THE EFFECT OF ORGANIC CERTIFICATION ON FARMLAND VALUE

by

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABSTRACT

This research considers the relationship between organic certification and farmland values. We employ the ARMS survey data from 2003 to 2011. We construct three models with different organic status classifications. We control for differences in farm type, NASS crop district, urbanization, and year fixed effects. We find that organic certification has a significant (statistically and economically) effect on farmland value. Our model suggests that a 1 percentage point increase in a farm's organic land would result a 0.23 percentage point increase in the farmland rental rate.

INTRODUCTION

Increased demand for organic food (Dimitri and Oberholtzer (2009)) and growth in the number of organic farms in the U.S. (NASS (2012); USDA (2015); USDA (2016b)) raise new research questions about the economics of U.S. agriculture. According to the Organic Trade Association, total organic product sales reached $39 billion in 2014 (Figure 1.1) including organic food and non-food products (alcohol, personnal care, textiles). U.S. organic agricultural production has grown steadily along with the increased demand for organic foods. A recent survey shows that total certified organic acreage reached 43.3 million acres in the U.S. in 2015 (USDA (2016b)). Existing research shows that acreage of certified organic major crops (wheat, soybean, corn) have been steadily increasing over this time period (McBride, Greene, Foreman, and Ali (2015)).

Data from the USDA Agricultural Resource Management Survey (ARMS) show that on average certified organic crop land rents for more than double that of conventional land. This evidence motivates our research hypothesis that organic certification has a positive effect on farmland value.

The farmland that meets the USDA organic certification conditions will be referred to as organic land through the this paper. Certified organic farmland must meet certain conditions and follow the USDA regulations. We will discuss more details later in our paper.

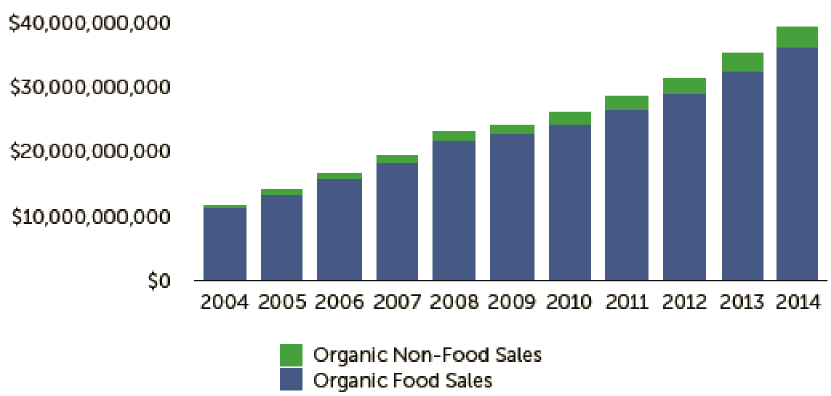
Our theory predicts that organic farmers may be willing to pay more for organic land if organic production is more profitable than conventional. Growing demand for organic products may lead to an increase of organic prices, therefore organic farmers could receive higher revenues. Also we predict that costs of organic practices are may be higher than conventional farming. The above mentioned statement is true, if the demand shift is accompanied by fixed supply. The potential economic gain is the main motivation to certify for organic farmers (Peterson, Barkley, Chacón-Cascante, and Kastens (2012)).

In order to consider the effect of organic certification we employ a simple output-input model in our research. According to the model, the demand shift for organic products will affect organic input markets, organic lands. The differences between conventional and organic land prices are not solely caused by the organic status. Thus we consider in our model other factors that could affect the value of organic land.

The literature on organic farming mainly compares organic and conventional farming in terms of profit and production potential (Richards (2011); Delbridge, Fernholz, King, and Lazarus (2013); Crowder and Reganold (2015); McBride et al. (2015)). Some literature analyzes economic factors and non-economic motives that affect farmers decision to certify as organic (Sierra, Klonsky, Strochlic, Brodt, and Molinar (2008); Veldstra, Alexander, and Marshall (2014); Trujillo-Barrera, Pennings, and Hofenk (2016)). Researchers argue that economic motives are the main reason driving organic farmers to certify as organic (Peterson et al. (2012); Trujillo-Barrera et al. (2016)). It is important to examine the relationship between organic certification and farmland value in context of organic products' profitability. Profitability has an impact on certification decision. We estimate the farmland value using standard farmland valuation models (Roberts, Kirwan, and Hopkins (2003); Hendricks, Janzen, and Dhuyvetter (2012)).

My research objective is to build a theoretical framework and econometric model capable of estimating the effect of organic certification on farm profitability and farmland values. The rest of my thesis is organized as follows. In the second chapter, I discuss the current state of U.S. organic agriculture and its issues. To do that we specifically focus on organic food demand and organic acreage supply. In the third chapter, we provide a literature review. The vast majority of current literature focuses on the financial performance of organic farming and its production efficiency. In the fourth chapter, we provide theoretical economic background on organic output and input markets. The effect of organic certification on the organic farmland market will be discussed. The research employs the Agricultural Resource Management Survey (ARMS). In the data section (chapter five), we discuss the ARMS survey features and present summary statistics. In chapter six, we provide econometric models and discuss regression results. The last chapter provides conclusions and a summary of my research.

Figure 1.1: Total U.S. Organic Sales Growth, 2004-2014



Source: Organic Trade Association

BACKGROUND

Organic Market

The U.S. organic market has experienced a rapid growth since at least 2004. Demand for organic food is one of main factors influencing industry growth. From $9 billion organic sales in 2002 it has increased up to $43.3 billion in 2015 (Figure 1.1; Greene and Kremen (2002)). An increase in organic food sales was due to the growth of retailers and wholesale markets. About 78% of organic sales go to wholesale markets and 14% go directly to retail markets (USDA (2015)). If we break down the organic sales by commodities, livestock and poultry products have $1.5 billion, vegetables - $1.25 billion, fruits and nuts - $1,032 billion, field crops - $718 million, livestock and poultry - $660 million respectively sales in 2014 (Figure 2.1; USDA (2015)).

According to USDA research certified organic crop acres increased from 1.3 million acres in 2002 to 3.1 million acres in 2011 (Greene (2009); Dimitri and Oberholtzer (2009); McBride et al. (2015)). The research shows that acreage of certified organic major crops (wheat, soybean, corn) have been steadily increasing over this time period. For example, organic wheat production has grown from 22,5000 acres in 2002 to 345,000 acres in 2011. Meanwhile acreage of certified organic corn increased from 96,000 acres in 2002 to 23,4000 acres in 2011. Certified organic wheat production has increased rapidly from 22,5000 in 2002 to 34,5000 in 2011, although organic wheat production reached its peak in 2008 with 400,000 acres (McBride et al. (2015)). The recent surveys on organic certified farmland indicate growth of total acreage from 2008 to 2015.

Input Market Changes

Organic farmland is an important input in the organic production process. An increasing demand on organic productions and foods will effect organic production input markets. In order to meet increased demand, the farmers should expand their production capacity. This decision will change the input allocation in organic food production. The farmers either increase organic acreages or increase production efficiency using intensive labors, fertilizers and other inputs. In this case, the demand for organic farmland will increase. Figure 2.3 shows the number of organic certified farmers over time. The number of certified organic farms has decreased from 2008 to 2011 period (Figure 2.3). We see the same decreasing trend in total organic acreage from 2008 to 2011 (Figure 2.2). However, the total certified organic production has increased in the same period (Figure 2.5).

Supply Shortage

Despite the fact that the organic industry has expanded over decades, the market faces some issues and challenges. As mentioned, demand for organic foods has increased and retail sales have expanded from 1997 to 2015 (Figure. 1.1). However, organic growers and supply chains have difficulties meeting market demand for organic food (Greene et al, 2009).Organic acreage has grown slower than demand for organic food. Certified organic acreage has doubled from 1.3 million acres in 2002 to 3.1 million in 2011, and a recent NASS survey shows that total acreages reached 4.36 million acres in 2015. (McBride et al. (2015); USDA (2016b)). Even though total certified organic crop acreage has increased, it makes up less than 1 percent of the total U.S. crop acreage (McBride et al. (2015)).

In order to meet demand for organic food, the organic industry either increase organic imports or domestic organic production (Figure 2.4; Figure 2.5). One way to increase organic food production is to increase organic acreage. National Agricultural Statistics Service's (NASS)surveys show an interesting path of organic acreage growth. The NASS surveys collect organic acreage, crops, and sales data in 2008, 2011, and 2014-2015. The NASS surveys collect certified organic cropland, rangeland, and pastureland in every state. We will use only the cropland acreage information from the surveys. The NASS survey is a population survey compare to the ARMS sample survey. Total acres of organic land has reached about 4 million acres in 2008, but it decreased in the following years. From 2014 to 2015 total acres of certified organic farms increase up to 4.3 million acres (Figure 2.2). Despite organic acres, turbulence, organic product sales have grown steadily in the same time period (Figure 2.4). These figures show that organic food production can grow in both extensive and intensive way.

The U.S. domestic organic food market experienced dramatic growth over a decade. Demand for organic food production merely meets domestic supply for organic foods. In order to fill the gap between demand and supply, the market has to import organic food products into the U.S. Analysis shows that U.S. organic imports grow from 2008 to 2014 and imports have reached over $1.2 billion dollar value (Figure 2.5; Jaenicke and Demko (2015)).

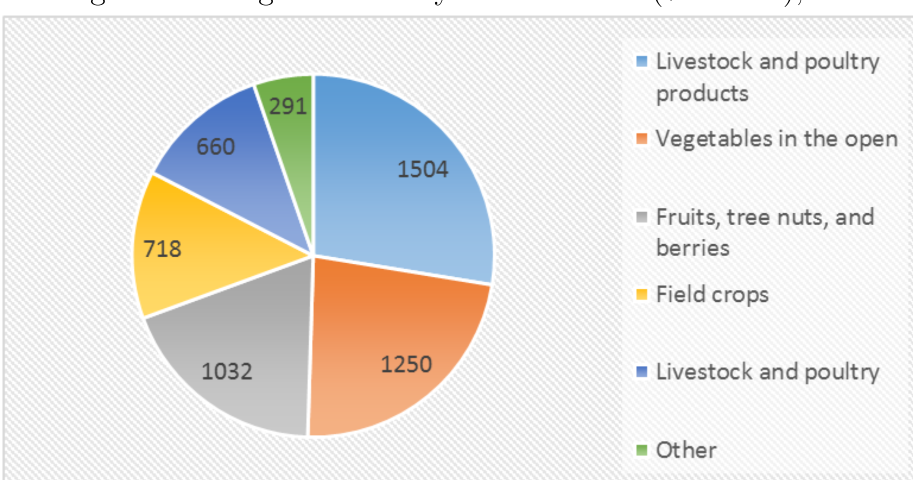
The U.S. organic market continues to grow and could conquer own niche in U.S. agriculture. The industry faces challenges and issues. Despite increased demand for organic products, organic food supplies have difficulties to meet domestic organic consumption. However, the organic industry has an advantage to maintain its expansion. Consumers willingness to pay for organic food is higher (Krystallis and

Chryssohoidis (2005)) and it allows organic producers to receive price premiums over the conventional producers.

