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PREDICTORS OF LAND VALUE SOLD AT AUCTION IN RICHLAND, EDWARDS, AND LAWRENCE ILLINOIS COUNTIES

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Submitted in Partial Fulfillment of the Requirements for the
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With increasing land prices and high inputs prices, it is essential for farmers and investors to understand the land-specific determinants that drive value. A growing population and less farmable acres increases the need for a better understanding of the variables that may impact selling price. By implementing the auction method to sell land, the landowner is thought to receive the market price for the land sold on a specific time, date, and location. However, there has been very little research that describes the relationship between land variables and selling price when land is sold at auction. This study explores the potential relationship between land variables and the selling price of the land sold at live auction. With the results, farmers, investors, and auctioneers may be able to better understand the determinants of land value for land sold at auction. Investors and farmers might have more information available to them for valuing land when land is sold at live auction.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1

INTRODUCTION

The auction method is a sales tactic that dates back to Biblical history. Today, the auction method can be used to sell anything from art to airplanes. The sale of farmland at auction, while not a new idea, is valuable in the agricultural sector. The selling price of a property is the result of at least two potential bidders' willingness to pay. Selling price at auction is thought to be the exact market price for a specific time, date, and location. Understanding the variables that determine the selling price of a property may be useful to auctioneers and potential bidders.

The farm financial crisis of the 1980's served as a landmark era for modern agriculture. While there were several sectors come in to play which led to the financial crisis, the agriculture sector suffered the hardest blow. Farmers filed for bankruptcy as small farms were sold and large farms, only growing in size, fed off of the smaller farms. Much of the acts of the 80's have determined modern farming practices. Farmable acres are decreasing due to a growing population, large farms are growing, and family farms are becoming extinct.

The objective of this study is to identify the variables which have the most significant impact on the auction selling price of a property in Richland, Edwards, and Lawrence Illinois counties. Doing so will benefit both auctioneers and potential buyers in the region. A multiple regression model will illustrate the relationship individual variables have on the total selling price of a property. The model will demonstrate the impact of up to fourteen independent variables on total selling price at auction across 77 transactions during a five-year period. Research on selling prices of land at auction are limited; this study may encourage further research on the important roll auctions play in the economy. Because the auction method is the primary transaction method of farmland in these counties, an analysis of variables may be beneficial to auctioneers, farmers, and potential investors.

CHAPTER 2

AUCTION FORMS & PRACTICES

Auctions have transcended the longevity of time, dating back to the Roman Empire and early Greece. Some believe that Jacob, son of Abraham, was sold into slavery using a form of the auction method.[1] Today, auctions are used to set market prices, transact property, and settle dispute. Anything can be sold at auction: livestock, vehicles, personal property, art, and land are commonly found on the auction block. In this paper, we will focus on land transacted using the auction method. Therefore, it can from here be assumed that discussion of auctions will relate to the transaction of land.

Before identifying different auction forms, some common denominators are identified. The goal of any auction is to derive information in the form of bids from prospective buyers. Auctions seek to elicit buyers' individual willingness to pay and produce an outcome-- that is, who wins and pays how much. The auction method is a universal tool in the sense that it can be utilized to sell any good or service. According to Vijay Krishna, author of *Auction Theory*, the form of the auction is not dependent on the good or service offered.[2] The buyer is the bidder who displays the highest willingness to pay among all interested parties. While the type of auction is not dependent on the good, the extraction of the bidders' willingness to pay may be dependent on the auction form.

While the range of auction possibilities is endless, there are three primary types of auctions used today: ascending auctions (also known as English auctions), descending auctions

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[1] Paul R. Milgrom, "Auction Theory," *Advances in Economic Theory: Fifth World Congress* 1 (1985): 32.
[2] Vijay Krishna, *Auction Theory* 2nd ed. (Burlington, San Diego, London: Elsevier, 2010): 2-10.

(also known as Dutch auctions), and second-price sealed-bid auctions (also known as Vickrey auctions). English and Dutch auctions are conducted orally, while sealed-bid auctions are conducted silently. Ascending (English) auctions award a property to the highest bidder in a live bidding environment. In a live bidding environment, there is an auctioneer (who offers a property by chanting) and two to more interested parties who bid on the property. The property is awarded to the bidder to place the highest value on it. Buyers bid until no other potential buyer desires to place an additional bid. The bidder who placed the second highest value to the property is referred to as the back-up bidder.[3] While the back-up bidder does not leave with a new piece of property, he is still essential to the transaction.

When an English auction is conducted, a bidder is successful because his willingness to pay exceeds that of all other potential bidders. However, the English auction method may not capture the buyer's highest demand price. A descending (Dutch) auction opens the bidding with a price that is sure to be above what any potential buyer would be willing to pay. An auctioneer lowers the price in increments until one of the bidders accept the last price offer. Doing so captures most of the successful buyer's willingness to pay (Boulding 1948). If a potential bidder waits too long to bid, he runs the risk of forfeiting the property. This mentality urges the potential buyer to bid at his highest demand price (Cassady 1967).

When an English or Dutch auction is conducted, all potential bidders are aware of the highest bid. However, this is not the case for a Vickrey, or second-price sealed-bid, auction. According to Vickery (1961, p. 20), the second-price sealed-bid auction is conducted as "... the

[3] Vicki M. Coppinger, Vernon L. Smith, and Jon A. Titus, "Incentives and Behavior in English, Dutch, and Sealed-Bid Auctions," *Economic Inquiry* 18, No. 1 (1980): 1-22.

usual practice of calling for the tendering of bids on the understanding that the highest... bid ... will be accepted..." Vickrey argues that a sealed-bid auction is not in favor of a Pareto-optimal and (p. 20-21) "Bids are to be tendered on the understanding that the award will be made to the highest bidder, but at a price equal to the second highest bid." The sealed bids are withheld from public knowledge and the property is awarded to the successful bidder.[4]

A Pareto-optimality can be demonstrated in any of the three afore-mentioned auction methods. *Pareto Optimality, Game Theory, and Equilibria* by Altannar Chinchuluun (2008, p. 481-482) defines Pareto-optimality as, "... enjoying maximum ophelimity when no one can be made better off without making someone else worse off." This definition explains Vickrey's motive to accept the second highest bid and award the property to the highest bidder. If the highest bidder were awarded the property at the price of his own bid, he would not be made better off. Because sealed-bidding requires bidders to truthfully reveal their highest demand price, no utility gain would be made by the winning bidder.

