ANALYSES OF ORGANIC GRAIN PRICES

By

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ABSTRACT

Organic has become a familiar term in agriculture, usually bringing to mind the phrases "no chemicals" and "large premiums." While organic products usually command a substantial price premium over their conventional counterparts, the determinants of this premium are generally unknown. The lack of literature covering organic prices is not from a lack of interest but from a lack of information and data for organic commodities. This study examines two aspects of organic grain prices in an attempt to learn more about the organic grain sector.

The first objective was to identify determinants of organic premiums received by members of a Kansas organic grain cooperative. Six different grains along with alfalfa hay were examined using hedonic models and bootstrapping statistical techniques. Findings of the hedonic analyses are as follows. Dairy farms seemed to pay a lower premium for feed grade corn and hard red winter wheat compared to other types of buyers. Buyers located in Kansas tended to provide a smaller premium than buyers located elsewhere. Early contract periods produced a smaller premium than later periods. Shipment timing was much the same, with fourth quarter shipments receiving the largest premium. Additionally, each subsequent contract year resulted in a larger premium. If the cooperative had arranged shipment of the commodity, a lower premium was acquired. Finally, longer contract lengths resulted in a larger premium.

The second part of this study examined various price series of organic and conventional commodities to determine if the two markets were related. Using vector autoregressive models, cointegration and causality tests were conducted, and speed of adjustment to a shock in the long run equilibrium and exogeneity were also examined.

Of the 43 pairs of organic and conventional price series tested, 29 were found to be cointegrated. Of those cointegrated pairs, 11 causal relationships were found. Five of these

causal relationships indicated that the conventional commodity prices led the organic. There were six instances where the organic commodity prices were found to lead the conventional. For most causal relationships, about 5% of the adjustment to a shock, or divergence from long run equilibrium occurred in one week.

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Finally, various professors and colleagues deserve recognition for assisting me along the way, especially Hikaru Peterson, who helped make this thesis what it is. It should also be noted that this project was funded through a research partnership between the Risk Management Agency at USDA and Kansas State University.

PREFACE

This thesis is composed of two separate and distinct types of analyses. As such, readers may find it easier to read this thesis in sections rather than reading from front to back. Chapters/Sections 2 – 2.3, 3 - 3.1, 3.3 – 3.3.1, 4.1, 5.1, and 6.1 pertain to the hedonic analysis of this study, while sections 2.4, 3.2, 3.3.2, 4.2, 5.2, and 6.2 pertain to the cointegration testing of this study. The reader may prefer to read chapter 1, then the hedonic portion, then the cointegration portion, followed by sections 6.3 and 6.4.

CHAPTER 1 BACKGROUND

Many people are familiar with the organic food market in the U.S. In fact, nearly two-thirds of Americans have tried organic foods and beverages (Whole Foods Market, Inc., 2005). Despite the familiarity with organic products, the details of organic farming are generally not known. This chapter provides background information on organic farming. First, the chapter covers a brief history of organic farming and where the market is today. Then organic farming is defined and the rules and regulations associated with production and handling of organic crops is summarized. The chapter then discusses issues pertinent to organic grains, including their marketing practices, sources of risks and benefits, and finally, takes a very brief look at organic farming's future in the U.S.

1.1 HISTORY

Around the late 1950's, R.I. Throckmorton wrote, "In recent years there has grown up in the country a cult of misguided people who call themselves "organic farmers" and who would – if they could – destroy the chemical fertilizer industry on which so much of our agriculture depends" (Throckmorton, p.1). He claimed organic farmers "preach[ed] a strange, two-pronged doctrine compounded mainly of pure superstition and myth" (Throckmorton, p. 1), and attributed such things as decayed teeth, cancer, apoplexy and cirrhosis of the liver to farmers' use of chemicals. Organic followers claimed chemically fertilized plants were less nutritious than non-fertilized and that insects and disease tended to ignore crops grown their "natural" way, and were drawn to chemically fertilized crops. Further, it was claimed mineral fertilizers destroyed earthworms and beneficial bacteria.

Advocates on both sides of the organic border made extreme claims to persuade the uninformed to join them during the infancy of organic farming. Today, most of these contemptuous feelings have subsided, and most public claims are backed with scientific proof. Indeed, some farm operations try to farm conventionally and organically, though it is becoming increasingly difficult to do with the rigid standards for organic practices.

Modern day chemical farming was thought to have come about during the 1940's, though its ancestry can be traced back as far as a century earlier with chemical fertilizer made of mineral salts. Over the years, it was noticed that continuous use of chemical inputs led to a decline in soil fertility. The concept of sustainable agriculture was introduced in the early 1900's, but was largely ignored (Mergentime, 2004). In 1924, Rudolf Steiner introduced the concept of composting, which is widely used in organic agriculture today. Another positive influence on organic farming was a man named J. I. Rodale. During a time when nearly all publications were about the benefits of chemical farming (with many institutes who published such papers being supported by chemical manufacturers), Rodale put out positive information about organics. He started a magazine, *Organic Farming and Gardening*, now called *Organic Gardening*. His magazine became popular and had a large impact on the development of the organic industry (Mergentime, 2004).

In 1953, one of the first marketing agencies-in-common type cooperative was formed in Atlanta, Texas. Its mission was to bring scattered organic producers and markets together and to provide organic market information. Most organic foods at this time were sold by roadside stands.

In 1962, a book entitled *Silent Spring* was written by Rachel Carson, expressing the danger to nature and humans resulting from over-used farm chemicals. She told of the system failures and a lack of creative solutions. Her work is credited with launching the environmental movement, and by the late 1960's a new generation of environmentally conscious consumers –

Baby Boomers – were coming of age and demanding foods produced without chemicals (Mergentime, 2004). Until 1970 however, organic farming was simply not taken seriously.

1.2 ORGANIC AGRICULTURE TODAY

Organic farming has grown to nearly an $11 billion industry in 2003, representing 1.9% of total U.S. food sales (Organic Trade Association, The OTA 2004…). Such major food companies as Dean Foods, Frito-Lay, General Mills, M&M Mars, Tyson, Kraft, Kellogg, Earthbound Farm, Brown and Foreman, Archer Daniels Midland Co., and Campbell's Soups now offer organic products. From 1997 to 2003, the average annual growth rate for organic food sales was in the range of 17-21% while total U.S. food growth was in the range of 2-4%. The organic food market has more than tripled since 1997 when total organic sales were about $3.6 billion (see Table 1.2A). The expected average annual growth rate for 2004-2008 is 18% (Organic Trade Association, The OTA 2004…).

Table 1.2A Organic Food Sales and Growth

	Food Sales ($Million)	Growth
1997	$3.57	na
1998	$4.27	19.8%
1999	$5.04	18.1%
2000	$6.10	21.0%
2001	$7.36	20.6%
2002	$8.62	17.2%
2003	$10.38	20.4%

Source: Organic Trade Association

In 2003, 47% of organic foods were sold in the natural foods/specialty retail channel, down from 49% in 2001 and 62% in 1998. 44% were sold in the mass market channel (composed of supermarkets, grocery stores, mass merchandisers, and club stores), which is comparable to 45% in 2001 and up considerably from 31% in 1998. Most of the remaining 9% in 2003 was sold directly to consumers through farmers' markets, cooperatives, and food service, which is similar to 6% in 2001 and 7% in 1998. A small portion of the 9% in 2003 was made up of organic exports. Marketing distributions for the years 1998, 2001, and 2003 as well as the distribution of organic food sales in 2003 are presented in the figures below.

Figure 1.2A

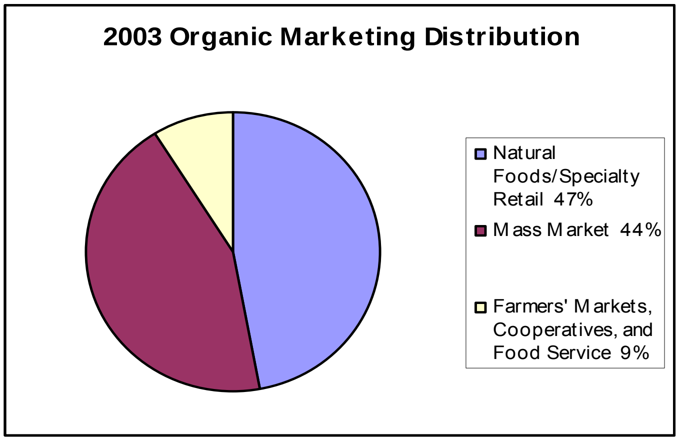


Figure 1.2B

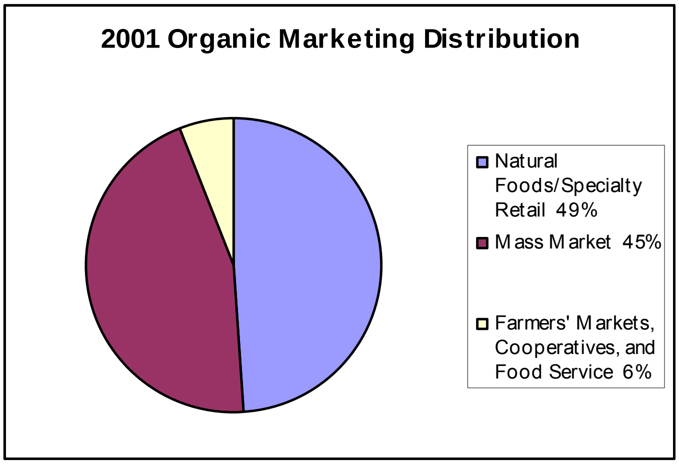


Figure 1.2C

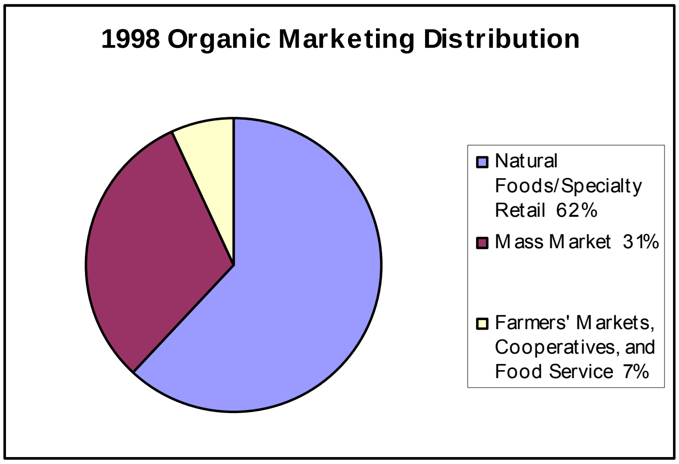
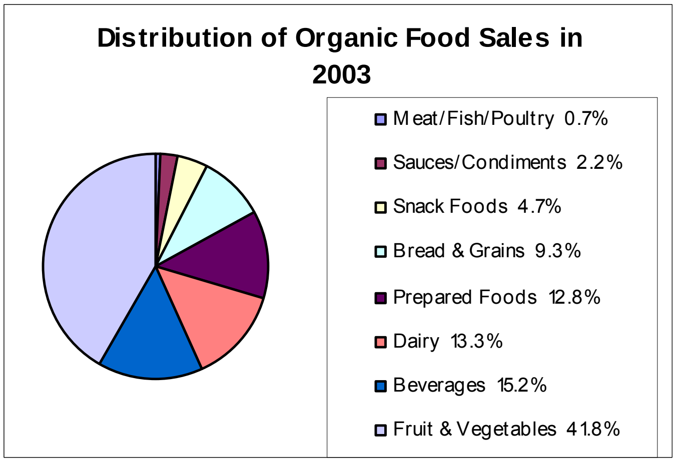


Figure 1.2D



(Sources: Organic Trade Association and Organic Consumers Association)

1.3 ORGANIC DEFINED

According to the website dictionary.laborlawtalk.com, organic farming is a way of farming that avoids the use of synthetic chemicals and genetically modified organisms (GMOs), and usually adheres to the principles of sustainable agriculture (a method of agriculture that attempts to ensure the profitability of farms while preserving the environment). Its theoretical basis puts an emphasis on soil health. Its proponents believe that healthy soil, maintained without the use of man-made fertilizers and pesticides, and livestock raised without drugs, yield higher quality food than conventional, chemical-based agriculture. In many countries, including the U.S. and the European Union, organic farming is also defined by law and regulated by the government.