Price Premium

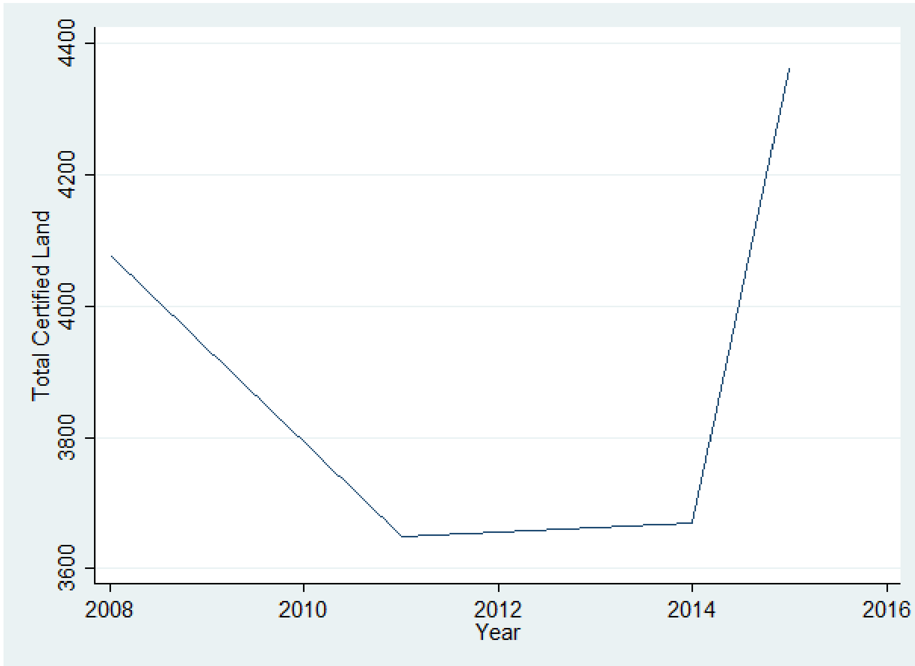
Farming using organic practices results in lower yield than conventional agriculture. If it is true then why do farmers decide to certify to organic farming? Farmers decide to certify organic farming due to potential profitability of organic farming over conventional. Certified organic farmers often receive a price premium over conventional farming. For example, in 2014 the price of organic feed corn was around $14 per bushel, whereas conventional corn price was around $5 per bushel (Figure 2.6; McBride et al. (2015)). Organic feed wheat price at the same time varied from $18 to $20 per bushel, whereas conventional wheat prices ranged from $6 to $8.50 per bushel (McBride et al. (2015)). The same research shows that organic soybean producers receive on average around $25-$30 in 2014.

Figure 2.1: Organic Sales by Commodities ($ million), 2014



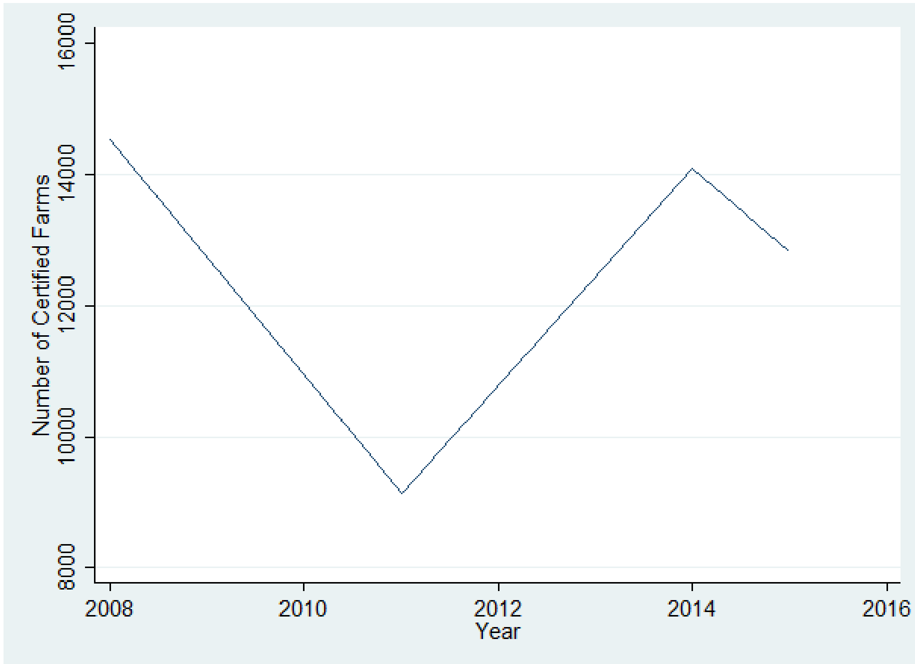
Source: NASS Organic Survey, 2014

Figure 2.2: Total Acres of Certified Organic Land (1000 acres), 2008-2015



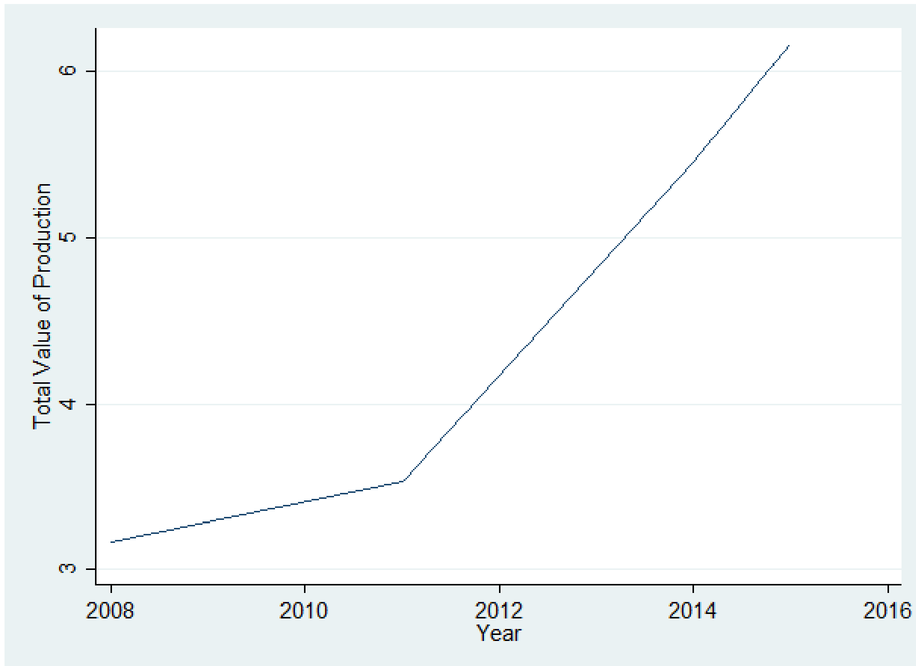
Source: NASS Organic Surveys, 2008, 2011, and 2014-2015

Figure 2.3: Dynamics of certified organic farms, 2008-2015



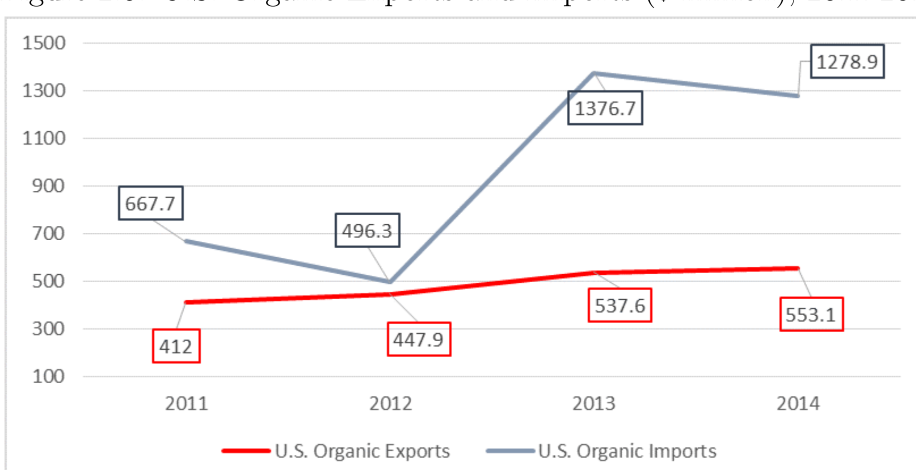
Source: NASS Organic Surveys, 2008, 2011, and 2014-2015

Figure 2.4: Certified Organic Production ($ billion), 2008-2015



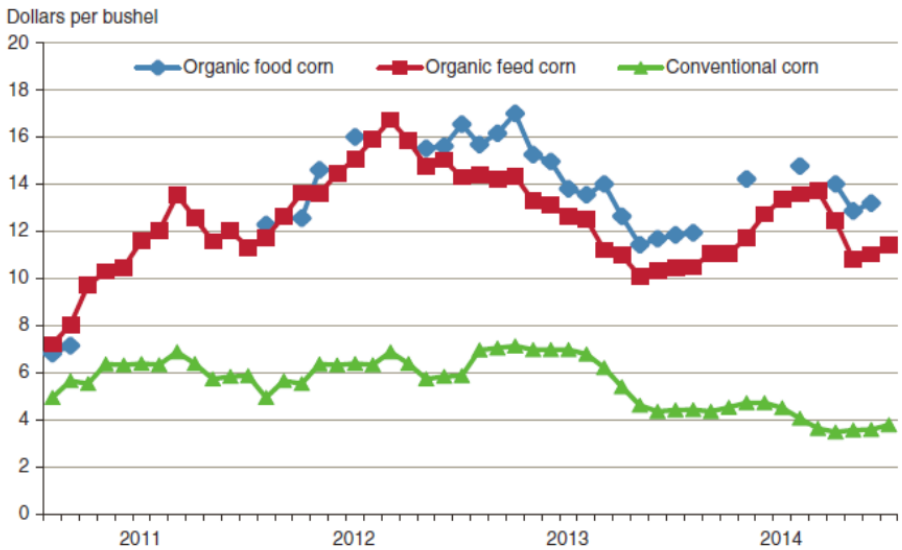
Source: NASS Organic Surveys, 2008, 2011, and 2014-2015

Figure 2.5: U.S. Organic Exports and Imports ($ million), 2011-2014



Source: Jaenicke and Demko (2015). Preliminary Analysis of USDAs Organic Trade Data: 2011 to 2014

Figure 2.6: Organic and Conventional Corn Prices, 2011-2014



Source: McBride et al., (2015) USDA Economic Research Report, 2015

LITERATURE REVIEW

The growing market for organic food has led to an enriched literature on the economics of organic agriculture. In my literature review we cover the following main topics in organic farming. The majority of the literature compares organic and conventional farms' economic and financial performance. Others examine alternative motive for organic certification.