An economic study by Coppinger, Smith, and Titus studies the Pareto-optimality of the English, Dutch, and Vickrey auctions. The study concludes English auctions tend to yield somewhat above the optimal price, Dutch auctions tend to yield below the optimal price, and second-price sealed-bid auctions tend to yield insignificantly above the optimal price.[5]
Charging a buyer’s premium at auction is a common practice among auction companies. The winning bidder pay the hammer price and an additional percentage, which is the buyer’s

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[4] Vickrey, “Counterspeculation, Auctions, and Competitive Sealed Tenders," 20-21.
[5] Coppinger, Smith, and Titus, "Incentives and Behavior in English, Dutch, and Sealed-Bid Auctions," 21-22.

premium. Most buyer's premiums hover around 10-17.5 percent.[6] While there is no recorded evidence evaluating the effects of a buyer's premium, many auctioneers who do not practice the buyer's premium believe that the buyer's premium lowers the total profit of the auction.

When large farms of parcels of land are sold at auction, they are often divided and sold using multi-parcel (multi-par) bidding systems. The auctioneer works closely with the seller to appropriately divide the farm or parcels of land. A multi-par bidding system allows interested bidders to bid on any tract or combination of tracts during the auction. Typically, the English auction form is used to sell land while using the multi-par biddings system. The multi-par bidding system is a technological improvement from using a large eraser board and employing staff to calculate the bids and combinations by hand.

While tracts may be sold individually, the multi-par bidding system offers a convenience to potential bidders. The multi-par screen shows the current winning bidder, the previous bid, the total price for a tract or combination, the price per acre for a tract or combination, and the total price of the sale at any time during the auction. The system can be made as confidential as necessary, as all or none of the afore mentioned information may be displayed to potential bidders at any time.[7]

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[6] Orley Ashenfelter and Kathryn Graddy, "Auctions and the Price of Art," *Journal of Economic Literature* 41 (2003): 763-786.
[7] Interview with Mark Rothrock, auctioneer/managing broker at Rothrock Auction LLC regarding the multi-parcel bidding system.

CHAPTER 3

FARM FINANCIAL CRISIS

The farm crisis of the 1980's served as a defining period for agriculture and farmland prices. The agriculture sector suffered the worst financial crisis that it has ever known, much due to what seemed as an agricultural boom in the 1970's. In the early 1970's, following World War II, the United States suffered a major trade deficit. Foreign countries did not place equal value to the dollar, making American exports seem expensive. To balance the trade disequilibrium, the United States moved to a floating exchange rate in 1973, which relied on supply and demand to determine the value of the dollar. During that time, the Vietnam War increased federal spending. Policy makers were concerned with a seemingly high inflation rate, and, therefore, imposed price controls (Barry, 2000).

According to Barry J. Barnett of Mississippi State University in his journal article *The U.S. Farm Financial Crisis of the 1980's*, "Expansionary fiscal policy is politically acceptable during times of recession, but contractionary fiscal policy is not politically acceptable at any time: a policy of higher taxes or less provision of government services has no political constituency." Imposing contractionary fiscal policy would likely have reduced inflation, but the motion to do so dare not be put on the table. Instead, tax policies and low interest rates encouraged investment. Price floors and price ceilings were implemented to maintain the prices of some agricultural commodities at dramatically high amounts. All of this created a mirage of relatively high and stable returns for those whom invested in agricultural land, an appreciating asset. Potential investors flocked to what is now known as the Farm Service Agency, who offered interest rates even lower than most banks and institutions.

In 1974, the inflation rate climbed up to around 11 percent. In 1977, the populist movement known at the American Agricultural Movement protested for lower commodity prices. Two years later, the Federal Reserve enacted contractionary fiscal policy, which led to higher interest rates and slower economic growth.[8] High interest rates came with ravage to the agricultural sector. Exports slowed as the value of the dollar raised and American commodities became monetarily less appealing to foreign markets. The Federal Reserve was successful in reducing inflation, as land values drastically declined. Asset values followed the same trend as land values, and producers were found under a heavy load of debt. Farm foreclosures rose, and owners were forced to sell for much less than they had paid. For farmers not forced to sell their land, government payments were responsible for a significant portion of the net farm income (Barry, 2000).

Rather than come to an abrupt halt, the farm financial crisis faded out. Historically, the agriculture sector is susceptible to periods of inflation and deflation. Figure 1. shows the yearly corn price per bushel average since 1980, according to the United States Department of Agriculture. From 1983 to 1986, corn prices fell drastically- hitting $1.50 per bushel by the end of that time period. Also during that period, land prices and asset prices crashed. The following years brought slow recovery for land prices and grain prices. In 2012, corn prices reached an all-time high, as did land prices. Figure 1 also shows the steady downfall of grain price since 2012. Whether or not history’s farm financial crisis is repeating itself in the same magnitude of the 80’s

[8] Barry J. Barnett, "The U.S. Farm Financial Crisis of the 1980's," *Agricultural History*, 74 No. 2 (2000): 336-380.

is debatable. Nevertheless, the periods of inflation and deflation in the agricultural sector are undeniable.

CHAPTER 4

CONSERVATION RESERVE PROGRAMS

Government policy plays a substantial role in agriculture, which may have an effect on how potential bidders' perceive a piece of property. In 1985, the Reagan administration signed the Conservation Reserve Program into law. The Conservation Reserve Program (CRP) encourages landowners to set aside environmentally sensitive farmland voluntarily in exchange for yearly rental payments. Land enrolled in CRP is typically contracted for 10-15 years. CRP allows the restoration of native plant and wildlife habitats while reducing soil erosion and improving water and air quality.[9]

A study by JunJie Wu and Haixia Lin, published by the University of Wisconsin Press (2010), finds CRP acres increased land value by $18 to $25 per acre. Wu and Lin used cross-sectional data from 1997 that covers 2,852 counties across the United States. To reach the results, Wu and Lin, "develops theoretical and empirical models to evaluate the effect of CRP on values of farmland and developed land." [10] Not only does CRP increase the value of farmland, but it also increases the value of developed land.

