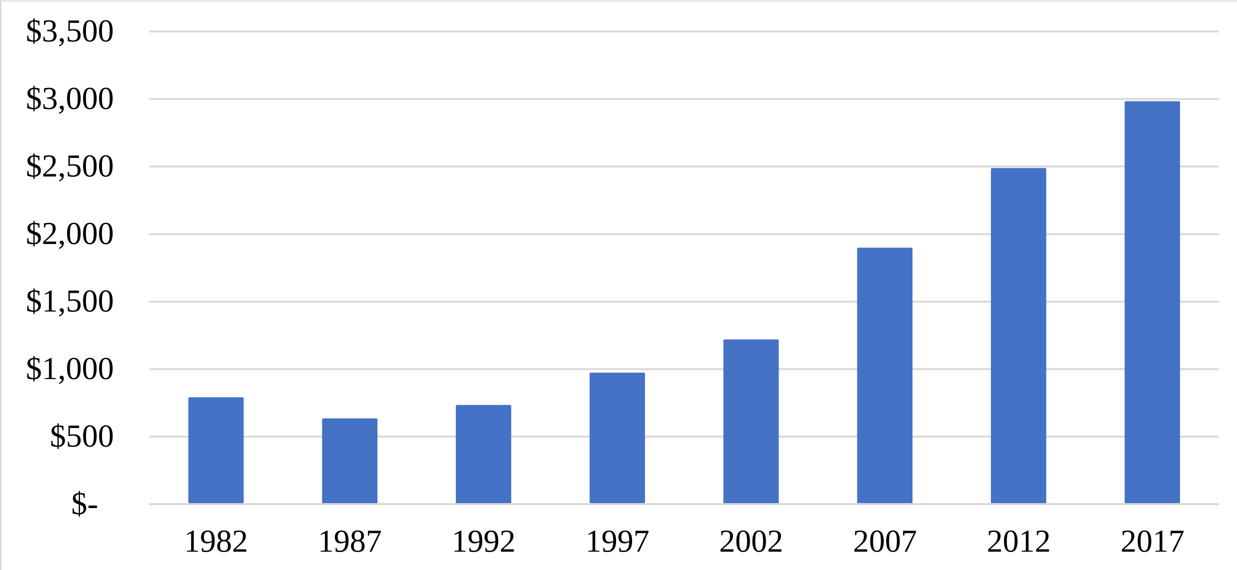

Figure 2.4. Value of United States Agricultural Land and Buildings per Acre, 1982 to 2017
Source: USDA

2.2. Investing in Farmland

In many agricultural areas, it is assumed that once a person possesses land, they will do everything in their power to maintain ownership of that land within their family. From this perspective, farmland ownership represents an opportunity to do better than the generation before or an opportunity to sustain a lifestyle. Investing in United States farmland is a relatively new concept. Previously, an individual without ties to agriculture would rarely consider buying farmland if they were not an operator because its investment opportunities were unknown and understudied. The average investor may have difficulty gaining access to farmland. In fact, only about one percent of all U.S farmland acres transfer ownership on a yearly basis, outside of wills and other transfers to family members (Sherrick 2018). Investors can acquire a parcel through auction, land sales, or through public listings. However, farmland investment is traditionally a large commitment because purchase prices often soar into the millions of dollars. FREITs have only recently been developed, creating easier access to farmland investment.

Investing in farmland may provide diversification to an investment portfolio because of its low correlation with other commonly held assets. Attractive potential investments are oftentimes correlated to others already held in a portfolio, thus offering little risk reduction. Exploring the relationships, or correlations, between assets is an important aspect of portfolio analysis. If two assets are highly correlated they will experience similar returns and losses, thus providing better return potential when things are going well but also creating greater losses in less favorable times.

A correlation matrix was developed to display farmland's unique diversification traits. This correlation matrix, Table 2.1, displays the correlation coefficients between returns for three types of United States farmland, gold, silver, the S & P 500 index, Dow Jones Real Estate Investment Trust (REIT) fund, the Bloomberg Barclay's U.S. Aggregate Bond Index (LBUSTRUU), and the Fama and French stock portfolio. The Fama and French 5 Factors (2x3) dataset, is given by the Kenneth French data library (Dartmouth College 2019). The Fama and French 5 factors use six value-weighted portfolios formed on three criteria: size and book-to-market, size and profitability, and size and investment. This includes the New York Stock Exchange, AMEX, and NASDAQ firms. The Fama and French series was created using data from the Center for Research in Security Prices (CRSP). The returns used were annual, ranging from 1998 to 2018. The bond index, LBUSTRUU, and the Fama and French stock measure are used in this study's modeling and are further explained in Chapter 4. The agricultural land including buildings, cropland, and pastureland categories were included separately because of their prominence later in this paper. Gold, silver, and stocks, which are represented by the S & P 500 index, were included because of their popularity. The Dow Jones REIT was included because it measures returns to real estate ownership.

As seen in Table 2.1, the three categories of U.S. farmland have negative correlation coefficients with all other assets except for LBUSTRUU. The one other exception is cropland's correlation to the S & P 500, which is 0.018. Both of these assets have low correlation with the three types of farmland. Therefore, farmland would appear to be a risk-reducing addition to a portfolio that has otherwise excluded it. As expected, the three categories of farmland are highly correlated with each other, suggesting that an investor achieves little diversification by holding both cropland and pastureland.

Table 2.1. Correlation Matrix for Returns to Selected Assets, 1998 to 2018

	U.S. Agri-cultural Land	U.S. Crop-land	U.S. Pasture-land	Gold	Silver	S & P 500 Index	Dow Jones REIT	Barclay's Bond Index	Fama/ French Stock Index
U.S. Agricultural Land	1.000								
U.S. Cropland	0.944	1.000							
U.S. Pastureland	0.758	0.666	1.000						
Gold	-0.016	-0.008	-0.110	1.000					
Silver	-0.170	-0.205	-0.239	0.751	1.000				
S & P 500 Index	-0.016	0.018	-0.070	0.064	0.253	1.000			
Dow Jones REIT	-0.064	-0.114	-0.058	0.231	0.527	0.197	1.000		
Barclay's Bond Index	0.047	0.027	0.083	0.282	-0.091	-0.348	0.140	1.000	
Fama/French Stock Index	-0.075	-0.039	-0.147	0.100	0.342	0.983	0.209	-0.403	1.000

Source: USDA, Bloomberg, FFrench

It is important to note that the correlation matrix in Table 2.1 reflects a relatively large time period. Because of this, some of the significant changes in the investment environment may not be easily observed. For example, farmland returns may have been more or less correlated to stock market returns in the first decade observed than after the 2008 recession. Table 2.2 examines several rolling windows of time for the correlation of these aforementioned assets' returns with those of U.S. agricultural land. As Table 2.2 displays, the five year correlations have stronger relationships, both positively and negatively, between farmland and the other commonly held assets. In the years leading up to 2008, many correlations between farmland and other assets were positive, while after 2008 most were negative for a number of years. Because of these negative correlation relationships, farmland was identified as a safe alternative for uncertain investors following the financial crisis of 2008. In the most recent time frame, 2014 to 2018, the S & P 500 Index held the closest correlation relationship with farmland, with a coefficient of 0.571.

Table 2.2. Five-Year Rolling Correlation Coefficients for Returns to U.S. Agricultural Land and Other Assets, 1998 to 2018

5 Year Corr. Coef.	Gold	Silver	S & P 500 Index	Dow Jones REIT	Barclay's Bond Index	Fama/ French Stock Index
1998-2002	-0.889	-0.209	0.513	0.203	-0.470	0.526
1999-2003	-0.899	-0.732	-0.138	-0.395	-0.084	-0.157
2000-2004	-0.880	-0.909	-0.550	-0.070	0.684	-0.609
2001-2005	0.194	0.630	0.052	-0.322	-0.578	0.043
2002-2006	0.163	0.602	0.034	-0.223	-0.562	0.007
2003-2007	0.205	0.513	-0.554	-0.241	-0.517	-0.554
2004-2008	0.386	0.579	0.307	0.256	-0.679	0.312
2005-2009	-0.124	-0.079	-0.190	-0.028	-0.715	-0.204
2006-2010	-0.124	-0.335	-0.342	-0.243	-0.416	-0.377
2007-2011	-0.277	-0.627	-0.646	-0.757	0.308	-0.670
2008-2012	-0.794	-0.647	-0.517	-0.486	-0.249	-0.543
2009-2013	-0.638	-0.668	-0.232	-0.705	-0.404	-0.248
2010-2014	-0.682	-0.823	0.223	-0.385	-0.422	0.135
2011-2015	0.155	0.076	0.636	0.523	0.228	0.614
2012-2016	-0.268	-0.450	0.571	0.470	0.146	0.499
2013-2017	-0.671	-0.914	0.511	0.364	-0.112	0.447
2014-2018	-0.327	-0.812	0.150	0.755	0.654	0.037

Source: USDA, Bloomberg, FFrench

The impact of the 2008 recession was felt throughout the world. The economic decline created uncertainty for the average investor, leaving them unsure about the stock market and looking for other safe investment options. An increase in gold and bond purchases was observed following the downturn (Painter 2011). These investments do not carry much risk into a portfolio, however, their returns are nearly the same as the average inflation when compared before taxes, and are less than the rate of inflation after taxes (Painter 2011).

In order to display farmland's risk over return characteristics, Sharpe ratios were calculated for the three types of U.S. farmland, as well as the other assets in previous comparisons. Sharpe ratios are found by dividing the mean of an asset's returns by its standard deviation. Sharpe ratios represent an asset's average return earned per unit of total risk. Investors may find Sharpe ratios as a quick and effective tool to analyze an asset's risk versus its reward. Generally, the greater the ratio, the more attractive the asset's returns are. In this case, the full 1998 to 2018 series of returns were used for each asset. As Table 2.3 displays, U.S. agricultural land and cropland have the highest Sharpe ratios of the listed assets, meaning they earn the highest return for the risk associated with investment. The aggregate bond index follows with a Sharpe ratio of 1.34.

Table 2.3. Sharpe Ratios for Selected Assets, 1998 to 2018

	Mean	St. Dev.	Sharpe Ratio
U.S. Agricultural Land	0.086	0.050	1.710
U.S. Cropland	0.095	0.056	1.708
U.S. Pastureland	0.064	0.070	0.907
Gold	0.083	0.145	0.574
Silver	0.077	0.277	0.279
S & P 500 Index	0.082	0.177	0.463
Dow Jones REIT	0.104	0.194	0.538
LBUSTRUU	0.048	0.036	1.340
FAMA French	0.086	0.183	0.469

Source: USDA, Bloomberg, FFrench

Although real estate investments can be vulnerable to downturns like other investment options, it is evident that real estate, specifically farmland, can be a powerful investment vehicle. Farmland was less susceptible to the effects of the recession than most of the other assets studied. Farmland experienced a near universal small decrease in market value in 2009, but the following year brought record prices to farmers and landowners. For example, in 2008, North Dakota cropland reached a record high average of $810 per acre statewide, dropping only 2.8% to $787 per acre in 2009. North Dakota cropland values increased each of the next five years (USDA, NASS). As people have discovered the potential that farmland holds, farmland investments have become increasingly common.