Organic Certification and Regulation

The National Organic Program (NOP) within the USDA Agricultural Market Service (AMS) sets regulations, organic labeling, and national organic standards for organic agricultural products. According to USDA organic regulations, organic operations must maintain soil quality and water quality. Synthetic fertilizers and genetic engineering may not be used in organic operations. The USDA standards allow four categories of organic production: crops, livestock, processed products, and wild crops. If an organic farm makes more than $5000 in gross annual sales, it must be certified. If the farms receives less than $5000, it may be exempt from organic certification. Certification allows the farms use the USDA organic seal on their products. If they are not certified (but can sell their organic products in the market), the farms may not use the seal.

In short the organic certification process takes the following steps. In the first stage, farmers sent an application to certifier agents. In the application, farmers should state their farm, farming operations, and their projected organic sales. In the next step, the organic certifiers review a new farmers application and inspect the farm. If the farmer meets organic operation standards, the certifier will issue the organic certification to the farmer (Coleman (2012)).

The farms can be certified by certifying agents. These agents have accreditation from the USDA to certify farms. The farmers can be certified by both government and private certifying agents. The certifying agents play a big role in formation of organic sectors (hotspots) in local areas (Jaenicke et al. (2015)). The hotspots are the areas where organic agriculture has high concentration. Jaenicke et al. (2015) find that the agents have a positive effect on local organic hotspot formation.

Once the farms choose to certify, they must go through the transition period, which take 36 months. According to the USDA regulation, the farms cannot use prohibited fertilizers and other substances during this period. Until the full transition period is over, the farms cannot sell or label their products as organic. Also farms cannot use the USDA organic seal. During transition period, the organic farms face several challenges and issues. The farms cannot charge a higher price premium for organic products. Organic farms will incur higher production costs than conventional practice (Oberholtzer, Dimitri, and Greene (2005)).

The certification process will take time and farmers also incur the costs of certification. The USDA has a cost sharing program which funds organic certified farmers costs. The National Organic Certification Cost Sharing Program (NOCCSP) and Agricultural Management Assistance (AMA) are available for organic farmers and producers.

Organic Certification Decision and Motives

Researchers divide the reasons and motives for organic certification into economic and non-economic motives. The main economic reason to certify organic farming is relative profitability of organic farming over its conventional counterpart. The non-economic factors could be environmental, personal, social, ideological or philosophical beliefs (Sierra et al. (2008); Veldstra et al. (2014);Trujillo-Barrera et al. (2016)) that aren't valued in the market.

We could categorize the organic farmers based on their motives to the following groups. There is a group of farmers who farm accroding to organic standards, but do not intend to certify. They see organic certification as a disadvantage and tend to be independent from organic regulations. They avoid certification because of higher production costs, higher certification costs, and lack of information on organic price and markets (Strochlic and Sierra (2007)). These farmers may use a combination of both conventional and organic practices. The next groups main motivation to certify is the economic factor. The last group see an organic farming as their environmental and social commitment. For them economic factors are secondary compared to their philosophy of organic farming (Darnhofer, Schneeberger, and Freyer (2005); Strochlic and Sierra (2007)).

Farmers tend to adopt organic practice over conventional farming based on expected economic rewards rather than social and personal rewards (Trujillo-Barrera et al. (2016)). The expected economic reward from organic practice is predominant among other factors. In addition the authors note that moderate risk tolerance has a positive impact on economic rewards.

The farmers make decisions to certify to organic farming based on their economic and non-economic motives. The literature generally finds that economic motives are the main reason to adopt organic farming practices. Organic farmers expect to receive higher economic profits from organic certification over conventional farming.

Profitability and Production Potentials of Organic Farming

The literature on the profitability of organic farming relative to conventional practice finds mixed conclusions. The researchers examine financial competitiveness of organic farming on a global scale. Crowder and Reganold (2015) argue that organic agriculture is significantly more profitable than conventional agriculture, because of organic price premiums over conventional agriculture. They state that in order to compete with conventional farms, the organic farms should receive on average at least 5-7% above them. The organic farms could achieve the profitability even with lower yields between 10-18% (Crowder and Reganold (2015)).

McBride et al. (2015) using the ARMS data analyzed the profit potential of organic farming compared to the traditional conventional practice. The research shows that organic farms receive positive economic profit for corn and soybeans compared to their counterparts. In addition the researchers find that the organic profitability also varies by region.

Some authors inspect the profitability and costs of organic crops such as wheat and soybean and other major crops (McBride and Greene (2009); Klonsky (2012); McBride, Greene, Ali, Foreman, et al. (2012)). The findings show that organic wheat has lower yields and has relatively lower per acre operating costs compared to conventional wheat. However, the total economic cost per acre for organic wheat is higher than conventional wheat. Due to higher price premiums, organic wheat is able to cover the differences in the total cost (McBride et al. (2012)). On the other side, organic soybean has higher per bushel operating costs than conventional soybeans. The organic soybean can achieve profitability over conventional soybeans if the producers receive higher price premiums. These studies show that organic crops might have higher operating costs than conventional crops (McBride and Greene (2009)).

Previous studies have found that organic farming receive higher revenue or at least a positive return than the conventional farming system. The other authors argue that organic profitability depends on farm sizes (Delbridge et al. (2013)).

Large organic farms tend to receive relatively higher returns than small conventional farms. However, it is difficult for bigger farms to manage an organic cropping system. If the farmers cannot manage accurately, the per acre profitability advantage over conventional farming fades (Delbridge et al. (2013)).

In contrast to Crowder and Reganold (2015), Uematsu and Mishra (2012) argue that organic profits aren't significantly higher than conventional farms. Although certified organic producers receive higher revenue than conventional farms, organic farms incur higher production costs, because organic farms tend to spend more on labor, insurance, and marketing charges. Uematsu and Mishra (2012) also compare organic and conventional farms' household incomes. The result suggest that organic farms have higher household incomes compare to conventional farms.

Risks and Organic Certification

Although the goal of this study is not comparison of risk attitudes of organic and conventional farming, we should note that risk perception and risk tolerance are one of the factors influencing the organic certification decision. Gardebroek (2006) argue that organic farmers are less risk averse compared to their counterparts. Again risk tolerance is highly correlated with the expected economic returns. If the farmer is risk averse or risk neutral, they will not adopt the new organic farming system, unless the expected economic rewards will compensate the extra risk (Trujillo-Barrera et al. (2016)). As we notice, for the organic farmer, the risk management is really crucial to sustain production and keep profitability. The organic farmers could face production risk, input risks, marketing risks, and agricultural policy risks (Hanson, Dismukes, Chambers, Greene, and Kremen (2004)). Also the organic farmers have fewer tools to manage pest and disease outbreaks, and there are fewer crop insurance products available.

Certified organic farms use crop diversification as a risk tool in their organic practices. Organic farms achieve crop diversity through growing different types of crops and longer crop rotations. The crop rotation is a major strategy to reduce production and financial risks (Moncada and Sheaffer (2010)). The crop diversification also increases crop yields or at least reduces yield gap between conventional and organic practices (Moncada and Sheaffer (2010); Ponisio et al. (2015)).

THEORY

The previous literature suggests that organic farming may be more profitable than conventional agriculture only if organic farming can capture price premiums. Studies show that organic food products do capture price premiums at the retail level (Jaenicke et al. (2015)). In addition, organic agriculture tends to incur higher production costs than conventional agriculture. Since the organic certification process affects farms profits and costs structure, it is worth wile to explore how organic certification may affect farm input prices. As said earlier demand for organic foods and crops has increased over time, which could increase prices for organic foods and inputs such as land. In this chapter we discuss the farmland value and its features. Second, we discuss how organic demand affect farmland values. We capture these topics in context of a multimarket model.

Farmland Value

Farmland is a crucial asset in the agriculture sector. Farm real estate (land and structure) accounts about 84% of the farm balance sheet in the U.S (Nickerson et al. (2012)). Because land is a durable good, we can see farmland not just as an agricultural input, but also a source of investment. As any other investment, farmland generates returns to its owners. The returns on agricultural land may include both agricultural and non-agricultural benefits. The farmland can be used in potential urban activities. Also farmland provides natural amenities (Borchers, Ifft, and Kuethe (2014)). A recent survey shows that the average value of farm real estate has been increasing over time and it has reached $3,010 per acre in 2016 (USDA (2016a)).

In farmland rental discussion we should consider the relationship between landowners and land tenants. Ultimately the landowner establishes and makes decision to change the rental rate. The statistics of the ARMS survey shows that on average certified organic crop land earns double the rent of conventional lands (Table 5.7). What factors might influence landowner to raise the rental after the farmland is organic certified ? On the other hand, why would organic farmer pay higher rental rate for his farmland if he converts to organic agriculture ? Agricultural land generally follows profitability of agricultural production. If organic production gives more profits, then the certified organic land return will rise. This means that the certified organic farmers pay higher rents for organic land due to organic product's profitability. On the other side, the land owners see the organic land as a source of high future returns compared to the conventional lands.

Organic farm profitability is an important component of the relationship between organic certification and farmland value. The land is a special input in agricultural production. It has immobility and the lands quality changes very slowly. It is complicated to determine the market land price. The literature provides standard approaches to measure farmland value (Roberts et al. (2003); Hendricks et al. (2012); Robbins, White, et al. (2014)). A standard approach to land valuation is to compute the land value as a present discounted value of expected cash flows (or earnings) from farms agricultural activities. Suppose the following equation (Hendricks et al. (2012)).

$$V_t = \sum_{t=0}^{T} \delta_t E_t(\pi_{t+1}) \tag{4.1}$$

where V_t is a land value at time t and δ_t is a discount rate. We treat the land value as a expected function (E_t) of future incomes (or profits) (π_{t+1}) at time $t+1$. The equation (4.1) shows to the full stream of future cash flows from farmland use. The current land price (V_t) shows the potential future profitable use of that farm land (Plantinga, Lubowski, and Stavins (2002)). As expected returns from farmland increases the land value also rises. However, we do not observe farmer's expected earnings, instead we observe the actual land values. We cannot observe the full stream of future profits like in equation (4.1), instead we observe only per period land values. In this case, the rental rate would be an appropriate measurement for land value. Consider next equation.

$$r_t = E_t(\pi_t) \tag{4.2}$$

where r_t is farmland rental rate at time t. Unlike equation (4.1), the rental rate is the per period price for land. At each period, the farmer will adjust his expectation. However, we do not observe the expected rental rate at each t time period. Instead we observe the actual cash rents for farmlands. The difference between expected rental rate and actual rents will lead to a measurement error (Hendricks et al. (2012);Kirwan and Roberts (2016)). Consider the following equation.

$$r_t = \overline{r}_t + \epsilon_t \tag{4.3}$$

where $\overline{r}_t$ is actual cash rents and r_t is expected rents from the model (4.2). The measurement error (ϵ_t) will lead to biased estimations in our regressions. At this stage, we cannot overcome the measurement error.