The Farm Service Agency (FSA) offers a variety of CRP programs to fit the needs of any landowner. CRP has several programs to preserve wetlands and floodplains. These include: Bottomland Hardwood Tree Initiative, Duck Habitat Imitative, and Floodplain Wetland Initiative. The Bottom Land Hardwood Tree initiative encourages the growth of oak, ash, maple, cypress, and other hardwoods found streamside. The initiative improves the environment by

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[9] USDA, Farm Service Agency, *Conservation Reserve Program*. www.fsa.usda.gov
[10] JunJie Wu and Haixia Lin, "The Effect of the Conservation Reserve Program on Land Values," *Land Economics* 86 No. 1 (2010): 1-21.

restoring hardwood forests near floodplain. In floodplain areas, hardwoods soil erosion and down-stream flooding. The hardwood forests are crucial habitat to many wild animals such as: turkey, migratory fowl, deer, and squirrels. [11] The Duck Habitat Initiative seeks to provide habitat to all migratory fowl but, specifically, duck species native to North America. [12] Many farmers face crop damage from flooding. Since the floodplains only offer a marginal amount of top soil, many farmers enroll floodplain acres into the Floodplain Wetland Initiative program. The floodplain is necessary, in that it provides shelter, protection, and food for native wildlife and fish.[13]

Other CRP programs include: Pollinator Habitat Initiative, Honeybee Habitat Initiative, Highly Erodible Land Initiative, and State Acres for Wildlife Enhancement Initiative. Because one-third of the food produced requires pollinators, the Honeybee Habitat Initiative and the Pollinator Habitat Initiative provide better access to nutrition for honeybees, butterflies, and wasps, beetles, moths, and flies. The Pollinator Habitat Initiative help to reduce the need for pesticides by creating an environment for predators of crop pests. [14] The Highly Erodible Land Initiative incentivizes landowners to retire land that is vulnerable to erosion. Long-term plant cover protects soil heath and water quality. [15] State Acres for Wildlife Enhancement (SAFE) is an "all of the above" initiative that ranges from wetlands to forests in order to restore natural wildlife habitat. SAFE includes buffers, wetlands, grasses, and trees that are specifically homes to endangered wildlife and fish species.[16] Along with several additional CRP options, these

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[11] USDA, Farm Service Agency, *Bottomland Hardwood Trees Initiative.* www.fsa.usda.gov
[12] USDA, Farm Service Agency, *Duck Nesting Habitat Initiative.* www.fsa.usda.gov
[13] USDA, Farm Service Agency, *Floodplain Wetland Initiative.*www.fsa.usda.gov
[14] USDA, Farm Service Agency, *Pollinator Habitat Initiative.* www.fsa.usda.gov
[15] USDA, Farm Service Agency, *Highly Erodible Land Initiative.* www.fsa.usda.gov
[16] USDA, Farm Service Agency, *State Acres for Wildlife Enhancement (SAFE) Initiative*. www.fsa.usda.gov

programs are far from all that CRP has to offer. Within each program are additional subdivisions that offer buffers and strips to landowners that may wish to enroll a small portion of tillable land to prevent run-off and improve the environment.

CHAPTER 5

THE PRODUCTIVITY INDEX

Soil can be a lead indicator in crop yield variability. Soil productivity indices take into account the inherent variability for soil types to produce crops. In 2000, the University of Illinois-Champagne-Urbana updated the soil productivity index (PI) and the list of soils types found in the state of Illinois. There are 998 recorded soil types in Illinois, each with its own PI.[17] Illinois soil productivity indices range from 47-147 and divide farmland into three prime agricultural land classes (Class A, Class B, and Class C). Prime soil types are determined by the use of productivity indices. Soils with optimum PI's range from 147-133, classified with Class A. Class B soils have PI's that range from 132-117, and Class C soils have PI's that range from 116-100. Any soil type with a PI that is 99 or below is not considered ideal for agricultural usage. Most Illinois soil types with PI's lower than 100 are found in the southern part of the state.

[17] Table 2 rev. Productivity of Illinois Soils Under Average Management, Slightly Eroded, 0 to 2 Percent Slopes From 1996 to present, the Illinois crop yield estimates and productivity indices by soil type were created by an UIUC, ACES task force of soil scientists, agronomists, crop scientists, and agricultural economists under the direction of Dr. Kenneth R. Olson, Professor of Soil Science in the Department of NRES.

CHAPTER 6

DATA AND METHODS

The data for the research regarding the predictors of land values in Richland, Edwards, and Lawrence Illinois counties is obtained from Rothrock Auction LLC. Rothrock Auction LLC is a traditional auction company operating out of Richland County, Illinois. The auction company conducts English auctions without using a buyer's premium. For some land auctions that offer two or more tracts of land to potential bidders, the auction company may use the multi-par bidding system. Using this system, land transactions are recorded by the acre per buyer and for the total amount. If one potential bidder is the winner of two or more tracts of land using the multi-par bidding system, it is accounted for as one transaction.

The data set is both cross-sectional and longitudinal data that contains 77 transactions between the three counties. For each individual transaction, the following are recorded:

- Year
- County
- Tillable Acres
- Non-Tillable Acres
- CRP Acres
- Waterway Acres
- Forest Acres
- Pasture Acres
- Productivity Index
- Improvements
- Price

Total selling price of the transaction is the dependent variable and all other variables are independent.

The 77 transactions occur during a five-year period: 2012-2016. Each acre type categorically divides the total acres of the transaction. Tillable Acres, Non-Tillable Acres, CRP Acres, Waterway Acres, Forest Acres, and Pasture Acres divide the acres. Categorical division of acres was determined through Farm Service Agency information and the auction bill- both of which were provided by the auction company.

The productivity index indicates the fertility of the soil in a transaction. Productivity indexes were found using Surety® - a customized online mapping system provided by AgriData Incorporated. All of the observed transactions have productivity indices which fall into the Class C category, according to the USDA's PI classifications. Any improvement found in this data is a pole barn or shed on a tract of land. While a house may be an improvement as well, the auction company did not sell a home with farmland in one single tract during the five year period.

