WHERE IS ORGANIC FOOD PRODUCED AND CONSUMED? THE DETERMINANTS OF THE LOCATION OF ORGANIC FOOD PRODUCTION AND CONSUMPTION IN THE U.S.A.

by

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Abstract

The objective of this thesis is to determine the factors that impact the location of organic food production and organic food consumption. The models used test to see if organic foods are consumed where they are produced, the characteristics of consumers which influence their organic consumption, and if organic production is located in the same areas as conventional production.

The results of this study showed that organic production is not dependent on conventional production. Education was found to be positively correlated to organic production and consumption while income actually had an opposite effect. Organic production and consumption were also linked to the political liberalness of a state. It was found that urban populations had a negative impact on organic production and Whole Foods stores had a positive effect.

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CHAPTER 1 - Introduction

Over the past couple of decades, the organic food industry has experienced tremendous growth. According the Organic Trade Association (OTA), organic food and beverage sales have grown from $1 billion in 1990 to a projected sales of $23.6 billion in 2008 (OTA). In 2002, United States consumers spent $709 billion on food (USDA/ERS, Amber Waves). The organic food industry is a growing segment of the food industry that deserves some attention. Quoted in a publication by Private Label Buyer, Laura Demerrit, President and Chief Operating Officer of the market research firm Hartman Group, states “We certainly think natural and organic products are going very mainstream. If you look at the people who currently buy organic, it’s pretty reflective of the population as a whole” (Burtley).

Congress originally passed the Organic Foods Production Act of 1990 (USDA/AMS). As part of the act, the National Organic Standards Board was developed, and by 1995 the board had officially defined organic agriculture as:

> An ecological production management system that promotes and enhances biodiversity, biological cycles and soil biological activity. It is based on minimal use of off-farm inputs and on management practices that restore, maintain and enhance ecological harmony (USDA/AMS).

However, it wasn’t until 2002 when the National Organic Program (NOP) came into existence that there was a government certification process established (USDA/AMS). A division of the United States Department of Agriculture (USDA), the NOP oversees all standards and regulations for the production, harvesting and handling of any organically produced agricultural product (USDA/AMS). Agricultural products or whole farms must be certified by an accredited certifier in order to be marketed as an organic product and/or farm (USDA/AMS).

Why has the large increase in organic foods occurred? Why have the increased government standards and regulations been implemented? A simple answer is: consumers. Consumers have pushed for more regulations along with more consistency and confidence in the organic products (Vandeman and Hayden, 1997). According to the Agricultural Outlook published by the Economic Research Service, consumers shop for many of the same characteristics in organic products as they do in conventional food products such as taste, freshness, and appearance. However, organic food consumers are also concerned with the absence of chemicals and the comfort of knowing that the organic products are environmentally friendly and therefore led to the implementation of certified organic food (Agricultural Outlook, USDA/ERS).

With the increase in organic food sales, it is clear that the organic food market is growing. In order to meet the demand for organic food, there must be an increase in the supply. The USDA's Economic Research Service (USDA/ERS) has collected data on the number of certified organic farm operations since 1997; there were 40 independently certified farms in 1997, and by 2005 that number was nearly 8,500 (USDA/ERS, 2004). The number of certified farms is continually growing and will do so to sufficiently meet the demand from consumers. Along with the increased consumer demand, there has been an increase in retail outlets for organic foods.

> Until 2000, the largest retail outlet for organic food was natural foods stores followed by direct market according to Natural Foods Merchandiser. In 2000, 49 percent of all organic products were sold in conventional supermarkets, 48 percent was sold in health and natural products stores, and 3 percent through direct-to-consumer methods (Dimitri and Greene).

With more consumers and retail outlets, where is the organic production occurring? Where is organic food coming from, and why is it produced in specific states? Is organic food consumed in the same states where it is produced or are there other factors that determine the location of organic food consumption? These questions will be addressed in this thesis by analyzing organic and conventional food production and consumption.

Data regarding conventional food production will be compared to organic food production data in the next section. Food production will be broken down into basic commodity groups at the aggregate level. Organic food production will be compared to conventional food production across all states. The top five organic producing states will be placed side by side to the top five conventional producing states in each commodity group. The information provided shows a geographic comparison between the production locations of organic foods verses conventionally-produced foods.

Organic Food Production

Analyzing organic food production requires data from both organic and conventional food production. Both conventional and organic data were necessary to assess where and to what extent organic products were being grown in all 50 states. The conventional production data came from the Ag Census in 2002 while the organic production data had been collected by the ERS. The conventional data were very detailed and broken down into several categories. However, the organic data were not as detailed. Therefore, the data were compiled into commodity groups for both the organic and conventional data sets to get an idea of where organic food is produced relative to conventional food production.

Seven different categories of organic and conventional commodities were analyzed: cattle, hogs and pigs, poultry, sheep, grains, fruits and vegetables. Each of these commodity groups are comprised of various more specific groups. Beef cattle and dairy cows are the main subgroups included in the cattle category. In the poultry category, layers, broilers and turkeys make up this commodity. The grain category included different types of grain; the major grains are wheat, oats, barley, sorghum and rice. Acreage of organic vegetables were primarily comprised of tomatoes, lettuce and carrots; mixed vegetables and unclassified also were included in the overall total. As for fruits, this commodity category contained all citrus, apples, tree nuts and other unclassified fruits as its subgroups.

A direct comparison of the conventional and organic data was used in the following figures. States were ranked by how many acres were farmed or the total number of livestock produced for each commodity. Then the top five states from conventional production and from organic production were graphed to provide a visual comparison of where the production occurred.

Figure 1.1 shows the top five states which contained the most conventional and organic production of cattle. The blue states, Nebraska, Kansas, Oklahoma and Texas, represent the conventional cattle herds and the green states, Oregon, Minnesota, Wisconsin and New York, ranked highest for organic cattle. California which is shaded blue ranked in the top five in both organic and conventional cattle production. In 2002 California produced 17,908 head of organic certified cattle and 5,234,177 head of cattle conventionally produced. Wisconsin ranked number one in organic cattle with 23,964 and Texas was the top conventional cattle producer with 13,978,987 head. With the exception of California, there is a clear separation between organic cattle producers and conventional cattle producers. Nebraska, Kansas, Oklahoma and Texas are known for the large conventional production feedlots for cattle. Organic cattle production, however, is not occurring on such a grand scale as conventional cattle production. Perhaps the organic cattle production is being driven by other factors than the traditional forces which have shaped the conventional cattle production.

Figure 1.1 Organic verses Conventional Cattle Production (number of head)

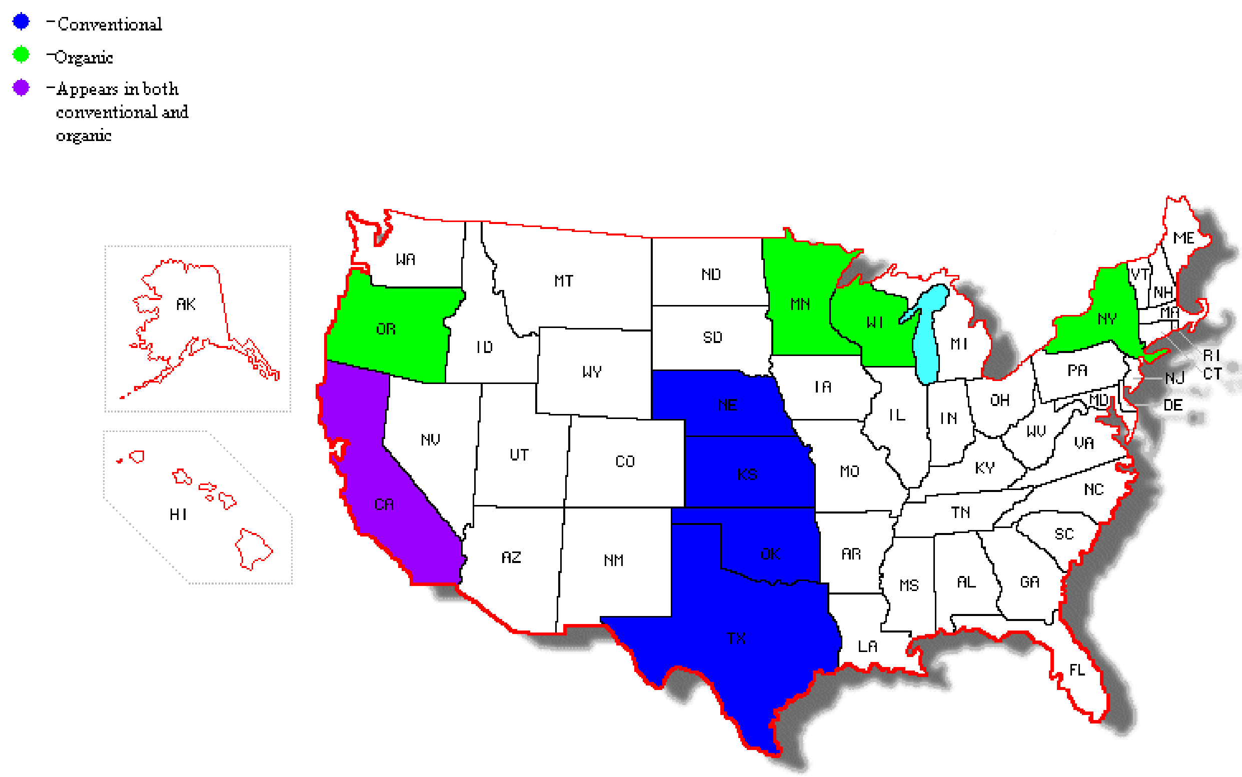
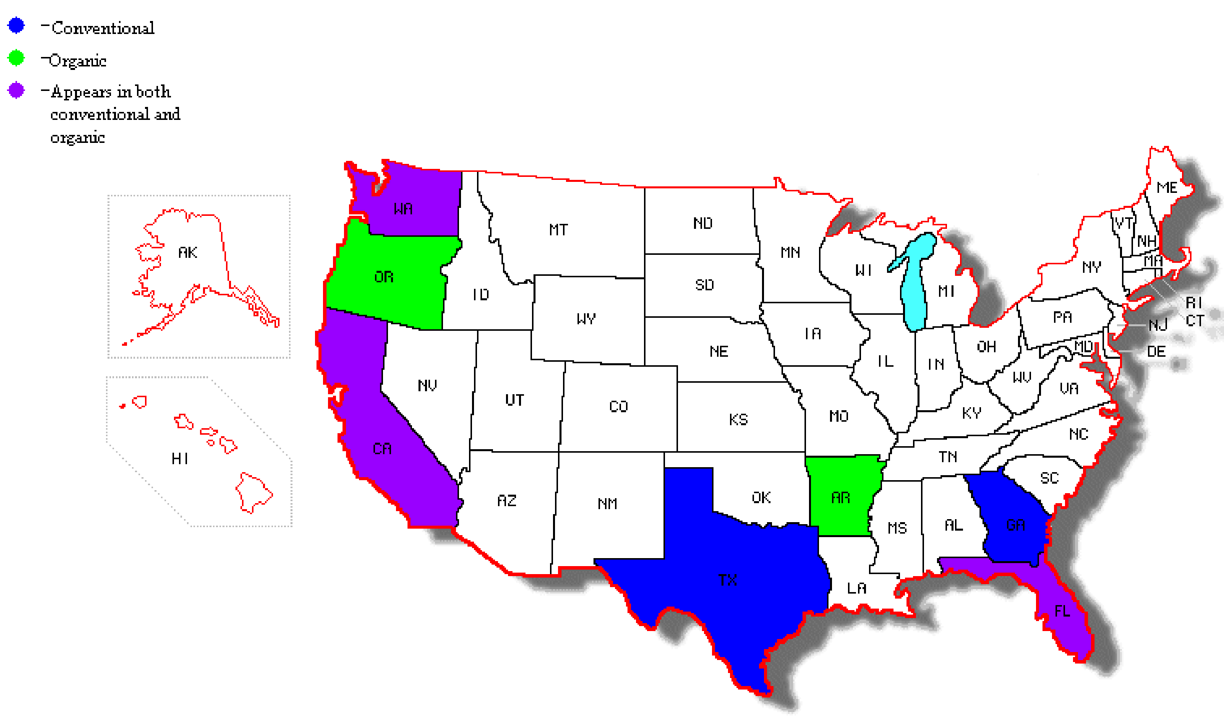