1.3.1 Rules and Regulations

In 1990, the Organic Foods Production Act was passed mandating the United States Department of Agriculture (USDA), 1) to establish national standards governing the marketing of certain agricultural products as organically produced products, 2) to assure consumers that organically produced products meet a consistent standard, and 3) to facilitate interstate commerce in fresh and processed food that is organically produced (Title XXI of the Food, Agriculture, Conservation, and Trade Act of 1990: Public Law 101–624).

Prior to this act, it was much easier for individuals to market their crops as organic, when in fact they were not, in order to receive premiums obtained from organic farming. An analysis by McCluskey (2000) showed that with a credence good (a good for which true quality is never known with 100% certainty, such as organic crops) and no monitoring, there is no premium for an organic claim. Since the consumer does not know how the product was produced even after consumption, it is not possible for the consumer to punish the producer by not purchasing the product in the future in response to a false claim. Her analysis showed that repeat-purchase relationships and third-party monitoring are required for the existence of high-quality credence goods.

1.3.2 Summary of Certification Process

The following three sub-sections are summaries of information available at the USDA's Agricultural Marketing Service website. To become certified, the agricultural enterprise must be certified by an accredited certifying agency, who themselves must be certified by the government. There are currently 54 domestic certifying agencies in the U.S., 11 of which are located in California. The basic process of certification includes submitting an application and fee, and developing an organic systems plan. An organic systems plan must contain the following:

> (1) A description of practices and procedures to be performed and maintained, including the frequency with which they will be performed;
>
> (2) A list of each substance to be used as a production or handling input, indicating its composition, source, location(s) where it will be used, and documentation of commercial availability, as applicable;
>
> (3) A description of the monitoring practices and procedures to be performed and maintained, including the frequency with which they will be performed, to verify that the plan is effectively implemented;
>
> (4) A description of the recordkeeping system implemented to comply with the following requirements:
>
>> (a) Be adapted to the particular business that the certified operation is conducting;
>>
>> (b) Fully disclose all activities and transactions of the certified operation in sufficient detail as to be readily understood and audited;
>>
>> (c) Be maintained for not less than 5 years beyond their creation;
>>
>> (d) Be sufficient to demonstrate compliance with the Act and regulations; and
>>
>> (e) The certified operation must make such records available for inspection and copying during normal business hours by authorized representatives of the Secretary, the applicable State program's governing State official, and the certifying agent;
>
> (5) A description of the management practices and physical barriers established to prevent commingling of organic and non-organic products on a split operation and to prevent contact of organic production and handling operations and products with prohibited substances; and
>
> (6) Additional information deemed necessary by the certifying agent to evaluate compliance with the regulations.

An initial submission may or may not be immediately rejected depending on the certifying agency's ability to perform the necessary procedure of certification for the given operation. Agencies differ because there are many different types of organic products being produced. For example, an apple orchard differs greatly from a wheat farm, and an agency that primarily certifies orchards may choose not to certify a wheat farm.

If the agency is able to handle the application, an on-site inspection is performed, which may include testing of the water, soil, waste, plant tissue, plants, animals and processed product samples. An exit interview is then conducted to discuss any issues or concerns which may be present after the inspection. An agent then reviews the inspection report, the results of any analyses, and any additional information. The operation is granted certification if: 1) the applicant's operation, including its organic system plan and all procedures and activities, is in compliance with the Organic Foods Production Act and regulations and 2) the applicant is able to conduct operations in accordance with its organic systems plan.

If not accepted, the applicant will receive a notice of non-compliance. The applicant is free to reapply after efforts are made to correct for the non-compliance, but if these measures are still not enough, he/she will receive a notice of denial. However, the applicant is still able to reapply at any certifying agency at any time, as long as they provide the notices of non-compliance or denial if applying with a different agency.

Continuation of certification requires annual inspections, some of which may be unannounced, along with updated organic system plans and annual certification fees. If at any time an organization's certification is suspended or revoked, the organization is able to appeal, but ultimately will need to apply with a different certifying agency if they wish to reapply.

1.3.3 SUMMARY OF REGULATIONS FOR ORGANIC CROP PRODUCTION

Land used for organic purposes must have had no prohibitive substances applied to it for the last three years before harvest and have defined boundaries and buffer zones to prevent contact with land or crops using prohibitive substances on adjacent land.

All production practices must maintain or improve natural resources (namely land and water quality) of the operation and must provide effective pest management, manage plant nutrients, and control erosion. This can be done through rotations which may include sod, green manure crops, catch crops, cover crops, and the application of plant and animal material. A green manure crop is one that can be grown over a season when the bed is not in use, often fall and winter, and later tilled into the soil to improve its fertility. Examples include vetch, clover, and alfalfa. A green manure crop grown over fall and winter also prevents the soil from eroding and compacting when not in use. Raw animal manure may be used, but additional regulations apply.

The producer must use preventive practices to manage crop pests, weeds, and diseases through such methods as crop rotation, soil and crop nutrient management, sanitation measures, and cultural practices that enhance crop health. Cultural practices include plant varieties suitable to site specific conditions with resistance to prevalent pests, weeds, and diseases. Pest control methods include the use of pest predators or parasites, development of habitat for natural enemies, and the use of lures, traps, and repellants.

Methods for weed management include mulching with biodegradable materials, mowing, livestock grazing, hand weeding, mechanical cultivation, flame, heat, or electric measures, and also some synthetic mulches as long as they are removed at the end of the season. Disease may be controlled through good management practices, and the use of non-synthetic biological, botanical, or mineral inputs. If any of these measures to control pests, weeds, and disease are inefficient, any substances allowed on the National Lists are allowed as long as conditions for using the substances are documented in the organic systems plan.

Additional materials/practices may be allowed if they are on the National List of synthetic substances allowed in crop production or not on the National List of non-synthetic materials prohibited in crop production (these lists are compiled by the USDA to confirm specific substances which are and are not allowed in organic agriculture). Sewage sludge, along with burning crop residue as a means of disposal is prohibited, although burning may be used to suppress the spread of disease or stimulate seed germination. Also, no lumber treated with prohibited substances may be used for any purpose if it comes in contact with the soil or plants used for organic purposes.

Organically grown seeds, annual seedlings, and planting stock must be used, unless these are not available, in which case untreated non-organic equivalents may be used. Seeds treated with allowable substances on the National Lists may also be used if the organic or untreated variety is not available.

Non-organic annual seedlings are allowed if a “temporary variance” occurs due to acts of nature, such as fire, flood, or frost. Planting stock for perennial crops may be sold as organic after it has been under organic management for at least one year. Seeds, annual seedlings, and planting stock treated with prohibited substances may be used to produce organic crops if the substance is a requirement of Federal or State phytosanitary regulations.

1.3.4 REGULATIONS FOR HANDLING AND LABELING OF ORGANICS

No packaging materials, storage containers, or bins that contain non-allowable substances (such as synthetic fungicide, preservative, or fumigant determined by the National Lists) may come in contact with a product to be labeled with the word organic. Additionally, if such storage items were once in contact with a prohibited substance, the container must be cleaned so as to present no risk of containing prohibited substances which could come in contact with organic products. Consequently, it is because of these rules and the fact that organic grain shipments are typically smaller than conventional, that transportation of organic grains is more complicated than that of conventional grains.

When processing organic products, mechanical or biological methods may be used. A product labeled as “100% organic” must contain 100% organic ingredients. Products labeled “organic” must be no less than 95% organic by weight or volume, and those labeled “made with organic…” must contain at least 70% organic ingredients by weight or volume. Any product containing the word organic may not have been processed or handled using ionizing radiation, ingredients made by excluded methods, or volatile synthetic solvents. However, an exception lies with products labeled “made with organic…,” as these may use volatile synthetic solvents.

A civil penalty of up to $10,000 can be levied on any person who knowingly sells or labels as organic a product that is not produced and handled in accordance with the National Organic Program regulations (Sustainable Agricultural Network, 2003).

1.4 ORGANIC (IDENTITY PRESERVED) GRAIN

The niche market of identity preserved (hereafter referred to as IP) grains has become more important for grain marketing firms. IP is a “traceable chain” of custody that begins with the grower’s choice of seed and continues through the shipping and handling system (Dye, 2000). A large portion of IP grain in the industry is organic, as the information associated with IP grains is very important to many who use organic. As such, the terms organic and IP will be used interchangeably for the purpose of this paper.

1.4.1 COSTS

Because grain marketing is an industry with economies of scale, grain merchandisers have been set up to handle very large quantities of grains. Most are not equipped to handle the smaller quantities of organic grains, and are almost never able to guarantee these will not come in contact with other conventional grains. There are many conflicts and challenges associated with successful marketing of these products. The core conflicts here are the costs associated with keeping organic grains separated from the rest and finding a market for these products.

IP requires segregation, the process of keeping quantities of grain with different characteristics separated from other quantities of grain. This is important since contamination from conventional grains would eliminate the organic premium. Identity preservation also requires retaining the identity of the product from the farm to the place of processing. Obviously, the cost associated with performing these activities will be more than for conventional grain handling. The cost of IP is estimated to range from 22 to 54 cents per bushel (Shoemaker et al., 2001). This extra cost is linked with the additional costs of storage, handling, risk management, analysis/testing, and marketing, which are associated with contracts between the producers and those purchasing the product. Although the costs are substantial, it is thought they are less than what it would cost to vertically integrate (Janzen and Wilson, 2002). However, as the organic market matures and demand and competition increase, integration will doubtlessly come into consideration (Janzen and Wilson, 2002).

Of those listed, one of the largest costs associated with specialty/IP grains is that of handling (Janzen and Wilson, 2002). Facilities are needed to handle smaller, segregated units of grain. This separation must occur throughout the stages of transportation and processing. Because grain transportation is set up to meet the demand of grain storage (bulk quantities to gain economies of scale), shipment of smaller quantities becomes a problem. As such, most organic grain is shipped by truck as opposed to rail or barge. Also, it is not uncommon for producers to be required to provide a value-added service (an example is grain cleaning) before the grain is delivered to the buyers.