Year, County, and Improvements are dummy variables. 2016-2012 take 1-5 respectively, with 2016 used as the base year. 2016 was chosen as the base year because of the significantly higher corn prices of 2012. (Figure 1.) Edwards County takes 1 (base), Richland County takes 2, and Lawrence County takes 3. For the improvements, a 1 or 0 is assigned. If there is an improvement on the property it takes the value of 1.

A multiple regression model is used to evaluate the relationship between the dependent variables and the independent variables. The Ordinary Least Squares (OLS) estimator will show the coefficients of the explanatory variable. The goal of this study is to calculate the total selling price of a land transaction by the estimated coefficients of the independent variables. The OLS estimator uses sample statistics to estimate the parameter for a linear regression model. OLS chooses the beta values that minimize the sums of squared errors. The OLS estimator makes six assumption that are essential to understanding of the results. The first assumption is the model is linear in its parameters. If a model were non-linear in its variables, it is still intrinsically linear in its parameters and can be corrected through logarithm. However, the opposite (non-linear in the parameters) is not able to be corrected. The second assumption assumes random sampling from the population. This is true for this data set in that the auction company cannot determine who will be the winning bidder until the hammer falls. Further, Rothrock Auctions $_{\text{LLC}}$ conducts live, pubic auctions and all members of the general public are invited to attend. Because the error term is a random variable, the dependent variable is random, too. The third assumption assumes the expected value of the mean of the error terms to be zero. The fourth assumption assumes there is no multicollinearity. Multicollinearity occurs when there is a linear relationship between two or more independent variables. The fifth assumption is homoscedasticity, meaning all the error terms have equal variances. The final assumption is error terms are normally distributed.

Several hypotheses are tested to evaluate the effects of the explanatory variables. Using a t-test, the null hypotheses will be individually rejected or failed to be rejected. The OLS estimator output will provide the calculated value for each independent variable, and the Student T table will provide the critical value at a 95 percent confidence interval. A two-tailed t-test will determine if the estimated coefficient for beta is statistically significant from zero. An F-test will determine if at least one variable is statistically significant from zero.

Equation 1.

Year and County variables are omitted from Equation 1. To accurately represent years and counties, they must be assigned dummy variables (Equation 2). Equation 1 is as follows:

Price per Acre= β_0 + $\beta 1$ (Tillable Acres) + β_2 (Non-tillable Acres) + β_3 (CRP) + β_4 (Waterway Acres) + β_5 (Improvements) + β_6 (PI) + β_7 (Forest Acres) + β_8 (Pasture Acres) + e_i

Where β_0 is the intercept of the dependent variable (price) when all independent variable are statistically insignificant from zero.

The hypotheses for Equation 1 are as follows:

1. H_0: $\beta_1 = 0$
2. H_0: $\beta_2 = 0$
3. H_0: $\beta_3 = 0$
4. H_0: $\beta_4 = 0$
5. H_0: $\beta_5 = 0$
6. H_0: $\beta_6 = 0$
7. H_0: $\beta_7 = 0$
8. H_0: $\beta_8 = 0$
9. H_0: $\beta_1 = \beta_2 = \beta_3 = \beta_4 = \beta_5 = \beta_6 = \beta_7 = \beta_8 = 0$

Under these hypotheses, some results can be expected. If the estimated coefficient is positive, then the independent variable associated with the positive coefficient increases the price of the transaction. If the estimated coefficient is negative, then the independent variable associated with the negative coefficient decreases the price of the transaction. The expected sign for the coefficients of and tillable acres, non-tillable acres, CRP, forest acres, pasture acres and waterway acres is positive. This is expected because, logically, every acre is worth some amount. However, some acres may decrease the total value of the land. Due to the results of a study discussed in the literary analysis, the coefficient for CRP is expected to be positive. Improvements are expected to have negative coefficients because they take away from income-producing acres. Improvements do not necessarily add value to a property.

Equation 2.

Dummy variables are used in this relationship. Each year and county is assigned a dummy variable, with 2016 used as a base for year and Edwards County used as a base for county. However, because of the dummy variables, degrees of freedom are lost. Equation 2 is as follows:

Price per Acre= $\beta_0 + \beta_1$ (Tillable Acres) + β_2 (Non-tillable Acres) + β_3 (CRP) + β_4 (Waterway Acres) + β_5 (Improvements) + β_6 (PI) + β_7 (Forest Acres) + β_8 (Pasture Acres) + β_9 (D2015) + β_{10} (D2014) + β_{11} (D2013) + β_{12} (D2012) + β_{13} (DRichland) + β_{14} (DLawrence) + e_i

Where *D* indicates that the variable is a dummy variable.

The hypotheses for Equation 2 are as follows:

1. H_0: $\beta_1 = 0$
2. H_0: $\beta_2 = 0$
3. H_0: $\beta_3 = 0$
4. H_0: $\beta_4 = 0$
5. H_0: $\beta_5 = 0$
6. H_0: $\beta_6 = 0$
7. H_0: $\beta_7 = 0$
8. H_0: $\beta_8 = 0$
9. H_0: $\beta_9 = \beta_{10} = \beta_{11} = \beta_{12} = \beta_{13} = \beta_{14} = 0$
10. H_0: $\beta_1 = \beta_2 = \beta_3 = \beta_4 = \beta_5 = \beta_6 = \beta_7 = \beta_8 = \beta_9 = \beta_{10} = \beta_{11} = \beta_{12} = \beta_{13} = \beta_{14} = 0$

Equation 2 acts as the unrestricted model, and Equation 1 acts as the restricted model. Equation 2 is the unrestricted model because it includes the dummy variables that account for additional influences on the dependent variable. Equation 1 acts as the restricted model because it does not include year and county, hypothesizing the following: H_0: $\beta_9 = \beta_{10} = \beta_{11} = \beta_{12} = \beta_{13} = \beta_{14} = 0$. If the null hypothesis is true, then we fail to reject the restriction because the estimated coefficients for the dummy variables years: 2012, 2013, 2014, and 2015, and counties: Richland and Lawrence are not statically significant from zero. If the restriction is not rejected, then Equation 1 offers sufficient representation of the data. If the tenth hypothesis in Equation 2 is rejected, then the restriction is rejected and Equation 2 more accurately represents the data. An F-test will show whether or not the restriction is valid.