2.3. Farmland Values

From 1997 to 2018, values increased by 239%, 225%, and 198% for U.S. agricultural land including buildings, U.S. cropland, and U.S. pastureland, respectively. Figure 2.5 depicts these increases over time. United States agricultural land including buildings was valued at just $926 per acre in 1997, compared to a record high of $3,140 per acre in 2018. The average U.S. cropland value was $1,270 per acre in 1997, climbing to $4,130 in 2018 and tying the highest value recorded for the country's cropland. U.S. pastureland value also reached a new high of $1,390 per acre in 2018. Because the United States is home to a wide variety of topographies, styles of agriculture, crops, weather, and other factors, the country's average land values do not represent all area's land values accurately. Because of this, better perspective is needed when looking at agricultural values.

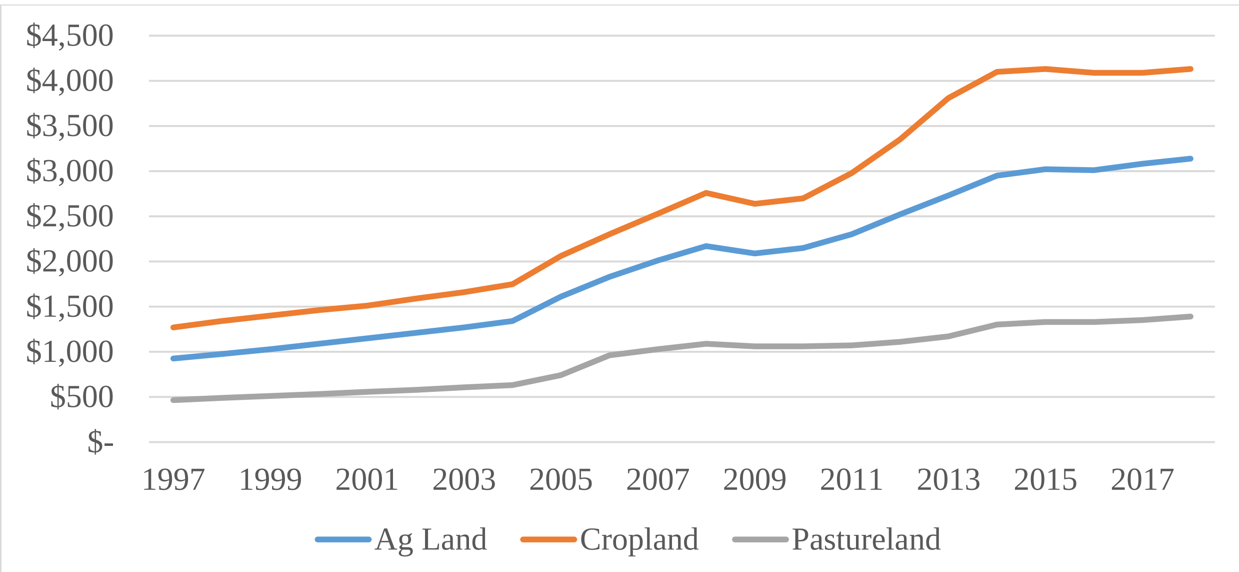

Figure 2.5. United States Farmland Values per Acre, 1997 to 2018
Source: USDA

Subtle differences in farmland values can be better observed at the regional level. Figure 2.6 illustrates the ten agricultural regions assigned by the USDA and the states that comprise each region. These regions are as follows: Appalachian, Corn Belt, Delta States, Lake States, Mountain, Northeast, Northern Plains, Pacific, Southeast and Southern Plains. The Corn Belt region had an average cropland value of $6,710 per acre in 2018, compared to $1,810 per acre in the Mountain region. Since 1997, the Northern Plains has experienced the greatest growth in value in all three land categories. Kansas, Nebraska, North Dakota, and South Dakota values are included in this region, in which general agricultural land values have increased by 351%, cropland values have increased by 347%, and pastureland values have increased by 419%. The Lake States followed closely with growth of over 300% in the three categories. Corn Belt farmland also appreciated substantially. This adds to the argument that investing in farmland may be desirable, especially in the Midwestern United States. Figure 2.7 contains a more complete picture of regional agricultural land values.

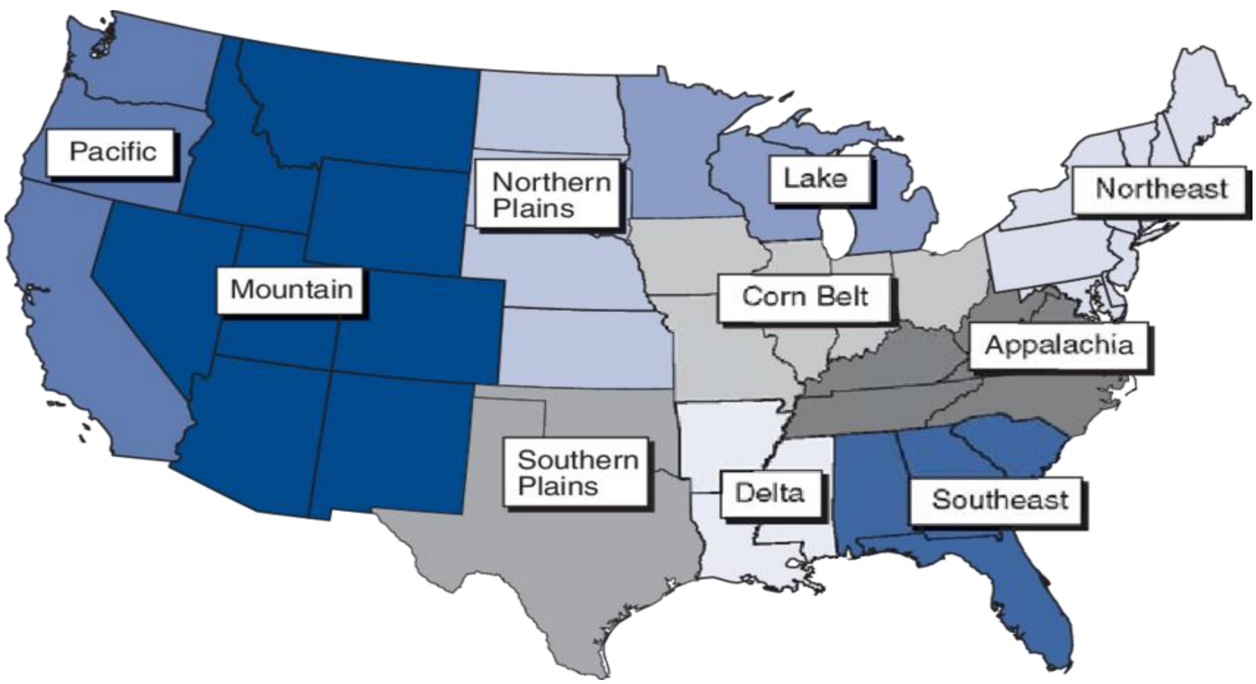

Figure 2.6. United States Agricultural Regions
Source: USDA

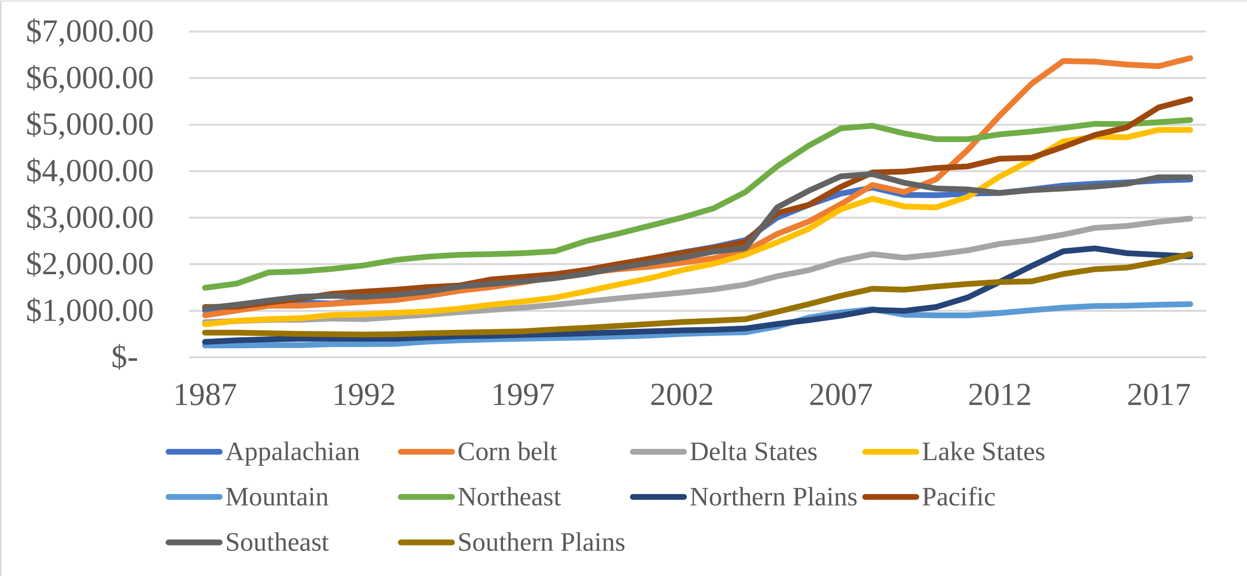

Figure 2.7. Regional Agricultural Land Values per Acre, 1987 to 2018
Source: USDA

State level analysis provides an even deeper look at farmland values across the United States. According to data from USDA NASS, New Jersey had the highest cropland and pastureland values in 2018, which were $12,900 and $12,500, respectively. New Jersey and a few of the other states with extremely high land values are all part of the Northeast region, which is home to less farmland acreage than many other regions, including the Corn Belt and Northern Plains. North Dakota cropland value per acre increased 368% from 1997 to 2018. However, this was not the greatest relative value increase in the region because South Dakota cropland values increased by over 600% during those two decades. North Dakota's other neighbors also experienced increased cropland values. Specifically, Montana cropland values increased by 125% and Minnesota cropland values increase by 340%.