1.4.2 MARKETING PRACTICES

The most important part of developing an organic grain market is identifying the consumers' wants, such as specific quality or variety. However, this can be very difficult, as consumers often do not know exactly what they want. Experienced producers know where the markets are, know how to negotiate, and have established themselves as reliable suppliers through long-term relationships with buyers (Born, 2005). Unlike the conventional grain market, where producers can increase profits by selling at high prices, organic producers can increase profits by gaining knowledge, experience, and forming strong relationships. Additionally, successful producers know that maintaining the quality of their grain and having plenty of on-farm storage along with having a good relationship with their banker are also important. A strong banking relationship is essential for organic producers because unlike conventional grains, turning a commodity into cash is not as easy without a spot market. Organic grain may need to be stored for long periods of time before it is sold, slowing up cash flow.

Some of the production of IP crops is done under a production contract, usually with a broker or processor, giving growers a guaranteed market (Janzen and Wilson, 2002). These contracts are very detailed, describing the quantity, approved seed, growing practices, inspections, documentation, pricing, delivery, and handling. Quantity is usually specified by acres planted so as not to fall short of requirements at harvest (as compared to a quantity measurement such as bushels), and the seed is typically purchased from the organization offering the contract. These contracts are usually formed based on how the two parties suit each other's needs. Terms of these contracts vary on such aspects as grain cleaning, delivery, shipping, and which party is responsible for each task's completion. For pricing, most contracts offer a premium over the basis of a specified month at specific delivery points. The producers then have a three to six month time frame in which to "price" or sell their grain. The grain is often stored by the producer until the buyer needs it, because on-farm storage is much more adaptable and convenient than trying to find an elevator set up to handle IP grain. It is worth noting that if grain is tested before arrival (or in the absence of a general manager from the buying firm), this alone may be enough to void the contract.

The fastest growing form of marketing for organic producers is through marketing agencies-in-common, which are organized by groups of cooperatives to coordinate marketing and other value-added services for the cooperatives. Each individual cooperative is responsible for its own management. These are usually marketing/bargaining cooperatives which do not take ownership or possession of the member's grain. Instead, the grain is stored on member farms (as nearly all organic grain is) until it is delivered to the buyer. These cooperatives act as the bargaining agent for their members in negotiating the full range of issues involved in contracting sales, including price, payment terms, delivery schedule, shipping, and cleaning. Once the commodity is contracted, the cooperative coordinates the delivery, quality control, document transfers, and payment settlements. Buyers pay the cooperative, and the cooperative settles payments with individual producers. Typical fees for this service are around 6% of the net sale value (Reznicek, 2004).

Other options for organic producers include being put on a buyer's e-mail list. The buyer will send out an order, and producers can make bids. Another option for organic farmers is selling directly to another farmer, who often owns a small-scale operation which requires organic grains (an example is organic beef cattle). However, this option presents more risk, as the grain producers have a higher chance of not being paid.

The key success factors in this industry are finding a market and identifying the specific needs in that market, contracting with individuals who are trustworthy and dependable, having the means to gather timely and pertinent data, and having the infrastructure, such as appropriate storage facilities, to support the needs of organic grain.

1.4.3 SOURCES OF RISK IN ORGANIC FARMING

Organic farming presents different risks than that of conventional farming. Those getting into the business expose themselves to a three-year transitional period where yields are typically lower than what they were under conventional farming methods. This in itself would not present such a problem, but there is practically no market for transitional grain, and as such, the price received is the same as that of conventional, lacking the premiums of organic.

Another risk is contamination from GMO grains. In 2002, the Organic Farming Research Foundation conducted a nationwide survey of organic farmers, which stated 8% of the farmers reported direct losses from GMO contamination. A survey of the Midwest however, where organic grain production is much higher, stated 80% of organic farmers reported losses from GMO contamination (Organic Consumers Association, 2005).

While GMO contamination is known to be a problem, no one knows for sure how extensive it is. There are several explanations for this. Current U.S. standards do not require GMO testing of organic grains. If the grain is produced according to the rules, it is considered organic whether contaminated or not. Also, some food companies and feed mills are reluctant to test organic grains for GMOs because they are afraid grains will test positive (Organic

Consumers Association, 2005). There are even organic seeds which do not test pure. Klaas Martins, an organic farmer in New York, attributes a portion of this blame to the National Organic Program's standards which currently allow types of conventional seed to be used in place of organic if no organic seed is available (Organic Consumers Association, 2005).

Another factor of GMO contamination is cross pollination. Although cross pollination can be minimized and potentially prevented using both physical and biological isolation (biological isolation is simply offsetting planting dates by one to two weeks to prevent simultaneous pollination of organic and conventional grains), it still involves uncertainty. Even with physical barriers such as buffer strips, tree rows, or valleys, pollen can potentially be carried for miles by the wind given favorable conditions. Other sources of contamination may occur through shared harvesting, storage, and shipping media of organic and conventional grains. Proper protocols for cleaning and decontamination are likely not always followed, resulting in contamination.

Currently, because of increasing occurrences of GMO contamination, agri-business is promoting "threshold levels" of contamination that would be considered acceptable and marketed as "GMO-free" nonetheless (Sorensen, 2001). The European Union and Japan have such thresholds with 1% and 5% contamination, respectively. However, the European Union does have proposed regulations that would require identity preservation systems to be used for all grains, food and feed alike.

There have been recent lawsuits filed by organic farmers against GMO companies claiming financial losses due to GMO contamination (Organic Consumers Association, 2002). One such lawsuit in November 2002, composed of nearly 1,000 Saskatchewan organic farmers filing a complaint against Monsanto and Aventis, reports losses due to the introduction of genetically modified canola of over $14 million. The lawsuit also sought to ban the introduction of genetically modified wheat, with estimated losses of $85 million over the next decade if GM wheat is allowed on the market. Many such losses result from a buyer's refusal to accept contaminated grain.

A third type of risk occurs with such rapid expansion in the industry. With recent phenomenal growth, some are worried supply will overtake demand (others believe this overtake has already began), eliminating price premiums. However, with the recent increases in GMO contamination and buyers' refusals to accept them, this may not pose a very large threat, as the acceptable GMO-free supply will likely not be as high as the certified supply.

Other risks associated with organic farming include shortages of certified organic seed, biological pesticides, and specialized farm equipment due to the relatively small market of organic farming. It is unprofitable for agri-businesses to provide small quantities to scattered farmers. Bankers' unfamiliarity with organic farming makes it difficult for organic farmers to acquire capital. Another concern developing in organic farming is that of large organic farms. Like its conventional counterpart, organic farming benefits from economies of scale. Large organic operations, which can provide retailers with large volumes of production, have tremendous leverage in the marketplace (Hanson et al., 2004).

Perhaps the most obvious risk associated with organic farming is production loss due to diseases, insects, weeds, and poor soil fertility. Since the chemicals and pesticides used for conventional farming are not allowed, organic farmers resort to practices such as crop rotations, use and establishment of natural predators to harmful insects, and mulches (These practices are previously listed under the "Summary of Regulations" section of this chapter).

The debate on yields and profit losses (if any), from farming organically as opposed to conventionally is ongoing. There seems to be evidence for both sides. Sell et al. (1996) examined 38 conventional and 41 sustainable (organic) farms in South Dakota in 1992. They found net farm income for conventional farmers to be nearly twice that of organic farmers. Yields for barley, corn, flax, oats, sunflowers, durum and spring wheat were also significantly higher for conventional farmers. Another study from Cornell University (Lang, 2005) reports organic farming produces the same yields of corn and soybeans as conventional farming, and uses less energy and water, and no pesticides. The Sustainable Agricultural Network (2003) on the other hand reports that usually, within three to five years after switching to organic, yields are within 90 to 95% of conventional yields.

Although the yields between conventional and organic farms are debated, variability in net income does seem to be reduced with organic farming. A six-year study in northeastern South Dakota found net returns to vary by $16/acre for organic farms and $31/acre for conventional farms (Sustainable Agricultural Network, 2003). Also, a study by Cornell University (Lang, 2005) found that in drought years, corn yields were actually 22% higher under an organic system.

Federal crop insurance, or multiple-peril crop insurance, is another problem for organic farmers. Although it is available, it does not cover the price premiums associated with organic grain. Rather, organic farmers are compensated based on conventional grain prices. Further, this crop insurance does not cover what many farmers consider a major risk: the loss of sales and markets due to accidental GMO contamination (Hanson et al., 2004).

It is also difficult for organic farmers to get coverage for less-common crops such as flax, which are used in crop rotations. Production histories for organic crops can be more difficult to determine than conventional crops because of the wide variety of crops planted each year to maintain a healthy crop rotation. Also, due to the number of crops typically grown in small scale, it is not practical to purchase different insurance for each type.

1.4.4 BENEFITS OF ORGANIC GRAIN FARMING

Besides the obvious price premium associated with organic farming, other benefits, which are directly attributed to the organic farming practices themselves, are also present. Hanson et al. (2004) conducted several focus groups with organic farmers, and the following views are supported by certain farmers who participated in these focus groups. With diverse cropping systems, the yields and prices of these various crops do not necessarily move together, which reduces variability of overall farm income (Diebel, Williams, and Llewelyn, 1995). Some organic farmers suggest their investment in soil quality enables their soil to hold more water than conventional soil, allowing them to withstand droughts better. Others believe they can plant a wider variety of crops without worrying how chemical residue will affect next season's crop. They also feel they have a better control on pest management because they don't have to rely on new types of chemicals due to pests' ongoing resistance development to those currently being used. Due to the many choices of crops to plant, if a crop is lost early in the season, another crop can be planted to replace it. Many farmers stated that the satisfaction that comes from farming organically is enough for them to do it, even without the premiums.

1.4.5 ENVIRONMENTAL BENEFITS FROM ORGANIC FARMING

In 1981, The Rodale Institute began a 23-year study comparing land farmed under conventional practices and land farmed under organic practices (Meyers and Straus, 2003). They found the organically farmed land held 15% to 28% more carbon than conventional land. Carbon content was higher in the organic soil because organic matter in the soil is primarily composed of carbon. Organic farming techniques build organic matter by using composts and cover crops, thereby trapping carbon in the soil. The effect of this trapped carbon is a reduction in carbon dioxide in the atmosphere, and therefore a reduction of the greenhouse effect. The amount of carbon that could potentially be removed from the atmosphere by converting to organic farming is staggering. Estimates indicate that if all 160 million acres of conventional corn and soybean farms in the U.S. were converted to organic, the soil on these farms would eventually absorb enough carbon to equal the amount of emissions produced by 58.7 million cars.

The Soil Association (2005) supports The Rodale Institute's findings of a reversed greenhouse effect by farming organically. They also indicate that because pesticide sprays are not used in organic agriculture, no blowing or drifting of these pesticides occurs, thereby keeping the air cleaner and reducing the distance that pesticides travel.