The expected signs of the estimated coefficients should agree with Equation 1, except the new dummy variables for year and county. D2012 is expected to have a positive effect on the price per acre because of the record high corn prices during that year. There were no abnormalities during the other years, so outside conditions may be assumed and D2013, D2014, and D2015 may be either positive or negative. Richland and Lawrence counties are expected to have a positive effect on price per acre when compared to Edwards County because Richland and Lawrence counties have higher PI values, indicating more fertile soils.

CHAPTER 7

RESULTS

Table 2 in the appendices shows the univariate statistics for each variable.

The OLS estimator was used in this study, and the estimated coefficients are added to Equation 1:

Price = -22,8367.00 + 6611.48 (Tillable Acres) + 7802.89 (Non-tillable Acres) + 2087.99 (CRP) + 4492.09 (Waterway Acres) - 61411.90 (Improvements) + 2360.12 (PI) - 159.63 (Forest Acres) - 141.72 (Pasture Acres$_{)}$ + e

As expected tillable acres, non-tillable acres, CRP, waterway acres, and PI all resulted in positive estimated coefficients. The coefficient for tillable acres indicates a one-acre increase in tillable acres will result in \$6,611.48 increase in total price. A one-acre increase in non-tillable acres will result in \$7802.89 increase in total price. A one-acre increase in CRP will result in \$2087.99 increase in total price. A one-acre increase in waterway acres will result in \$4492.09 increase in total price. A one-unit increase in the productivity index will result in \$2360.12 increase in total price. Negative estimated coefficients for forest acres and pasture acres was not expected. For every one-acre increase in forest acres, total price decreases \$159.63. For ever one-acre increase in pasture acres, total price decreases \$141.72. The adjusted R^2 for Equation 1 is .9754, which indicates tillable acres, non-tillable acres, CRP, waterway acres, improvements, PI, forest acres, and pasture acres can explain 97.54 percent of the variation in total price.

To determine whether or not the estimated coefficients of the independent variables are statistically significant or not, a t-test is conducted using a critical value of +/- 1.671 with 60 degrees of freedom at the .05 level of significance. Although the actual degrees of freedom is 69, 60 degrees of freedom is used to determine the critical t-value because 70 would not accurately reflect the data because it does not have at least 70 degrees of freedom. Tillable acres has a significant test statistic of 35.236. Therefore, we reject the null hypothesis: H_0: $\beta_1 = 0$, because 35.236 is greater than +/- 1.671. The test statistic for non-tillable acres is 4.139, and we can reject the null hypothesis again. CRP has a calculated test statistic of 1.549, concluding we fail to reject the null hypothesis. When the null hypothesis is not rejected, it indicates the coefficient for CRP acres is statistically insignificant from zero. Waterway acre has a test statistic of 1.488, concluding we, again, fail to reject the null hypothesis. Improvements has a test statistic equal to -1.984, therefore, we reject the null hypothesis. Productivity index has a test statistic equal to 2.187, rejecting the null hypothesis. Forest acres has a test statistic equal to -0.2173, and pasture acres has a test statistic equal to -0.5283. For both forest acres and pasture acres, the null hypotheses are rejected. The calculated p-values conclude with the results of the t-test for Equation 1.

Equation 1 resulted in a calculated F-value of 337.255. With a F-critical value of + 3.30 with seven numerator degrees of freedom and 60 denominator degrees of freedom, we reject the null hypothesis. At least one beta is statistically significant from zero. The F-test concludes with the findings of the t-test.

To confirm the OLS assumption of no multicollinearity, a correlation matrix (Table 3) was created. The correlation matrix shows any correlation among independent variables. Most of the independent variables displayed correlation less than 0.30 and greater than -0.20. However, forest acres and tillable acres had a correlation coefficient of 0.55. While this indicates they are positively correlated and highly correlated, it is not to a degree which is considered problematic. The R^2 for Equation 1 indicates 97.45 percent of the variation in price (dependent variable) can be explained by the variation in the independent variables. Likewise, 2.55 percent of the variation in price cannot be explained by the independent variables. The model summary can be found in Table 6 of the appendices.

Equation 2 includes the dummy variables for year and county. The estimated coefficients are added to Equation 2:

Price = -22,9024.00 + 6611.58 (Tillable Acres) + 7614.83 (Non-tillable Acres) + 2170.28 (CRP) + 4008.29 (Waterway Acres) - 56522.9 (Improvements) + 2323.08 (PI) - 204.40 (Forest Acres) - 117.08 (Pasture Acres) + 771.58 (D2015) - 19848.70 (D2014) + 10874.10 (D2013) + 13786.70 (D2012) + 2307.43 (DRichland) + 9690.26 (DLawrence) + e

Again, tillable acres, non-tillable acres, CRP, waterway acres, and PI all resulted in positive estimated coefficients. However, the estimated coefficients for these variables are slightly different from Equation 1. As in Equation 1, improvements, forest acres, and pasture acres resulted in negative coefficients that are only slightly different from Equation 1. The primary motive to conduct Equation 2 is to observe the impact of the dummy variables: year and county. 2012 was expected to have a positive coefficient, and the expectation was met. 2015 and 2013 also had positive coefficients. 2014 resulted in a negative coefficient. As observed in Figure 1 in the Literary Analysis, 2012 recorded historically high corn prices. Corn and soybeans are the primary grain outputs for the areas observed in this study. In 2014, the corn price plummeted further, which may be the reason for the negative coefficient. As output value decreases, willingness to pay for inputs also decreases. 2016 is used as the base year. The total value of a land transaction increased $771.58 if it occurred in 2015 as opposed to 2016. The total value of a land transaction decreased $19,848.70 if it occurred in 2014 as opposed to 2016. The total value of a land transaction increased $10,874.10 if it occurred in 2013 as opposed to 2016. The total value of a land transaction increased $13,786.70 if it occurred in 2012 as opposed to 2016. When comparing the coefficients for 2012 and 2013, a 2013 transaction is $2,912.60 than a 2012 transaction. This may be due to output prices beginning to fall in 2013.