Among the Midwest states summarized in Figure 2.8, it comes as no surprise that Iowa cropland consistently stood out as the most valuable farmland. However, even in an agricultural hotspot such as Iowa, values are still recovering after peaking in 2014. Although the peak year varies from 2014 to 2015, six of the seven states included in Figure 2.8 experienced some softening in land values due to reduced commodity prices following the highly profitable 2010 to 2013 period. For example, North Dakota cropland held an average price per acre of $840 in 2010 that increased through 2015, ultimately reaching a peak at $2,140 dollars per acre. In other words, North Dakota farmland owners saw their most important asset more than double its value in six years.

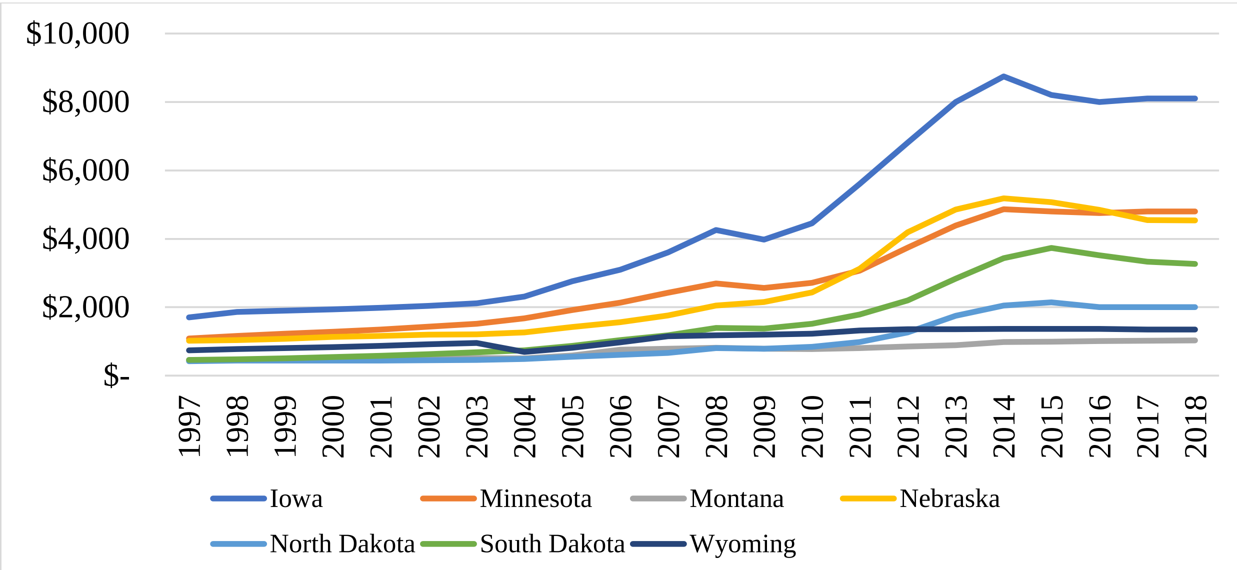

Figure 2.8. Cropland Values per Acre for Selected States, 1997 to 2018
Source: USDA

While farmland values have appreciated consistently throughout the time period included in this study, it should be noted that farmland values have experienced several bubbles throughout time, or extended periods of value appreciation, followed by a burst of that bubble, or a swift depreciation of value in a short time period. Figure 2.9 displays the value of U.S. agricultural land including buildings from 1919 to 2018 in both nominal and real dollars. The real values were adjusted by a consumer price index (CPI) given by the United States Bureau of Labor Statistics that uses years 1982 to 1984 as the base. The real values account for inflation year over year, giving a more realistic value for agricultural land. U.S. agricultural land values steadily increased throughout the 1910s and early 1920s. By 1922, values dropped and only continued to decrease and become stagnant until 1942. Land values experienced another bubble beginning in the 1980s after appreciating throughout the 1960s and 1970s. The 1980s bubble caused many farmers to liquidate farm assets and change their lifestyle. While farmland values have been dependable for the majority of the twenty-first century, investors must still be aware of potential downfalls if farmland value patterns repeat themselves.

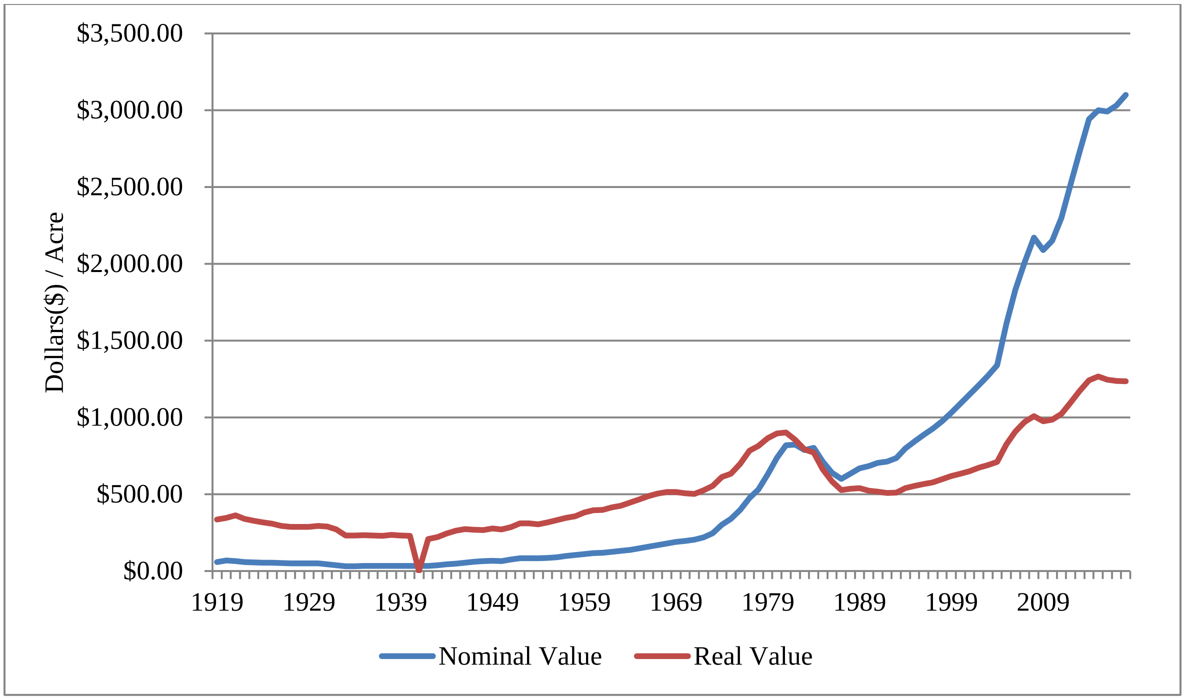

Figure 2.9. Nominal and Real U.S. Agricultural Land Values, 1919 to 2018
Source: USDA, U.S. Bureau of Labor Statistics

2.4. Estimating Farmland's Value

There are countless methods for estimating the value of land because its intangible qualities create complexities in valuation. The income approach is a method of valuing farmland which appraises land's value based on the income the property generates. A parcel's value is found by dividing its net operating income by a capitalization rate. Market valuation is another method that is frequently used as a starting point in real world transactions. In market valuation, a parcel's value is based on what similar land has recently been sold for in the area, with adjustments made for the recentness and similarity of the comparison sales. When making a transaction, buyers and sellers need to come to an agreement on a value, which is most often based upon the market.

Rent to value (RTV) calculations can also be used to understand farmland values. RTV is simply calculated by dividing the rental rate for a farmland parcel by the parcel's value. According to the income capitalization approach to farmland valuation, RTV should be close to the interest rate at a given point in time. That is, an RTV of 10% implies that the capitalization rate is 10% and that market interest rates are also near to that value. Alternatively, the reciprocal of RTV is called the RTV multiplier. It can be calculated by dividing a parcel's value by its rental rate. Figure 2.10 illustrates how RTV multipliers have behaved over time in each of the three land categories. The RTV multiplier has increased noticeably for each category, most prominently with a 100% increase for pastureland since 1997. Agricultural land including buildings' multiplier has increased by 65%, and cropland has increased 49% in that time frame.

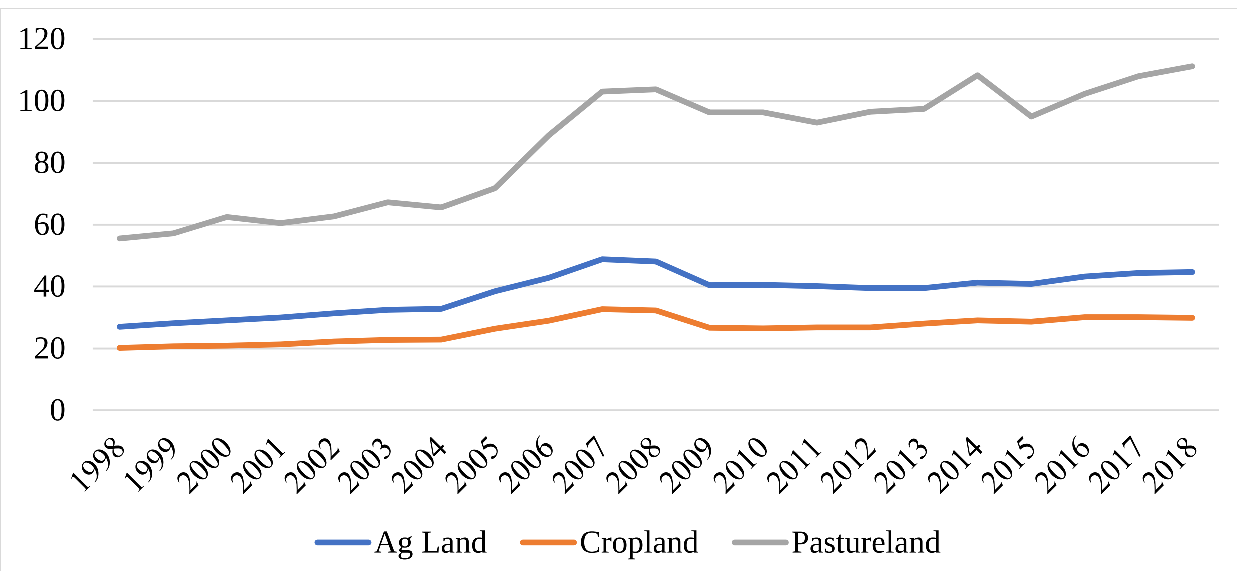

Figure 2.10. United States Farmland RTV Multipliers, 1998 to 2018
Source: USDA, FRED

Table 2.4 displays the changes in RTV multipliers for 37 states that had rent and value data for all years. The table's columns show each included state's RTV multiplier every five years from 1997 to 2017. The table reveals drastic changes in some RTV multipliers during the two-decade time period. North Dakota's RTV climbed from 14.37 to 35.77 in those years. During the same time, the U.S. Treasury 10-Year Bond rate ranged from 6.35% in January of 1997 to 2.91% in December of 2018. Analyzing the correlation coefficient between states' RTV multipliers and the interest rate change is another way to understand the relationship between the two. In theory, if the interest rate on long-term bonds increases, farmland's attractiveness should decrease because of the better earning potential of the low-risk asset. That is, there should be a negative correlation between interest rates and farmland values.