Figure 1.2 displays the fruit commodity, measured in acres of production. California was the top organic and conventional fruit producer with 33,522 acres of organic fruit and 2,871,626 acres of conventional fruit production. It is shaded in purple because it appeared in both the organic fruit top five as well as the conventional top fruit producers. The same was true for the states of Washington and Florida. Florida had 894,955 acres of conventional fruit production and 4,515 acres of organic fruit production. Washington produced 12,111 acres of organic fruits and 311,194 acres of conventional fruit. Oregon and Arkansas were shaded in green because they were in the top five producers of organic fruits. Their acreages were 2,708 in Oregon and Arizona had 2,157. The other top conventional fruit producers were Texas with 224,271 acres and Georgia with 145,602 acres. The conventional fruit producers were shaded in blue.

Considering that three states fall into both the top conventional and organic fruit-producing states, it is plausible that fruit production, whether conventional or organic, is contingent on some of the same variables. Weather can greatly affect the production of fruit. This could be a contributing factor as to why the same states produce both organic-and conventionally-produced fruit.

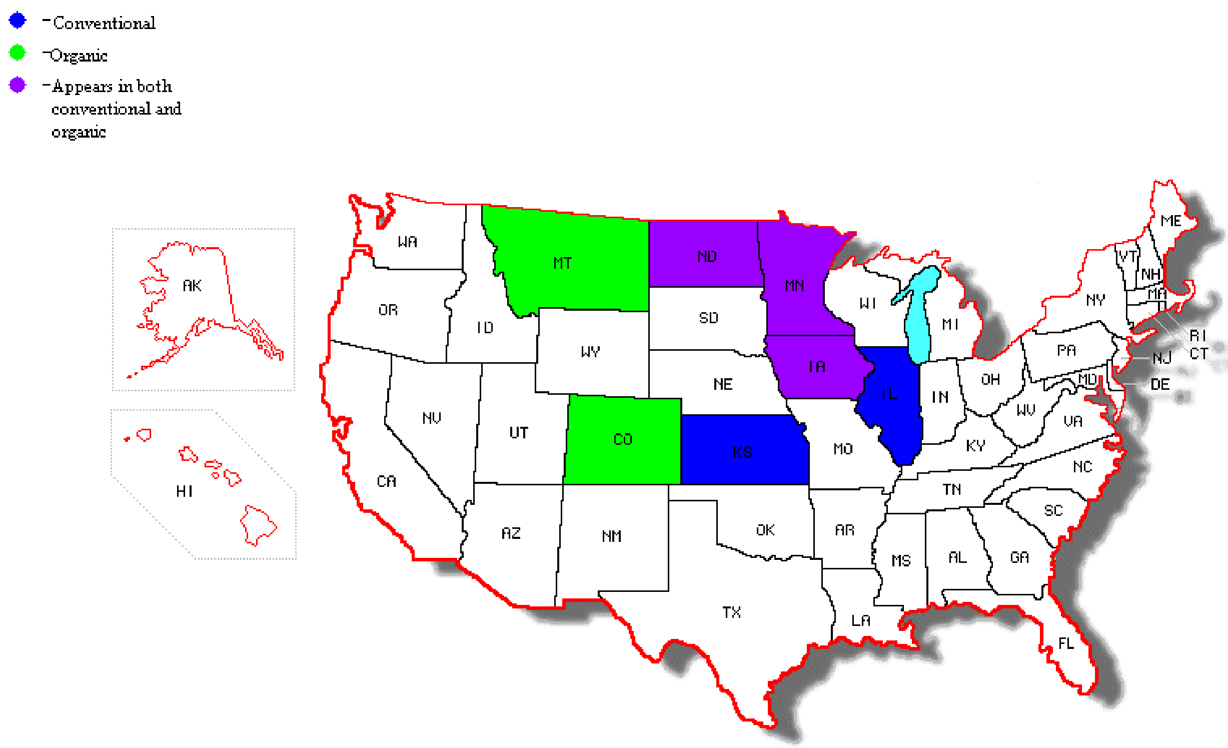
Figure 1.2 Organic verses Conventional Fruit Production (acres)



In Figure 1.3, Montana and Colorado were shaded in green because they were in the top five organic grain producers. Montana produced 54,737 acres of organic grains and Colorado had 45,013 acres. North Dakota had 53,601 acres of organic grain production and 19,908,697 acres of conventionally-produced grain which placed it in the top five for both categories and is therefore shaded in purple. The other two states that also fell on both lists were Minnesota and Iowa. Minnesota produced 54,737 acres of organic grain and 19,398,309 conventional grain acres, while Iowa produced 29,481 acres of organic grains and 23,994,343 conventional acres of grains. With 22,562,904 and 18,976,719 acres of conventionally-produced grains, Illinois and Kansas were in the top five states for conventionally-produced grains.

In the states that have both organic and conventional grain production, the portion of organic grain acreage is a small fraction of total conventional grain production. With the exception of Minnesota and North Dakota, the number of conventional grain acreage is similar throughout the other top producing states. So why is it that only North Dakota, Minnesota, and Iowa are not only conventional grain producers but produce organic grain as well? Perhaps there is a comparative advantage in these states, an availability of land and growing conditions which allow for more production. Production could also be linked to factors such as the state's liberalness or the perception of organic goods.

Figure 1.3 Organic verses Conventional Grain Production (acres)



Hog production is shown in Figure 1.4 for the top producing states. Iowa, shaded in purple, topped both the organic and conventional hog production charts with 1015 head of organic hogs and 15,486,531 conventionally-produced hogs. The other organic hog producing states were Maine with 425 hogs, Montana with 398 hogs, Wisconsin with 300 hogs and New Jersey with 156 head of organic hogs. These states were shaded in with green. The conventional-hog producing states were filled in with blue. They were North Carolina with 9,887,421 hogs, Minnesota had 6,440,067 hogs, Illinois produced 4,094,706 conventional hogs and Indiana had 2,933,620 hogs in 2002.

Organic hog production is interesting, because only Iowa is ranked for both organic and conventional hog production. The other top organic hog-producing states are different from the conventional hog-producing states. Hog production is not greatly affected by issues such as climate. A producer needs hog facilities and hogs in order to produce hogs. It is interesting that a state like New Jersey ranks in the top five for organic hog production. New Jersey is such a small state in comparison to the others and since it is not known for its conventional hog production, it is reasonable to believe that organic hog production is being driven by non-conventional hog production characteristics. Perhaps organic production is being driven by consumers in that area demanding organic pork.

Figure 1.4 Organic verses Conventional Hog Production (herd size)