The t-test is also used for Equation 2 with a critical t-value of +/- 1.676 with 50 degrees of freedom at the .05 level of significance. The calculated t-value for tillable acres is equal to 35.236. As in Equation 1, we reject the null hypothesis for β_1. Non-tillable acres resulted in a t-value equal to 4.139, rejecting the null hypothesis. CRP has a t-value equal to 1.549, and waterway acres has a t-value equal to 1.488. Therefore, we fail to reject the null hypotheses for both CRP and waterway acres. Improvements has a t-value equal to -1.984, and PI has a t-value equal to 2.187. The null hypotheses for both improvements and PI can be rejected. Forest acres has a t-value equal to -0.262, and pasture acres has a t-value equal to 0.039. Again, we fail to reject these hypotheses. None of the dummy variables for year nor county displayed any significant t-values. Therefore, we fail to reject the null hypotheses for year 2015 (t = 0.041), year 2014 (t = -0.651), year 2013 (t = 0.468), year 2012 (t = 0.537), Richland County (t = 0.107), and Lawrence County (t = .311). Using the p-value, we fail to reject the null hypothesis for improvements with a p-value equal to .052. This conclusion does not match that of the t-test for improvements. However, because the p-value for improvements is considered marginal, it could be concluded either way. The p-values of all other variables agree with the t-test.

The F-test utilizes the sum of squared residuals from both Equation 1 and Equation 2 to create the modified F-value. The sum of squared residuals is the portion of error not explained by the regression line. The critical F-value is + 2.30 with thirteen numerator degrees of freedom and 60 denominator degrees of freedom. The calculated F-value is 0.192, which does not fall in the rejection region. Because 0.192 is less than 1.50, we fail to reject the null hypothesis. Because none of the dummy variables for years: 2012, 2013, 2014, and 2015, and counties: Richland and Lawrence posed any significance, we fail to reject the restriction and deem Equation 1 as sufficient representation of the data.

CHAPTER 8

DISCUSSION

This study resulted in Equation 1 sufficiently representing the data, with several significant variables. The independent variables explain most of the variation in price. Tillable acres has the largest impact on selling price for Richland, Edwards, and Lawrence counties' farmland. Non-tillable acres, CRP acres, waterway acres, improvements, and the productivity index are all significant, also. Forest acres and pasture acres did not pose any significance on the selling price of land. For these three counties, the variation in the independent variables explain 97.54 percent of the variation in the selling price at auction. We can conclude county and year show no significance in this study.

Three implications may be discussed in this study. Such a small sample size of only 77 observations may not produce results comparable to a larger sample size. If observations were spread across the state, more variation in soil types, auction methods, and farming practices may play a part in the findings. However, the three counties observed have comparable qualities, and the data set may be an accurate representation of the chosen geographical area. The second implication is noted when there are very few comparable studies. There are many studies examining auction theory and methods, but few studies observe the results of applying auction theory. Many studies have observed online auctions, but few observe live auctions. One reason for this may be the accessibility of online auction data. Because items are sold online, all data is automatically recorded. At a live auction, however, data must be manually recorded. The final implication is only one auction company. Observing data from several auction companies would provide a more accurate representation of the parameters. Having data from only one auction company goes hand-in-hand with a small sample size.

Farmers are trusted to make economic decisions based on both controllable and uncontrollable variables. With increasing inputs and decreasing outputs, land prices in the coming years are uncertain. Auctioneers, farmers, and investors may be able to use this model to estimate the selling price of land at auction in Richland, Edwards, and Lawrence counties. The live auction method has survived generations and will continue to be practiced in generations to come. Perhaps this model will lead to further auction-related studies regarding goods and services sold at auction.

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APPENDIX

Table 1. Definitions and descriptive statistics used in the empirical model

Variable	Description	Mean (SD)
DEPENDENT VARIABLE:		
Transaction Price		$321104.62 ($352898.4)
INDEPENDENT VARIABLES:		
Division of Acres According to Usage		
1.	Tillable acres are the number of acres on a tract currently used for farming	$45.358 ($51.12)
2.	Non-tillable acres- acres not used for farming, CRP, waterway, forest, or pasture	$0.698 ($4.42)
3.	CRP acres produce yearly government payments and help to protect wildlife and the environment.	$1.487 ($5.41)
4.	Waterway acres are acres used for drainage.	$0.841 ($2.81)
5.	Forest acres	$7.016 ($11.76)
6.	Pasture acres	$0.489 ($2.53)
Productivity Index		
1.	The productivity index accounts for the soil type fertility and likeliness to produce favorable yields on a tract of land.	103.058 (11.76)
INDEPENDENT DUMMY VARIABLES:		
Year of Transaction		
1. 2012	*1 if 2012, 0 otherwise*	
2. 2013	*1 if 2013, 0 otherwise*	
3. 2014	*1 if 2014, 0 otherwise*	2.273 (1.41)
4. 2015	*1 if 2015, 0 otherwise*	
5. 2016	*1 if 2016, 0 otherwise*	
Geographical Location by County		
1. Edwards County, Illinois	*1 = Edwards, 0 otherwise*	
2. Richland County, Illinois	*1 = Richland, 0 otherwise*	1.922 (0.53)
3. Lawrence County, Illinois	*1 = Lawrence, 0 otherwise*	
Improvements		
1.	Improvements in this data are pole barns. *1= improvement, 0 otherwise*	0.078 (0.27)

Table 2: Univariate Summary Statistics

Univariate statistics
=====================

Number of Observations: 77

	Mean	Std Dev	Minimum	Maximum
Price	321104.6	352898.4973	24000	2007000
Year	2014.727	1.4108	2012	2016
County	1.9221	0.5323	1	3
Tillable Acres	45.3577	51.1201	1	291.2
Non-tillable Acres	0.6986	4.4194	0	38.6
CRP	1.487	5.4101	0	40
Waterway Acres	0.8472	2.8103	0	20
Improvements	0.0779	0.2671	0	1
PI	103.0584	7.2671	89	128.8
Forest Acres	7.0166	11.7569	0	55.6
Pasture Acres	0.4896	2.598	0	2.53