Of the states described in Table 2.4, Indiana's RTV multipliers hold the closest relationship to interest rates with a correlation coefficient of -0.90. Other states with large negative relationships are Iowa, Illinois, North Dakota, and Minnesota. Interestingly, RTV multipliers in states such as Missouri, California, New Mexico, and Florida have strong positive correlations with interest rates. Although interest rate changes seem related to farmland values, the exact relationship is variable across the country. There seems to be no regional trend that can fully explain these scattered correlations.

With so many ways to estimate land's value and so many immeasurable aspects of that value, it is useful to analyze the portfolio investment aspect of farmland ownership through CAPM. Landowners and investors may both be interested in knowing if the CAPM holds as a worthy method of valuing land risk and returns. If the data does not hold true to the model, perhaps this method is a poor perspective for farmland's risks and returns.

Table 2.4. State RTV Multipliers, 1997 to 2017

	1997	2002	2007	2012	2017
Alabama	51.15	62.29	70.79	68.24	68.76
Arkansas	-	30.24	45.00	38.16	41.69
California	-	521.31	696.90	60.50	63.40
Colorado	-	26.70	65.75	42.30	49.60
Delaware	44.80	68.39	154.68	94.59	80.05
Florida	224.94	274.15	361.86	119.97	110.17
Georgia	199.43	48.02	91.35	43.39	38.64
Idaho	-	24.86	51.15	26.93	29.29
Illinois	19.24	20.23	29.81	30.49	34.84
Indiana	21.23	26.43	32.69	35.02	37.62
Iowa	16.08	17.55	24.39	29.86	37.08
Kansas	136.59	23.00	29.42	33.93	38.83
Kentucky	30.87	43.22	57.26	32.25	35.23
Louisiana	308.72	30.32	36.47	42.30	46.87
Maryland	72.82	85.28	152.05	83.38	71.48
Michigan	29.62	45.42	56.86	38.22	41.42
Minnesota	15.82	20.07	31.50	26.55	30.62
Mississippi	180.16	28.70	37.22	31.04	28.82
Missouri	143.46	160.15	212.76	34.39	36.78
Montana	84.38	34.93	72.95	59.90	67.91
Nebraska	116.43	15.42	20.26	25.60	27.13
New Jersey	179.75	221.05	377.98	201.81	182.55
New Mexico	174.16	165.90	211.59	84.91	76.53
New York	48.01	58.33	70.03	64.14	55.39
North Carolina	53.56	67.88	90.53	71.85	60.03
North Dakota	14.37	14.84	19.89	25.46	35.77
Ohio	30.43	39.18	46.95	41.72	41.21
Oklahoma	119.65	132.96	177.42	73.74	96.25
Oregon	-	37.57	56.65	36.33	43.08
Pennsylvania	57.08	86.64	99.80	80.38	76.84
South Carolina	84.48	102.49	144.51	97.42	78.84
South Dakota	62.70	72.11	99.38	25.55	32.32
Tennessee	40.47	53.92	69.25	58.37	58.09
Texas	136.38	60.34	115.69	127.88	145.98
Utah	-	125.89	391.27	135.88	150.31
Virginia	67.86	93.12	147.26	122.18	109.27
West Virginia	73.57	121.49	219.17	347.27	114.81
Wisconsin	23.32	34.86	54.80	39.78	41.69
Wyoming	-	82.06	133.86	69.80	73.89

*Any "-" signifies the respective state's rent data was unavailable for 1997.
Source: USDA, FRED

3. LITERATURE REVIEW

3.1. Investment Diversification

Risk is inherent with investing. Every investor possesses different risk preferences, which are personal tolerances for taking on risk. It makes sense that a person who tolerates risky investments is doing so to pursue high returns. A risk-averse investor can eliminate much of the risk by carrying a diversified portfolio of stocks, bonds, securities, or other holdings. Diversification in a portfolio is achieved when the returns of included assets offset each other during times of loss for some assets. Perfectly offsetting investments possess a correlation coefficient of negative one. Diversification is done to protect an investor from suffering in times of uncertainty and creates more stable returns. Some of a portfolio's risk is undiversifiable. This risk is called systematic risk. However, unsystematic risk can be eliminated from a portfolio through diversification of assets. Investing in relatively uncorrelated assets prevents the investor from losing value in several assets simultaneously if one particular asset is experiencing a downward trend.

The E-V model outlined by Markowitz (1959) is at the foundation of efficiency analysis. The E-V model creates a portfolio comprised of assets in their optimal proportions. This optimal investment portfolio experiences returns greater than all others when measured in return per unit of risk assumed. Markowitz defined two common wants within all investors: they want returns to be high; and they want dependability, stability, and certainty with their portfolio. Markowitz proved that diversification, or owning assets with low correlation with each other, provides a portfolio with much less overall risk than that associated with the individual assets.

The Capital Asset Pricing Model (CAPM) developed by Sharpe (1964) is another method for analyzing investment risk. Sharpe concludes that if investors carry efficient portfolios, they should only be concerned by the total portfolio risk, or systematic risk, provided by adding another asset, rather than the unsystematic risk that an asset holds while on its own. The CAPM approach has been applied to farmland returns by Peter Barry (1979). Barry analyzed eleven agricultural regions across the United States from 1950 to 1977. He found that holding farmland as an investment added little to no systematic risk to a well-diversified portfolio, as most farmland risk is diversifiable risk. Excess returns to farmland alone (6.60%) proved to be higher on average than that of stock-bond indexes (4.31%), while an index including all three investment types provided returns of 4.74%. Although the excess returns are more modest when including farm real estate, stocks, and bonds, the risk associated with farmland has a significantly lower range than the risk of common stocks and risk comparable to long-term bonds.

Ibbotson and Siegel (1984) studied common stocks and real estate values between 1947 and 1982, finding that other asset returns did not match the rate of inflation during this period. Ibbotson and Siegel also noted the differences between real estate and typical stocks, bonds, and cash. Real estate is not easily transferrable to cash, due to its large transaction costs. Real estate transactions at a parcel's appraised value are not instantaneous for three particular reasons. First, the appraised price of real estate is simply an approximation of its market value, which is truly unknown, while the transaction price may end up changing. Next, every piece of real estate has unique characteristics, creating a niche and limiting buyers. Finally, once the two interested parties seek each other out, they must come to an agreement on price and deal structure, thus leading to more complexity. In related research, Kaplan (1985) found that farmland provided an increase in total returns to a portfolio, as well as low correlation with other assets, increasing the ability to achieve diversification.

Libbin, Kohler, and Hawkes (2004) conclude that the most important result of the CAPM is the relevant risk of an asset, and its contribution of risk to a portfolio. This relevant risk is represented by the beta coefficient, which is discussed further in Chapter 4. This beta coefficient inside the CAPM equation tends to be higher for an asset with a high standard deviation of returns. Assets with high risk on their own will contribute more risk when brought into a portfolio. Assets with high correlation to the market will also have high beta coefficients, because high correlation isn't diversifiable in a portfolio. Hence, an asset's movements up and down with changes in the market are measured by its beta coefficient. Assets with average levels of risk tend to have beta coefficients near 1.0. Less risky investments have beta coefficients closer to zero, and riskier investments are above 1.0.

More recently, Painter (2011) examined the risk and return of investing in Canadian farmland after the 2008 recession. Painter found that an investor with low risk tolerance would not have benefitted from taking on a farmland or gold investment from 1972 and 2009, but an investor seeking a medium level of risk associated with their portfolio would have benefitted. These investments may add systematic risk to a portfolio, but this may be overshadowed by the diversification benefits. It is crucial for investors to understand the difference between risk that farmland holds alone and the small amount of systematic risk it carries into a portfolio when added. Painter showed farmland to be less risky than stocks, gold, and other real estate investments, and reiterated that there is little to no correlation with other financial assets' returns.

Deininger (2011) sought to discover if the recent surge in farmland investment was similar to past spikes in farmland demand, or if investors were pushing a new boundary in land purchasing. Deininger found that in countries with an abundance of farmland, but less structure in the rights and transfers, there were generally more transfers of farmland around 2009.

Regression analysis showed that much of the transfer of farmland that took place during this resurgence was due to domestic investors, rather than foreign investors finding their way into other countries.

Painter (2015) used CAPM to evaluate the risk premium associated with North American farmland while comparing it to other commonly held assets. He concluded that this farmland, referred to as North American FREIT, had a low beta value, meaning it provided little risk to a diversified portfolio. Along with the North American FREIT, gold and oil carried low or no beta. Painter pointed out that the CAPM is an equilibrium pricing model, suggesting that an asset should only provide a yield equal to its CAPM required yield. If this asset yields a higher return than this level, it is underpriced. The reverse is true for the opposite case. The way the asset price adjusts to its CAPM required yield is dependent on how investors buy or sell the asset, which corrects the price. If an asset is underpriced, investors will rush to take advantage of it, causing the price to rise. If the asset is overpriced, investors will sell it, thereby driving the price down.

3.2. Determinants of Farmland Value

Hanson (2013) examined the determinants of farmland prices in Illinois. He found that an important driver of farmland prices is pressure from the surrounding population. With the population constantly increasing, farmland is being transitioned into residential and commercial land in order to meet demand. Hanson found that transitional land tended to be sold for higher prices than other land because the developers were willing to pay in order to create more urban area. Developers can make a profit while paying higher land prices simply by increasing their selling price in the next transaction. Hanson also found that soil quality is connected to farmland price. Quality soil is more productive in farming, therefore generating more income. Land that earns more income from productivity tends to have a higher value.

Schnitkey and Sherrick (2011) explain how risk in the real estate market is influenced by income and capitalization rates. Schnitkey and Sherrick note that present value models are often used when assessing farmland value. These models include current returns, expected returns through growth rates, and a discount factor. Some more complicated versions may include capital gains, property taxes, income taxes, as well as transaction costs. However, whether the model is simple or includes several variables, one thing is consistent: farmland value comes from discounted future returns. Decreases in the discount factor, also known as the interest rate, increase values. The opposite is true for increases in interest rates, because increases in interest rates drive down farmland attractiveness. Since the 1980s, interest rates have been on a gradual decline, thus raising the attractiveness and value of farmland. Farmland's long-term investment characteristics make its value more sensitive to interest rate changes than short-term assets. Commodity prices are another determinant of value, because they determine a parcel's income generating potential. That is, with increases in commodity prices come increases in the value of farmland, although this effect tends to lag slightly behind the current market.