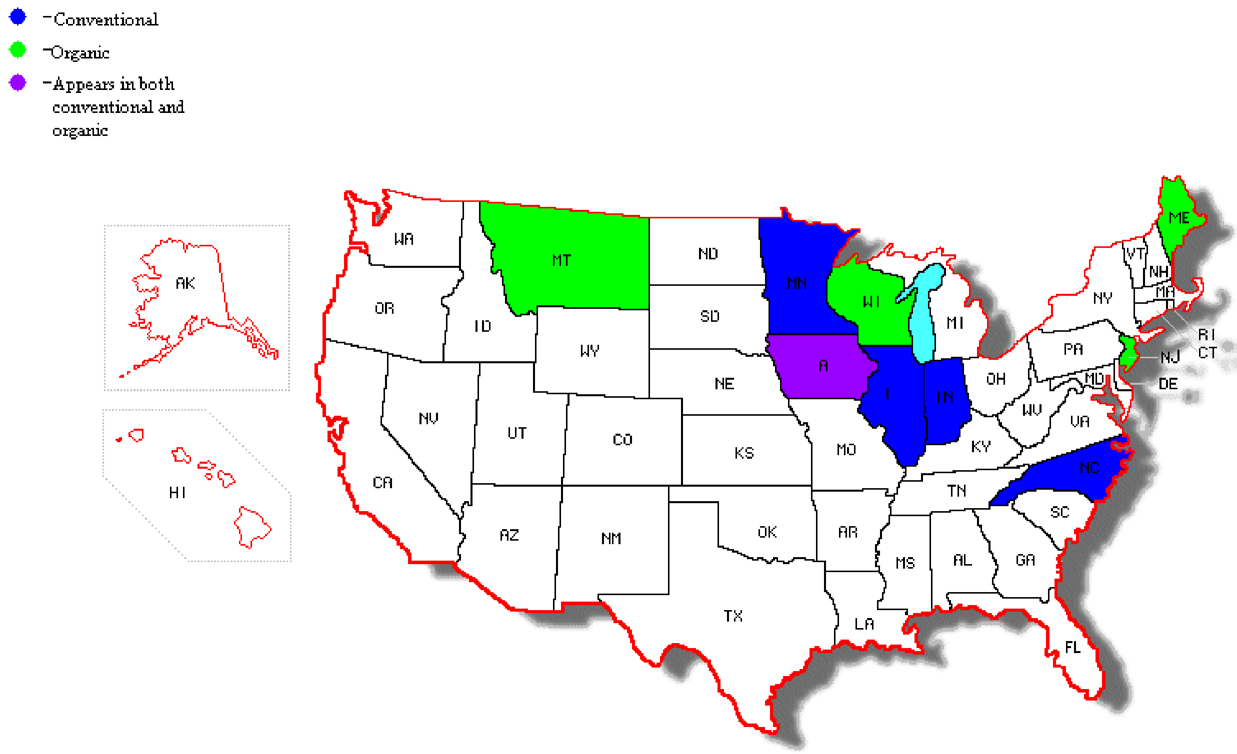
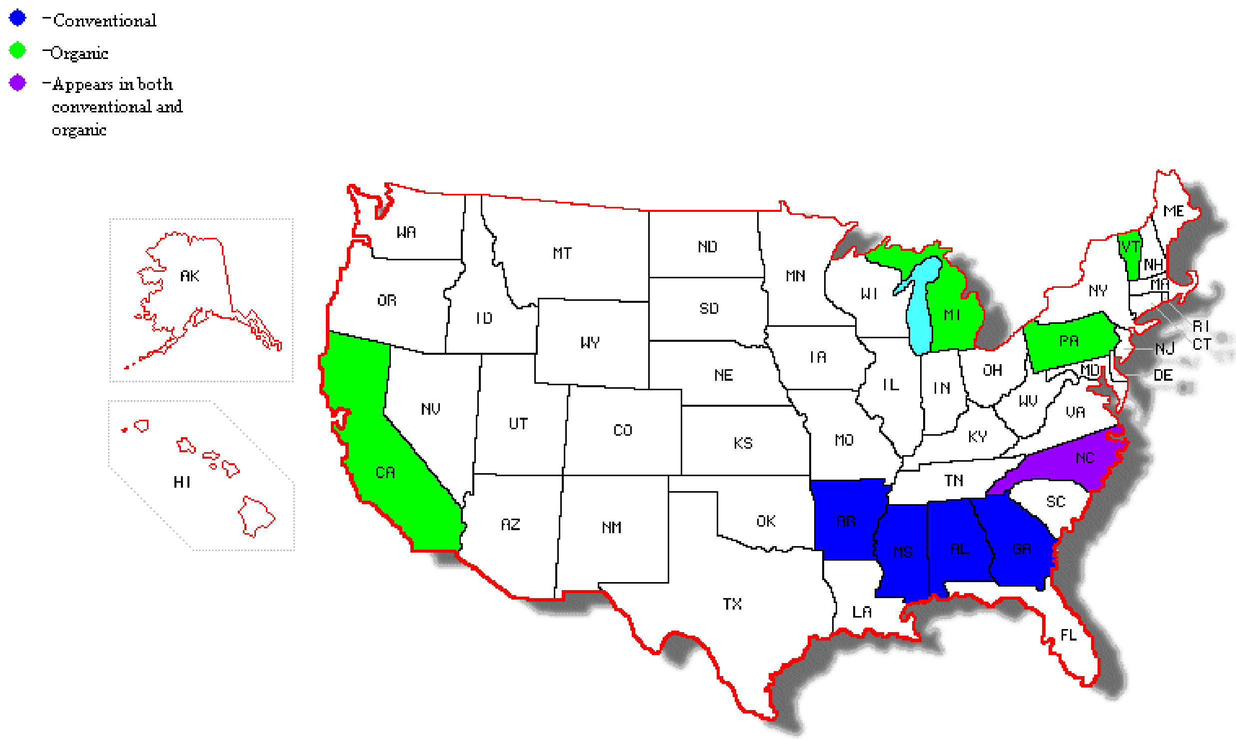


Figure 1.5 shows the difference in states as to where conventional poultry is produced verses organic poultry. The top conventional poultry producers in total birds produced were Georgia 224,701,662, Arkansas 203,348,643, North Carolina 174,144,034, Alabama 167,953,042 and Mississippi 140,126,213. These states were shaded in blue, with the exception of North Carolina which was colored purple because it was also in the top five for organic poultry producers as well. The other organic poultry producers were shaded in green. Those states and their production numbers are as follows: California 1,624,143, Virginia 1,213,806, Pennsylvania 430,238 and Michigan 200,160.

Poultry production is similar the hog production in the fact that production can occur basically anywhere there are the necessary facilities. It does not need many acres nor does weather greatly impact production. The separation between the organic poultry producing states and the conventional poultry producing states means there are other factors contributing to a producer's decision to produce organic poultry than what drives a conventional poultry producer. These factors might include consumer demand for organic food or perhaps it is the education and progressive producers that opt for organic production.

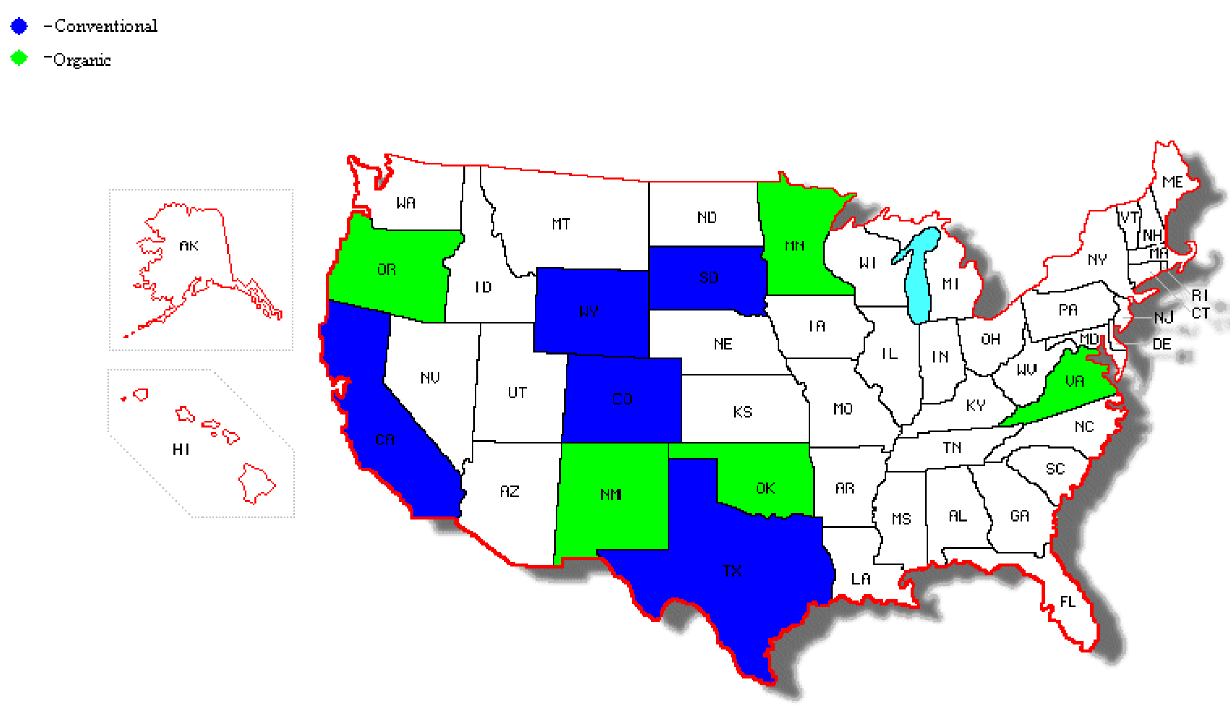
Figure 1.5 Organic verses Conventional Poultry Production (flock size)



Organic and conventional sheep production is displayed in Figure 1.6. This is the only category where the organic states are completely different than the conventional sheep producing states. The top five organic sheep producing states in green were New Mexico, Virginia, Minnesota, Oklahoma and Oregon. New Mexico produced organic 1,400 sheep in 2002, Virginia had 749 organic sheep, Minnesota produced 731 organic sheep, Oklahoma had 678 organic sheep and Oregon produced 522 organic sheep. Shown in blue, the conventional sheep production states are Texas with 1,029,813 sheep, California had 731,558 sheep, Wyoming produced 459,682 sheep, Colorado had 382,933 sheep and South Dakota had 376,468.

Since there is a distinct separation between the conventional and organic sheep production, it is likely that there is different factors determining organic production verses conventional. Sheep production requires land for grazing. Typically sheep do well in higher altitudes or cooler weather. Each of the aforementioned states contains areas that would fit the necessities but why is there a clear distinction between conventional and organic sheep production. What other factors could be causing this distinction? Organic production might be influenced by consumers who have different education levels and incomes.

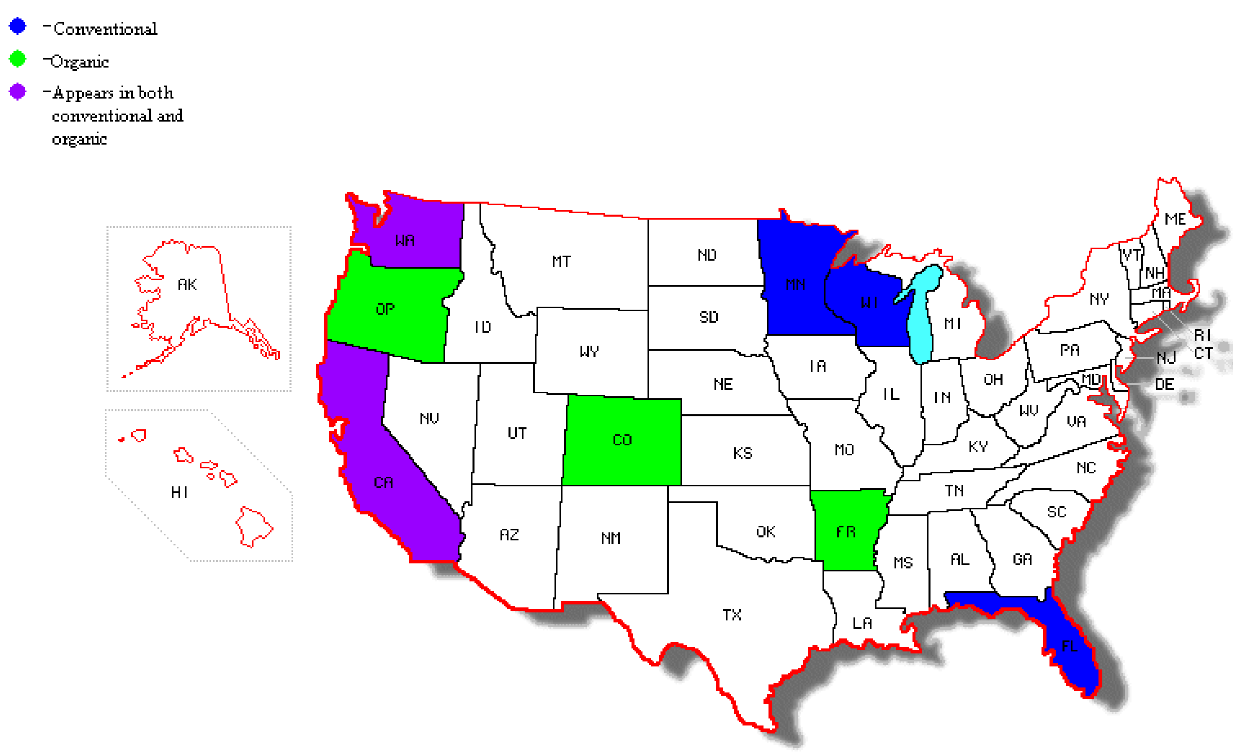
Figure 1.6 Organic verses Conventional Sheep Production (flock size)



Lastly, Figure 1.7 is the comparison of conventional and organic vegetable production. The blue shaded states were the top conventional vegetable producing states; these were Minnesota, Wisconsin and Florida. The states' vegetable acreage was 225,203, 210,008, and 198,378 in that order. In green is the organic vegetable producing states- Oregon, Colorado and Arkansas with 2,648, 2,075 and 4,975 respectively. California and Washington were both states that appeared in the top five for organic and conventional vegetable production. California's organic vegetables totaled 38,355 acres and conventional vegetables were produced on 1,025,056 acres. Washington produced 210,008 acres of conventional vegetables and 6,802 acres of organic vegetables.