Rattan Lal, a professor of soil science and director of the Carbon Management and Sequestration Center at Ohio State University, and Goro Uehara, a soil scientist at the University of Hawaii, were skeptical of the amount of carbon absorption from the Rodale study (Lewerenz, 2003). Uehara stated the numbers seemed twice as high as what they should be (Lewerenz, 2003). In addition, recent literature has suggested that conventional no-till farming practices also have a significant impact on reducing atmospheric carbon. Sandretto (2001) reports that no-till farming has the potential to reduce atmospheric carbon by up to 10 tons over 25-30 years. No-till farming in the U.S. has increased from 38.9 million acres in 1994, to 62.4 million acres in 2004, representing almost 23% of all U.S. cropland in 2004 (Conservation Technology Information Center, 2004). Since no-till farming practices have been increasing in recent years, the results of the Rodale study likely do not reflect the practices of modern conventional farming.

McIsaac and Cooke (1999) tested runoff water from five organic fields and five conventional fields over three years from 1997-1999. They found that on average, nitrate and chloride levels in drainage water from the organic fields were significantly less (typically less than half) than that of the conventional fields. The Soil Association notes that because organic soil has higher water retention due to more organic matter in the soil, less runoff occurs on organic farm ground, and consequently, lessens the need for irrigation.

Brenner (1991), as well as a study conducted in the United Kingdom by Hole et al. (2005), found that organic agriculture provided increased bird, butterfly, beetle, bat, and wild-flower populations as compared to those on conventional farms. Brenner notes studies done by Rogers and Freemark (in press), Grue et al. (1989), and Brewer et al. (1988) showed that higher populations of birds exist on organic field crop farms as compared to those of conventional. They also showed that mortality rates for birds which inhabit fields sprayed with certain pesticides on conventional farms are much higher than for the same birds found on organic farms. The Soil Association also notes there is more wildlife on organic farms as opposed to conventional farms.

Reganold, Elliott, and Unger (1987) compared two adjacent farms, one organic and one conventional, both of which had been under their current farming practice since 1948. He found the organic farm had higher organic matter content, total nitrogen, available phosphorus, polysaccharide content, and 16 cm more topsoil than the conventional farm. He also notes similar studies, one about two gardens in New Zealand by Robertson (1984), and one about two farms in Australia by Forman (1981), which had results comparable to his.

An article by Trewavas (2001) on the other hand, suggests lower levels of aphids on organic fields may be due to lower nitrogen levels, protein content, and yields of the organic crops. Trewavas argues that organic farmers make more passes over their fields in an attempt to control weeds, thereby using more fuel and reducing the moisture content in the soil. He also suggests the use of manure as a fertilizer may pose possible health risks to humans. Trewavas states that conventional farming can provide some of the same benefits as organic farming and more, due to conventional farming's efficiency.

1.5 THE FUTURE OUTLOOK OF ORGANICS

Wier, Hansen, and Smed (2001) studied the organic market of Denmark, which possibly has the highest per capita consumption of organic foods in the world. They stated that the Danish market provides insights about future markets in other countries as it is considered to be relatively mature, lacking the imperfections and barriers found in markets outside of Denmark. Organic sales accounted for 4% of total food sales in Denmark in 1999 (Organic Trade Association, 2003, Chapter 3.1). Given that U.S. organic sales are around 2% of total food sales, does this mean we can expect our organic market to slow down after doubling? The answer is not straightforward, since the two markets are not really comparable. It is inevitable that the rapid rise in production will eventually reduce or even eliminate the premium prices that have attracted many new growers to certified organic production (Born, 2005). However, current attitudes reflect those of Jennifer Tesch, marketing manager for SK Food International, who says of organic grain, "The supply is not increasing as quickly as the demand" (The Non-GMO Report, 2005). As organic grain production increases, one begins to wonder at what point supply will saturate the market.

CHAPTER 2 LITERATURE REVIEW

Organic fruits and vegetables are important in the organic sector because they are "gateway" products, or the first organic products purchased by consumers. Organic gateway products, which also include dairy, nondairy (soy), and baby food products, often steer consumers toward other organic products, such as cereals, snacks, and meat and poultry, and are perceived as important frontline commodities for the industry (Oberholtzer, Dimitri, and Greene, 2002). Because purchasing organic produce is the first step in purchasing other organic foods, and the fact that nearly all past and present organic literature concerned with determinants of price premiums deal with produce, consumer willingness to pay (WTP) and consumer profiles regarding organic produce will briefly be reviewed.

Sections 2.1 and 2.2 cover ten articles, first reviewing the articles' purposes and providing a general description of how they were completed. The articles are sorted by those that surveyed consumers, those that surveyed organic market managers or organic retailers and wholesalers (those in the supply chain), and by those that gathered previously conducted research and reported their findings (summary articles). The findings of these articles will then be summarized together, according to different topics. It should be noted that the findings reported from these papers are limited to those relevant to this review.

Section 2.3 and 2.4 discuss the two types of models used in this study, the hedonic price model and the autoregressive model. Section 2.3 will discuss the hedonic price model and its application in literature, while section 2.4 will discuss autoregressive models, along with variations of these models that allow for testing of speed of adjustment, and price leadership between two commodity price series. Cointegration and lag length selection techniques are also discussed, along with literature that demonstrates uses of autoregressive models.

2.1 CONSUMER SURVEYS

Loureiro and Hine's (2002) goal was to determine what type of eco-label would result in the highest premium for Colorado grown potatoes. They wanted to determine if there were differences in WTP for the three different labels of organic, GMO-free, and Colorado grown. They also wanted to analyze differences in WTP based on socio-demographic factors.

To complete these tasks, Loureiro and Hine conducted a survey in the fall of 2002 at supermarkets and stores across Colorado. Consumers were solicited and asked for voluntary participation in the survey. Four hundred thirty-seven usable surveys were collected with a 40% response rate. Of those who responded, 60% were female, average respondent age was 44, most had some sort of college education, 31% had at least one child, and over one-half of respondents had no children. They also had average incomes greater than $50,000 in the year 2000.

The key question on the survey was: Assuming fresh potatoes were priced at $1.00 per pound at your grocery store, how much of a premium per pound if any, would you be willing to pay for fresh potatoes containing the following characteristics: GMO Free, Organically Grown, and Colorado Grown? Participants were then given price premiums in five-cent intervals to choose from. A multiple bounded probit model was used to analyze the responses.

Govindasamy and Italia (1999) examined socio-demographic (race, sex, age, income, household size, education) variables, along with attitudes and risk perception impacts on WTP for organic produce. They collected data from a consumer survey conducted by Rutgers Cooperative Extension, which was distributed to five grocery stores in New Jersey in March 1997. Four hundred eight surveys were distributed by approaching consumers at random and 291 were returned (the surveys were mailed back in postage-paid envelopes). Of those who responded, 66% were female, 83% had some college education, 58% were less than 49 years old, 33% had children, and 37% earned less than $39,999 per year.

Cunningham's (2003) objective was to produce a general profile of a Canadian organic consumer. The profile included how often the consumer purchased organics, age, education, income, where they purchase organic foods (what types of stores, such as supermarkets, local grocery stores, farmers' markets), and general traits and values of the typical Canadian organic consumer. Cunningham used data from the Environics International Food Issues Monitor survey (conducted in October 2000) and the Canadian Health Food Association survey (conducted in July 2000). Other studies such as the U.S. Hartman Group study (2000) and other sources of information were also used. Information from all of these sources was compiled to form the Canadian organic consumer profile.

Jolly (1991b) wanted to better understand consumer perceptions, attitudes, and activities affecting food purchase decisions. In particular, he wanted information on consumer attitudes toward organic food products to explain why some consumers purchase organic products while others do not. Specifically, he wanted to know if there were systematic and statistically significant demographic, economic, and psycho-graphic differences between organic food buyers and non-buyers, and if these traits affected the buyer's willingness to pay an organic price premium. A mail survey was randomly sent to consumers in the California counties of Marin, Sacramento, and San Diego in September and October 1987. Fifty-four percent of the 1,769 surveys were completed and returned. Questions asked covered factors affecting food purchasing decisions and how consumers rate the overall level of quality of flavor and healthfulness of the food supply in comparison with the five years previous. ANOVA analysis was used to test the hypothesis of no difference between buyers and non-buyers.

Misra, Huang, and Ott (1991b) wanted to determine Georgian consumers' preference for fresh organic produce, and whether the importance of sensory quality (color, shape, firmness, and smell) and testing of organic produce to be free of pesticide residue were in the decision of purchasing fresh organic produce. They also wanted to measure consumers' WTP higher prices if the produce was indeed certified pesticide- residue free. To accomplish these tasks, a mail survey was sent to 580 Georgian households in the spring of 1989. Three hundred eighty-nine households responded, with a response rate of 67%.

Of those who responded, 68% were female and 77% were white. Less than 10% of respondents were 25 years or younger, though distribution between age groups 26-35, 36-45, 46-60 and over age 60 was relatively even. Twenty-three percent of respondents had income less than $15,000, and 35% had income over $35,000. Also, 48% of respondents had some college education. Chi-square contingency tests were used to determine if there were significant differences for respondents' preferences for organically grown produce due to age, education, income, race, sex, and product attributes and concern variables.

Thompson and Kidwell (1998) collected in-store data by surveying 340 organic consumers to determine key demographic and socio-economic characteristics of consumers purchasing organic produce. They collected data on price and cosmetic quality of organic and conventional produce items at a specialty regional chain grocery store and a local cooperative in Tucson, Arizona between February 7, and April 26, 1994. Of those interviewed, 160 respondents were from the specialty store, and 180 were from the cooperative. Consumers who purchased fresh produce (specifically Red Delicious apples, broccoli, carrots, green leaf lettuce, and tomatoes) were the consumers chosen to be interviewed to gather the desired data. In general, respondents had higher incomes, higher education, and were older than the census tracks for their location. A two-equation probit model was used to determine the probability of whether a participant of the interviews would purchase organic or conventional produce.

2.1.1 SUPPLY CHAIN SURVEYS

Morgan and Barbour (1991), along with the Stony Brook-Millstone Watershed Association, gathered information about the organic produce market. Five hundred fifty-two surveys were mailed to New Jersey produce retailers and wholesalers in February and March 1989. 201 surveys were returned, for a response rate of 36%. Market size, reasons for selling organics, obstacles for the organic produce market, quality and supply problems of organic foods, organic items in demand, and the market for transitional organic produce were all topics discussed in Morgan and Barbour's article.

Kremen, Greene, and Hanson (2004) focused on the role of farmers' markets as a marketing tool for organic growers and on customer attitudes about organic products at these markets. They collected data by interviewing 210 market managers by phone in more than 20 states about their 2002 market season (interviews were conducted in late 2002 and early 2003), with the majority of interviews coming from the eastern portion of the U.S. Data such as market type (metro or rural market, as well as if the market sold all organic products or some organic products), the average numbers of farmer attendance at these markets, and the distance customers traveled to get to these markets were collected. The authors also collected subjective assessments of demand for organic products from the managers at the markets interviewed.