4. MODEL, DATA, AND METHODOLOGY

4.1. Model

In this paper, the excess returns of owning agricultural land are regressed on the excess returns to market by way of the CAPM formula, which is defined by:

$$E(R_i) = r_f + \beta_i[E(R_m) - r_f] \tag{4.1}$$

where $E(R_i)$ is the expected return on asset i, r_f is the risk-free rate of return, β_i is the beta coefficient for asset *i*, and $E(R_m)$ is the expected return on the market portfolio, Subtracting the risk-free rate from expected returns puts equation (4.1) in terms of excess returns to both asset *i* and the market portfolio. The relationship between these excess returns can then be estimated by regressing a time series of individual asset excess returns, which are returns to farmland in this study, against a time series of market portfolio excess returns. That is:

$$ER_{it} = \alpha_i + \beta_i ER_{mt} + e_{it} \tag{4.2}$$

where ER_{it} and ER_{mt} are excess returns on asset *i* and the market portfolio, respectively, in period *t*, and e_{it} is the error term. Alpha (α_i) is expected to be zero, and any nonzero estimates imply returns or losses on asset *i* are greater than those needed to account for systematic risk.

In the formula above, a particular category of farmland is referred to as asset i. The risk-free rate of return is a return that can be earned on an asset that is considered to be risk-free. In Section 4.2.2 the risk-free asset is described. The market portfolio is comprised of returns to stocks, bonds, and other assets that represent a typical portfolio. The beta coefficient for i, β_i, represents the systematic risk that farmland presents in a well-diversified portfolio. Mathematically, the beta coefficient is defined as:

$$\beta_i = \left(\frac{\sigma_i}{\sigma_m}\right)\rho_{im} \tag{4.3}$$

where β_i is the beta for asset i, σ_i is the standard deviation of returns to asset i, σ_m is the standard deviation of returns to the market portfolio, and ρ_{im} is the correlation coefficient between asset i's returns and the returns of the market. The standard deviation and correlation coefficient components of beta are a reminder that beta represents both an asset's riskiness, from dividing the standard deviation of the asset by the market's, and its correlation to the market.

As mentioned in Chapter 3, the beta coefficient is arguably the most important component of the CAPM equation because it explains an asset's systematic risk. That is, beta explains the risk associated with farmland that results from its responsiveness to changes in the market. Section 4.2 explains the data used for this study's estimation of the CAPM. .

4.2. Data and Variables

The components of the CAPM formula are discussed in this section, A discussion of how data were shaped to fit this study's requirements is also presented. Finally, this section includes an overview of the variables that collectively form the CAPM model for farmland investment.

4.2.1. Farmland Return Variables

Agricultural land values were found through the United States Department of Agriculture's National Agriculture Statistics Service (USDA, NASS). Land values were found for three geographic levels: individual states, agricultural regions, and national. The agricultural regions are ten regions defined by the USDA. Data were also collected for three different types of agricultural land: agricultural land including buildings, cropland, and pastureland. Values are specified in dollars per acre. Data values from 1997 to 2018 were collected.

USDA data were used to compile information for land in farms, cropland acres, pastureland acres, and woodland acres. Cropland, pastureland, and woodland acreage totals were collected via the Census of Agriculture. Because the censuses are usually completed every five years, all years in between the censuses lacked acreage totals. A straight-line smoothing process was used where the differences in acres between one census and the next were connected by distributing the difference evenly over the years without census data.

Property tax data were gathered from the United States Department of Agriculture Economic Research Service (USDA ERS) in the form of state and national agricultural property taxes per year. Yearly data was available through 2018. Because property taxes data were available in aggregate dollar amounts at the state and national levels, a conversion to dollars per acre was necessary. For this conversion, aggregate property taxes were divided by acreage totals in each state and in the United States as a whole.

The generalized category of farmland, agricultural land including buildings, was calculated using its corresponding land values, property taxes, and the aforementioned weighted rents from upcoming Equation (4.6). In this general category, property taxes per acre were simply found by dividing annual total property taxes by the corresponding land in farms acreage totals. This method provided general returns to agricultural land.

Cropland and pastureland differ in many ways including usage, profitability, value, and cash rent. Returns were calculated differently for each type of land. Using the land value and rent per acre, simple return equations were set up for each cropland and pastureland. For these simple returns, property taxes were found by dividing total property taxes by the land in farms acreage total. This method treats all acres, cropland or pastureland, as if they are taxed the exact same. This, of course, is not the case. Land is taxed proportionally to its value, so if a parcel is worth more than another parcel it will be taxed as such. This applies to cropland and pastureland more often than not, because cropland tends to be more expensive due to its theoretical profitability through production.

In order to asses property taxes paid more appropriately, a second method of assigning property taxes was developed. First, the total dollar value of the broad agricultural land including buildings, cropland, and pastureland categories was necessary for each year in each territory, shown in Equation (4.4). Both V_t and $Acres_t$ represent the value and acres in the corresponding land category for year t.

$$Asset\ Value = V_t\ x\ Acres_t \tag{4.4}$$

Then,

$$Taxes\ per\ Acre_{Cropland,Pastureland} = \frac{\left(\frac{Asset\ Value_{Cropland,Pastureland}}{Asset\ Value_{Agricultural\ Land}}\ x\ Total\ Property\ Taxes\right)}{Total\ Acres_{Cropland,Pastureland}} \tag{4.5}$$

With the total dollar values for the three farmland categories were determined, Equation (4.5) was used to compute annual property taxes per acre for both cropland and pastureland. By using Equation (4.5) the amount of property taxes assessed to cropland or pastureland is a percentage of the total property taxes, based on the amount of included cropland or pastureland acres, then divided by the number of cropland or pastureland acres in order to achieve the per acre unit. This property tax formation addresses the fact that cropland and pastureland are not assessed taxes of the same amount because of valuation differences. It assigns a more accurate proportion of the total taxes to the different land categories. As mentioned, not every acre of land is the same, therefore not every acre is taxed the same. Unfortunately, this creates a downside to the specificity of the property tax calculation, because this estimation treats every cropland acres within a state the same, and every pastureland acre within a state the same.

USDA ERS provided total land in farms acreage for individual states and the United States as a whole. Each state's cropland, pastureland, and woodland acres were then weighted to better understand land distribution within the country's land in farms, and more specifically the Midwest. Woodland accounts on average for seven percent or less of Illinois, Indiana Iowa, Kansas, Minnesota, Montana, Nebraska, and Wyoming's land in farms. In North and South Dakota, woodland acres accounted for less than one percent of land in farms, while Wisconsin was the outlier with nearly 19% of land in farms accounted for by woodlands. This analysis of the three subcategories' acreage weights for each respective state was done to create more accurate assumptions about property taxes. Because woodland accounts for such a small percentage of the land in farms, in this study it is assumed that the vast majority of agricultural property taxes are distributed throughout cropland and pastureland in farms.

USDA data provide only an aggregate dollar amount of rent paid annually for a generalized land category that includes buildings. Because of this, it was necessary to create a weighted rent formulation that describes average rents for the most general farmland category. The weighted rent calculation mentioned is defined as:

$$Weighted\ Rent = \left(\frac{Cropland\ Acres}{Cropland\ Acres + Pastureland\ Acres}\ x\ Cropland\ Rent\right) + \left(\frac{Pastureland\ Acres}{Cropland\ Acres + Pastureland\ Acres}\ x\ Pastureland\ Rent\right) \tag{4.6}$$

Equation (4.6) explains the computation behind creating a weighted rent value for each respective state, region, and the U.S in the given year included.

Agricultural land value and rent data are from annual surveys of farmers and ranchers administrated by the USDA. Because of a lack of survey participation, some states lack observations throughout the time period. In most cases, if a state did not have sufficient data for one category, the other categories lacked as well. This is especially common for the small, east coast states such as Connecticut, Delaware, Maine, Massachusetts, New Hampshire, Rhode

Island, and Vermont. Other states that provided poor data were those with a small or unusual agricultural footprint. Examples of these are Alaska, Hawaii, and Nevada. In the case of rent, far more states were missing observations, making the calculation of returns difficult without eliminating many states from the study. Many of the states lacking USDA NASS data were missing property tax values from the USDA ERS as well. However, with only a few exceptions, the Midwestern states that were the focal point of this study tended to have near complete sets of data.

Returns to agricultural land are the topic of this study. The calculation for a simple return to farmland is described as:

$$Return = \frac{(V_t - V_{t-1}) + r_t - T_t}{V_{t-1}} \tag{4.7}$$

where V_t is the asset value per acre in time period, and V_{t-1} is the asset value per acre is the preceding year. Rent per acre is listed as *r*, and *T* is the property taxes paid per acre. Rent is included in this return calculation because of the income an acre of farmland may generate when not operated by its owner.

The returns per acre of farmland were finally calculated as shown in Equation (4.7). Because returns for the agricultural land category required weighted rents to be created, only states with full series of both cropland and pastureland were included. The cropland taxed generally and the more specific cropland categories each had 29 states able to be included, while the agricultural land, generally taxed pastureland, and more specific pastureland categories all had 17 included states.

Excess returns are the farmland's value return (simple return) less the risk-free rate. In this study the risk-free rate is the interest rate on a 1 Year U.S. Treasury bond. Short-term treasury bonds are considered to be risk-free because of their low and inelastic, yet positive rates.

Excess returns to agricultural land including buildings are given in percentages in Table 4.2.1. This table describes the mean, standard deviation, and coefficient of variation for excess returns of the nation, 10 agricultural regions, and 17 states. The full time series 1998 to 2018 was used for these results. As the table illustrates, farmland has provided very solid returns throughout the time frame, especially in the states that are known to be highly involved in production agriculture. From a regional standpoint, the Northern Plains agricultural land averaged a 9.55% excess return, followed by the Corn Belt at just over 8%. Many of the states that make up these regions displayed even greater returns when observed individually. Iowa, Nebraska, and North Dakota all earned excess returns to farmland above 10%, followed closely by Minnesota (9.04%) and Illinois (8.08%). These are substantial returns that would please many landowners or investors. Regions earning the lowest excess returns were the Appalachian and Southeast. Among the states earning the lowest returns were Alabama, North Carolina, and Virginia with excess returns of 2.67%, 2.94%, and 2.77% respectively. The market value return less the risk-free rate averaged a 5.41% excess return throughout the same time period. It is clear that nationally, United States farmland provided better returns than the market, while just six of the included states fell below the market returns.