Although there are some overlap with Washington and California as both organic and conventional vegetable producers, the other states vary. The conventional and organic vegetable producing states are spread across the U.S. and are not commonly linked to a climate or specific growing conditions. It is apparent that there are other factors influencing production other than climatic factors.

Figure 1.7 Organic verses Conventional Vegetable Production (acres)



Summary statistics of production data are presented in the following table. A mean, standard deviation, minimum and maximum was calculated for each of the commodity groups across all 50 states. The first section looked at the organic production while the second focused on the conventional production. The third section showed the percentage of organic production. Much of the organic production was a small fraction of the total conventional production. For the commodity groups of organic cattle, hogs, sheep and grains, the percentage of organic was less than one percent. Organic poultry and vegetables consisted of 2.3 percent but organic fruits had the largest share of organic production with 11.95 percent.

Table 1.1 Summary Statistics by State of Organic Food Production Data, 2002.

Variables	Mean	Standard Deviation	Minimum	Maximum
ORGANIC PRODUCTION				
Cattle (number of head)	2,014	4,506	0	23,964
Hogs (number of head)	55	167	0	1,015
Sheep (number of head)	98	265	0	1,400
Poultry (flock size)	87,801	289,260	0	1,624,143
Vegetables (acres)	1,398	5,477	0	38,355
Fruits (acres)	1,214	5,016	0	33,522
Grains (acres)	9,910	14,594	0	54,737
CONVENTIONAL PRODUCTION				
Cattle (number of head)	1,909,960	2,370,136	5,308	13,978,987
Hogs (number of head)	1,204,502	2,745,152	0	15,486,531
Sheep (number of head)	126,836	194,359	530	1,029,813
Poultry (flock size)	35,982,346	54,924,259	4,809	224,701,662
Vegetables (acres)	68,665	152,585	127	1,025,056
Fruits (acres)	106,609	421,418	0	2,871,626
Grains (acres)	6,053,945	6,726,933	17,820	23,994,343
ORGANIC PERCENTAGE OF PRODUCTION				
Cattle (number of head)	0.16%	0.39%	0.00%	2.27%
Hogs (number of head)	0.20%	1.19%	0.00%	8.40%
Sheep (number of head)	0.08%	0.23%	0.00%	1.03%
Poultry (flock size)	2.33%	9.26%	0.00%	56.79%
Vegetables (acres)	2.36%	4.86%	0.00%	27.62%
Fruits (acres)	11.95%	24.65%	0.00%	100.00%
Grains (acres)	0.17%	0.25%	0.00%	1.31%

Although organic food production is a fraction of conventionally-produced foods, studying organic production is quite interesting. The earlier figures of the United States and the comparison of organic food production to conventional production show the amount of differences between organic and conventional food production. It is clear that there are variations between the locations of conventionally-produced foods and organically-produced foods. It is these differences which serve as a basis for the thesis. The next section provides a more clear purpose with the research objectives.

Research Objectives

The objective of this thesis is to determine the factors that impact organic production and organic consumption. The thesis will focus on four specific areas questions:

1. Is organic foods consumed in the same location that it is produced?
2. Is organic production occurring in the same location as conventional production?
3. Is organic production based on agronomic characteristics of the location where it's produced?
4. Is organic consumption based on the sociological demographics in a location?

These questions are important to ask in order to explain the variation in the location of organic food production and conventional food production. Although the organic food industry is a small, it is a growing segment of the U.S.'s total food industry. It is also quite unique because organic food production is not occurring in the same locations as the conventional food production. Understanding the factors which are driving organic consumption and determining where organic food production is occurring is of interest.

Having looked at the objectives of the thesis, the following seven chapters explain how the objectives will be addressed. Next a literature review chapter is included to support the decision behind the model and the selected variables. Following the literature review are chapters that describe the conceptual and empirical models. These models examine the sociological demographics as well as the production location characteristics. Next is a description of the data used in the models along with the results from the models. Finally, conclusions are included in the last chapter.

CHAPTER 2 - Literature Review

The objective of this chapter is to review previous literature that has addressed similar topics covered in this paper. Also it serves as support to why specific variables were included in the model.

Previous reports have examined industry clusters; one in particular looked at the organic industry at the county level. Eades and Brown examined the shift from conventional operations to organic in “Identifying Spatial Clusters within U.S. Organic Agriculture.” Three different models were used to determine where organic clusters exist at the county level. Their results showed that using data from sales and urban populations, acreage of organic products and production levels organic clusters were found to be concentrated at the county level (Eades and Brown). However, when analyzing the number of organic farms results showed more dispersion between counties. Overall, states that showed high concentration of organic production included California, Washington, Oregon, the Great Plains states, New England and Mid-Atlantic states (Eades and Brown). These results are consistent with the results of this papers analysis.

A second compelling article examined multiple industries throughout the U.S. Authors Ellison and Glaeser (1997) write that almost all industries are somewhat localized in their publication “Geographic Concentration in U.S. Manufacturing: A Dartboard Approach.” The major question being asked is if industries are geographically concentrated (Ellison and Glaeser, 1997)? Using Census Bureau and the Census of Manufacturing data, Ellison and Glaeser (1997) wrote that “almost all industries are somewhat localized. In many industries, however, the degree of localization is slight.” While the authors did not specifically analyze organic food production, they did look at the food sector overall which was found to only be slightly concentrated. However when categories like dairy production or grapes used for winemaking were analyzed they were found to be highly concentrated.

Ellison and Glaeser (1997) had two explanations for this. First the dairies tended to be concentrated near processing facilities that either bottled milk or manufactured other dairy products like ice cream or frozen desserts. Natural advantage was the explanation for the concentration of grapes and winemaking. The concentration of grapes in California, explained by the authors, is due to the climate which in conducive to the growing of grapes. Natural advantage is one aspect that was accounted for in this paper. By comparing conventional production to organic helped to determine whether or not there was a natural advantage.

A second article by Ellison and Glaeser (1999) set out to prove that industry clusters can be determined by natural advantages. They were able to account for 20 percent of industry concentrations being explained by a small collection of advantages. This is a strong result that supports the decision to implement natural advantages into the model used to explain where organic production is occurring in the United States.

Another interesting article was written by Lohr et al. (2001), which focused on predicting potential growth areas for organic markets. There is much potential for expansion in the organic market, whether it is increasing the number of organic farms or broadening the base of end retailers (Lohr et al. 2001.). Their results showed that there was room for growth in all of the 50 states. States that could sustain the most expansion of organic farms were Arkansas, Indiana, Iowa, Kansas, Michigan, North Carolina, Ohio, Tennessee, Virginia and West Virginia. Despite the growth potential for the various states, the West and North Central regions would continue to thrive and develop strong organic markets (Lohr et al. 2001). Since then the organic markets have experienced tremendous growth, especially states such as California, Washington and Wisconsin.

In a second article by Lohr (2002), comparisons between organic farmers and conventional farmers were discussed. There were several distinctions made between the two producers. This research showed that organic farmers tend to be educated women who are on average seven years younger than the typical conventional farmer. "Counties with organic farms have stronger farm economies and contribute more to the local economies. These counties also give strong support to rural development" writes Lohr (2002).

While Lohr examined organic production at county levels, this thesis focuses on the state levels. G. Barton examined the shifts in agricultural production after the World War II (1961). These shifts were correlated with the USDA and ERS's division of states. The ten divisions of states included Pacific, Mountain, Northern Plains, Lake States, Corn Belt, Southern Plains, Delta States, Southeast, Appalachian and Northeast. Among these divisions Barton also described the various types of agriculture that was concentrated in these areas. The production of beef was found in the Corn Belt and Northern Plains while the dairy production tended to be concentrated in the Northeast, Lake States and Corn Belt (Barton). Poultry production was found to be clustered in the Southeast division. Crop production, which included grains, oil crops, fruits and vegetables, was more spread out. Oil production was found in the Southeast and Delta states while fruits and vegetables were found in the Southeast, Mountain and Pacific divisions. Grains were grown throughout the Corn Belt, Northern Plains and Southern Plains primarily (Barton). Overall Barton wrote that there were few major shifts in where agricultural production occurred. Production tends to be based in geographic areas that were suitable for the type of specific production.

Although Barton's research was in 1961 little has changed in the divisions of states and agricultural production since then. The USDA still uses a very similar division of states for farm production (USDA/ERS). It is this breakdown and descriptions of regions that was utilized in categorizing agriculture across the state for the purpose of the thesis.

Having discussed where organic and conventional production is occurring now it is time to examine the organic consumer. Grebitus et al. did just that when they evaluated the characteristics of the organic consumer verses the conventional consumer providing insight into today's organic consumer. This information was important in determining which independent variables should be included in the model for this paper. The authors specifically examined the dairy and pork industries. Their results described an organic dairy consumer typically was a younger female while organic pork consumption was negatively correlated to household size and positively correlated to education levels. These results served as a basis to include education levels into the model.

While the trend of organic products continue to grow, Oberholtzer et al. (2005) took a closer look at the market expansion and what it means for producers and consumers alike. Given the labor intensive aspect of organic farming, producers have enjoyed demanding a price premium. "Price premiums for organic products have contributed to growth in certified organic farmland and, ultimately, market expansion," writes Oberholtzer et al. However, the paper also discussed how half of today's organic consumers have an income below $30,000 (Oberholtzer et al). Price premiums, if too high, will deter the consumers from purchasing organic foods. Overall results from their data showed that organic price premiums are slowly narrowing. This could potentially constrict future expansion of the organic markets. Although data was not available on all the market prices, median income was included as a variable to account for the consumers' ability to purchase goods.

Chung Huang took a more specific look at the demographics of the organic consumer. Tests and simulations were ran and examined for the key points of the consumer. Huang wrote that consumers who prefer organically grown produce could be categorized as by their education, size of the family and income levels. Consumers with the higher income levels were not only concerned with the environmental quality and food safety but the overall appearance of the produce was also important (Huang). The results from Huang's simulations provide reasoning behind the inclusion of the consumer demographics. Although family size was not included, aggregate data on the states' median income and the percentage of population which had a degree were included in the models.