Output and Input Markets

To illustrate how changing demand for organic products affects land and other farm input markets, we present a simple multimarket model in Figure 4.1. Organic farms produce or grow an organic product (output) using multiple inputs. In the farm output market, we suppose demand for organic food shifts from D0 to D1. This demand shift represents growth in organic food consumption as seen in Figure 1.1. As a result of the demand shift, both output price and quantities increase. The equilibrium price rises from P0 to P1, and the equilibrium quantity of organic food increases from Q0 to Q1 (Panel a, Figure 4.1). Supply for organic products (S) is a derived from the production function that describes how organic inputs can be converted to organic output.

Higher output prices (or higher organic price premiums) might increase organic farms' profits. A price increase of organic products (from $P0$ to $P1$) is a result of the demand shift for organic products (Panel a, Figure 4.1). The demand shift could affect other linked organic input markets. A higher price will increase revenue for organic outputs.

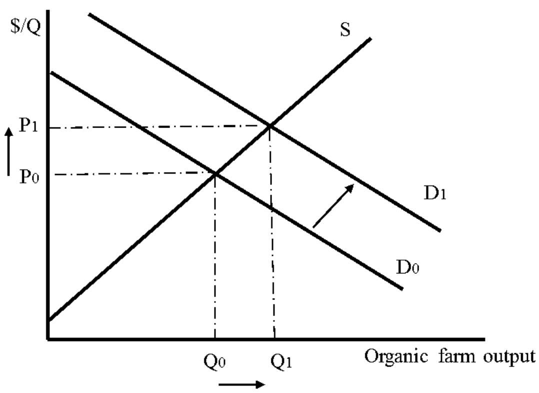
In order to sell products with the organic label and capture any organic price premium, the new incoming organic farmers have to certify. It would increase the quantity of supplied organic products. The organic certification process takes time (3 years) during which yields are generally lower and farmers cannot label products as organic. During this period farmers may incur revenue losses and household income reduction. If the expected returns from organic farming exceed conventional farming over a relevant time horizon that includes transition and post-certification revenues, then farmer would consider organic certification.

The certification process also has impacts on organic farmers' production input allocation. In order to increase crop production farms can either increase acres of cropland or increase per acre yields. If an organic farmer chooses to increase organic acreage, it could affect the organic farmland market. In Figure 4.1, we show this as a shift from D0 to D1 (Panel b), causing the organic land rental rate to increase from r0 to r1.

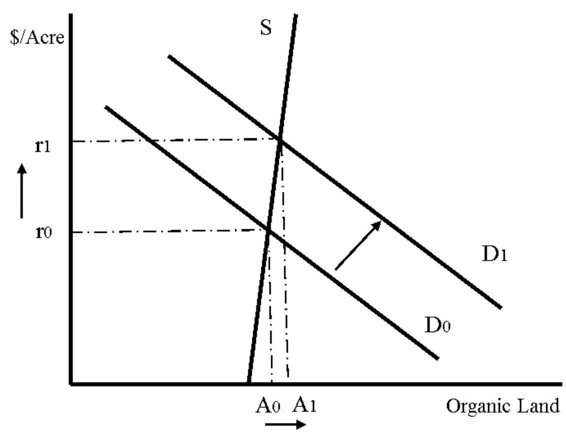
We assume that in the short run organic land supply is relatively inelastic. The transition period makes the land supply inelastic in the short run. However, conventional land can transition to organic over a period of three years, so organic land supply is more elastic over a time horizon of several years or more. If the demand for organic land increases, the equilibrium amount of organic land acreage also goes up (from A0 to A1) (Panel b, Figure 4.1). In our model, the shift in demand for organic land induces a greater percentage increase in the price of organic land than the percentage increase in quantity of that land, because organic land supply is relatively inelastic. Also we assume that demand curve for organic land should be relatively inelastic than land supply. Under this condition the effect of the demand shift (D0 to D1) for land will have larger impact on farmland value.

Organic farming is more labor intense relative to the conventional farming (Crowder and Reganold (2015)). It uses less chemicals and pesticides than its counterpart. Organic farming uses other substitutes for synthetic chemicals such as composting and bio pest management (Oberholtzer et al. (2005)). Our data shows that fertilizers and composts for organic farming and seed costs are higher than conventional practices. Organic farming practices are more expensive due to the higher price of inputs (Veldstra et al. (2014)). Organic farms spend more time managing soil fertility, crop disease, and overall crop rotation management (Moncada and Sheaffer (2010)).

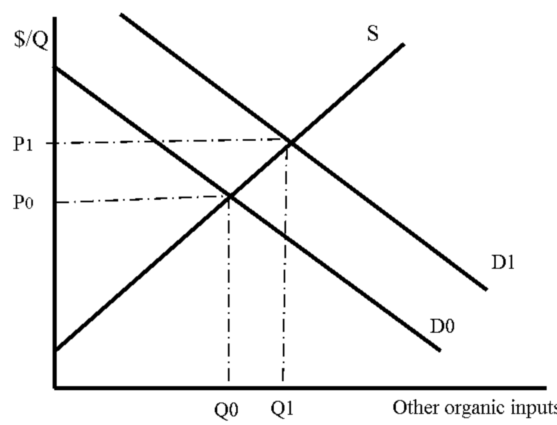
The multimarket model suggests a hypothesis that the organic certification might have a positive relationship with farmland value. However, we can test this hypothesis under the following conditions. If the organic certification hasn't have a transition period, where the organic farms can convert their farmland immediately, we would see a perfectly elastic supply of farmland. Without transition period and other costs related to the conversion, farmers would not have any barriers and constraints to freely convert their farmlands. Therefore, we would likely to observe a fixed rental rate, which is not different than conventional land price. In general, the supply of farmland would be perfectly elastic in the long run. We can test our hypothesis in the short term, where supply of land is relatively inelastic.



(a) a



(b) b



(c) c

Figure 4.1: Farmland Output And Input Markets

DATA

The ARMS Survey

To study the relationship between organic certification, farm profitability and land values, we use Agriculture Resource Management Survey (ARMS) data collected by the National Agricultural Statistics Service (NASS) of the USDA. NASS interviews a nationally-representative sample of approximately ten thousand farms every year. It does not follow the same farmers every year, instead it re-samples the population of US farmers each year. Therefore, the ARMS survey is repeated cross-sectional data. The ARMS survey records farms' total acreages, cropland, production quantities and prices, production costs, and records socio-economic characteristics of the farm operator.

The ARMS data consists of several phases. In the first phase, NASS interviews potential farms who grow specific commodities applicable in phase two. In the second phase, NASS conducts surveys at the field level collecting data on the use of chemicals, seeds, irrigation, and other farmland characteristics. The survey also gets information on livestock. At phase three, the ARMS collects data at the individual farm level. At this stage the survey observes price, costs, assets, liabilities and other financial info.

List of Variables

The ARMS survey provides data on rented acres, total operated acres, crop acres, cash rental expenditures, estimated market value of farmland, crop production costs, value of crop productions, government payments, and other variables at the individual whole farm level. We define the list of variables used in our analysis generated from the ARMS in Table 5.1.

We define our variables on a per acre basis. To do that we use number of the ARMS survey's acreage variables. We divide cash rental expenditure by acres cash rented to calculate the per acre cash rental rate. We use total cropland acres to calculate per acre revenue. To calculate per-acre costs we divide farm-level costs by the total operated acres. The total operated acres considers all farm's production activities. According to the data, organic farms on average have less owned acres than conventional farms. on average organic farms have 169 owned acres, whereas the conventional farms have 245 acres (Table 5.3). Conventional farms have higher operational and cropland acreages than organic farms. On average conventional farms have 648 operated acres and 523 cropland acres. On the other side, organic farms on average have 532 operated acres and 404 cropland acres. These differences in means between organic and conventional farms are not statistically significant.

Revenue, production costs and organic status are essential variables in the relationship between certification, profitability and land values. We construct two different types of organic status variables. First, in the binary organic status classification, we treat the farms with any certified organic cropland acres as certified organic farms. If the farms do not have any organic cropland, then we treat them as conventional farms. Second, we define organic status as a ratio of certified organic crop acres to total cropland acres by individual farm, county and year (Eq 5.1)

$$Organic_{ijt} = \frac{OrganicCroplandAcres}{TotalCroplandAcres} \tag{5.1}$$

As previously noted, profitability plays an important role in a producers' decision regarding organic certification. We measure per acre revenue as the ratio of the value of crop production to total crop acres. We expect that higher farm revenue has a positive impact on farmland value.

We categorize the listed farm costs in Table 5.1 as variable and fixed costs. Costs of seeds, fertilizers, other chemicals, labor, and fuel are the main variable costs in farm operations. Organic farms spend more on labor, seeds and fuel compared to conventional farms. These farms spend even more on fertilizer and organic compost (Klonsky (2012)). We expect that due to regulated limits on synthetic fertilizers, the organic farms would spend more on organic based fertilizers than the conventional farms. The fertilizer cost is a sum of fertilizer, lime, soil conditioner and chemicals for crops, livestock, poultry, and general farm.

Our labor cost is a sum of cash wages, payroll taxes and benefits, and contract labor. We would expect that organic farms might have higher labor costs than conventional farms. Organic production is labor intense and uses specialized equipment (Oberholtzer et al. (2005)).

Fixed costs in our model are taxes, interest, and farm insurance. The tax cost is a sum of property taxes on real estate, livestock and machinery. We expect higher property tax expenses would have a negative relationship with the value of land. Interest cost is interest paid on debt secured by real estate and debts not secured by real estate.

Government payments and subsidies play an important role in agricultural production and farmland value. We include direct government and counter cyclical payment and federal crop insurance as a farm income in our model. We expect that government direct payments have a positive impact on farmland value. The literature show that the government payments and subsidies increase the farmland rental rate (Roberts et al. (2003); O'Donoghue and Whitaker (2010); Hendricks et al. (2012); Kirwan and Roberts (2016)).

Previous literature suggests that higher off-farm income increases per acre farmland value (Uematsu and Mishra (2012)). The authors argue that higher off-farm incomes increase farms financial stability and ability to pay debts. Farms with higher off-farm incomes are less dependent on incomes from farm income. We calculate household total and off-farm incomes on per acre basses. We divide household incomes by total operation acres.

Crop rotation and crop diversity is a major challenge in organic farming practice. Organic farming relies heavily on soil fertility. The crop diversification provides not only soil fertility but also receives higher price premiums (Oberholtzer et al. (2005); Veldstra et al. (2014)). In order to estimate the crop diversity, we create a variable which counts each unique crop. If the farmer harvests at least one acre for a certain crop, we count it as one type of crop. For example, if the farmer harvests 3 acres of fruits and 230 acres of wheat, then the farmer grows 2 types of crops. However, this variable ignores relative sizes of harvested acres.

The urbanization influences both organic status and farmland value. In urban areas, the land value tends to be higher (Kuethe, Ifft, Morehart, et al. (2011)). The remote and rural areas are not favorable for organic farming (Kostandini, Mykerezi, and Tanellari (2011)). Urbanization has a positive impact on farmland value. If organic farms grow organic products near urban areas, they will receive higher rents than conventional farms. In addition organic farms near urban areas have access to markets, therefore, they capture higher price premiums. Also the organic lands could be used for residential and commercial use, which increases the future returns (Kuethe et al. (2011)). The ARMS data defines urbanization by category from rural to most urbanized area. For example, if urbanization code equals to one, it means that farms are located in counties in metro area more than 1 million population. If it equal to two, the farms are located in urban area of less than 1 million population. There are nine categories for urbanization in the ARMS survey data. In order to capture the urban influence on farmland value, we generate dummy variables for each categories.