Table 4.1. Excess Returns to Agricultural Land, 1998 to 2018

Territory	Mean	Standard Deviation	Coefficient of Variation
United States	6.45%	4.62%	0.72
Appalachian Region	3.44%	3.81%	1.11
Corn Belt Region	8.06%	6.26%	0.78
Delta States Region	5.69%	2.69%	0.47
Lake States Region	7.73%	4.70%	0.61
Mountain Region	5.43%	7.44%	1.37
Northeast Region	2.63%	3.95%	1.50
Northern Plains Region	9.55%	8.83%	0.92
Pacific Region	6.34%	4.82%	0.76
Southeast Region	3.41%	7.70%	2.26
Southern Plains Region	5.72%	4.41%	0.77
Alabama	2.67%	2.34%	0.87
Colorado	4.54%	4.99%	1.10
Georgia	4.33%	8.83%	2.04
Illinois	8.08%	7.20%	0.89
Iowa	10.17%	9.15%	0.90
Kansas	6.80%	8.16%	1.20
Louisiana	5.14%	3.24%	0.63
Minnesota	9.04%	6.40%	0.71
Mississippi	5.59%	2.49%	0.45
Montana	5.98%	11.97%	2.00
Nebraska	10.35%	9.65%	0.93
North Carolina	2.94%	4.22%	1.44
North Dakota	10.28%	10.13%	0.99
Tennessee	3.49%	3.03%	0.87
Texas	5.74%	4.76%	0.83
Virginia	2.77%	6.26%	2.26
Wisconsin	7.65%	4.94%	0.65

4.2.2. Market Variables

Comparisons to market returns are key to the CAPM model used in this paper. Therefore, the next step is creating a theoretical market portfolio that demonstrates the return that investors can expect. This market portfolio exemplifies where typical investors place their savings. As Barry (1979) noted, a complete representation of the world investment market is virtually impossible to create. Indeed, there are far too many investment avenues throughout the world to condense them into this study. However, it is important to account for the sectors with significant market shares. A few of the most common investments are stocks and bonds. Because this study focuses on returns to farm real estate, farm real estate is also included in the market portfolio.

Because the overall stock and bond market is nearly impossible to represent and include in this study, market proxies were used in order to simulate as much of the market as possible. The first step in creating this overall proxy is gathering an index for stock investment. This was done using the Fama and French 5 Factors (2x3) dataset, given by the Kenneth French data library (Dartmouth College 2019). The Fama and French 5 factors use six value-weighted portfolios formed on three criteria: size and book-to-market, size and profitability, and size and investment. This includes the New York Stock Exchange, AMEX, and NASDAQ firms. The Fama/French series was created using data from the Center for Research in Security Prices (CRSP).

The bond side of this proxy was Barclay's United States Aggregate Bond Index, which has the ticker symbol LBUSTRUU. This index has also been known as the Barclay's Capital Aggregate Bond Index and the Lehman Aggregate Bond Index in the past. The LBUSTRUU is weighted based on market capitalization, meaning included securities are weighted by their market size. Nearly all U.S. traded investment bonds are captured, including Treasury securities, government agency bonds, mortgage-backed bonds, corporate bonds, and a small number of foreign bonds traded in the U.S.

The overall market was comprised of the stock and bond proxy and farm real estate, all of which were value weighted. The value invested in farm real estate in a given year was calculated by multiplying the number of acres in U.S. farms by the. average price of U.S. agricultural land, annually. The value of stock investments is represented by the U.S. corporate equity investment value, given by the St. Louis Federal Reserve. Total U.S. debt securities, also given by the St. Louis Federal Reserve, represent the value of bond investment. Interestingly, although U.S. farmland was worth roughly 2.87 trillion dollars in 2018, that is only 11% of the overall market portfolio of American investors simulated in this study. For the 21 years analyzed in this study, the overall market weights for farmland, corporate equities, and debt securities averaged 12.1%, 62.3% and 25.6%, respectively. After these annual weights calculated, they were multiplied by the annual return from each of the three corresponding sets of investment types, thus creating weighted returns. The overall market portfolio now is the sum of these three weighted returns, defined as:

$$Weight_{Farmland,Stocks,Bonds} = \frac{Asset\ Value_{Farmland,Stocks,Bonds}}{\sum Asset\ Value_{Farmland,Stocks,Bonds}} \quad (4.8)$$

The weights derived from equation 4.8 are then multiplied by the excess returns of agricultural land including buildings, debt securities, and corporate equities. These weighted returns are then summed to make up the total returns of the market portfolio. Equation 4.9 illustrates this calculation:

$$Market\ Return = \sum (Weight_{Farmland,Stocks,Bonds} x Excess\ Return_{Farmland,Stocks,Bonds}) \quad (4.9)$$

The final step in creating this study's variables was subtracting the risk-free rate from both the returns to farmland and returns to market, transforming them both into excess return series. This risk-free rate was measured in an annual percent and was not seasonally adjusted.

4.3. Methods

Regressions are estimated for three separate categories of agricultural land: agricultural land including buildings, cropland, and pastureland. Regressions are estimated at the state, regional, and national levels. Data from 1998 to 2018 are used to estimate these regressions. As shown in Equation (4.2), excess returns to farmland are regressed on excess returns to the market. The most important coefficient in this equation is beta (β_i), which is the indicator of the asset's systematic risk. In this study, each different asset, denoted *i*, is a farmland category at the state, regional, or national level.

This model can be estimated separately for geographic entities like states, regions, or the entire U.S. The data can also be pooled both regional and state analysis. These pooled series are advantageous because they provide more observations for regression analysis. This allows for aggregate results that may capture more of the systematic risk associated with the farmland assets.

The model can also be modified to use fixed and random effects. These forms of regression modeling cannot be conducted at the national level but they are possible for regions and states. With the fixed effects modeling, a territory-specific fixed term is added to the region and state equations. This may account for un-modeled effects specific to a particular region or state. The random effects model accounts for the structure of the panel data but does not assign a fixed term to each region or state.

Summary statistics for the national, regional, and state level models are posted in tables 4.2, 4.3, and 4.4, respectively. In each of the tables, excess returns are listed for the market portfolio, agricultural land including buildings, cropland and pastureland. Both cropland and pastureland returns were calculated using the more specific method of taxation that was previously mentioned.

Table 4.2. Summary Statistics for National Farmland Model

	Obs.	Mean	St. Dev.	Min.	Max.
Market return	21	0.054	0.111	-0.188	0.225
Agricultural land return	21	0.065	0.046	-0.021	0.192
Cropland return	21	0.073	0.055	-0.017	0.180
Pastureland return	21	0.042	0.063	-0.027	0.257

Table 4.3. Summary Statistics for Regional Farmland Model

	Obs.	Mean	St. Dev.	Min.	Max.
Market return	210	0.054	0.109	-0.188	0.225
Agricultural land return	210	0.058	0.060	-0.101	0.346
Cropland return	210	0.064	0.068	-0.087	0.400
Pastureland return	210	0.045	0.091	-0.159	0.840

Table 4.4. Summary Statistics for State Farmland Model

	Obs.	Mean	St. Dev.	Min.	Max.
Market return	357	0.054	0.109	-0.188	0.225
Agricultural land return	357	0.062	0.073	-0.217	0.471
Cropland return	357	0.064	0.073	-0.134	0.501
Pastureland return	357	0.053	0.106	-0.304	0.850

5. RESULTS AND DISCUSSION

The CAPM models discussed in the previous chapter were first estimated separately for each state, region, and the entire U.S. The full 21 year series from 1998 to 2018 was used. Table 5.1.1 displays results of the national and regional regressions of agricultural farmland including buildings. The beta coefficient at the national level was 0.008 and the alpha coefficient was 0.064. Beta was found to be not significantly different from zero, while alpha was significant at the 1% level. At the regional level betas ranged from -0.103 in the Southern Plains to 0.092 in the Northern Plains, all of which were not significantly different from zero. Alphas ranged from 0.026 to 0.078, and all were statistically significant at least at the 10% level.

Table 5.1. CAPM Regressions Results for National and Regional Agricultural Land Including Buildings, 1998 to 2018

	(α) Alpha	(β) Beta	R-Squared
United States	0.064***	0.008	0.000
	(0.012)	(0.095)	
Appalachian	0.037***	-0.042	0.016
	(0.009)	(0.077)	
Corn Belt	0.078***	0.042	0.006
	(0.016)	(0.129)	
Delta States	0.058***	-0.022	0.009
	(0.007)	(0.055)	
Lake States	0.078***	-0.009	0.000
	(0.012)	(0.097)	
Mountain	0.057***	-0.052	0.006
	(0.019)	(0.153)	
Northeast	0.027**	-0.008	0.001
	(0.010)	(0.081)	
Northern Plains	0.092***	0.092	0.013
	(0.021)	(0.181)	
Pacific	0.068***	-0.080	0.034
	(0.011)	(0.097)	
Southeast	0.036*	-0.035	0.003
	(0.019)	(0.158)	
Southern Plains	0.063***	-0.103	0.068
	(0.010)	(0.087)	
Observations	21		

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

State level regressions are reported in table 5.2. At the state level, betas ranged from -0.133 in Texas to 0.171 in North Dakota, none of which were significantly different from zero. State alpha values ranged from 0.026 in Alabama to 0.101 in Nebraska. All alphas were found to be statistically significant, with the majority significant at the 1% level. Beta standard errors were relatively large for all territories and the R-squared results tended to be low.

As many beta coefficients are negative, agricultural land including buildings proved to be a useful diversification tool when compared to the rest of the market. The states with positive beta coefficients are consistent with results from Barry (1979) as the betas all fall below 0.5, making them comparable to long-term bonds. Most common stocks include betas between 0.5 and 1.5 (Sharpe 1978), displaying their greater susceptibility to the market.

The same regression methods applied to agricultural land including buildings category were also applied to the cropland and pastureland categories. For cropland and pastureland, regressions were estimated for returns based on two different property tax calculations. That is regressions were estimated for the generally taxed cropland and generally taxed pastureland categories, but because these were less accurate than the cropland and pastureland categories with weighted taxes applied, results were deemed less important. Table 5.3 displays the more specific cropland CAPM results from regressing its excess returns on the market's excess returns. The United States cropland model held a beta of 0.047, which is not significant at the 1% level, and an alpha of 0.071, which is significant at the 1% level. Regional betas ranged from -0.161 in the Southeast to 0.067 in the Northern Plains. No regional betas are significantly different from zero. Regional alphas ranged from 0.031 in the Northeast to 0.101 in the Northern Plains and all alphas were statistically significant at the 5% or 1% levels.