An article published in the British Food Journal examined how the demand for organic food relates to consumers' views. Variables such as age, sex, education, politics, religion, familiarity with food, location of food production, perceived health related to food, vegetarian and vegan views and convenience were all examined (Onyango et al.) The findings in this article stated "Females and young people buy organic foods on a regular basis, as do the more politically liberal and moderately religious" (Onyango et al.) These results were interesting because they linked organic consumption to consumer attributes such as how liberal the consumer is.

The organic industry has been analyzed in the past. Authors examined the growing trends and the uniqueness of the organic consumer and others looked at the validity of using certain variables like income and education as determinants in models. These previously published results serve as a basis for variables that were chosen for the models in this thesis. Chapter 3 provides the conceptual models and chapter 4 will further describe the selected variables.

CHAPTER 3 - Conceptual Models

This chapter introduces the conceptual models that are used in the thesis. These models provide an overview of the relationships that are examined and further defined. The purpose of this thesis is to examine the organic food sector. Production determinants will be tested to determine whether or not they are significant in determining where organic production will occur. In the same manner, consumer characteristics will be examined to establish the effect that they have on organic production and consumption. These variables will be used to examine if organic production is related to conventional production and what characteristics of the consumer might affect organic consumption and production

The overall conceptual models for the organic production and consumption included the production characteristics and the consumer characteristics as shown below. The conceptual model used production and consumer characteristics as the independent variables which tested for the organic production and consumption. With the objective of determining where organic production and consumption occurs, it was hypothesized that the production and consumer characteristics are significant in determining that, which leads to the conceptual models shown below. The model is specified for analysis of data across the 50 states, where i = state i = 1, 2 …50.

1. Organic Food Production$_i$ = f(production characteristics$_i$, consumer characteristics$_i$) where i= state, i= 1-50
2. Organic Food Consumption$_i$ = f(production characteristics$_i$, consumer characteristics$_i$) where i= state, i= 1-50

Both production characteristics and consumer characteristics are believed to drive the production and consumption of organic goods. Production characteristics include conventional farm data such as the total number of farm operations in each state, total agricultural sales, and a grouping of states based on agronomic characteristics. These agronomic variables are the type of soil, total rainfall and climatic temperature patterns. Unfortunately, data on these variables were considered too aggregated to be meaningful for the present study; however, production regions defined by the U.S. Census Bureau will account for the agronomic characteristics. In the reviewed literature, Barton researched these production areas and determined that the groupings were related by production characteristics. U.S. Census regions and divisions of states are used to account for variations of agronomic characteristics in the U.S.

Consumer characteristics include data related to aggregate income levels, urban populations, education levels of consumers and the states' voting record. Education levels were found to be positively correlated to organic consumers in a study done by Grebitus et al. and therefore included in the conceptual model. Organic production and consumption is hypothesized to be related to levels of education of the consumer. Similarly, income levels were previously found to be linked to organic consumption by Oberhotzer et al. and by Huang. Income levels and education are both characteristics that describe the consumer. When analyzing the production and consumption of organic foods, these two variables were included based off the reviewed literature and the results that showed a positive correlation.

Urban populations and the states' voting records were also selected. These are believed to be related in organic production. Eades and Brown implemented an urban factor in their models linking it to organic production. Unlike conventionally grown foods, organic operations are more likely to be smaller and therefore potentially located in non-conventional areas or smaller areas in and around more urban settings. To test this connection to organic production, urban populations were included as an independent variable in the models. There also is a perception about organically produced food and that it is consumed and produced by more liberal-minded people. Onyango et al. published results which linked organic consumption to more liberal consumers. In these models, the states' voting records encompassed the liberal component. Therefore urban populations and states' voting records were included as independent variables.

The models below show a slightly more detailed set up of the dependent and independent variables which were previously described.

3. Organic Food Production$_i$ = f(total number of farms, organic sales, regions, income, urban populations, education, political record)
   where i= state, i= 1-50

4. Organic Food Consumption$_i$ = f(total number of farms, organic sales, regions, income, urban populations, education, political record)

   where i= state, i= 1-50

While the conceptual models provide a brief overview of the actual models used in this thesis, the next chapter gives a further explanation and description of the production and consumer characteristics. The empirical models discussed in Chapter 5 will more deeply explore the actual models and the variables.

CHAPTER 4 - Data

To analyze where organic food production occurs, data relevant to the production of organic foods were collected.   Although organic food production is not new, collecting data on organic foods by the Economic Research Service (ERS) did not begin until recently. The USDA/ERS has collected statewide organic food data since 1997 (USDA/ERS) while it wasn't until 2002 Ag Census when there were two questions for farmers to answer relating to organic food production (USDA/Census of Ag). Despite the limited amount of data, all of the data used in the analysis of where organic food production is concentrated have come from ERS, USDA and the Census Bureau. This chapter will describe the data and variables used in the model.

To explain the differences between where organic commodities are produced verses conventional commodities, many independent variables were included based on the conceptual models in the previous chapter. The variables can be broken into two groups: consumer and production characteristics. Consumer characteristics included income, education, urban populations, Whole Foods stores, an interaction term between the percentage of urban population and the states' voting records. Production characteristics included total number of organic farms, number of total farms (organic and conventional farms), total number of organic sales and total sales for farms. Each of the variables was collected at the aggregated state level. Further descriptions of the variables follow.

Descriptions of Consumer Characteristics

Income and education levels were both taken from the 2000 Census. A median income level for all states was selected from the Census data. For the education variable, the percent of the population in each state which had a degree was selected. A degree included a bachelor's degree and any higher education beyond a bachelor's degree.

Populations for each state were also collected from the 2000 Census. The population was broken down into two subcategories, urbanized areas and urban clusters. According to the Census definition, "an urban cluster consists of densely settled territory that has at least 2,500 people but fewer than 50,000 people," and "an urban area consists of densely settled territory that contains 50,000 or more people" (U.S. Census Bureau). After examining the population data it was determined that the urban cluster population would be used in the models because it best represented densely populated areas while excluding the rural areas. The urban cluster data contains areas that are more densely populated, typically food production does not occur in these type of areas.

Whole Foods Market, an all natural and organic grocery store chain, has a total of 258 stores in the U.S. These stores have sprung up across the nation and have been presumably located where there is consumer demand for organic and natural products. A Whole Foods variable was developed to include this trend across the nation. The Whole Foods variable consisted of summing the total number of stores in each state. This helped to account for consumer preferences and demands across all 50 states. Table 4.1 shows the number of Whole Foods stores in each state.

Table 4.1 Number of Whole Foods Stores

State	Whole Foods Stores	State	Whole Foods Stores	State	Whole Foods Stores
Alabama	1	Louisiana	3	Ohio	6
Alaska	0	Maine	1	Oklahoma	1
Arizona	7	Maryland	7	Oregon	6
Arkansas	1	Massachusetts	19	Pennsylvania	7
California	50	Michigan	4	Rhode Island	3
Colorado	18	Minnesota	2	South Carolina	2
Connecticut	5	Mississippi	0	South Dakota	0
Delaware	0	Missouri	3	Tennessee	3
Florida	14	Montana	0	Texas	14
Georgia	7	Nebraska	1	Utah	4
Hawaii	0	Nevada	5	Vermont	0
Idaho	0	New Hampshire	0	Virginia	8
Illinois	16	New Jersey	9	Washington	5
Indiana	2	New Mexico	5	West Virginia	0
Iowa	0	New York	8	Wisconsin	2
Kansas	2	North Carolina	5	Wyoming	0
Kentucky	2	North Dakota	0		

Having defined the population and Whole Foods store variable, it is important to describe the interaction variable. The interaction term was used to account for the possible interrelationship between the percentage of urban populations and Whole Food stores. It is unlikely that Whole Foods would open a store in an unpopulated area. In fact, according to the Whole Foods Market website, there must be a minimum of 200,000 people within a 20 minute drive of location before Whole Foods will consider a site. To derive the interaction term the number of Whole Food stores per state was multiplied by the state’s percentage of urban population. This allows for a measurement of any statistically significant interaction between the urban population and the number of Whole Foods stores.

One important element in the organic market that needed strong consideration was factoring in how liberal each state's population was. An index was developed using data from the 2000 election results posted on the CNN website (CNN). The percentage of votes for the presidential candidate Al Gore in each state was collected. This data served as the Gore index in the models.

Descriptions of Production Characteristics

The production characteristics came from USDA's 2002 Ag Census. The total number of farms, total number of organic farms, total value of agricultural sales, total value of organic sales for each state was all data from the 2002 Ag Census. Each of these variables were used in models to explain where organic foods production was occurring.

Agronomic conditions was another component used to explain the differences in organic production location and conventional. To incorporate an agronomic variable, states were categorized for broadly defined climates and growing conditions. The Census Bureau has specifically defined four regions of the U.S which have similar conditions. These four regions were then broken down into nine divisions. The four regions are the West, Midwest, South and Northeast. The Northeast region contains the New England and Middle Atlantic divisions. The Midwest region is made up of the East North Central and West North Central divisions. The South Atlantic, East South Central and West South Central divisions are all part of the South region. Finally the West region is composed of the Mountain and Pacific divisions. Figure 4.1 shows the states broken into regions and Figure 4.2 shows the states categorized by divisions.