2.1.2 SUMMARY ARTICLES

Thompson (1998) analyzed consumer demand characteristics for organic produce and organic apples by compiling many articles from roughly 1987-1997. The articles summarized were Jolly (1991a), Goldman and Clancy (1991), Misra, Huang, and Ott (1991a), Byrne, P.J., J.R. Bacon, and U.C. Toensmeyer (1994), Baker and Crosbie (1993), Swanson and Lewis (1993), Parkwood Research Associates (1994), Thompson and Kidwell (1998), Reicks, Splett, and Fishman (1997), Hartman Group (1996), Food Marketing Institute (1997), and The *Packer* (1998). The contents of these articles were summarized and reported. Specific characteristics reported include income, store effects (where and what type of stores consumers purchase organic produce at), age, gender, marital status, education, and household size.

Oberholtzer, Dimitri, and Greene (2005) gathered and reported information about organic consumer profiles from multiple sources as well. The sources used were the Hartman Group (2002), Nutrition Business Journal (2003), a survey by Whole Foods Market (2004), Thompson and Kidwell (1998), Estes and Smith (1996), and Govindasamy and Italia (1990).

2.2 ARTICLE FINDINGS

Many of the previous studies concern consumers' willingness to pay (WTP) for organic produce and profiles of consumers who do and do not purchase organic produce. The underlying reason for all these studies is an attempt to help determine which consumers to target for maximum organic sales and how to best market these organic products. Many of these studies have contradicting results, though there are certain consumer characteristics that most studies agree on.

2.2.1 DEMOGRAPHIC EFFECTS ON ORGANIC PURCHASES

Studies done by Loureiro and Hine (2002), Govindasamy and Italia (1999), and Jolly (1991a), have found as age increases, WTP for organic produce decreases. Govindasamy and Italia (1999) found consumers over age 65 are willing to pay the smallest premium for organics, while those under 36 would pay a 52% higher premium than those over age 65. Consumers between the ages of 36-50 would pay a 38% premium above those over age 65, and consumers between the ages of 51-65 would pay a 28% premium above those over age 65.

However, some studies (Thompson and Kidwell, 1998) found age to be statistically insignificant. Thompson and Kidwell's (1998) findings reflect views of other studies in the industry, such as Oberholtzer, Dimitri, and Greene (2005). The possible reasons given for such findings include a more restrictive diet and routine and less income, which restricts ability to pay organic premiums.

A survey of Canadian consumers (Cunningham, 2003) found the age effect to be nonlinear. Consumption of organic foods for consumers between the ages 18-44 increased with age, took a dip between the ages 45-55, and then peaked for those over age 55.

Education is a variable generally found to be statistically insignificant. Govindasamy and Italia's (1999) survey found having some sort of college education renders the consumer 18% less likely to pay the same premium than those without any college education. They gave such reasons as less educated consumers may exaggerate the true risks of pesticide usage, and that more educated consumers may have a higher degree of confidence in produce safety standards.

Loureiro and Hine (2002) found wealthy and educated consumers are willing to pay a higher premium, while Jolly (1991a) found education to be statistically insignificant, and Jolly (1991b) found the willingness to pay a higher premium increases directly with education. Organic markets near universities and other centers for higher education are likely to exhibit strong demand (Kremen et al., 2004).

Loureiro and Hine (2002) and Govindasamy and Italia (1999) both agree that an increase in family size will decrease willingness to pay. However, Thompson and Kidwell (1998) found that households with more children under the age of 18 were more likely to purchase organic produce. A suggested reason for such a finding is parental concern regarding their children's health (stemming from the belief organic food is in some way healthier than conventional food).

Over half of those who frequently buy organic food in the United States have incomes below $30,000 (Hartman Group, 2002). General findings with regard to income show upper income consumers have the highest WTP, followed by the lower income consumers, with middle-income consumers coming in last. Misra, Huang, and Ott (1991a, 1991b) found about 60% of their respondents who were willing to pay over a 10% premium earned above $40,000 per year. However, of those who would pay up to a 10% premium, 60% of them earned less than $40,000 per year.

Govindasamy and Italia (1999) found consumers earning less than $30,000 per year were 16% less likely to pay a premium than those earning over $70,000 per year. Those earning $30,000-$49,000 were 26% less likely to pay. Jolly (1991b) found the income variable to have a small effect.

With regard to Canadian consumers, those making under $20,000 purchase around 14% of organic foods sold in Canada. Those making between $20,000 and $40,000 have the highest percentage at around 27%. Consumers whose incomes are between $40,000 and $60,000 purchase about 22%, those between $60,000 and $80,000 purchase the least at about 13%, and those making over $80,000 purchase about 18% of organic food sales in Canada (Cunningham, 2003). Also, organic shoppers are more likely to be female than male.

2.2.2 CONSUMER KNOWLEDGE, PERCEPTIONS, AND BELIEFS

Consumers' knowledge, perceptions, and beliefs of organic products, along with their personalities and preferences, have major impacts on their decisions regarding purchases of organics. For example, quality potatoes labeled "Colorado Grown" received a higher premium from Colorado consumers than being labeled GMO free or organic (Loureiro and Hine, 2002). This implies Colorado consumers have a preference for locally grown produce, or a willingness to support local farmers. It also demonstrates that eco-labeling may work better for certain types of commodities. In fact, a study by Wessells, Johnston, and Donath (2000) stated eco-labeling might work better for some fish species than others. It appears eco-labeling may have the same effect when applied to organics. Eco-labeling is defined as a voluntary trademark that is awarded to products deemed to be less harmful to the environment than other products within the same category (United Nations, Dept. of Economic and Social Affairs Background Paper).

Other studies have implied the importance of producer-consumer relationships in local organic farmers markets. One manager at an all-organic market in Vermont explained, "The most important thing is establishing a relationship between the customers who are waiting to see if a grower is going to be reliable with product quality and attendance…that connection is more important than [a] label" (Kremen, Greene, and Hanson p. 6, 2004). This statement not only implies the importance of producer-consumer relationships but also demonstrates some sort of loyalty between consumers and certain producers.

The more consumers know about organic farming practices, the more likely they are to purchase organic products. For example, knowledge of integrated pest management increases the likelihood of purchasing organics by 20% (Govindasamy and Italia, 1999). Other findings by Govindasamy and Italia include that people who are generally among the first to try new products are 15% more likely to pay a premium, and those who consistently purchase organics are 45% more likely to pay a higher premium than those who do not.

2.2.3 CONSUMER CONCERNS

Consumers' concerns play a big part in their decision to buy organic foods. Jolly's (1991b) survey found that concerns about pesticide residue, artificial coloring and additives and preservatives were all statistically significant, along with concern about food irradiation, sugar, salt, and the importance of the healthfulness of the food supply to food purchasing decisions. Misra, Huang, and Ott's (1991b) survey supports that of Jolly's (1991b), finding the top three concerns of Georgia consumers to be pesticide use (51% of respondents), preservatives and additives (31%), and food poisoning (29%). Misra, Huang, and Ott (1991b) also found that consumers with greater concern for pesticides, preservatives, prices, and nutritional values are more likely to tolerate defects. High price was found to be statistically insignificant toward making a decision to purchase organic foods, with only 27% of the respondents showing concern.

Canadians' top food concerns were bacterial contamination, air, water, and soil pollution, food safety, and use of chemicals. Their determining factors for choosing food were taste (93% of respondents ranked this as important), nutrition and health (89%), ease of preparation (68%), preparation time (66%), and price (62%), (Cunningham, 2003).

2.2.4 PRODUCT ATTRIBUTES

Important product attributes to organic consumers in Georgia are freshness, appearance, nutritional value, and low price, though low price is the only variable of significance between consumers who prefer organic produce and those who do not (Misra, Huang, and Ott, 1991b). It is interesting to note that over one-half of respondents in Misra, Huang, and Ott's (1991b) survey who expressed interest in organics refused to accept any sensory defects (which include color, shape, firmness, and smell), while one-fourth would, and one-fifth were uncertain. Also, non-whites are more sensitive to defects, yet are more likely to purchase organics than whites.

A survey of Californian organic consumers found safety, freshness, general health benefits, nutritional value, effect on the environment, flavor and general appearance of the products were important in choosing organic foods (Jolly, 1991b).

2.2.5 EFFECTS OF PRODUCT PRICE

Govindasamy and Italia (1999) had 67% of the respondents from their survey state they would be more willing to purchase organics if they were priced lower, while the majority of respondents indicated they would be willing to pay some sort of premium for organic products. Thirty-six percent of their respondents stated they would pay more than a 10% premium, but 19% said they would not pay any premium. Sixty-five and one-half percent stated they would be more likely to purchase organic products if they were more readily available.

Jolly's (1991b) survey showed 65% of respondents rated organic food the same or better than conventional food. Twenty-three percent regularly purchased organic food, and 29% planned on buying organic foods within the next month. He also found high price, store location, and search time to be the most constricting factors for consumers who have tried, but no longer purchase organic foods. For those consumers who have never purchased organics, price, location, and search time were also important, although availability of organics was more important than price. Morgan and Barbour (1991) also found price and availability to be the largest barriers with regard to suppressed sales of organics.

Misra, Huang, and Ott (1991b) found 66% of their respondents would pay 10% above the conventional food price, 12% of those surveyed would pay even more than 10%, and 22% of those surveyed wouldn't pay any premium.

2.3 HEDONIC PRICES

The essence of hedonic prices arises from the general idea that products have certain characteristics, which for heterogeneous goods are not the same. "Product heterogeneity can arise in various ways. Two products can possess different amounts of the same characteristics or one product can contain a characteristic that the other does not. Two products may contain two completely different sets of characteristics" (Ladd and Martin, p. 21). Heterogeneous goods receive different prices based on these sets of characteristics.

Hedonic prices are the prices associated with intrinsic values of heterogeneous goods, specifically, the individual prices associated with each individual characteristic. In a perfectly competitive market (agriculture is about as close as they come), the hedonic price of each characteristic should equal the input price associated with producing that characteristic. In other words, the marginal cost of producing each characteristic will equal the marginal benefit (price associated with the worth of the particular characteristic for a competitive market, i.e., hedonic price) of that characteristic. A hedonic model is used to assign a unique intrinsic value (hedonic price) to each individual characteristic associated with a good.

Many in the agricultural industry have used hedonic modeling to estimate the intrinsic value of characteristics on price for a variety of products and animals. This study will use hedonic models to estimate the intrinsic value of certain characteristics of different organic grains and alfalfa hay associated with the premium (the difference between the organic and conventional market prices) of these organic commodities. Much of the literature using hedonic analysis applies Ladd and Martin's hedonic model. As such, their model is presented before proceeding with a review of its applications. It should be noted that this literature is being covered to demonstrate the use of the hedonic price model. As such, the findings of the literary pieces are only presented to the extent they are relevant to this study.