Table 5.2. CAPM Regressions Results for State Level Agricultural Land Including Buildings, 1998 to 2018

	(α) Alpha	(β) Beta	R-Squared
Alabama	0.026***	0.019	0.008
	(0.006)	(0.048)	
Colorado	0.042***	0.062	0.019
	(0.012)	(0.102)	
Georgia	0.045*	-0.035	0.002
	(0.022)	(0.182)	
Illinois	0.078***	0.049	0.006
	(0.018)	(0.148)	
Iowa	0.098***	0.072	0.008
	(0.023)	(0.188)	
Kansas	0.060***	0.147	0.040
	(0.020)	(0.164)	
Louisiana	0.051***	0.0088	0.001
	(0.00811)	(0.067)	
Minnesota	0.087***	0.063	0.012
	(0.016)	(0.131)	
Mississippi	0.058***	-0.045	0.041
	(0.0061)	(0.050)	
Montana	0.065**	-0.101	0.009
	(0.030)	(0.245)	
Nebraska	0.101***	0.050	0.003
	(0.024)	(0.198)	
North Carolina	0.035***	-0.101	0.071
	(0.010)	(0.084)	
North Dakota	0.094***	0.171	0.035
	(0.025)	(0.205)	
Tennessee	0.037***	-0.040	0.022
	(0.0075)	(0.062)	
Texas	0.065***	-0.133	0.096
	(0.011)	(0.093)	
Virginia	0.030*	-0.047	0.007
	(0.016)	(0.128)	
Wisconsin	0.085***	-0.148	0.111
	(0.012)	(0.096)	
Observations	21		

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 5.3. CAPM Regressions Results for National and Regional Cropland, 1998 to 2018

	(α) Alpha	(β) Beta	R-Squared
United States	0.071***	0.047	0.009
	(0.014)	(0.113)	
Appalachian	0.040***	-0.014	0.002
	(0.008)	(0.067)	
Corn Belt	0.080***	0.044	0.005
	(0.018)	(0.145)	
Delta States	0.075***	0.050	0.033
	(0.0076)	(0.062)	
Lake States	0.083***	0.027	0.004
	(0.012)	(0.102)	
Mountain	0.063***	0.020	0.001
	(0.019)	(0.152)	
Northeast	0.031**	-0.133	0.083
	(0.012)	(0.101)	
Northern Plains	0.101***	0.067	0.006
	(0.025)	(0.203)	
Pacific	0.064***	-0.0073	0.000
	(0.019)	(0.157)	
Southeast	0.053**	-0.161	0.039
	(0.022)	(0.183)	
Southern Plains	0.067***	-0.112	0.108
	(0.009)	(0.074)	
Observations	21		

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Regression results for cropland in different states are shown in Table 5.4. State betas ranged from Georgia's -0.195 to North Dakota's 0.174. Pennsylvania and South Carolina were the only betas with statistical significance, both of which at the 10% level. State alphas ranged from 0.001 in New Jersey to 0.109 in Nebraska. All states' alphas were significant except for Delaware and New Jersey. The majority of beta standard errors were again relatively high and R-squared values tended to be relatively low with South Carolina cropland posting the highest R-squared of 0.178.

Table 5.4. CAPM Regressions Results for State Level Cropland, 1998 to 2018

	(α) Alpha	(β) Beta	R-Squared
Alabama	0.047***	-0.059	0.039
	(0.008)	(0.067)	
Arkansas	0.075***	0.095	0.128
	(0.007)	(0.057)	
Colorado	0.064***	0.161	0.061
	(0.017)	(0.146)	
Delaware	0.057	-0.002	0.000
	(0.035)	(0.293)	
Georgia	0.078***	-0.195	0.045
	(0.025)	(0.206)	
Idaho	0.078***	0.064	0.006
	(0.022)	(0.185)	
Illinois	0.079***	-0.002	0.000
	(0.019)	(0.158)	
Indiana	0.073***	0.020	0.001
	(0.016)	(0.139)	
Iowa	0.097***	0.056	0.004
	(0.024)	(0.198)	
Kansas	0.073***	0.084	0.010
	(0.023)	(0.190)	
Kentucky	0.057***	0.040	0.023
	(0.007)	(0.061)	
Louisiana	0.068***	-0.024	0.004
	(0.010)	(0.087)	
Michigan	0.057***	0.028	0.004
	(0.012)	(0.105)	
Minnesota	0.092***	0.094	0.022
	(0.017)	(0.145)	
Mississippi	0.083***	0.061	0.039
	(0.008)	(0.070)	
Montana	0.053***	0.064	0.011
	(0.017)	(0.141)	
Nebraska	0.109***	0.024	0.001
	(0.026)	(0.219)	
New Jersey	0.001	-0.005	0.000
	(0.017)	(0.146)	
New York	0.042***	-0.091	0.055
	(0.010)	(0.086)	
North Carolina	0.032***	-0.020	0.004
	(0.009)	(0.074)	
North Dakota	0.104***	0.174	0.028
	(0.028)	(0.237)	

Table 5.4. CAPM Regressions Results for State Level Cropland, 1998 to 2018 (continued)

	(α) Alpha	(β) Beta	R-Squared
Ohio	0.054***	0.024	0.003
	(0.011)	(0.094)	
Oregon	0.067***	-0.017	0.002
	(0.011)	(0.092)	
Pennsylvania	0.035***	-0.148*	0.142
	(0.010)	(0.083)	
South Carolina	0.042***	-0.155*	0.178
	(0.009)	(0.076)	
Tennessee	0.038***	-0.016	0.004
	(0.007)	(0.061)	
Texas	0.065***	-0.134	0.114
	(0.010)	(0.085)	
Virginia	0.038**	-0.073	0.013
	(0.018)	(0.149)	
Wisconsin	0.090***	-0.095	0.047
	(0.012)	(0.099)	
Observations	21		

Standard errors in parentheses
*** $p<0.01$, ** $p<0.05$, * $p<0.1$

Much like agricultural land, cropland proved to be an effective diversification tool with low betas. Cropland returns tend to withstand lulls in the market and its associated risk displays its portfolio capabilities. These beta coefficients display cropland's relatively safe performance compared to the changes in the overall U.S. market portfolio.

As mentioned, the less specifically taxed pastureland results have not been included though were tested. Table 5.5 displays the more appropriately developed pastureland regression results. Pastureland regressions followed the same steps as the aforementioned tests, and use data from 1998 to 2018. United States pastureland provided a beta of 0.031 and a significant alpha of 0.040 at the 5% level. Regional beta values ranged from -0.209 in the Pacific to 0.016 in the Northern Plains, while none were statistically significant. Regional alphas ranged from 0.013 in the Northeast to 0.091 in the Northern Plains. The Appalachian, Northeast, and Southeast regions were the only to have insignificant alphas.

Table 5.5. CAPM Regressions Results for National and Regional Pastureland, 1998 to 2018

	(α) Alpha	(β) Beta	R-Squared
United States	0.040**	0.031	0.003
	(0.016)	(0.130)	
Appalachian	0.026	-0.039	0.004
	(0.017)	(0.139)	
Corn Belt	0.058***	-0.091	0.035
	(0.013)	(0.110)	
Delta States	0.038***	-0.056	0.015
	(0.013)	(0.105)	
Lake States	0.079***	-0.157	0.074
	(0.016)	(0.127)	
Mountain	0.045*	-0.015	0.000
	(0.025)	(0.209)	
Northeast	0.013	-0.039	0.006
	(0.014)	(0.113)	
Northern Plains	0.091***	0.016	0.000
	(0.021)	(0.172)	
Pacific	0.039**	-0.209	0.101
	(0.017)	(0.144)	
Southeast	0.058	-0.185	0.012
	(0.047)	(0.386)	
Southern Plains	0.055**	-0.120	0.029
	(0.020)	(0.160)	
Observations	21		

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 5.6 contains state level results. Betas for the states varied from -0.25 in Wisconsin to 0.108 in North Dakota. Pastureland betas were not significantly different from zero for any state. State alphas ranged from 0.222 in Virginia to 0.10 in North Dakota. 13 of 17 states' alphas were significant at least at the 10% level, with Colorado, Georgia, Montana, and Virginia being those that were not. Much like agricultural land and cropland, standard errors of betas were relatively high and R-squared values were low. Pastureland appears to be inversely responsive to the market in most of the 10 regions and 17 states included in this regression model, meaning it is extremely useful in diversification measures.

Table 5.6. CAPM Regressions Results for State Level Pastureland, 1998 to 2018

	(α) Alpha	(β) Beta	R-Squared
Alabama	0.027**	0.055	0.017
	(0.012)	(0.096)	
Colorado	0.023	0.085	0.014
	(0.02)	(0.161)	
Georgia	0.048	-0.195	0.011
	(0.053)	(0.432)	
Illinois	0.063*	0.043	0.002
	(0.030)	(0.251)	
Iowa	0.090***	-0.056	0.004
	(0.027)	(0.218)	
Kansas	0.057**	0.076	0.010
	(0.021)	(0.175)	
Louisiana	0.027*	-0.001	0.000
	(0.013)	(0.109)	
Minnesota	0.083***	-0.104	0.019
	(0.021)	(0.169)	
Mississippi	0.039**	-0.100	0.033
	(0.015)	(0.125)	
Montana	0.068	-0.055	0.001
	(0.048)	(0.399)	
Nebraska	0.095***	-0.057	0.004
	(0.026)	(0.210)	
North Carolina	0.026*	-0.044	0.007
	(0.014)	(0.118)	
North Dakota	0.100***	0.108	0.016
	(0.023)	(0.193)	
Tennessee	0.028*	-0.112	0.037
	(0.016)	(0.131)	
Texas	0.053**	-0.138	0.038
	(0.019)	(0.160)	
Virginia	0.022	0.004	0.000
	(0.023)	(0.193)	
Wisconsin	0.093***	-0.25	0.134
	(0.018)	(0.146)	
Observations	21		

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Barry is the pioneer of applying CAPM to farm real estate. He applied this methodology to national and regional farm real estate over the years of 1950 to 1977, which was an interesting time period because it did not include major events such as the Great Depression, the 1980s farming crisis, and the World Wars. Betas from Barry's study were similar to this study, in that all were low. However, none of his betas were negative. Another similarity between the two studies is that betas tended to be statistically insignificant, while alphas proved the opposite.

In Painter's CAPM analysis of North American FREIT from 1972 to 2013, beta was 0.010. The North American FREIT's beta is also similar to betas found in this study because it was low and was also found to be statistically insignificant. Painter concluded that because of this low beta, farmland adds no risk to a diversified portfolio and should earn yields similar to a risk free asset, but has outperformed its CAPM required yield throughout time. The low betas estimated in this study could be partially explained by the correlation matrix in Table 2.1. Specifically, multiple types of farmland held negative correlations with the assets that comprise the market portfolio, which ultimately leading to low and negative beta coefficients throughout the estimations.