Figure 4.1 U.S. Census Regions

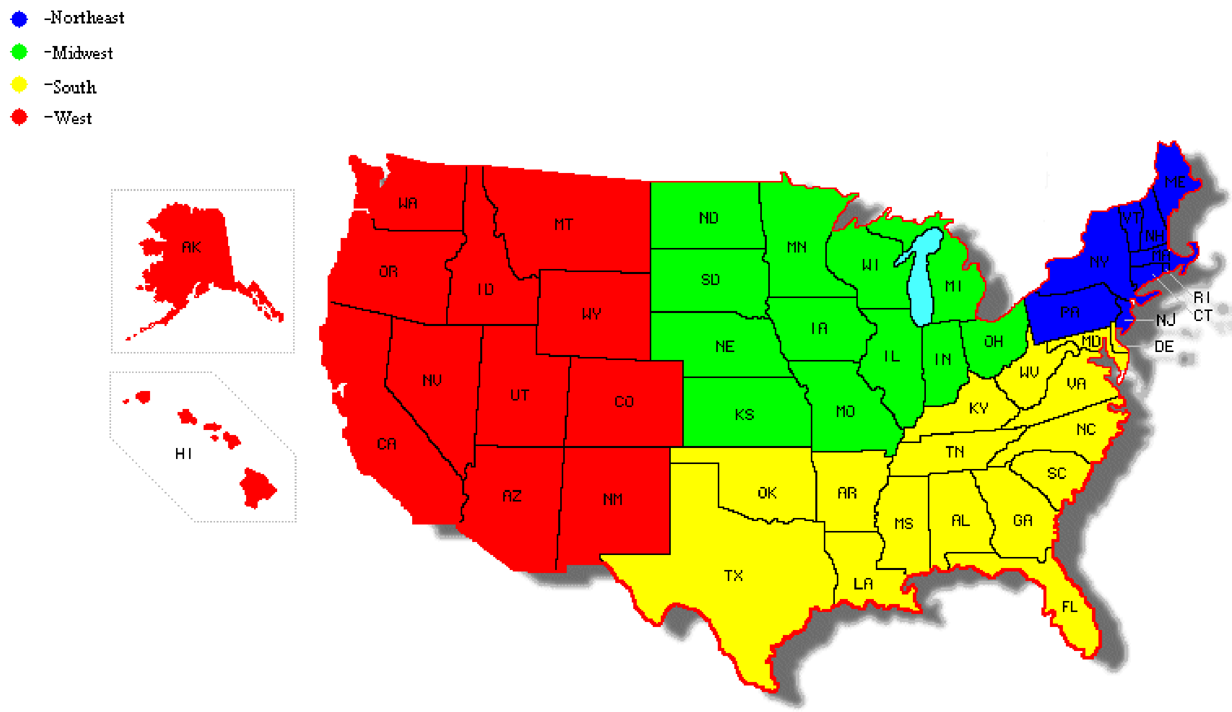
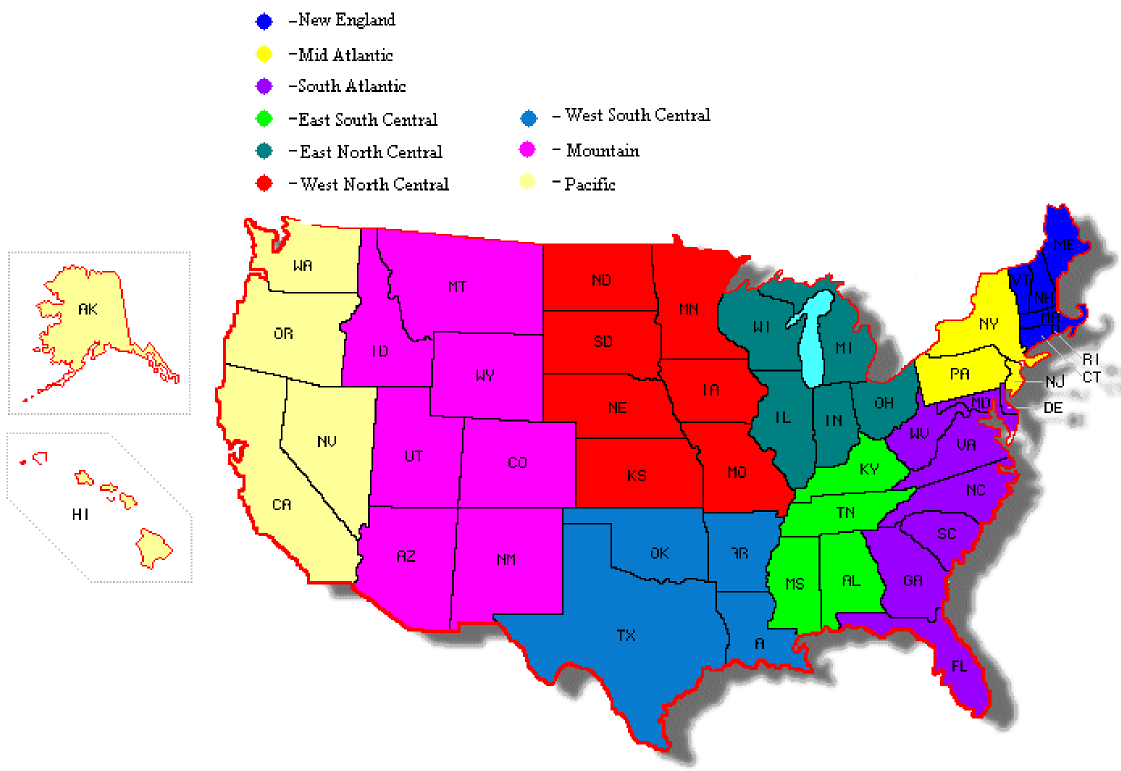


Figure 4.2 U.S. Census Divisions



Summary statistics of the complete data set are displayed in Table 4.1. A mean, standard deviation, minimum and maximum was calculated for each variable across all 50 states. The mean of organic farms was approximately 146 while the number of total farms was 42,579. Total organic sales were reported at $7,856,280 per state. The mean of total agricultural sales was approximately $4,012,927.100 in 2002. The organic farms and organic sales are fractions of the total number of farms and total number of agricultural sales. The mean of the median incomes was $48,617 and there mean of Whole Food stores in a state was 5.16. States' mean urban population was 600,734. The interaction term which is the urban population multiplied by the number of Whole Foods stores was 5,180,268.28. The mean of the percent in a state with at least a two year degree was 30 percent and approximately 45 percent of the population in each state voted for Gore in the 2000 presidential election.

Table 4.1 Summary Statistics of Model Variables

Variables	Mean	Standard Deviation	Minimum	Maximum
DEPENDENT VARIABLES				
Organic Farms #	146.46	236.489	0	1,487
Total farms, 2002	42,579.64	39,695.227	609	228,926
Sales $1,000, 2002	4,012,927.1	4,449,133.317	46,143	25,737,173
Organic Sales $1,000, 2002	7,856.28	21,223.319	0	149,137
INDEPENDENT VARIABLES				
Median Income-2000	48,617.7	7,267.074	34,560	63,131
# Whole Foods Stores	5.16	8.082	0	50
Population in Urban Clusters	600,734.3	479,404.395	25,027	2,408,419
Whole Foods & Urban Interaction	5,180,268.28	15,085,157.630	0	101,982,750
% with Degree	0.302	0.049	0.19164	0.40404
Gore	0.453	0.086	0.26	0.61

Chapter 4 has described all of the variables which are used in the models. These descriptions of the variables are useful in fully understanding the models. Each of the variables will later be examined to see if they are significant in determining where organic food production and consumption occurs. The next chapter explains the structure of the models and how the variables are used within them.

CHAPTER 5 - Empirical Models

The purpose of this paper is to explain what factors determine where organic production occurs. As depicted in the earlier Figures 1.1-1.7, there are many differences in the locations of the organic production and the conventional production. Consumer and state demographics have been selected to test their reliability in understanding these differences in organic and conventional product. A linear regression model was used to identify and quantify the determinants of organic food production and consumption. This section includes four different models all based on linear regressions.

A list of all the variables in the models was compiled into in Table 5.1. Table 5.1 is to be used as a reference for the abbreviations of the variables. The %TOF was simply the total organic farm number divided by the total conventional farm number in each state. It is similar for the %TOS; this is the total organic sales divided by the total sales of agricultural products. The divisions and regions variables included each of the previously described groupings of states. For simplicity purposes these two variables were used to encompass all the groupings.

Table 5.1 Organic Model Variables

NAME	DESCRIPTION
TOF#	Total Organic Farm #
TCF#	Total Conventional Farm #
TOS	Total Organic Sales ($)
TCS	Total Conventional Sales ($)
%TOF	Percentage of total organic farm numbers
%TOS	Percentage of total organic sales
URBCLST	Urban Cluster Population
WHLFD	Whole Foods stores
MDINC	Median Income
%DEG	Total percent of the population with a two year degree or higher
DIVS	U.S. Divisions
NE	New England States
MA	Mid-Atlantic States
ENC	East North-Central States
WNC	West North Central States
SA	South Atlantic States
ESC	East South Central States
MNT	Mountain States
PAC	Pacific States
REGS	U.S. Regions
GORE	Gore index
INT	Interaction term between Whole Food & Urban Population

Model 1.A Organic Food Production

The first model uses the number of organic farms (TOF#) as the dependent variable. The independent variables include median income (MDINC), the Whole Foods variable (WHLFD), the total number of conventional farms (TCF#), the urban cluster term(URBCLST), interaction term(INT), the percent of population with a degree (%DEG), divisions of states (DIVS) and the Gore index (GORE).

TOF# = f(MDINC, WHLFD, TCF#, URBCLST, INT, GORE, %DEG, DIVS)

$$TOF\# = \alpha_0 + \alpha_1 \text{ MDINC} + \alpha_2 \text{ WHLFD} + \alpha_3 \text{ TCF\#} + \alpha_4 \text{ URBCLST} + \alpha_5 \text{ INT} + \alpha_6 \text{ GORE} + \alpha_7 \text{ \%DEG} + \alpha_8 \text{ NE} + \alpha_9 \text{ MA} + \alpha_{10} \text{ ENC} + \alpha_{11} \text{ WNC} + \alpha_{12} \text{ SA} + \alpha_{13} \text{ ESC} + \alpha_{14} \text{ MNT} + \alpha_{15} \text{ PAC} + \mu$$

Model 1.B Percent Organic Food Production

Model 1.B uses the percent of organic farms as the dependent variable (%TOF). The percentage is derived by dividing the number of organic farms by the total number of farms in each state. The independent variables in this model consist of median income, the Whole Foods index, urban cluster population, interaction term, and percent of population with a degree, divisions and the Gore index.

%TOF = f(MDINC, WHLFD, URBCLST, INT, GORE, %DEG, DIVS)

$$\%TOF = \alpha_0 + \alpha_1 \text{ MDINC} + \alpha_2 \text{ WHLFD} + \alpha_3 \text{ URBCLST} + \alpha_4 \text{ INT} + \alpha_5 \text{ GORE} + \alpha_6 \text{ \%DEG} + \alpha_7 \text{ NE} + \alpha_8 \text{ MA} + \alpha_9 \text{ ENC} + \alpha_{10} \text{ WNC} + \alpha_{11} \text{ SA} + \alpha_{12} \text{ ESC} + \alpha_{13} \text{ MNT} + \alpha_{14} \text{ PAC} + \mu$$

Model 2.A Organic Food Consumption

In the third model, "organic sales" is the dependent variable (TOS). Median income, the Whole Foods index, total number of conventional sales, urban cluster population, interaction term, and percent of population with a degree, divisions and the Gore index are the independent variables used to explain the organic sales.