	Sum	Variance
Price	2.473D+11	1.245D+11
Year	155134	1.99
County	148	0.28332
Tillable Acres	3492.54	2613.26671
Non-tillable Acres	53.79	19.53103
CRP	114.5	29.26915
Waterway Acres	64.77	7.89793
Improvements	6	0.072796
PI	7935.5	52.81009
Forest Acres	540.28	137.22653
Pasture Acres	37.7	6.39989

Table 3: 2012-2016 Independent Variables Correlation Matrix

Correlation Matrix

	Tillable	Non-tillable	CRP	Waterway	Improvement	PI	Forest	Pasture
Tillable	1.0000							
Non-tillable	0.2569	1.0000						
CRP	-0.0598	-0.0424	1.0000					
Waterway	0.1614	-0.0471	-0.0589	1.0000				
Improvement	0.2797	0.0652	-0.0741	-0.0876	1.0000			
PI	0.1598	0.2252	0.0477	0.0575	-0.0459	1.0000		
Forest	0.5519	-0.0563	0.1153	0.0729	0.2554	0.1669	1.0000	
Pasture	-0.1145	-0.0309	-0.0481	-0.0587	-0.0566	0.0065	-0.0347	1.0000

Table 4: Model Summary

Dependent Variable: Price, Equation 1 Mean of Price: 32,1102.63 R^2: 0.975 Adj. R^2: 0.973		Number of Observations: 77 F: 337.255 Chow Test (Equations 1 &2): 0.192	
Independent Variable	Estimated Coefficient	T-Value	P-Value
Tillable Acres	6611.48	37.751	.000
Non-tillable Acres	7802.89	4.659	.000
CRP Acres	2087.99	1.639	.106
Waterway Acres	4492.09	1.822	.073
Forest Acres	-159.63	-0.217	.829
Pasture Acres	-141.72	-0.053	.958
Improvements	-61411.90	-2.304	.024
Productivity Index	2360.12	2.426	.018