Although Barry and Painter conducted similar studies of CAPM on different time periods and regions, there are several important takeaways from their results that may be applicable to the results of this study's CAPM regression models. All alpha values from each of the three discussed tables were positive, which may imply that farmland has offered premiums above those for systematic risk. In other words, this particular farmland investment outperformed the market and most individual assets as well (Barry 1979). Although the R-squared results in this study appear to be quite low, they are consistent with values reported from previous studies conducted on individual securities.

Regional data were pooled in order to conduct further regression analysis. Table 5.7 displays the results for regional pooled models. Variables were each land category's excess returns and the market excess returns. For each of the three categories, beta values were insignificant, ranging from -0.09 in pastureland to -0.022 in the agricultural land and cropland categories. Alphas were significant at the 1% level, ranging from pastureland's 0.050 to cropland's 0.066. The R-squared of each of these models is low, with pastureland's model having a value of 0.011.

Table 5.7. Pooled CAPM Regressions Results for Agricultural Region Regression, 1998 to 2018

	Agricultural Land	Cropland	Pastureland
Alpha (α)	0.059***	0.066***	0.050***
	(0.0047)	(0.005)	(0.007)
Beta (β)	-0.022	-0.022	-0.090
	(0.038)	(0.043)	(0.058)
Observations	210	210	210
R-squared	0.002	0.001	0.011

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

State data were also pooled to further regression analysis. This pooled analysis allow for the number of observations to multiply for the five categories of land included, which is helpful in trying to decipher the overall coefficients associated with farmland. Table 5.8 shows the full results from the state pooled regressions of each of the categories. Beta coefficients ranged from -0.044 in pastureland to 0.0 in agricultural land including buildings, and were statistically insignificant for each of the three land categories. Alphas ranged from 0.056 in pastureland to 0.064 in the cropland category, and were again significant at the 1% level. Again, almost none of the variation in the models was explained, according to the very low R-squared values.

Table 5.8. Pooled CAPM Regressions Results for State Level Regression, 1998 to 2018

	Agricultural Land	Cropland	Pastureland
Alpha (α)	0.062***	0.064***	0.056***
	(0.004)	(0.003)	(0.006)
Beta (β)	-0.00	-0.002	-0.044
	(0.035)	(0.027)	(0.051)
Observations	357	609	357
R-squared	0.000	0.000	0.002

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Both fixed and random effects models were applied to the data in order to capture other risk effects from farmland investment. The first random effects models were conducted for all land types at the state and regional levels, and results were similar to pooled regression results. At both the geographical levels the beta coefficients for all three land types were negative with no statistical significance. All alpha coefficients were statistically significant at the 1% level. The fixed effects models were conducted and results were nearly identical. Beta coefficients at both levels and for all land types were small and negative with no significance. Alphas were again highly significant for all land types at both levels. Statistically insignificant beta coefficients simply mean that they are small and indistinguishable from zero, which signifies very low systematic risk provided by the types of farmland.

For further analysis, random and fixed effects models were conducted using the pooled data. Table 5.9 illustrates the random effects model on the three land types at the regional level. Beta coefficients were negative for each of the land types, and all were statistically insignificant. Alpha coefficients were statistically significant at the 1% level for each land type.

Table 5.9. Random CAPM Regressions Results for Agricultural Regions, 1999 to 2018

	Agricultural Land	Cropland	Pasture
Alpha (α)	0.059***	0.066***	0.050***
	(0.007)	(0.008)	(0.008)
Beta (β)	-0.022	-0.022	-0.090
	(0.037)	(0.042)	(0.057)
Observations	210	210	210
Number of Regions	10	10	10

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

A random effects model was then applied to the farmland types at the state level. The results of this estimation are displayed in Table 5.10. Much like the regional level, significance was not found in any of the beta coefficients. All beta coefficients were again negative, and all alpha coefficients were again significant at the 1% level.

Table 5.10. Random Effects CAPM Regressions Results for States, 1999 to 2018

	Agricultural Land	Cropland	Pastureland
Alpha (α)	0.062***	0.064***	0.056***
	(0.007)	(0.005)	(0.007)
Beta (β)	-0.000	-0.002	-0.044
	(0.034)	(0.026)	(0.051)
Observations	357	609	357
Number of States	17	29	17

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Fixed effects models were applied to the regional and state level pooled datasets. At the regional level, beta coefficients were again all negative and statistically insignificant. Alpha coefficients were again all statistically significant at the 1% level. Results from these models are included in Table 5.11.

Table 5.11. Fixed Effects CAPM Regressions Results for Agricultural Regions, 1999 to 2018

	Agricultural Land	Cropland	Pastureland
Alpha (α)	0.059***	0.066***	0.050***
	(0.004)	(0.005)	(0.007)
Beta (β)	-0.022	-0.022	-0.090
	(0.037)	(0.042)	(0.057)
Observations	210	210	210
R-squared	0.002	0.001	0.012
Number of Regions	10	10	10

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

State level results for the fixed effects model are displayed in Table 5.12. Much like the regional results, beta coefficients were all negative and statistically insignificant. Alpha coefficients were all significant at the 1% level.

Table 5.12. CAPM Regressions Results for States, 1998 to 2018

	Agricultural Land	Cropland	Pastureland
Alpha (α)	0.062***	0.064***	0.056***
	(0.004)	(0.003)	(0.006)
Beta (β)	-0.000	-0.002	-0.044
	(0.034)	(0.026)	(0.051)
Observations	357	609	357
R-squared	0.000	0.000	0.002
Number of States	17	29	17

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Because the original data used only dated back to 1998, the first regression estimation on the CAPM formula was conducted on a longer time series using only agricultural land including buildings data. The other categories did not have older data available. A longer time series analysis was conducted to test the validity of CAPM results previously noted in this study. Perhaps a longer time series with more data would provide different results, thus implying the significance of the length of study. This estimation uses data from 1986 to 2018. However, little significance was found in this model for both the beta and alpha coefficients. The beta coefficient was once again low with 0.054, stating farmland provides very little risk to a well-diversified portfolio. Results are shown in Table 5.13.

Table 5.13. CAPM Regressions Results for United States Agricultural Land, 1986 to 2018

	Agricultural Land
Alpha (α)	0.018
	(0.012)
Beta (β)	0.054
	(0.106)
Observations	33
R-squared	0.008

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

6. SUMMARY AND CONCLUSIONS

This study analyzes United States farmland investment by examining data from 1998 through 2018. Empirical results show that farmland has strong portfolio diversification potential when included in a well-balanced portfolio of United States investments. Farmland's returns have withstood the impacts of a recession, low commodity prices, and an unusual interest rate environment over the last two decades. Its systematic risk proves that is a low-risk investment that provides solid returns, especially throughout the predominantly agricultural states of the Midwest. Based on returns and diversification attributes, farmland in Illinois, Iowa, Minnesota, Nebraska, and North Dakota is among the top performers in that asset class.

The beta coefficients estimated in the CAPM model were largely statistically insignificant. That is, across a variety of farmland types, low beta coefficients proved that farmland is a useful diversification tool. While beta coefficients often lacked statistical significance, meaning they are small coefficients that are indistinguishable from zero. These coefficients demonstrate the minimal sensitivity of farmland returns to overall market turmoil. These results were comparable to those of similar studies conducted in the past. Although times and farmland values have changed, farmland's relationship to the market has not changed much. It is important for investors and land owners to understand that farmland is a powerful asset that is capable of producing consistent, strong returns all the while lessening the impact of a market loss. Based on these findings, it would make sense if FREIT investment continued to rise, as this investment vehicle is relatively new and has experienced strong positive market activity.

Throughout numerous CAPM regressions, alpha values tended to be highly significant, while the amount of variation explained by the models, or R-squared values, tended to be low. Past works by Barry and Painter have also reached similar results and conclusions when testing

CAPM on farmland. Indeed, investors are drawn to farmland because of its low risk and high return characteristics. Perhaps more importantly, it is most often uncorrelated with other commonly held assets. The high alpha, low beta attributes of real estate have been referred to as the "real estate risk premium puzzle" (Lusht 1988).

Real estate is generally illiquid when compared to other assets. Transaction costs, tax obligations, indivisibilities, and thin markets where about 1% of farmland changes ownership annually may bias resulting returns to farmland upwards. Nonetheless, the CAPM treats risk pricing equally throughout investable assets which provides important information about the effects of investor behavior and market characteristics. It also provides a framework for analyzing how risk preferences of farm and nonfarm investors can be influenced by tax, credit, and farm policies, and resulting implications for farm size, ownership, and control (Barry 1979).

As with any research, this study possesses limitations. At a fundamental level, Shahi and Shaffer (2017) found that CAPM does not account for asset return distributions changing over time, but rather assumes constant distributions. Therefore, CAPM may be overly simplistic or nor fully representative of the real world.

Because this study was highly dependent on data gathered from USDA surveys, many states were not included due to unavailable data. This was particularly true for states on the east coast and states with unique topographies such as Alaska, Hawaii, and Nevada. Because of this, many of these states supplied the USDA with little to no data, excluding them from the study. Results of the CAPM regressions, however, would not have been altered greatly by the hypothetical inclusion of these states because of the relatively small portion of the United States' farmland within them. With complete data, this study could have analyzed each of the fifty states to go along with the regional and national levels.

The property tax data used in this study created additional limitations. As mentioned previously, property tax data were only given in dollars aggregated at the state and national levels. Although a select few states that had missing tax data, this problem was uncommon. Regional tax figures were then formed by combining data from the states in each region. This process, of course, is dependent on the states' reported data. In order to provide a more realistic proportion of taxes per cropland and pastureland, the weighted tax equation was implemented. This is not a perfect representation of actual tax dollars assigned, but it was necessary for better analysis.

Data on farmland values are not perfect. Part of the issue is that farmland type and production vary so greatly across the country, leading to difficulties in accurately measuring its aggregate value. Furthermore, with relatively few and nonrandom transactions occurring each year, the actual aggregate value of farmland may not be accurately derived from those sales. This highlights the importance of research on farm real estate by institutions such as land grant universities, Federal Reserve Banks, and the USDA, by way of surveys of market participants and empirical analysis (Kuethe 2016).

Future studies could extend the CAPM approach used in this study by adopting factor modeling. Factor models are asset pricing models that use many factors, such as size, value, market, returns, and expenses to determine an asset's investment properties. Implementing factor modeling of farmland could provide further insights about the asset's true advantages and disadvantages. Factor models may also use more in-depth analysis to better capture the variables that are not included in this CAPM application. These added variables can give a more accurate depiction to the risk-reward characteristics of farmland, compared to the other investment routes. Interest in farmland investment is extremely high and it seems likely that there will be further developments with assets such as FREITs. These possibilities are a reminder that research on farmland returns and ownership will be relevant well into the future.

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