In order to measure farm product specialization, we create dummy variables corresponding to the ARMS farm type code. The farm type is a categorical variable, which defines farm specialization based on the farms' crop, livestock, and other agricultural production. There are sixteen categories of farm production in the ARMS data.

Summary Statistics

Our sample period runs from 2003 to 2011. We use this period because the ARMS data includes certified organic cropland acres as an only organic variable in survey. We don't have a consistent measurement of certified acres outside this period. For these years, we have initially $187,174$ individual farm-year level observations after pooling data over this period. The summary statistics use the ARMS survey sampling weights. The ARMS weights measure how each farm is representative in a given year (O'Donoghue and Whitaker (2010)). The sampling weights (or probability weights) are inverse of probability. If the sampling weight for observation is 2000, means that the farm represents 2000 U.S. farms. In other word, the probability of being selected in the sample is 1/2000 (Cameron and Trivedi (2009)).

According to the USDA organic regulation, if the farm makes more than $5000 in annual sales, it must be certified to sell organic products. Therefore, we exclude those farms who make less than $5000 in value of crop production. The organic farmers can certify not only their cropland but also pastureland and rangelands. However, we observe only certified organic cropland in our sample. If the farmer has certified organic cropland, we treat him as a certified farmer. Because of that we also exclude any livestock related production activities and sales from our sample. After these exclusions, we have 81593 total observations. Only 2177 observations have certified organic cropland (Table 5.2). The proportion of observed organic farms is consistent with other literature (e.g., Uematsu and Mishra (2012)).

In Table 5.3, we describe summary statistics for rental rates and land values at the farm-year level. We calculate both land values and cash rents on a per acre basis. We have a full number of observations on acreage and land value variables. After we divide rents and land values by acres, we lose some observations, because farms either don't have acres for rent or they simply are not renting any acres of land. As a result of calculation we lose about 49.5% of organic farms and 41.6% of conventional farms. The proportion of renting organic farms (50.5 %) are lower than conventional farms (58.4%), but the difference is not dramatic. On average, organic farms rent 576 acres, whereas conventional farms rent 235 acres. From Table 5.3 we could see that organic farms have a higher per acre rental rate than the conventional farms. Organic farms pay an average of $458 per acre, whereas conventional farms pay $179. This supports our main hypothesis that organic farms tend to pay higher rental rates than conventional farms, but we cannot conclude that certification causes this differences before controlling for other factors.

About 2.6 % of our total sample is certified farmers (Table 5.4). The proportion of certified farms in the total sample is similar to the U.S. organic farms' proportions. It means only 2.6 % our sample have any certified organic cropland. If we consider the distribution of organic proportion status variable, then 40.5 % of organic farms are fully converted their croplands into organic cropland. The rest 59.5 % of organic farms partially converted their farmland. Organic farms who fully converted their farmland tend to have on average 311 acres of cropland. The farms who partially converted their farmland have on average 4.88 acres of organic cropland.

Both conventional and organic farms earn positive per acre revenues (Table 5.2), but organic farms are more relatively profitable than their counterparts. If the organic farms are able to receive that high revenue, then it might be worth the cost to certify. In terms of variable costs, organic farms tend to have on average higher costs than conventional farms (Table 5.2). Organic farms tend to have higher costs for fertilizers and labor. Organic farms have also higher costs for fixed costs. Conventional farms have higher government subsidies than organic farms (Table 5.2).

However, the summary statistics show that the standard deviations are enormous for all variables. At this point we cannot see any statistically significant difference between conventional and organic farms. The organic farms have especially large standard deviations. Such huge standard deviations could be result of skewed distributions. We usually observe heavy-tailed distributions due to the presence of outliers. For our data it this be the case, where some farms have the biggest revenue and costs. Some farms with small acres tend to have much higher costs than average farms. If we look at scatter plot graph for cost variables within 100 acres, we could observe there are many farms with more than $\$10,000$ per acre costs (Figure. 9). We construct our variables per acre terms. In this case, farms with small acreage could have extreme per acre costs.

One of our concerns over the data is that it has a skewed distribution. To address the presence of outliers, we use two methods: excluding very small farms and winzorizing. First, we drop the farms who have small acres in operations. We drop farms who have less than or equal to 20 acres. By dropping small farms we mitigate the effect of outliers. After the exclusion, we observe in overall 76194 individual farms, which include 1952 certified organic farms (Table 5.5). In this subsample, about 45524 conventional and 1952 organic farms pay cash rents (Table 5.6). Organic farms still pay higher cash rents than conventional farms. On average organic land pays $287 per acre compare to $113 for conventional lands. The difference in cash rent between organic and conventional lands still remains. Even after excluding farms, we still get huge standard deviations for revenue and costs. This indicates that the data still suffers from outliers. In this case we decide to winsorize the data.

Winsorization is one of the methods to deal with the outliers issue. In the previous section, we trimmed farms with small acreages. But, the difference between trimming and winsorizing is that the last one does not exclude the outliers out of sample . Instead winsorizing places the outliers with certain percentiles. In our case, we winsorize all cost variables at the $99th$ percentile. It means all values at the top $99th$ percentile will be replaced by the least value at the same percentile. We replace all our variables including costs. We do not winsorize cost variables at the bottom percentile. Because the minimum value for costs are zeros. We do winsorize the income variables at the bottom 1% percentile. After we winsorize the data we still get the same number of observations, because we do not trim the data at the top percentiles (Table 5.7; Table 5.8). Winsorizing makes the standard deviations lower, because outlier values have been replaced. Organic farming still receive higher rents than conventional farms. Organic farms receive higher revenues than conventional farms. The costs are relatively low compared to the previous descriptive statistics (Table 5.5). Labor, seed, and fertilizer costs are highest among variable costs. However, we cannot see a statistical difference between organic and conventional farms in terms of revenue and costs. The organic lands still pay higher cash rents than conventional lands (Table 5.8). On average organic land pays $220 per acre whereas the conventional land - $102 per acre.

If we describe costs by crop types, we get lower per acre variable costs than at the farm level summary statistics. Also the standard devaitions are smaller than at the farm level. For example, the costs for wheat are relatively similar to the soybean costs (Table 5.9; Table 5.10). Unlike soybeans and wheats, the fruit growers tend to have a bit higher production costs and returns (Table 5.11). In 2006 the USDA

ERS conducted an organic soybean survey, and organic wheat in 2009 (McBride and Greene (2009); McBride et al. (2012)). The authors estimate the cost and returns for organic soybean and wheat production. They use the ARMS phase II survey data in the analysis. Our estimated costs and revenue are similar to the previous study. For example, organic wheat receive higher per acre revenues than conventional wheat. Seed costs for organic wheat is higher than conventional, although the costs on fertilizers are higher in conventional wheat. Hired labor cost for organic wheat is higher than conventional wheat.

Prior to our econometric analysis, we make a log transformation of variables. The log transformation makes it easier to estimate regression models. In presence of the outliers the log transformation helps to normalize our distributions. In addition the log-log model gives easier interpretation of estimates in our models. In some cases we observe zero values in the data. This complicates the log transformation of the data. To overcome this problem we add 0.0000001 to the data. In addition, all variables are in per acre term which means they area proportion of two variables. For example, revenue is computed by dividing value of crop production and crop acres. If the value of a variable is between 0 and 1, the log transformation will return a negative value in the data.

Table 5.1: Variable Definitions.

Variable	Variable Definition
Certified Organic	= 1 if farm is certified organic, 0 otherwise.
Cash rental rate	$/acre year
Revenue	$/acre year.
Variable cost	$/ acre year. Sum of the following variables:
- Seed	
- Fertilizer	
- Labor	
- Fuel	
- Custom work	
- Maintenance	
- Utility	
- Other costs	
Fixed costs	$/ acre year. Sum of the following variables:
- Taxes	
- Insurance	
- Interest	
Marketing charge	$/ acre year.
Direct payment	$/acre year. Sum of direct and counter cyclical payments.
Federal crop insurance	$/ acre year.
Total household income	$/ acre year.
Off-farm income	$/ acre year.
Crop diversification	Count of harvested crops.
Urbanization	Min=1 (more urbanized), max=9 (less urbanized)

Table 5.2: Summary Statistics of Costs and Revenue at the Farm Level ($/acre), 2003-2011 (Untransformed).

Variables	Total sample		Conventional		Organic	
	Mean	St.Dev	Mean	St.Dev	Mean	St.Dev
Variable Cost:	1,597.56	15,487.32	1,562.68	14,266.38	3,818.16	50,483.50
-Seed	351.73	4,784.96	350.86	4,742.56	407.35	6,973.64
-Fertilizer	137.09	953.69	135.69	910.40	226.72	2,457.86
-Labor	586.44	7,269.09	568.45	6601.47	1,731.60	25,323.71
-Fuel	122.61	1,598.02	121.0	1,603.27	225.03	1,213.79
-Custom Work	29.20	526.15	29.03	529.11	39.84	278.65
-Maintenance	88.48	736.87	86.74	712.14	199.31	1,677.17
-Utility	76.71	723.06	75.23	693.42	171.03	1,785.64
-Other Costs	205.30	3,183.64	195.68	2,647.83	817.29	14,448.47
Fixed Costs:	171.38	998.97	168.99	983.33	323.63	1717.30
-Taxes	56.12	427.85	55.44	427.82	99.27	428.12
-Insurance	51.12	369.0	50.55	365.51	88.59	546.01
-Interest	64.13	541.70	63.0	532.66	135.77	952.19
Marketing Expense	60.45	2,602.57	51.02	767.57	626.22	1,9430.84
Revenue	4,287.92	44,596.81	4,198.81	42,785.80	9,960.24	10,9707.30
Net Farm Income	597.46	9520.50	577.93	8,156.7	1,841.08	40,305.02
Off-farm Income	1,540.84	8,636.45	1,519.47	8,533.51	2,933.12	13,705.98
Direct Payments	11.46	23.43	11.48	22.66	10.41	52.53
Federal Crop Insurance	26.01	443.78	25.57	444.8	72.52	314.51
N	81,593		79,416		21,77	

Note: The summary statistics are weighted.

Table 5.3: Summary Statistics of Cash Rents and Land Values, 2003-2011 (Untransformed).