2.3.1 LADD AND MARTIN'S HEDONIC MODEL

The following model is Ladd and Martin's (1976) Neoclassical Input Characteristics Model (ICM) and is presented following its summarization in Wilson (1984). An in-depth look at this model can be found in Ladd and Martin (1976). We begin with a production function for good *y*

Eq. 2.3.1A $$q_y = f_y(q_{1y}, q_{2y}, \ldots, q_{my})$$

where q_y is the quantity of *y* produced, and q_{jy}, where $j = 1, \ldots, m,$ is the total quantity of characteristic *j* used in *y*, q_{jy} is a function of input use x_{iy} and the quantity of characteristic *j* contained in each unit of x_{iy} such that:

$$q_{jy} = f_j(x_{1y}, x_{2y}, \ldots, x_{iy}, x_{j1y}, x_{j2y}, \ldots, x_{jny})$$

where x_{jny} is the quantity of the characteristic *j* contained in each unit of x_{jy}. The production function can now be restated as:

$$q_y = G_y(x_{1y}, x_{2y}, \ldots, x_{ny}, x_{j1y}, x_{j2y}, \ldots, x_{mny}).$$

The profit of a firm that produces *y* goods from *m* inputs is

Eq. 2.3.1B $$\Pi = \sum_{y=1}^{Y} P_y f_y(q_{1y}, q_{2y}, \ldots, q_{my}) - \sum_{y=1}^{Y} \sum_{i=1}^{n} P_{x_i} x_{iy}$$

where P_y and P_{x_i} are output and input prices, respectively and x_{iy} is the quantity of input *i* used for producing *y*. Using the production function's restatement, the profit function could now be rewritten as:

$$\Pi = \sum_{y=1}^{Y} P_y G_y(x_{1y}, x_{2y}, \ldots, x_{ny}, x_{j1y}, x_{j2y}, \ldots, x_{mny}) - \sum_{y=1}^{Y} \sum_{i=1}^{n} P_{x_i} x_{iy}.$$

In equation 2.3.1B, f_y is a function of the x_{jy} and the x_{jy} are functions of x_{iy}, so to differentiate equation 2.3.1B with respect to x_{iy}, the rule for differentiating a compound function must be used:

$$\partial f_y/\partial x_{iy} = \sum_j (\partial f_y/\partial q_{jy})(\partial q_{jy}/\partial x_{iy}).$$

We use the above equation to differentiate equation 2.3.1B and get:

$$\partial \Pi/\partial x_{iy} = P_y \sum_j (\partial f_y/\partial q_{jy})(\partial q_{jy}/\partial x_{iy}) - P_{x_i}$$

Solving for P_{x_i}, we get:

Eq. 2.3.1C $$P_{x_i} = P_y \sum_{j=1}^{m} (\partial f_y/\partial q_{jy})(\partial q_{jy}/\partial x_{iy})$$

where $\partial q_{jy}/\partial x_{iy}$ is the marginal yield of characteristic j in the production of y from input i, and $P_y(\partial f_y/\partial q_{jy})$ is the value of the marginal product of characteristic j used in the production of y (the hedonic price in the j^{th} characteristic of y). Equation 2.3.1C can be simplified by letting $P_y(\partial f_y/\partial q_{jy})$ equal B_j and letting $\partial q_{jy}/\partial x_{iy}$ equal x_{jiy}, and assuming both B_j and x_{jiy} are constant. Assuming x_{jiy} is constant implies that yield of each characteristic from an input is not affected by the use made of the input: "the yield of protein from a bushel of No. 2 yellow corn is the same whether the corn is fed to hogs or dairy cattle" (Ladd and Martin, p. 23).

With these assumptions we now have:

Eq. 2.3.1D $$P_{x_i} = \sum_{j=1}^{m} B_j x_{jiy}.$$

Equation 2.3.1D is our basic hedonic model, which states the price of an input is equal to the sum of the products of marginal yields of the characteristics and the hedonic prices of the characteristics. This equation assumes the price of the input is linearly related to the quantity and/or quality of the characteristic (Ladd and Martin). We will now commence our review of the hedonic literature.

2.3.2 APPLICATIONS OF THE HEDONIC PRICING MODEL

Espinosa and Goodwin (1991) begin with Ladd and Martin's model to provide estimates of the hedonic prices of many different Kansas wheat characteristics (such as protein and water levels, density, and dockage and defects) to determine if the current U.S. grading system for wheat was efficient. Panel data spanning 17 years (1970-1987) were collected from each of nine districts in Kansas. The annual average prices received by producers for each district was collected as well. Because the data included 17 years, the prices were converted to 1987 dollars by using an index of average U.S. wheat prices, which allowed interpretation of prices in each year to be compared in 1987 dollars.

Because there is only one input and output, subscript *i* and *y* can be eliminated from equation 2.3.1D. Espinosa and Goodwin also add an intercept term to allow for premiums and discounts (the coefficient/hedonic price) for wheat to be compared to a base price (which is the intercept). In addition, they included regional dummy variables to account for differences in regions across cross-sectional units of the panel data. The Hausman test was used to see if the cross-sectional effects were of a fixed or random nature. The test revealed the effects were fixed, so dummy variables were used to account for these effects. To account for heteroskedastic time-series correlation, Espinosa and Goodwin used Parks' (1967) model. Thus, the model Espinosa and Goodwin use for their analysis is:

Eq. 2.3.2A $$P_{rt} = \alpha_0 + \sum_{k=1}^{m} \beta_k z_{rtk} + \sum_{r=1}^{n} \mu_r d_r + u_{rt},$$

where P_{rt} is the deflated price of wheat ($/bu) form the r^{th} region in the year t, d_r's are the regional dummy variables, β_k's are the hedonic prices for the $k = 1, \ldots, m$ wheat characteristics given by the z_{itk}'s, $\alpha_{0r} = \alpha_0 + \mu_r$ is the intercept for the r^{rh} region, and the error term u_{rt} follows a heteroskedastic first-autoregressive process as follows:

$E(u_{rt}u_{jt}) = \sigma_{rj}$ for $r = j$ and 0 otherwise

and,

$u_{rt} = \rho u_{rt\text{-}1} + e_{rt}$

where e_{rt}'s are white noise residuals.

Espinosa and Goodwin had two subdivisions of their data set, the second of which covered the years 1980-1987, and contained information on milling and dough characteristics. The other section covered the full 17 years with information on moisture, density, protein, and defects. The 17 year section of data was regressed individually first, and then together with the milling and dough characteristics to determine which set of characteristics (moisture, density, protein, and defects alone, or these coupled with milling and dough) had more price determining power. It should be noted the regression containing the milling and dough characteristics was done using nested regressions. For both regressions, F-tests and nested F-tests were used to validate the importance of explanatory variables. R^2 coefficients were also examined to weigh the model's explanatory power.

Wilson (1984) too used Ladd and Martin's hedonic model for estimating quality factor prices for malting barley. Specifically, the quality attributes of plumpness and protein, a grading system (values of 1, 2, and 3), barley variety and the price of feed barley were all used in the estimation of malting barley price. The dependent variable of malting barley price consisted of spot prices at the Minneapolis Grain Exchange.

Wilson's data were comprised of a cross-section of observations for each Wednesday of the week, though the number of observations was not consistent week to week. Weekly data were pooled together, and an analysis of covariance, which followed Maddala's (1977) example (pp. 322-325), tested for the correct pooling. For the first two years of observations (1978/79-1979/80), only two varieties of barley were included in the sample. However, during the second and final two years of observations (1980/81-1981/82), two more varieties were included, for a total of four.

Wilson's empirical equation, which was estimated using standard regression procedures, included variety, grade, and month as intercept shifters. Each year was modeled separately to reduce the potential problems of inter-crop year variability in the marginal implicit prices. These could be attributed to changes in the supply and/or demand for the characteristics, which would largely stem from the varieties produced (since varieties were not the same throughout the years), weather, and agronomic practices (both of which affect the level of quality characteristics and therefore supply) (Wilson, p. 33). Heteroskedasticity was tested using the Goldfeld-Quandt test, and in all cases, homoskedasticity could not be rejected. The serial correlation however could not be tested for due to the unequal number of observations in the weekly cross-sections.

Because of this model's unrestrictive nature, testing for the equality of some of the coefficients was possible. The slope coefficients were tested for being the same across varieties and grades for each year's regression. This test determined whether or not the hedonic prices estimated were statistically different across these variables. Also, a hypothesis of homogeneity in implicit prices for both plumpness and protein across varieties and grades were tested for each year (Wilson, p. 34). Tests were also conducted to see if variety, grade, and month (all three of which shift the intercept) were statistically significant for determining the price of malting barley (the null hypothesis is the effects of all these variables are equal to zero). Constancy of the factors' effects on the malting barley price was also tested for, by adding second and third polynomials in plumpness and protein (Wilson, p. 35).

Estes (1986) estimated the hedonic prices for green bell peppers using linear (log-log) regression. Estes noted that general demand and supply functions may be desired when determining hedonic prices when the data cover a large area (where supply/demand factors may differ across the region) or if the data span a certain amount of time (where supply/demand may change through the passage of time). Rather, hedonic price relationships reflect short run equilibrium observations and are necessarily time and location specific (Estes, p. 9). Estes also noted that if a general demand function for a characteristic is desired, Rosen (1974) showed how to achieve it. Estes' paper did not generate any demand functions however, as the data did not allow for it (the data did not have collections over several time periods or locations). In fact, care was taken to obtain data from the same market for three different days (each day's data reflected a single eight hour marketing time frame), each day reflecting a different period in the pepper-growing season (therefore, three separate regression were used). This allowed for a comparison of the importance of each implicit characteristic throughout the harvest season. As such, demand functions were neither desired nor needed. Supply factors were ignored due to a lack of evidence that supply affected the consumers' decisions (conversations were had with buyers at each marketing time to assess this information).

To determine what type of functional form to use, Estes went with Jordan et al.'s (1985) suggestion of using Box-Cox power transformation parameters to allow the data to determine what type of form to use. A general hedonic model that utilized a Box-Cox transformation, as given in Estes, is given:

Eq. 2.3.2B
$$\frac{Y^{\lambda_0}-1}{\lambda_0} = \beta_0 + \sum_{i=1}^{k} \beta_i\left(\frac{X_i^{\lambda_i}-1}{\lambda_i}\right) + e_i$$

where Y is the dependent variable, X_i is the i^{th} independent variable, $\lambda_0, \lambda_1, \ldots, \lambda_k$ are the transformation parameters (which are to be estimated), β_0 is the intercept, β_i is the i^{th} coefficient associated with the i^{th} independent variable, and e_i accounts for the error terms.

Solving for Y we get:

Eq. 2.3.2C
$$Y = \left[\lambda_0\left(\beta_0 + \sum_{i=1}^{k}\beta_i\left(\frac{X_i^{\lambda_i} - 1}{\lambda_i}\right)\right) + 1\right]^{(1/\lambda_0)} + e_i.$$

Important pepper characteristics tested in this paper were pepper size (measured by count per bushel), the color of the pepper (the range of "greenness" measured by a percentage), pepper firmness (again measured as a percentage), physical defects of the peppers, and the average temperature of the peppers, tested from a sample bushel from the crate brought to market (peppers are sensitive to temperature and may be harmed if not stored at an appropriate temperature).