TOS = f(MDINC, WHLFD, TCS, URBCLST, INT, GORE, %DEG, DIVS)

$$TOS = \alpha_0 + \alpha_1 \text{ MDINC} + \alpha_2 \text{ WHLFD} + \alpha_3 \text{ TCS} + \alpha_4 \text{ URBCLST} + \alpha_5 \text{ INT} + \alpha_6 \text{ GORE} + \alpha_7 \text{ \%DEG} + \alpha_8 \text{ NE} + \alpha_9 \text{ MA} + \alpha_{10} \text{ ENC} + \alpha_{11} \text{ WNC} + \alpha_{12} \text{ SA} + \alpha_{13} \text{ ESC} + \alpha_{14} \text{ MNT} + \alpha_{15} \text{ PAC} + \mu$$

Model 2.B Percent Organic Food Consumption

The 2.B model was the model that included percentage of organic sales as the dependent variable (%TOS). The number of organic sales divided by the total number of sales is the percentage of organic sales. The only independent variables selected for Model 2.B were median income, the Whole Foods index, urban cluster population, interaction term, and percent of population with a degree, divisions and the Gore index.

$$\%TOS = f(MDINC, WHLFD, URBCLST, INT, GORE, \%DEG, DIVS)$$

$$\%TOS = \alpha_0 + \alpha_1 MDINC + \alpha_2 WHLFD + \alpha_3 URBCLST + \alpha_4 INT + \alpha_5 GORE + \alpha_6 \%DEG + \alpha_7 NE + \alpha_8 MA + \alpha_9 ENC + \alpha_{10} WNC + \alpha_{11} SA + \alpha_{12} ESC + \alpha_{13} MNT + \alpha_{14} PAC + \mu$$

These models provide the framework for testing the relationship of the production consumer characteristics. It is these models that will determine the significance of the variables. The data which was explained in a previous chapter will now be tested in the models. Chapter 6 presents the results from the models and the significance of the variables.

CHAPTER 6 - Results

The results from estimating the models are presented in this chapter. Regression tests confirmed that certain variables were significant, depending on which model was being tested.

Model 1.A Organic Food Production

Model 1.A examines the ability of the previously-described variables to predict the total number of organic farms at the state level. Results from the linear regression on Model 1.A are strong. Model 1.A had an R^2 of 0.792, and an adjusted R^2 of 0.701, which means that 70 percent of the variation in organic food production is explained by the model. Significant variables for this model were median income, the Whole Foods urban cluster interaction term, percent of population with a degree, the Gore index and three of the divisions of states (East North Central, West North Central and Pacific).

Median income had a negative effect on the total number of farms. It has an elasticity of -2.656 and is significant at the 10 percent level. If the median income increased by one percent then the total number of organic farms would decrease by 2.656 percent. This result says that organic farms are not typically found in high income areas. High income areas do not usually include areas which contain much agriculture. Areas which contain farming operations are more likely to have lower incomes on average.

Table 6.1 Regression Results: Model 1.A Organic Food Production

	Coefficients	*Mean*	*Standard Error*	*t Stat*	*P-value*	*Elasticity*
Intercept	-286.46	-	229.64	-1.247	0.221	-
Total farms, 2002	0.001	42579.640	0.001	0.75	0.458	0.291
Median Income-2000	-0.008	48617.700	0.004	-1.874	0.07*	-2.656
# Whole Food Stores	-9.77	5.160	6.989	-1.398	0.171	0.005
Inside urban clusters	-1.05E-04	600734.300	0.000	-0.828	0.413	-0.082
WhlFd UrbCl INT	1.65E-05	5180268.280	0.000	4.146	0***	-
% with degree	1452.415	0.302	809.56	1.794	0.082*	2.999
Gore	550.311	0.453	321.675	1.711	0.096*	1.704
New England States	64.881	-	133.89	0.485	0.631	-
Mid-Atlantic States	162.972	-	131.755	1.237	0.225	-
East North Central States	262.01	-	103.681	2.527	0.016**	-
West North Central States	191.819	-	96.055	1.997	0.054*	-
South Atlantic States	73.08	-	99.96	0.731	0.47	-
East South Central States	57.982	-	95.174	0.609	0.546	-
Mountain States	138.312	-	108.626	1.273	0.212	-
Pacific States	284.959	-	125.058	2.279	0.029**	-

Regression Statistics	
Multiple R	0.89
R Square	0.792
Adjusted R Square	0.701
Standard Error	129.374
Observations	50

Single, double and triple asterisks indicate statistical significance at the 10%, 5% and 1% levels respectively.

The second statistically significant variable was the interaction term of the Whole Foods and urban clusters. Since this term is an interaction of two separate variables. To adequately analyze what was occurring specifically with each variable in the interaction term, derivatives from the whole equation were used to obtain the full effects of the individual terms, Whole

Foods and Urban Clusters. Once the derivative of the Whole Foods variable or the Urban Cluster is derived, the mean number of Whole Foods or Urban population is used in calculating the full affect for each variable for each variable, as shown below.

Model 1.A: Full Effect of the Whole Foods Variable

$$\partial TOF\#/\partial WHLFD = -9.7699 + 0.0000165\ (URBCL)$$

$$= -9.7699 + 0.0000165\ (600{,}734.3) = 0.142$$

In the full equation, the Whole Foods variable appears two times; once as itself and a second time in the interaction term. The equation above shows the first derivative of the total number of organic farms equation with respect to the Whole Foods variable. The elasticity of the Whole Foods variable is 0.005. This positive relationship means that a one percent increase in the Whole Foods variable will increase total number of organic farms by 0.005 percent. This is somewhat unexpected because Whole Food stores are located in more populated urban areas, and therefore, it is unlikely that organic farms would be operating in or near highly populated areas. However, it could be that Whole Foods not only builds stores near consumers but also near input suppliers like an organic farmer.

Like the Whole Foods variable, the urban cluster variable also appears by itself and in the interaction term of the Model 1.A. The equation below takes the first derivative of Model 1.A to determine the full effect of the urban cluster variable. The second step of the process was to insert the mean for the Whole Foods term to fully calculate the effect of the urban cluster variable on Model 1.A

Model 1.A: Full Effect of the Urban Cluster Variable

$$\partial TOF\#/\partial URBCL = -0.000105 + 0.0000165\ (WHLFD)$$

$$= -0.000105 + 0.0000165\ (5.16) = -0.0000199$$

It was expected that there would be a negative impact by the urban cluster variable. Although it is a small impact it is important to examine why this occurred. Model 1.A is examining the relationship of urban cluster variable to the total number of organic farms in a state. A negative impact implies that organic farms are not located in populated areas. With an elasticity of -0.082, the total organic farms will decrease by that percentage if the amount of urban population increased by one percent.

Model 1.A also contained other significant variables. The percent with a degree and the Gore variable were also found to be significant. A one percent increase in the percent of a state that has at least a two year degree will have almost a three percent increase in the total number of organic farms. It's clear that the percent of the population in a state with an education made an impact on the total number of organic farms. The same holds true for the Gore index. The Gore index had an elasticity of 1.7, which means that if the percent of population which voted for Gore increased by one then there would also be an increase of 1.7 percent in the total number of organic farms in that state. As described earlier, the Gore index was used to capture the liberalness of a state. Thus as a state votes more liberally, the organic production will increase also. From these results, the number of organic farms is positively linked to education and the liberalness of a state.

Although the total farms variable was not found to be significant at the tested level, this in and of itself was interesting. The total farms variable was to account for current agricultural production. Finding this variable to be insignificant showed that organic production is not contingent on conventional agricultural production. According to these results, organic production is not contingent on conventional production in a state.

Three of the divisions were found to be significant in reference to the default division. The default was the West South Central category. East North Central, West North Central and Pacific divisions were found to be statistically significant. Earlier when the top organic producing states were discussed many of them fell into one of the aforementioned divisions. East North Central division includes Wisconsin and Michigan. Wisconsin ranked in top for organic poultry, swine and cattle production while Michigan produced large quantities of organic poultry. In the West North Central division, North Dakota produced high amounts of organic grain. Minnesota was a top organic producer of cattle, sheep and grains. Iowa, a West North Central state, ranked in the top five as an organic grain producing state. The third significant division, Pacific states, contained Washington, Oregon, Nevada and California. Nevada was a top organic poultry producer while Washington, Oregon and California produced organic fruit. Oregon also was a top organic sheep and cattle producer. California also topped the list as an organic cattle producer.

Model 1.B Percentage of Organic Farms

Model 1.B, tested ability of the independent variables to predict the percent of organic farms. Model 1.B is similar to Model 1.A; it simply moves the independent variable of total conventional farms to the left hand side of the equation to create the percent of organic farms dependent variable. The percent of organic farms equation is as follows:

%TOF = TOF#/ TCF#

Model 1.B only explained 65 percent according to the R^2 and 51 percent adjusted R^2. These statistics mean that 51 percent of the percentage of organic food production is being explained by Model 1.B.

Table 6.2 Regression Results: Model 1.B Percent Organic Food Production

	Coefficients	*Mean*	*Standard Error*	*t Stat*	*P-value*	*Elasticity*
Intercept	-0.009	-	0.01	-0.858	0.397	-
Median Income-2000	-4.53E-07	48617.700	0	-2.298	0.028**	-3.867
# Whole Food Stores	-5.85E-04	5.160	0	-1.85	0.073*	-0.339
Inside urban clusters	-1.93E-09	600734.300	0	-0.56	0.579	0.395
WhlFd UrbCl INT	3.51E-10	5180268.280	0	1.967	0.057*	-
% with degree	0.076	0.302	0.037	2.065	0.046*	4.038
Gore	0.025	0.453	0.014	1.754	0.088*	1.991
New England States	0.014	-	0.006	2.461	0.019**	-
Mid-Atlantic States	0.003	-	0.005	0.659	0.514	-
East North Central States	0.005	-	0.004	1.102	0.278	-
West North Central States	0.002	-	0.004	0.394	0.696	-
South Atlantic States	0.001	-	0.004	0.269	0.789	-
East South Central States	0.001	-	0.004	0.145	0.886	-
Mountain States	0.005	-	0.005	0.992	0.328	-
Pacific States	0.01	-	0.005	1.881	0.068*	-

Regression Statistics	
Multiple R	0.807
R Square	0.65
Adjusted R Square	0.511
Standard Error	0.006
Observations	50

Single, double and triple asterisks indicate significance at the 10%, 5% and 1% levels respectively.

Similar to Model 1.A, the median income variable was significant and also had a negative impact in the empirical equation. The median income was more elastic in Model 1.B; the elasticity increased from -2.65 to -3.867. As income increases, organic production would decrease. Income has a large impact on the percent of organic farms in a state.

Once again to adequately interpret the impact of the Whole Foods variable and the urban cluster variable. The first derivative of Model 1.B with respect to Whole Foods and the urban cluster variable is shown below. Both terms appear twice in the equation because of the interaction term. In the second step, the mean of the urban cluster or Whole Foods variable was used to fully determine the effects. The Whole Foods variable has a -0.000374 impact on Model 1.B and the urban cluster variable has a positive but small impact at 3.7412E-09.

Model 1.B: Full Effect of the Whole Foods Variable

$$\partial\%TOF/\partial WHLFD = -0.000585 + 3.5E\text{-}10\ (URBCL)$$
$$= -0.000585 + 3.5E\text{-}10\ (600{,}734.3) = -3.74E\text{-}04$$

Model 1.B: Full Effect of the Urban Cluster Variable

$$\partial\%TOF/\partial URBCL = -1.93E\text{-}09 + 3.5E\text{-}10\ (WHLFD)$$
$$= -1.93E\text{-}09 + 3.5E\text{-}10\ (5.16) = 3.741E\text{-}09$$

The elasticities of these variables were -0.339 for the Whole Foods variable and 0.395 for the urban cluster variable. If the percent of urban clusters increases by one percent then the percent of organic farms will increase by 0.395 and for Whole Foods variable, if it increases by one percent then the percent of organic farms would actually decrease by -0.339 percent.