Variables	Total sample		Conventional		Organic	
	N	Mean St.Dev	N	Mean St.Dev	N	Mean St.Dev
Acres Cash Rented	8,1593	301.73 (917.17)	79,416	301.43 (914.31)	2,177	320.55 (1083.85)
Acres Owned	81,593	244.66 (726.13)	79,416	245.84 (724.82)	2,177	169.74 (801.78)
Cash Rent Paid	81,593	21,883.26 (89,919.87)	79,416	21,712.70 (84,949.18)	2,177	32,725.98 (251,651.42)
Value of Land	81,593	744,421.49 (2,753,153.73)	79,416	738,015.70 (2,666,861.27)	2,177	1,152,208.75 (6,099,305.46)
Cash Rents ($/acre)	47,444	182.12 (1,556.23)	46,364	178.90 (1,554.60)	1,098	458.52 (1,667.44)
Value of Land ($/acre)	74,144	6,599.40 (31,018.64)	69,196	6,534.33 (31,002.54)	1,948	10,834.91 (31,771.99)

Note: The summary statistics are weighted.

Table 5.4: Summary Statistics of Organic Statuses, 2003-2011.

	Organic Indicator	Organic Proportion
Mean	0.026	0.016
Percentage=0	97.4	97.4
Percentage=1	2.6	1.6

Table 5.5: Summary Statistics of Costs and Revenue at the Farm Level ($/acre), 2003-2011 (After excluding small farms).

Variables	Total sample		Conventional		Organic	
	Mean	St.Dev	Mean	St.Dev	Mean	St.Dev
Variable Cost:	497.81	3,959.59	483.85	3,840.50	1,539.74	9,163.19
-Seed	71.26	989.75	71.06	989.09	86.68	1037.64
-Fertilizer	83.40	296.10	82.81	289.66	127.58	606.27
-Labor	168.64	1,904.54	160.34	1,833.70	788.08	4,797.61
-Fuel	38.02	265.58	37.33	259.87	89.05	540.26
-Custom Work	17.84	158.43	17.65	156.42	32.21	268.53
-Maintenance	41.04	199.02	40.25	195.15	99.94	387.13
-Utility	21.95	177.84	21.22	171.85	76.57	430.24
-Other Costs	55.65	852.52	53.19	803.06	239.62	2609.41
Fixed Costs:	71.75	263.62	70.38	258.6	174.04	504.35
-Taxes	21.61	66.61	21.23	65.29	50.52	128.67
-Insurance	21.03	108.87	20.74	108.35	42.50	140.90
-Interest	29.11	165.63	28.41	161.94	81.02	339.31
Marketing Expense	28.33	326.61	25.90	305.89	200.65	1002.32
Revenue	1,574.32	25,720.54	1,537.96	25,599.90	4,288.23	33,419.03
Net Farm Income	216.39	2,150.93	212.52	2,120.23	504.95	3,786.48
Off-farm Income	505.52	1,559.04	498.18	1,467.03	1070.19	4,851.52
Direct Payments	12.33	19.27	12.40	19.18	7.41	24.79
Federal Crop Insurance	22.48	327.84	22.11	328.32	62.20	268.44
N	76,194		74,242		1,952	

Note: The summary statistics are weighted.

Table 5.6: Summary Statistics of Cash Rents and Land Values, 2003-2011 (After excluding small farms).

Variables	Total sample		Conventional		Organic	
	N	Mean St.Dev	N	Mean St.Dev	N	Mean St.Dev
Cash Rents ($/acre)	4,6575	115.50 (541.67)	4,5524	113.77 (536.57)	1051	287.0 (900.79)
Value of Land ($/acre)	66,392	4,512.54 (24,797.64)	64,641	4,490.07 (24,925.33)	1,751	6,168.46 (12,019.24)

Note: The summary statistics are weighted.

Table 5.7: Summary Statistics of Costs and Revenue at the Farm Level ($/acre), 2003-2011 (After exclusion and winsorizing).

Variables	Total sample		Conventional		Organic	
	Mean	St.Dev	Mean	St.Dev	Mean	St.Dev
Variable Cost:	417.15	1,481.44	406.44	1,452.79	1,216.66	2,797.48
-Seed	48.19	215.02	48.06	214.71	57.83	236.77
-Fertilizer	78.81	127.14	78.44	125.43	106.34	218.03
-Labor	129.42	758.86	123.08	739.67	602.52	1,580.30
-Fuel	32.10	69.93	31.60	68.84	69.06	121.83
-Custom Work	14.62	47.19	14.51	47.0	22.40	59.41
-Maintenance	37.01	77.64	36.35	76.11	86.27	145.76
-Utility	18.42	55.91	17.94	54.71	54.41	108.02
-Other Costs	39.60	201.42	38.07	195.29	153.26	457.48
Fixed Costs:	66.38	133.01	65.29	130.47	148.22	247.15
-Taxes	19.84	37.73	19.53	37.21	42.78	61.75
-Insurance	19.18	38.77	18.93	38.21	37.29	66.55
-Interest	24.96	72.98	24.50	71.56	59.29	139.47
Marketing Expense	21.20	135.80	19.81	129.03	119.80	368.17
Revenue	1,038.06	4,386.43	1,011.81	4,301.70	2,997.51	8,386.72
Net Farm Income	184.41	697.91	181.46	683.46	405.08	1,389.08
Off-farm Income	425.74	739.66	422.16	734.41	701.40	1,032.04
Direct Payments	12.05	16.49	12.13	16.49	6.44	15.32
Federal Crop Insurance	13.56	42.76	13.42	42.37	28.62	71.81
N	76,194		74,242		1,952	

Note: The summary statistics are weighted.

Table 5.8: Summary Statistics of Cash Rents and Land Values, 2003-2011 (After exclusion and winsorizing).

Variables	Total sample		Conventional		Organic	
	N	Mean St.Dev	N	Mean St.Dev	N	Mean St.Dev
Cash Rents ($/acre)	46,575	103.37 (140.21)	45,524	102.19 (136.13)	1051	220.70 (343.52)
Value of Land ($/acre)	6,6392	3,858.17 (5,291.85)	6,4641	3,835.14 (5,246.21)	1,751	5,555.02 (7,782.06)

Note: The summary statistics are weighted.

Table 5.9: Summary Statistics of Wheat Costs and Revenue ($/acre), 2003-2011 (After exclusion and winsorizing).

Variables	Conventional		Organic	
	Mean	St.Dev	Mean	St.Dev
Variable cost:	164.64	204.40	249.16	473.51
-Seed	24.89	32.85	25.91	38.36
-Fertilizer	58.96	59.55	49.45	92.59
-Labor	15.03	81.59	71.78	261.96
-Fuel	20.15	25.89	29.63	46.60
-Custom Work	7.31	21.0	12.55	28.48
-Maintenance	21.27	31.29	18.55	56.27
-Utility	7.25	19.76	12.04	33.04
-Other Costs	9.53	29.63	18.55	56.27
Fixed Cost	30.73	36.96	39.26	43.34
-Taxes	7.60	14.37	9.60	11.04
-Insurance	11.33	25.14	12.97	19.47
-Interest	11.74	25.14	16.69	28.47
Revenue	323.29	803.84	440.93	732.92
N	24,160		552	

Note: The summary statistics are weighted.

Table 5.10: Summary Statistics of Soybean Costs and Revenue ($/acre), 2003-2011 (After exclusion and winsorizing).

Variables	Conventional		Organic	
	Mean	St.Dev	Mean	St.Dev
Variable cost:	185.91	184.17	178.85	170.14
-Seed	36.08	37.51	29.02	18.97
-Fertilizer	68.88	50.68	43.97	63.34
-Labor	9.99	61.14	24.43	84.97
-Fuel	21.04	22.18	24.77	22.93
-Custom Work	8.15	18.01	9.90	20.80
-Maintenance	25.0	32.43	28.44	36.02
-Utility	6.07	10.80	6.12	8.20
-Other Costs	10.48	34.60	12.20	21.22
Fixed Cost	40.61	42.79	45.07	40.60
-Taxes	11.37	16.36	12.17	12.35
-Insurance	13.25	13.55	12.46	15.81
-Interest	15.94	30.66	20.44	27.75
Revenue	387.12	603.83	336.20	332.23
N	38,436		663	

Note: The summary statistics are weighted.

Table 5.11: Summary Statistics of Fruit Costs and Revenue ($/acre), 2003-2011 (After exclusion and winsorizing).

Variables	Conventional		Organic	
	Mean	St.Dev	Mean	St.Dev
Variable cost:	1,469.92	2,253.56	2,388.88	3,663.81
-Seed	51.37	227.23	61.72	230.09
-Fertilizer	215.85	251.61	186.25	280.29
-Labor	667.39	1315.44	1302.95	2120.06
-Fuel	73.20	103.81	105.47	142.23
-Custom Work	63.42	116.96	35.10	80.84
-Maintenance	90.40	129.32	153.81	195.36
-Utility	79.83	112.07	102.74	142.73
-Other Costs	157.31	376.46	295.28	632.86
Fixed Cost	214.12	263.64	263.15	323.23
-Taxes	66.94	70.88	71.32	77.91
-Insurance	53.78	70.90	66.77	89.24
-Interest	80.28	160.35	103.58	190.55
Revenue	3,058.60	4,662.43	4,294.33	6,318.37
N	9,643		683	

Note: The summary statistics are weighted.

ECONOMETRIC MODEL

The main objective of this research is to examine the effect of organic certification on land values. Our hypothesis is a positive relationship between farmland values and organic status. Organic status, which is the result of certification, may affect land value through various channels such as profitability, government payments, urbanization, and other unobserved factors.

To estimate the effect of organic status on farmland value, we construct three main OLS models. The first model uses a binary classification of the farmer's organic status (6.1).

$$r_{ijt} = \beta_0 + \beta_1 I_{org=1} + \beta_2 \pi_{ijt} + \epsilon_{ijt} \tag{6.1}$$

where r_{ijt} is a actual cash rent for the ith farm in the jth county (state) in t period. $I_{org=1}$ is a dummy variable (= 1 if the ith farm in the jth county (state) in t period, 0 otherwise). In this model, the coefficient β_1 measures the effect of organic certification on land value without considering the farm's relative organic production to its total production. As a result the first model may underestimate the effect of certification. The coefficient β_2 in model 6.1 estimates the effect of profits on the farmland value. To control for effect of profitability, we include revenue and cost variables in our model.

In the second model we include the proportional organic status classification instead of binary status (Eq 6.2).

$$r_{ijt} = \beta_0 + \beta_1 Organic_{ijt} + \beta_2 \pi_{ijt} + \epsilon_{ijt} \tag{6.2}$$

The advantage of using the proportional classification over the binary is that the proportional status allows to estimate the effect of organic land participation in the total cropland. It also includes more info than organic dummy status. In other words the coefficient β_1 estimates effect of additional organic acres in the total cropland acres. The interpretation of coefficient β_2 stays the same as in equation 6.1.

The third model includes both binary and proportional organic statuses to estimate the certification effect on land value (6.3).

$$r_{ijt} = \alpha_0 + \alpha_1 I_{org=1} + \alpha_2 Organic_{ijt} + \alpha_3 \pi_{ijt} + \epsilon_{ijt} \tag{6.3}$$

In the third model, the binary status ($I_{org=1}$) estimates the effect of certification on land value whether farmer certified or not. The proportional organic status variable as in the model 6.2 will add the effect of organic land participation in the total cropland. The sum of these two organic classifications (sum of coefficients of α_1 and α_2) will allows to estimate an overall marginal effect of full organic certification on farmland value.