Estes (p. 7) states that results from Jordan et al. and convenience considerations suggest that equations with the general form of equation 2.3.2C may be simplified by assuming equal λ values for all of the independent variables. Thus only two λ values remain; one for the dependent (denoted above as λ_0) and one for the independent variables (to be denoted as λ_1). He also notes a nonlinear grid search algorithm may be used to determine sets of parameter estimates (for λ_0, λ_1, and β_i), which result in the smallest sum of squared errors. If all λ's equal 1, the equation is linear. As λ's approach zero, a log-log model is implied. Also, the dependent and independent λ's need not be equal. One could restrict the dependent λ to zero and the independent λ's to one giving us a semi-log model. It should be noted the λ's need not be restricted to values between zero and one (Berndt, p. 128).

Initial testing using non-linear regression techniques gave smaller error values as both λ's approached zero. An additional iterative grid search procedure employing the false position method (SAS algorithm DUD) around lower mean square error estimates indicated that there was no significant difference between the converged λ_0 and λ_1 values generated by DUD and a log-log functional form (Estes, p. 9). As such, a log-log form equation was estimated. Evaluation of R^2 values and F-statistics were used to evaluate the variables' explanatory powers.

Nganje et al. (2005) tested whether or not consumers were willing to pay more for bread labeled "low carbohydrate" by using a hedonic model to estimate the premium for the low carbohydrate characteristic. Here, the low carbohydrate characteristic was expected to generate additional utility due to expected perceived health benefits resulting from foods low in carbohydrates. Product characteristics used in the model were serving size, product quantity per package, and also calories, fat, protein content, carbohydrate content, sugar content, and fiber content (all expressed as grams/serving). Nganje notes that along with carbohydrate content, the other variables were included because low carbohydrate claims are typically made with other nutritional claims that contribute to the product quality. It is also noted that consumer demand for nutritious food follows a holistic view of associated quality attributes, and as such, other variables added to the analysis are store type, store location, and the amount of shelf space given to the breads used in the analysis (Nganje, p. 6). These data were collected from the locations, of Fargo, ND, Moorhead, MN, and the internet.

For this study, the bread market was assumed to be competitive. This assumption translates into the first order necessary condition (FONC) idea that the marginal cost of producing each intrinsic characteristic of the bread is exactly equal to the worth at which the consumer values it. Also, because the market was assumed perfectly competitive, no negotiation was expected to occur with bread price. As such, the listed, or store price, for the bread could be used in this analysis as opposed to using the transaction prices. In other words, these prices should be the same.

Nganje used a linear empirical model since according to Maguire, Owens and Simon (2004), characteristics can vary independently of each other, and thus the linear hedonic price function is appropriate. Also, this allowed parameters to be directly interpreted as implicit prices. The locations of Fargo and Moorhead were not considered separately, as it was assumed the costs of movement between Fargo and Moorhead were negligible. The type of store where the bread was sold was considered however, since different types of stores may have different costs. Tests were done considering an aggregation across store types. F-test results showed there was a statistically significant difference between store types, and as such, separate models were used for each store type (the composite data set was also regressed, and all four estimate results were reported).

Heteroskedasticity of the error terms was tested for using White's test, partially because it makes no assumptions about the form of heteroskedasticity. Heteroskedasticity was confirmed in the composite data set, as well as the other three (grocery stores, non-grocery stores, and internet). Normality was also tested for using the Kolmogorov-Smirnov test. Error term normality was rejected in all three of the data sets, indicating the OLS estimator would no longer be the best choice. As such, the MLE approach was used to provide consistent and robust parameter estimates. Under assumptions of normality, MLE is also asymptotically normal (Nganje, p. 10).

2.4 AUTOREGRESSIVE (AR) MODELS

The other major objective of this paper is to determine if the organic and conventional grain markets are related to, and have an effect on each other, to determine if a price forecast for the organic grain market may be derived. Specifically, it would be useful to know if conventional grain market information can be used to forecast the organic prices.

Many studies have examined relationships between multiple sets of price data, though to date, little research has analyzed the relationship between organic and conventional prices. This portion of the chapter will review time series models that can be used to determine if relationships between the organic and conventional grain markets exist. Because much literature in the industry uses the vector autoregressive model to examine price relationships, a brief review of this model will be presented following Griffiths, Hill, and Judge (1993), prior to the discussion of the literature that demonstrates its use.

2.4.1 VECTOR AUTOREGRESSIVE (VAR) MODELS

Given two endogenous random variables (which for this analysis can be thought of as prices for conventional and organic grains) that are jointly determined, we can construct a simultaneous equations model to explain their behavior. For example, we may assume X depends on its past values and the current and past values of Y. In turn, Y depends on its past values and current and past values of X. Together, these equations can form a system of simultaneous equations to explain how each affects the other. These equations can be written to express the endogenous variables of X and Y in terms of exogenous and lagged endogenous variables to produce two reduced form equations (i.e., equations derived from the matrix form of the system of simultaneous equations). These reduced form equations are useful if we are interested in forecasting the value of either X or Y, and together form a vector autoregressive model.

More than one lagged variable can be used within the VAR model. For example, to determine if the value of X one month ago is more effective in determining its current value than its value three months ago, both one- and three-month lag variables should be included. Consequently, the order of the VAR model is determined by the number of lag variables included in the system of equations. For example, if only one lag is included for each equation expressing X and Y, the VAR model they form is of order 1 and denoted VAR (1). The type of VAR model we have described, involving a system of two equations, is called a bivariate equation. If more than two equations are used in the system, the VAR model is called a multivariate model.

To estimate VAR models, a few important assumptions must hold. First, no serial correlation may exist in the reduced form models' error terms, meaning they must be uncorrelated from one observation to the next. Second, the VAR process must be stationary. In our example, this would mean that the average values of X and Y and their covariances are constant over time. "In practice, these assumptions mean that the time series may not have trends, nor seasonal patterns, nor variances that change over time" (Griffiths, Hill, and Judge, 1993, p. 693).

If the previous assumptions hold, OLS regression may be used to provide consistent and approximately normally distributed error terms for large samples. If the data series is not stationary, i.e., has a trend, it can be transformed to remove the trend, using one of two common procedures: an estimation of time trend regressions or differencing the data series once or more.

Before non-stationary data can be made stationary, it must first be determined what type of trend exists. If the series is a function of time only and follows a linear trend, we can estimate the least squares residuals of this function, which will form a de-trended, stationary series that can be used in a regression analysis. For example, given

Eq. 2.4.1A $$z_t = \alpha + \beta t + \varepsilon_t$$

where z_t is a function of time, t, and the error term, ε_t, is distributed with a mean of zero and a standard deviation of σ^2, we can estimate the least square residuals

Eq. 2.4.1B $$\overset{\wedge}{\varepsilon}_t = z_t - \overset{\wedge}{\alpha} - \overset{\wedge}{\beta} t$$

where $\overset{\wedge}{\alpha}$ is the estimated intercept from equation 2.4.1A and $\overset{\wedge}{\beta}$ is the estimated time coefficient from equation 2.4.1A. Griffiths, Hill, and Judge (1993) note that series that can be de-trended in this way are called trend stationary processes (TSP). Conversely, if the series follows a random walk with a trend or drift:

Eq. 2.4.1C $$z_t = z_{t-1} + \beta + \varepsilon_t$$

where $\varepsilon_t \sim (0,\sigma^2)$ is a stationary error process and β is constant, then z_t is made stationary by differencing once, since the following equation is stationary

Eq. 2.4.1D $$\Delta z_t = z_t - z_{t-1} = \beta + \varepsilon_t .$$

Series which can be de-trended in this way are called difference stationary processes (DSP). To determine if a time series is TSP or DSP, the Dickey-Fuller test may be used. It is based on the following model:

Eq. 2.4.1E $$z_t = \alpha + \beta_t + \rho z_{t-1} + \varepsilon_t .$$

If $\rho = 1$ and $\beta = 0$, then $z_t = a + z_{t-1} + \varepsilon_t$ and the series is difference stationary. If $|\rho| < 1$, then the series is trend stationary. To test the null hypothesis of difference stationary, the following statistic with an F distribution,

$$u = \frac{(RSS - USS)/J}{(USS)/(T-K)}$$

is used, where *RSS* is the restricted residual sum of squares, *USS* is the unrestricted sum of squares, *J* is the number of hypotheses, *T* is the number of observations, and *K* is the number of regressors including the intercept in the unrestricted model. The unrestricted model is

Eq. 2.4.1F $$\Delta z_t = a + \beta t + (\rho - 1)z_{t-1} + \sum_{j=1}^{n} \rho_j \Delta z_{t-j} + \varepsilon_t$$

and the restricted model, which holds true under the null hypothesis, is

Eq. 2.4.1G $$\Delta z_t = a + \sum_{j=1}^{n} \rho_j \Delta z_{t-j} + \varepsilon_t \; .$$

Critical values for this test are presented below in Table 2.4.1.

Table 2.4.1 Critical Values for Dickey-Fuller Test

Sample Size *T*	α = .05 Critical Value for *u*
25	7.24
50	6.73
100	6.49
∞	6.25

Source: Dickey and Fuller (1981, p. 1063, Table VI).

2.4.2 COINTEGRATION

A concept discovered by C. W. Granger is that of cointegration, which addresses the issue of integrating short-run dynamics with long-run equilibrium. First, a few definitions are needed. A stationary time series is integrated of order zero or I(0), and a time series y_t is I(1) if Δy_t is a stationary time series. A time series y_t is said to be I(2) if Δy_t is I(1), and so on. If

$y1_t$~I(1) and $y2_t$~I(1), $y1_t$ and $y2_t$ are said to be cointegrated if there exists a β such that $y1_t - \beta y2_t$ is I(0). In other words, the two series are cointegrated if there exits a linear combination of them, $\varepsilon_t = y1_t - \alpha - \beta y2_t$, that is I(0), i.e., stationary. This means that $y1_t$ and $y2_t$ are cointegrated of order (1,1) or CI(1,1). If $y1_t$ and $y2_t$ are CI(1,1), then the regression

Eq. 2.4.2A $$y1_t = \alpha + \beta y2_t + \varepsilon_t$$

will make sense since the two series $y1_t$ and $y2_t$ do not diverge over time. Thus, a long-run relationship exists between them.

If the two stationary time series are cointegrated, we can use an OLS regression to regress $y1_t$ on $y2_t$ to explain the relationship between the trends of $y1_t$ and $y2_t$. However, it must first be determined if the two series are cointegrated. To do this, we determine if ε_t in Eq. 2.4.2A is stationary and is integrated of order zero. If $y1_t$ and $y2_t$ are not cointegrated, then ε_t ~I(1) and is not stationary. OLS regression can be used to test if the residuals $\hat{\varepsilon}_t$ are stationary by use of the Augmented Dickey-Fuller unit root test. We will let $\hat{\varepsilon}_t$ be the least squares residuals from Eq. 2.4.2A to form

Eq. 2.4.2B $$\hat{\varepsilon}_t = \rho \hat{\varepsilon}_{t-1} + v_t$$

where $\hat{\varepsilon}_t$ will be stationary if $|\rho| < 1$. If $\rho = 1$, errors are non-stationary. To test the null hypothesis H_o: $\rho = 1$, a t-test with the critical values given in Table 2.4.2 below are used.