Another significant variable from the regression is the percent of population with a degree; it was found to be significant at the ten percent level. The regression showed that the percent with a degree had a positive effect on the empirical equation and elasticity of 4.038. According to these results, populations with degrees have a strong influence on the percent of organic farms in a state. The percent of organic production in a state will increase by four percent if the percent of degrees increased by one percent.

The Gore index was also found to be a significant variable in Model 1.B at the ten percent level and had an elasticity of 1.991. Therefore it was positively correlated to the percentage of organic farms. States that tend to be more politicically liberal are more likely to adopt organic farming practices according to this variable.

In the divisions of states the West South Central division was held as the default category. With that as the base, the New England and Pacific divisions were found to be significant in Model 3. Maine was the only New England state that made the top five lists for any type organic production. The organic production for Maine was noted as sheep production. The Pacific states had a wider variety of states and various organic productions. California ranked high in organic poultry, cattle, fruit and vegetable production. Oregon also produced high amounts of organic vegetables, fruit, cattle and sheep. Washington was the third major organic producer of vegetables and fruits.

Model 2.A Organic Food Consumption

Model 2.A focused on the demand side of the organic production. The goal of this model was to determine how effective the variables were at predicting organic sales. Overall the model had an R^2 of 92.9 percent and an adjusted R^2 of 89.8 percent.

Table 6.3 Regression Results: Model 2.A Organic Food Consumption

	Coefficients	*Mean*	*Standard Error*	*t Stat*	*P-value*	*Elasticity*
Intercept	-595.127	-	11979.751	-0.05	0.961	-
Sales $1,000, 2002	0.002	4012927.100	0.001	3.359	0.002***	1.022
Median Income-2000	-0.222	48617.700	0.228	-0.973	0.337	-1.374
# Whole Food Stores	-459.716	5.160	365.028	-1.259	0.216	0.210
Inside urban clusters	-0.018	600734.300	0.004	-3.949	0***	-0.841
WhlFd UrbCl INT	0.001	5180268.280	0	5.407	0***	-
% with degree	10479.305	0.302	42844.652	0.245	0.808	0.403
Gore	15293.845	0.453	16714.941	0.915	0.367	0.883
New England States	7346.662	-	6899.358	1.065	0.294	-
Mid-Atlantic States	11776.047	-	6338.98	1.858	0.072*	-
East North Central States	9444.149	-	5003.533	1.888	0.068*	-
West North Central States	-765.054	-	5653.968	-0.135	0.893	-
South Atlantic States	4470.44	-	4861.798	0.92	0.364	-
East South Central States	6055.688	-	4981.271	1.216	0.232	-
Mountain States	9258.703	-	5374.153	1.723	0.094*	-
Pacific States	13722.433	-	6023.807	2.278	0.029**	-

Regression Statistics	
Multiple R	0.964
R Square	0.93
Adjusted R Square	0.898
Standard Error	6764.387
Observations	50

Single, double and triple asterisks indicate significance at the 10%, 5% and 1% levels respectively.

The total sales variable was significant at the one percent level and had an elasticity of 1.022. States with conventional agricultural sales will tend to also have organic agricultural sales according to this model. If the total sales increased by one percent, organic sales would also increase by a percentage of 1.022.

The urban cluster variable was found to be a significant variable in Model 2.A as well. It too was significant at the one percent level. However to completely interpret the impact it played on the total amount of organic sales derivates are derived from the interaction term because it includes both the urban cluster variable. As in Model 1.A and 1.B, the urban cluster variable appeared twice in the equation. Therefore taking the derivative of Model 2.A with respect to the urban cluster variable, gave the correct function. To completely solve for the full effect, the mean of the Whole Foods was plugged into the derived equation as shown below.

Model 2.A: Full Effect of the Whole Foods Variable

$$\partial \%TOF/\partial WHLFD = -459.716 + 0.001297\ (URBCL)$$

$$= -459.716 + 0.001297\ (600{,}734.3) = 319.436$$

Model 2.A: Full Effect of the Urban Cluster Variable

$$\partial TOF\#/\partial URBCL = -0.0177 + 0.001297\ (WHLFD)$$

$$= -0.0177 + 0.001297\ (5.16) = -0.0110$$

The urban cluster variable has negative overall impact on the total amount of organic sales. This is reaffirmed by examining the elasticity of the urban variable, it was -0.841. The Whole Foods variable had a positive overall effect on the organic sales and its elasticity was 0.210.

Divisions of states that had significant P-values were Mid-Atlantic, East North Central, Mountain and Pacific states. Once again these are in regards to the West South Central division which was used as the default group. The Mid-Atlantic region contains the states of New York, Pennsylvania and New Jersey. New York ranked in the top five states which raised organic cattle. Pennsylvania and New Jersey were in the top five producers of organic poultry and hogs, respectively. In the East North Central division, Wisconsin was a top producer of organic cattle and hogs. Michigan, also an East North Central state, ranked in the top five as an organic poultry producer. The Mountain division was the next significant set of states. Montana, Colorado and New Mexico were ranked as top organic producers. New Mexico was one of the top five organic sheep produces while Montana was in the top five as an organic grain and hog producing state. Colorado also ranked in the top five as an organic grain producer but it also was in the top five for having produced organic vegetables. The last significant division, Pacific states, contained Washington, Oregon, Nevada and California. Nevada was a top organic poultry producer while Washington, Oregon and California produced organic fruit. Oregon also was a top organic sheep and cattle producer. California also topped the list as an organic cattle producer.

Model 2.B Percent Organic Food Consumption

The dependent variable in Model 2.B was the percent of organic sales. This percent was found by dividing the total number of organic sales by the total number of agricultural sales. The dependent variables on the right side of the equation were the same as the previous models. The results from this regression are interesting because like Model 1.B the R^2 and adjusted R^2 were lower than the first two models. In Model 2.B the R^2 was 66.3 percent and the adjusted R^2 dropped to 52.8 percent.

Table 6.4 Regression Results: Model 2.B Percent Organic Food Consumption

	Coefficients	*Mean*	*Standard Error*	*t Stat*	*P-value*	*Elasticity*
Intercept	-0.002	-	0.005	-0.474	0.639	-
Median Income-2000	-9.59E-08	48617.700	9.64E-08	-0.994	0.327	-1.691
# Whole Food Stores	1.51E-04	5.160	1.55E-04	0.975	0.336	0.209
Inside urban clusters	1.47E-11	600734.300	1.68E-09	0.009	0.993	-0.070
WhlFd UrbCl INT	-6.47E-11	5180268.280	8.74E-11	-0.741	0.464	-
% with degree	0.014	0.302	0.018	0.761	0.452	1.536
Gore	0.007	0.453	0.007	1.046	0.303	1.152
New England States	0.009	-	0.003	3.073	0.004***	-
Mid-Atlantic States	0	-	0.003	0.067	0.947	-
East North Central States	0.001	-	0.002	0.401	0.691	-
West North Central States	0	-	0.002	0.182	0.857	-
South Atlantic States	-1.40E-04	-	0.002	-0.069	0.946	-
East South Central States	0	-	0.002	0.071	0.944	-
Mountain States	0.002	-	0.002	0.954	0.347	-
Pacific States	0.003	-	0.003	1.375	0.178	-

Regression Statistics	
Multiple R	0.815
R Square	0.663
Adjusted R Square	0.529
Standard Error	0.003
Observations	50

Single, double and triple asterisks indicate significance at the 10%, 5% and 1% levels respectively.

The results of the regression showed that there was only one significant variable, the New England division of states. Once again the West South Central division was withheld in the analysis. The only state that ranked in the top for producing any of the organic commodities was Maine and it was a top producer of organic hogs.

The significant variables for each of the models have been discussed. Each model contained slightly different significant variables. The significant variables in Model 1.A were income, the interaction term, education, Gore index and the East North Central, West North Central and Pacific divisions. In Model 1.B, the significant variables were income, Whole Foods stores, interaction term, education and the Gore index. The significant divisions were New England, Mid-Atlantic and Pacific. Model 2.A showed urban clusters, the interaction, Mid-Atlantic States, Mountain States, and Pacific States as significant variables. Unlike Model 2.A, Model 2.B only had one significant variable, the New England States. However, conclusions can still be made from the analysis. The last chapter gives insight into the overall impacts of the models and the relationship between the variables and organic production.

CHAPTER 7 - Conclusions

This thesis presented an analysis of variables which impact organic production based on organic production data from the USDA's Economic Research Service. Key findings from the analysis are summarized in this chapter.

The models show that organic production is likely to occur in less-densely populated areas. It is unlikely that in urban areas, a person would find large-scale organic production occurring. Organic production is more likely to occur in non-urban where there are fewer people and more land available for production.

A second major conclusion is that education has a positive impact on organic production and consumption. Both producers and consumers who are educated are more likely to produce or consume organic foods. Organic production requires additional knowledge and skill in order to successfully produce quality goods. Also educated consumers are more likely to understand the difference and the perceived quality associated with organic goods therefore organic goods are more likely to be consumed by the more educated consumers.

Organic production is a growing sector of the agricultural industry. Sales in 2008 are expected to exceed $23.6 billion, according to the Organic Trade Association. It is clear that consumers are purchasing more and more organic products and organic producers are trying to keep up with the demand. Stores like Whole Foods Market are expanding and developing more locations throughout the U.S. because of the consumer demand. Seventy-eight stores are in development across the U.S. for Whole Foods Markets according to its website.

Production will also be expanding in order to keep up with the growing consumer demand. Will organic production expand where current conventional agriculture is currently located or will it be driven by other factors? This was the question that this thesis addressed. Regression results did not show a particular connection between organic production and conventional production. Conventional production was not found to be a significant variable in determining the location of organic production. While organic production is likely to expand and grow, it is unlikely that it will occur in traditional production locations.

While this thesis examined the aggregated state level, possible extensions might include examining the county level nationwide. Examining data at this level could provide a more detailed outlook on organic production and would a research to look at concentrated areas of organic industry. Data evaluated at this level could also provide more information pertaining to the local organic demand, the consumer demographics as well as the producers more specific demographics.

A final thought can be attributed to the recent economic downturn that the United States has been experiencing. All industries have been affected by the recent events; the organic industry will have repercussions as well especially as the consumer's budget is stretched thinner. Organic products which tend to bring a higher premium on the shelf may be overlooked when the consumer compares prices with conventionally produced products. If this happens the demand for organic goods will surely fall and thus result in a decline of organic production.

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