There are several downsides to models 6.1-6.3. First, the farms were not randomly assigned as certified organic farms in this study. If so, we could use an average treatment effect model and compare the average land values of treatment and control groups. Instead, the farms choose to certify as organic. In other words, certified organic farms have various reasons they self select into the treatment group. Without controlling for these factors that lead farmers to certify as organic may cause bias in the coefficient estimates in our models. One way to mitigate bias is to include in our models a vector of covariates X_{ijt}, which includes the direct government payments variables. The covariaties X_{ijt} controls for other factors that may potentially affect the farmland value.

In all previous models, we estimate rental rate in time t as a function of observed profits in time t. The landowners tend to establish the rental rate at the beginning of production season, but we observe realized revenues and costs at the end of season. The timing difference between our dependent and explanatory variables could lead to measurement error in explanatory variable. The rental rate is set by expected revenues and costs, but we observe the actual realized profits at the end of production season (Hendricks et al. (2012)). The difference between expected and actual values might cause a measurement error in explanatory variables, which leads to bias in estimated coefficients. Under the assumptions that prices of organic outputs and inputs are stable through out year, the difference between realized and expected values might be small.

We also include urbanization, time trend, NASS crop districts, and farm types as dummy variables to control for local and production differences between organic and conventional farms in our models. Let consider our preferred model with all control variables (6.4).

$$r_{ijt} = \beta_0 + \beta_1 Organic_{ijt} + \beta_2 \pi_{ijt} + \beta X_{ijt} + t + \theta_{ij} + \psi_{ijt} + \epsilon_{ijt} \tag{6.4}$$

where t is a time dummy, which controls for differences between organic and conventional land prices over time. θ_{ij} is NASS crop districts in jth district, ψ_{ijt} is a farm type. We argue that NASS crop district is preferable to the county control dummy variables. The NASS crop districts are larger than counties, and it allows to observe the regional differences in organic practices in each crop region. Also the NASS districts have bigger sample size. Small sample size have less variation in organic farms. It will be difficult to use the fixed effects with smaller sample size. The crop districts are larger than counties, which allow to observe more organic farms than in county level. The farm type variable controls for the production specialty of farms. We include only crop farms in our data. We exclude any livestock production activities from our sample. The farm type variable represents the largest portion of gross value of sales for crops. If the farm's largest portion of gross sales is soybean, then the farmer's main specialization would be soybean. The variable measures production differences in crop types.

If we include the control variables for profit (π_{ijt}) and other factors (X_{ijt}), these controls will affect interpretation of the coefficient estimate (β_1) in our regression model (6.4). After we include profit variable, we control for economic motives to certify into organic practice. The coefficient of estimate β_1 shows the effect of organic certification if the farmer converts fully into organic practice from conventional farming. The effect will be significant if the farmer goes fully into organic farming.

These three specification models use standard OLS methods. However, the standard OLS model equally weights each observations in the regression. It means that the OLS model will oversample the farms with smaller acreages. As a result the standard OLS underestimates the effect of organic certification. In our case, where we have small farm outliers, the standard OLS model's estimation would be biased. The weighted OLS model will give to each observations the appropriate sampling weights to make the sample nationally representative.

An alternative method to our previous models to estimate the effect of certification is a pseudo-panel method. The ARMS survey collects independent cross-sectional data in every year. The survey does not follow each farm in each year. This means that we cannot follow an individual farmer over time and observe his production and financial activities in previous years. Thus we cannot use the panel data method. An alternative is to build a pseudo-panel to estimate the effect of organic certification on farmland value. Deaton (1985) suggested to construct panel data (both balanced and unbalanced) with cohorts (or groups) that have similar characteristics that do not change over time. For example, observations can be grouped into the cohorts by their birth date, gender, and geography etc.The pseudo-panel allows us to estimate the fixed effects. The fixed effects allow us to measure the unobserved characteristics of organic farms. We are concerned with whether the farmland and farmer's unobserved factors could potentially effect on certification decision. If the farmers decide to certify due to his unobserved individual factors, then the pseudo-panel method is appropriate. If in fact these factors have no effect on farmer's certification decision, the Model (6.3) can be used. The advantages of pseudo-panel models are that data less suffer from sample attrition, and cover longer times and geographical units (O'Donoghue and Whitaker (2010)).

The pseudo-panel method has advantages and disadvantages to use it. Pseudo-panel less suffers from sample attrition, and it is more representative in terms of time and geography (Moss, Featherstone, Park, and Weber (2012)). However, there is a trade-off between number of cohorts and number of observations in each cohorts (Moss et al. (2012)). As the cohorts get larger, there are smaller observations go into each cohorts. A larger number of observations in a cohort eliminates cross sectional variations and reduces sample size which may reduce the precision of our econometric estimates.

RESULTS

In this section we present results from weighted OLS and pseudo-panel regression models. We estimate both models using the organic proportion and organic dummy statuses to classify farms as organic or conventional. We observe a strong relationship between the organic certification and farmland rental rate across all farms with different farm types in different NASS crop districts.

Table 7.1 reports the results of the weighted OLS models. All continuous variables are expressed in logs but organic statuses (dummy and proportional) are not. The first model (Column 1) shows the effect of certification using the proportional organic status variable. The results suggest that a 1 percentage point increase in a farm's organic land would result a 0.23 percentage point increase in the farmland rental rate. The result is obtained after we control for other potential factors that may affect the farmland value. We also find that the variable and fixed costs have positive effects on rental rate. A 1 percentage point increase in variable cost may associated with an increase the land rental rate by 0.20% point, and a 1% point increase in fixed costs would also associated with an increase of 0.02% point. There are statistically insignificant relationships between production costs and rental rate. The positive correlation between costs and rental rate might be caused by high farm incomes. The farms with higher incomes pay higher rental rate. It might be case, that high income farms also incur higher production costs, therefore they tend to pay higher rental rates. Farms with the federal crop insurance have higher rental rate on land. On average 1% point increase in federal crop insurance is associated with an increases the land rental rate by 0.2%. The effect is not meaningful in magnitude. The farms with higher off-farm income pay lower rental rate on organic land. Although the magnitude of estimated coefficient is not meaningful, farms with more crop diversity have lower rental rates. The results meet our theoretical expectations. The sign of organic status is positive, which means the organic certification has a positive effect on farmland value fixing other variables. Revenue has also positive effect after controlling for other factors.

The second model (Column 2) uses the organic dummy variable to present organic status. The dummy organic status variable measures whether farmer has any certified organic cropland. If the farmer certifies any of his land, the model predicts the farmer receives (or pays) on average 7.7% point higher rental rates than conventional land. However, the effect of binary status is not statistically significant on farmland value. We do not consider the effect of additional organic acres. Because of that we underestimate the effect organic certification on farmland value. The effects of other control variables stay same on farmland value (Table 7.1).

The third (Column 3) model estimates the effect of certification with both proportion and dummy organic statuses. The sum of these coefficients shows the relationship between fully certifying as organic and the rental rate paid by the farm. If both coefficients are significant then there may a nonlinear relationship between organic certification and land values. This model shows that total effect of two organic status variables are same as the first model (Column 1). The marginal effect of estimated coefficient on binary organic indicator is not significant. We cannot argue that there is a direct effect of organic certification farmland value according to the binary organic status. However, if we consider the effect of full organic certification using proportional status, the result will be 0.37% point. A 1% point increase in organic land is associated with an increase of farm rental rate by 0.37% point. We obtain these result after controlling other factors. We see that revenue, costs, incomes, subsidies, and other control variables have the same effects on farmland value as in the model 1.

The weighted OLS models shows that the model 1 (Column 1) and the model 3 (Column 3) have the same results despite having different organic status variables. Also the R-squares show the same values. We prefer the first model over the third model. The third model allows to decompose the effect of organic certification in general and with consideration of organic acres as a percentage of total acreage.

Table 7.2 shows results for our preferred model with the effect of including different fixed effect variables. We estimate different models by including each control dummies step by step. The fifth model is the preferred model. The models in Table 7.2 show proportion status as organic classification. In the first model we estimate the certification effect without any fixed effects. The proportion organic status has no significant effects on farmland value, although the magnitude of coefficient is negative (-0.085%). If the farmer increases his organic acreage in the total cropland acres by 1% point, the land value lowers by 0.085% than the conventional land. If we ignore the regional and farm production differences, we could underestimate the certification effect on farmland value. There is a positive correlation between revenue and rental rate. If farmer increases his revenue by 1% point, then the farmer pays 0.48 percentage point higher rental rate.

In the second model (Column 2), we include the farm specialization dummy variable (farm type). The effect of proportional organic status on land value is still not statistically significant. However, the magnitude of organic status increases from -0.08% to 0.04% points (Table 7.2). Farm type dummies allows us to capture the differences in organic productions. For example, we can control for differences in production between organic crop producers and fruit producers.

The third model includes the NASS crop districts dummy variables (Column 3). After we control for the geographical differences between organic and conventional land prices, the effect of organic certification becomes statistically significant and increases in magnitude. A 1% point increase in organic acres may increase the land value by 0.23% point if we control for regional price differences. The revenue has still a positive correlation with the land value, although the magnitude has decreased to 0.25% point. It might be the case that the geographical location of farms play important role in organic decisions and the land value. Depending on regional specifics, farmers might decide to fully certify into organic practice. Also the regions with developed agriculture and markets have better environment for organic practice. In the regions where organic practice is traditionally developed, the farmers may decide to certify into organic farming. The variable and fixed costs have statistically significant effect on the land value. The majority of variations in regression could come from the geographical differences in organic practices.

The fourth model controls for differences in organic practices between urban and rural areas (Column 4). The effect of proportional organic status stays statistically significant. The magnitude of the organic effect increases to 0.249% in the model. The result suggests that there is an effect of urbanization on farmland value. There is no changes in magnitude between revenue, variable costs, fixed costs and land value. By including urbanization into the model, we control for differences in organic practices between rural and urban areas.

Finally in the fifth model we include year dummy variables to control for unobserved factors that may lead to differences in land prices. Overall the coefficients of interest changes in magnitude, and it is 0.23%. The revenue has increased in magnitude to 0.26%.

The results of first model (organic proportion status) and third model (organic and binary organic statuses) are practically identical, except the main organic explanatory variables (Table 7.1). The R-squared for these models are also identical. However, the estimated coefficient on binary organic status is not significant in the third model. It is difficult to estimate the overall effect of organic certification in the third model. Also the interpretation of organic statues is more complicated in the third model. We choose the first model for the simplicity of interpretation of organic certification.