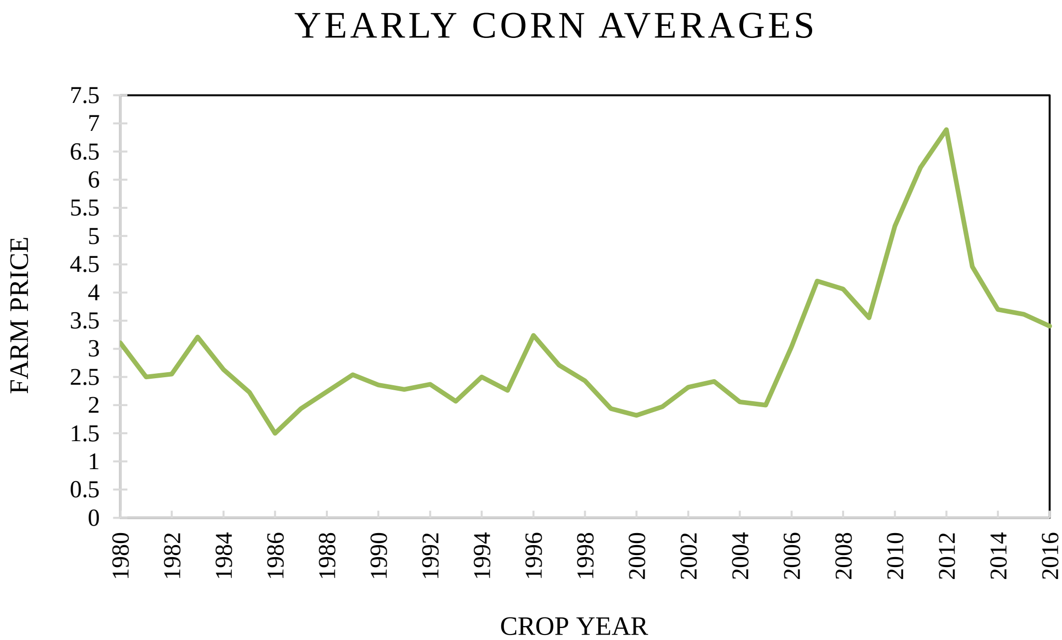

Figure 1. Yearly Corn Averages

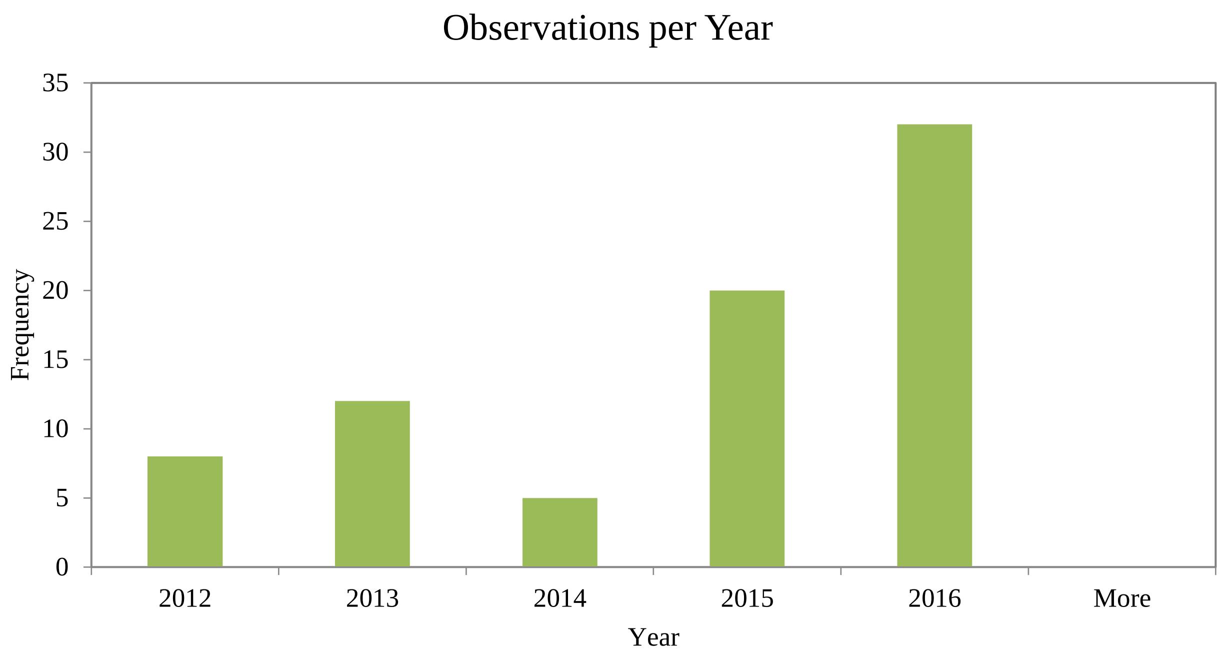

Figure 2: 2012-2016 Observations

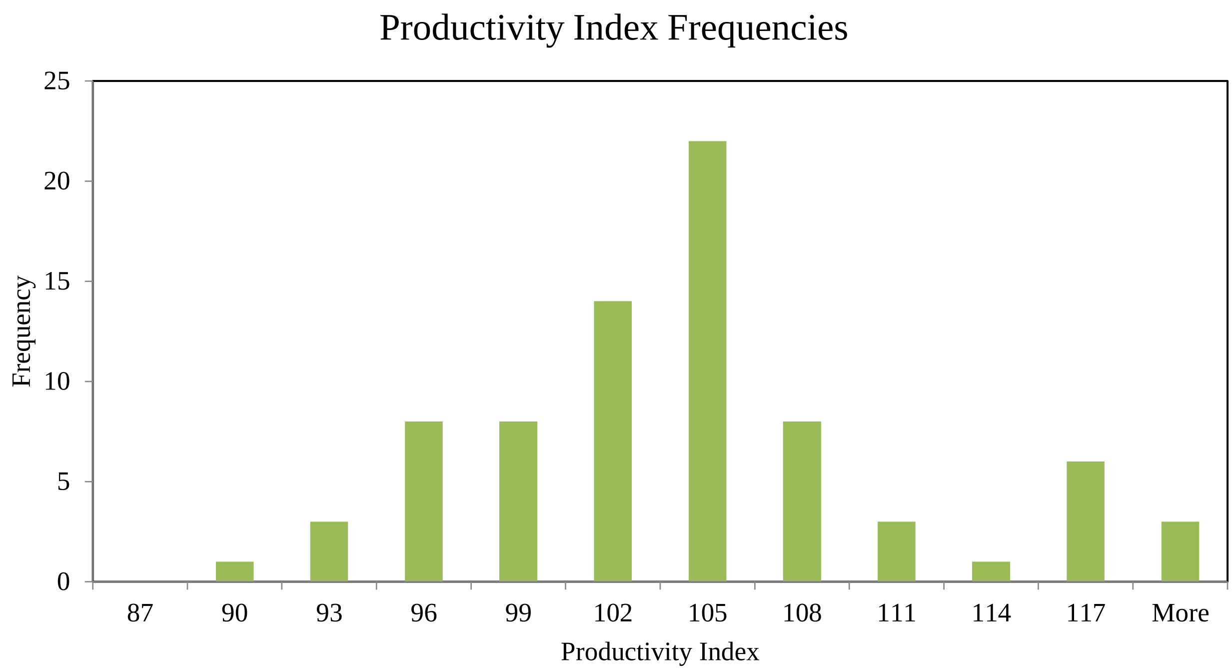

Figure 3: Productivity Index Frequencies

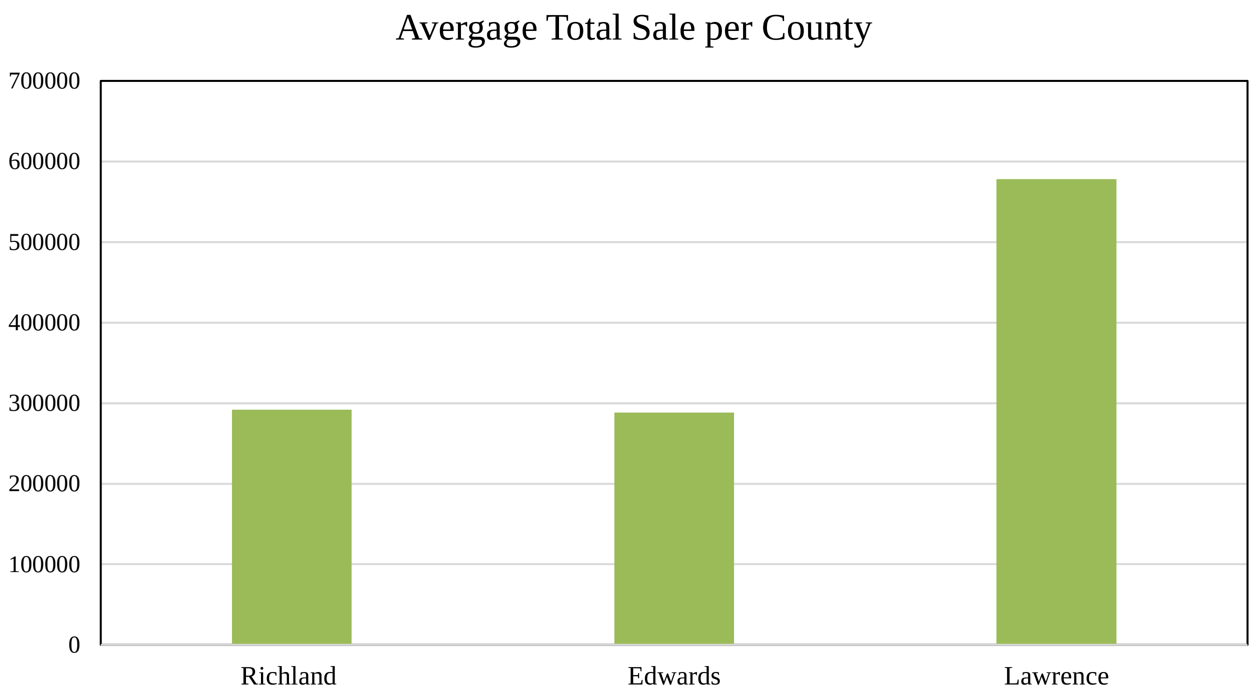

Figure 4: Average Total Sale per County

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