Table 7.2 shows the results of pseudo-panel models. In these models, we use the NASS crop districts as cohorts to build a panel. Column (1) - (3) represent the each models with different organic statuses. The model 1 (Column 1) shows that a 1% increase in organic crop acreage participation in the total crop acres leads to 0.60 percentage point increase in the farmland rental rate. The effects is two time bigger than the weighted OLS model results (model 1, Table 7.1). Such bigger marginal effect on organic acres might result of adding the fixed effects. The fixed effects deal with time invariant unobserved variables. We include time fixed effects into the regression model. However, by aggregation to the cohort level, we lose the variation within the cohort in our estimation. Even with fixed effect, we may overestimated the organic effects on farmland value. The standard error relative to the organic coefficient is big. The revenue from organic products increases the farmland rents by 0.147 percentage point. The variable cost has a positively significant impact on farmland value. An increase of total household income tend to decrease the farmland rents by 0.04 percentage point.

The model 2 (Column 2) as in the previous Table 7.1, has the similar effects on farmland value. The dummy organic status has no significant impact on farmland rental rate. Other than that the effects of other control variables on farmland value is same as in the model 1 (Table 7.3).

The third model (Column 3) follows the same logic as in the Table 7.1. The sum of organic proportion and organic dummy statues give the same effect as in the model 1. The total effect of these two organic statuses is 0.49 percentage point increase on farmland value. After we include year fixed effect and time trends, we get the above results. The revenue, costs, and other control variables as the other two models (Column 1 and 2) have the same effects on farmland value.

In Table 7.4 we estimate the pseudo-panel models using the state cohorts. However, the results and patterns differ from the previous models (Table 7.1; Table 7.3). In all three models (Column 1 - 3) we do not see the significant effect of organic certification on farmland value. The variable costs have positively significant effect on farmland value. The rest of the control variables have no significant impacts on farmland value. As the size of each cohort increases, the number of cohorts decreases leaving fewer observations for use in our estimation.

Table 7.1: Effect of Organic Certification on Farmland Value (Weighted OLS)

	(1)	(2)	(3)
Log of	Organic Proportion	Organic Indicator	Organic Proportion and Indicator
Organic	0.231**		0.371***
	(0.110)		(0.146)
Organic Indicator		0.077	-0.118
		(0.074)	(0.091)
Revenue	0.261***	0.261***	0.261***
	(0.031)	(0.031)	(0.031)
Variable Cost	0.207***	0.208***	0.207***
	(0.051)	(0.051)	(0.051)
Fixed Cost	0.019***	0.019***	0.019***
	(0.005)	(0.005)	(0.005)
Marketing Charge	0.004**	0.004**	0.004**
	(0.002)	(0.002)	(0.002)
Direct Payment	0.001	0.001	0.001
	(0.001)	(0.001)	(0.001)
Federal Crop Insurance	0.002***	0.002***	0.002***
	(0.001)	(0.001)	(0.001)
Total Household Income	-0.002	-0.002	-0.002
	(0.006)	(0.006)	(0.006)
Off-farm Income	-0.002**	-0.002**	-0.002**
	(0.001)	(0.001)	(0.001)
Crop Diversity	-0.040***	-0.040***	-0.039***
	(0.006)	(0.006)	(0.006)
Time Trend	-0.003	-0.003	-0.003
	(0.005)	(0.005)	(0.005)
Urban and Rural	Yes	Yes	Yes
Year Dummy	Yes	Yes	Yes
Farm Type	Yes	Yes	Yes
NASS Crop Districts	Yes	Yes	Yes
R-squared	0.599	0.598	0.599

The robust standard errors are in parentheses. ***$p < 0.01$ **$p < 0.05$ *$p < 0.1$.

Table 7.2: Effect of Organic Certification on Farmland Rental Rate (Weighted OLS)

	Organic Proportion Status				
Log of	(1)	(2)	(3)	(4)	(5)
Organic	-0.085	0.046	0.237**	0.249**	0.231**
	(0.132)	(0.087)	(0.113)	(0.112)	(0.110)
Revenue	0.480***	0.544***	0.253***	0.253***	0.261***
	(0.038)	(0.043)	(0.03)	(0.030)	(0.031)
Variable Cost	0.190***	0.250***	0.206***	0.205***	0.207***
	(0.050)	(0.062)	(0.051)	(0.051)	(0.051)
Fixed Cost	0.032***	0.025***	0.019***	0.019***	0.019***
	(0.008)	(0.006)	(0.005)	(0.005)	(0.005)
Marketing Charge	0.011***	0.009***	0.004**	0.004**	0.004**
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Direct Payment	0.019***	0.007***	0.001	0.001	0.001
	(0.002)	(0.002)	(0.001)	(0.001)	(0.001)
Federal Crop Insurance	-0.002***	-0.002**	0.002**	0.002**	0.002***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Total Household Income	0.025***	0.033***	-0.001	-0.002	-0.002
	(0.007)	(0.007)	(0.006)	(0.006)	(0.006)
Off-farm Income	0.007***	0.002	-0.002**	-0.002**	-0.002**
	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)
Crop Diversity	-0.075***	-0.071***	-0.041***	-0.014***	-0.040***
	(0.008)	(0.007)	(0.006)	(0.006)	(0.006)
Time Trend	-0.037***	-0.055***	-0.003	-0.003	-0.003
	(0.004)	(0.004)	(0.004)	(0.004)	(0.005)
Farm Type	No	Yes	Yes	Yes	Yes
NASS Crop Districts	No	No	Yes	Yes	Yes
Urban and Rural	No	No	No	Yes	Yes
Year Dummy	No	No	No	No	Yes
R-squared	0.361	0.420	0.596	0.597	0.599

The robust standard errors are in parentheses. ***$p < 0.01$ **$p < 0.05$ *$p < 0.1$.

Table 7.3: Effect of Organic Certification on Farmland Rental Rate (Pseudo-Panel using NASS district cohorts)

	(1)	(2)	(3)
Log of	Organic Proportion	Organic Indicator	Organic Proportion and Indicator
Organic	0.606*		0.767*
	(0.346)		(0.406)
Organic Indicator		-0.001	-0.276
		(0.328)	(0.372)
Revenue	0.147**	0.145**	0.147***
	(0.057)	(0.058)	(0.057)
Variable Cost	0.236***	0.234***	0.233***
	(0.053)	(0.053)	(0.052)
Fixed Cost	0.030	0.031	0.029
	(0.045)	(0.046)	(0.045)
Marketing Charge	-0.001	-0.001	-0.001
	(0.003)	(0.003)	(0.003)
Direct Payment	-0.004	-0.004	-0.004
	(0.006)	(0.006)	(0.006)
Federal Crop Insurance	0.004	0.004	0.004
	(0.003)	(0.003)	(0.003)
Total Household Income	-0.041**	-0.040**	-0.041**
	(0.017)	(0.017)	(0.017)
Off-farm Income	0.016	0.017	0.016
	(0.013)	(0.013)	(0.013)
Crop Diversity	0.00	0.00	0.001
	(0.008)	(0.008)	(0.008)
Year FE	Yes	Yes	Yes
Time Trend	Yes	Yes	Yes
R-squared	0.159	0.157	0.159

The robust standard errors are in parentheses. ***$p < 0.01$ **$p < 0.05$ *$p < 0.1$. The data collapsed at the NASS crop districts and year levels. N = 2239

Table 7.4: Effect of Organic Certification on Farmland Rental Rate (Pseudo-Panel using State Cohorts)

	(1)	(2)	(3)
Log of	Organic Proportion	Organic Indicator	Organic Proportion and Indicator
Organic	-0.239		-0.771
	(0.678)		(0.788)
Organic Indicator		0.964	1.374
		(1.083)	(1.164)
Revenue	0.115	0.131	0.117
	(0.158)	(0.158)	(0.160)
Variable Cost	0.331**	0.339**	0.345**
	(0.164)	(0.165)	(0.165)
Fixed Cost	0.118	0.096	0.122
	(0.168)	(0.165)	(0.165)
Marketing Charge	-0.007	-0.008	-0.008
	(0.004)	(0.004)	(0.004)
Direct Payment	-0.017	-0.012	-0.011
	(0.024)	(0.023)	(0.023)
Federal Crop Insurance	0.016	0.016	0.015
	(0.010)	(0.010)	(0.010)
Total Household Income	0.037	0.023	0.016
	(0.10)	(0.096)	(0.093)
Off-farm Income	-0.049	-0.032	-0.030
	(0.083)	(0.082)	(0.08)
Crop Diversity	0.013	0.009	0.008
	(0.023)	(0.024)	(0.025)
Year FE	Yes	Yes	Yes
Time Trend	Yes	Yes	Yes
R-squared	0.248	0.253	0.258

The robust standard errors are in parentheses. $***p < 0.01$ $**p < 0.05$ $*p < 0.1$. The data collapsed at the state and year levels. N=419

CONCLUSION

In this paper, we research the relationship between organic certification and farmland values. The main hypothesis is that organic certification has a positive impact on farmland value, and we confirm this hypothesis. We also find that farm revenue has a positive effect on farmland value. We estimate regression models using the USDA ARMS data. Our dependent variable is the cash rental rate paid by farmers. To classify farms as organic, we generate a binary status variable if the farm has some organic acres and measure the proportion of certified organic crop acres. The models use binary status and proportion of acres organic statuses to an organic classification. We estimate weighted OLS models with NASS crop districts, farm specialization, urbanization, and year fixed effects. We use farm's revenue and production costs to estimate the profitability of organic farms. In addition, the OLS models include any government direct payments, federal crop insurance, total household income, off-farm income, and crop diversity. As an alternative model, we estimate pseudo-panel regressions with fixed effects at the crop district or state levels.

We find a positive, statistically significant relationship between organic certification and farmland value, even after controlling for profitability, location, and other factors. According to our preferred model, a 1 percentage point increase in organic land in a farm's total cropland is associated with an increase farmland rental rate by 0.23% point after controlling other factors. The result meets our theoretical expectations. Our model predicts that a 1 percentage point increase of revenues from crop production is associated with an increases the farmland value by 0.26 percentage point.

Finally, we run pseudo-panel models with same fixed effects. The results show a statistically significant relationship between organic certification and farmland value.

The magnitude of organic coefficient is 0.60% point, which is three times more than the results of weighted OLS model.

We face several limitations in our study. We are unable to control for farm level unobservable factors such as land productivity, farmer's skill, or experience because our paper is based on repeated cross-sectional data. Panel data would allow us to follow each individual farmers in each period, and observe dynamic changes in farmland values.

Without panel data we cannot control for unobserved factors which could affect the farmer's certification decisions. We are unable to control for farmer's experience and management skill in organic agriculture. Also the land productivity might affect the choice of organic certification and farmland rental rate. However, we are unable to access field level data.

Second, we cannot observe dynamic changes in farmer's production and financial records. The ARMS data cannot track the same individual farmer over time. The dynamics would allow us to track farmer's pre and post organic certification changes in rental rate and production costs. A panel data would allow to control for time-invariant unobservable factors.

In order to separate a true exogenous effect of organic certification, we would like to have an instrument variable in our model, to isolate exogenous shifts in organic certification. A valid instrument would be not correlated with the farmland rental rate or other input decisions, but correlated with organic certification. Some measure of changing demand for organic food at the farm-level would be an ideal instrument.

To summarize, the results of our research show that the effect of organic certification on farmland value is positive and significant, even after controlling for profitability, location and other factors.

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