Table 2.4.2 Critical Values for the Cointegration Test
When the Cointegrating Regression Contains Two Parameters

	α		
Sample Size *T*	0.01	0.05	0.1
50	-4.32	-3.67	-3.28
100	-4.07	-3.37	-3.03
200	-4.00	-3.37	-3.02

Source: Engle and Yoo (1987, p. 157, Table 2, minus signs added).

2.4.3 SPEED OF ADJUSTMENT, CAUSALITY, AND PRICE LEADERSHIP

Following Schroeder (1997), we can form vector autoregressive models to determine price leadership and speed of price adjustment, having found that the proceeding equation with two I(1) variables is stationary

Eq. 2.4.3A $$y1_t = \beta_0 + \beta_1 y2_t + e_t .$$

The parameter estimates of this regression are used to calculate estimates of the residual errors, $\hat{e}$, where

Eq. 2.4.3B $$\hat{e}_t = y1_t - \hat{\beta}_0 - \hat{\beta}_1 y2_t .$$

As discussed in Enders (p. 337), VAR models with two cointegrated I(1) variables are estimated using an error correction model to avoid misspecification as follows

Eq. 2.4.3C $$\Delta y1_t = \alpha_1 + \alpha_{1y}\hat{e}_{t-1} + \sum_{i=1}^{k}\alpha_{11}(i)\Delta y1_{t-1} + \sum_{i=1}^{k}\alpha_{12}(i)\Delta y2_{t-1} + \varepsilon_{1t};$$

Eq. 2.4.3D $$\Delta y2_t = \alpha_1 + \alpha_{2y}\hat{e}_{t-1} + \sum_{i=1}^{k}\alpha_{21}(i)\Delta y1_{t-1} + \sum_{i=1}^{k}\alpha_{22}(i)\Delta y2_{t-1} + \varepsilon_{2t} ,$$

where $\hat{e}_{t-1}$ is the error term from Eq. 2.4.3B. The α_{1y} and α_{2y} are speed of adjustment coefficients (Schroeder, 1997). These parameters estimate how quickly the dependent series value responds to the independent series' deviations from long-run equilibrium. Estimates close to one in absolute value indicate a quick response to the deviations from equilibrium, while an absolute value close to zero implies slow to no response. As noted by Schroeder, speed of adjustment parameters only measure the immediate shock response and do not indicate the entire adjustment, which is captured in the VAR estimates.

Griffith, Hill, and Judge (1993) state that a variable $y1_t$ is Granger-Caused by $y2_t$ if current and past information on $y2_t$ helps to improve the forecasts of $y1_t$. From Eq. 2.4.3C, $y2$ does not Granger-Cause $y1$ if and only if the coefficients for past values of $y2$, $\alpha_{12}(i)$, as well as α_{1y} both equal zero. Standard F-tests may be used to test the null hypothesis H_o: $\alpha_{12}(i) = 0$ and $\alpha_{1y} = 0$. The Granger-Causality can be examined for general VAR models.

Additionally, weak exogeneity of a series may be tested for cointegrated series. Exogeneity differs from Granger-Causality in that Granger-Causality jointly tests whether or not past and present information for one series affects the current value of the other, while for $y1$ to be exogenous, current information of $y2$ must not affect it (Enders, p.283).

2.4.4 LAG SELECTION

Another concern with autoregressive (AR) models is determining the appropriate number of lags to use. Enders (p. 69) gives two common criteria for this task, the Akaike Information Criterion (AIC) and Schwartz Bayesian Criterion (SBC), computed as

$$\text{AIC} = T\ln(\text{RSS}) + 2n$$

$$\text{SBC} = T\ln(\text{RSS}) + n(\ln)T$$

where n is the number of parameters estimated including a possible constant term, T is the number of usable observations, and RSS is the residual sum of squares. Because observations are typically lost when creating lagged variables, T should be kept fixed, and can be explained with the following example. Suppose we have 100 data points and are estimating an AR(1) and AR(2) model. The T value that should be used is the one corresponding to the AR(2) model, which is $T = 98$. To determine the appropriate number of lags, we choose the model that gives us the smallest value of either the AIC or SBC, which can assume negative values. For each criteria, increasing the number of lags and therefore regressors increases n, but will reduce the residual sum of squares. As such, if an added regressor contains sufficiently small explanatory power, its use will cause both AIC and SBC values to increase. SBC is known to penalize useless regressors more than AIC. AIC tends to over-parameterize more than SBC, and SBC works better for larger samples (Enders, p. 69).

2.4.5 APPLICATIONS OF AUTOREGRESSIVE MODELS

Schroeder (1997) used price data from 28 U.S. fed cattle slaughter plants to verify the extent of their cointegration. Given this measure of cointegration, he was able to determine the geographic market for fed cattle. He also determined where most price discovery for this market takes place.

To accomplish these tasks, bivariate time-series models were used to test for spatial price relationships. Multivariate models were not used because data from the different slaughter plants were highly correlated, and multicollinearity is a problem with the multivariate models. Schroeder noted that if the plants were operating in the same geographical market, their prices should not diverge from each other, suggesting price cointegration between the plants. He suggested cointegration occurs through arbitrage between markets or by buyers and sellers that overlap market regions.

Ordinary least squares regression was used to estimate parameters of the cointegration regression, which were then used to calculate estimates of the residual errors using the augmented Dickey-Fuller test. The appropriate lag length was tested for using the Schwartz-Bayesian Criterion. After determining cointegration existed, Schroeder used vector autoregressive models to determine price leadership and speed of price adjustment. Error correction models were used to estimate the VAR models to avoid misspecification error. The error correction models used in Schroeder's analysis "are similar to standard VARs using differenced data, although the lagged error correction term [the error from the cointegration regression] is added to the VAR" (Schroeder, p. 349).

Bernard and Willett (1996) examined the relationship between wholesale and farm broiler prices to see if a response to a price increase is different than a response to a price decrease. They used monthly USDA prices of wholesale and farm broiler prices, No. 2 yellow corn, and soybean meal, as well as transportation costs to specifically determine if: 1) broiler producers received a larger share of price decreases in wholesale broiler prices relative to increases, 2) consumer prices are more sensitive to price increases in wholesale broiler prices relative to decreases, and 3) these occurrences vary at the retail level in different market regions.

To accomplish their tasks, Bernard and Willett used a single-period autoregressive model, and a unit root test was conducted using the augmented Dickey-Fuller test. Lag length was then determined following Hsiao's (1979) testing methodology and the Schwartz Bayesian Criterion. After determining the appropriate lag length, causality tests were performed to explain the broiler price, using the Granger-Causality method and a method proposed by Geweke, Meese, and Dent (1983), both of which produced the same results. The results from causality and lag length tests, along with gas prices were then used in a model to determine if upward and downward price movements of each series were statistically equal to the other. Asymmetry was tested on a period-by-period basis, where for each period a new restricted equation was used, with upward and downward price movements for that period replaced by their combined price changes, leaving the other periods separated by upward and downward movements.

Maynard (1997) used price data from two price discovery units in the egg industry to determine if egg prices were lower than the equilibrium price level. At the time, egg prices were based on quotes from Urner Barry Publications, and egg farmers were worried these quotes were understating the equilibrium egg price. Egg Clearinghouse, Inc. (ECI) also provides a means of price discovery by providing a public forum for egg producers to post the cash prices they have recently received. Daily egg prices from January 4, 1994 to November 30, 1995 were collected from both companies. Additionally, ECI reported six different regions where transactions took place, and Urner Barry reported four. While ECI reported which specific region sales occurred in and which specific region purchases occurred in, Urner Barry simply reported regions where either a sale or transaction occurred. As such, ECI prices were compared with weighted averages of the Urner Barry prices, those weights being determined by ECI transactions. "If ECI did not trade in a given region on a given day, the weight on that region's Urner Barry quote was set equal to zero. If ECI trading did involve a given region, that region's Urner Barry quote was weighted by a ratio based on the regional distribution of ECI deliveries during the 1994-95 fiscal year" (Maynard, p. 24).

To begin testing for a relationship between the two data sets, non-stationarity was tested for and found using the Dickey-Fuller test and corrected for by first-differencing the time series. To correct for serial correlation, an autoregressive integrated moving average (ARIMA) process was identified for each time series, the parameters of the process were then estimated, and the residuals from the estimation were then used for analysis. A Granger-Causality test using a set of past lagged terms only was then used to determine if either of the price sets led the other. The vagueness of this test prompted a second Granger-Causality test, using both past and future lag terms. Maynard noted that differencing might have resulted in a loss of long-run information if the two series had been cointegrated and the difference operator was not recognized in the error process. As such, cointegration was tested for using the augmented Dickey-Fuller test.

Zapata, Fortenbery, and Armstrong (2005) determined if cointegration exists between the world cash market for sugar and the New York futures market for world #11 sugar. Specifically, they wanted to see if the futures market is a price discovery mechanism and if it could provide a means for risk management for producers and exporters of Dominican Republic sugar.

Average monthly closing New York futures prices for world #11 sugar and monthly world #11 sugar cash prices from January 1990 to April 2002 were used for the analysis. Regarding the futures prices, the nearby contract was used for each monthly price. Zapata, Fortenbery, and Armstrong used an error correction model (a vector autoregressive model that accounts for short-term price fluctuations between two series by adding lagged variables) to accomplish their goals. They first tested for unit-roots using the augmented Dickey-Fuller test, for lag length using the Schwartz Bayesian Criterion, and for cointegration using Johansen-Juselius Lambda Max and Trace statistics, although Zapata, Fortenbery, and Armstrong did note that typically Granger-type causality tests are used when studying lead-lag relationships. Error correction models were also used to estimate impulse response functions to identify the time path followed by either price series to a one-unit shock in the innovations of each series.

CHAPTER 3 DATA

Three sets of data were obtained for the analyses in this thesis. The hedonic analysis conducted to identify the determinants of organic commodity premiums used organic data purchased from the Kansas Organic Producers (KOP) cooperative, as well as conventional grain price data received from the USDA. The USDA data were used in conjunction with the KOP data to derive the organic premiums (the differences between the organic and conventional prices) to be used as the dependent variables in the hedonic analyses. The time series analysis also required organic and conventional price series data. The organic price series were purchased from Organic Business News. The conventional price series were taken from the same USDA data set used for the hedonic analyses. Summary statistics for all price series can be found in Appendix A.

3.1 KANSAS ORGANIC PRODUCERS DATA

The data obtained from the Kansas Organic Producers (KOP) cooperative spanned roughly two years, covering the end of 2003 to the end of 2005. The data contained information which consisted of commodity type, the buyer (whose identity was camouflaged), the truck number if shipped by semi or the car number if shipped by rail, the date the commodity was shipped, the producer of the commodity, the producer's price per unit, the buyer's cost per unit, net sales (producer price multiplied by total units), total sales (buyer's cost multiplied by total units), total units of the commodity, commodity weight, and the shipping cost if it was incurred by KOP. Differences in net sales and total sales mainly reflect KOP commission. Additional information, which included the state in which the buyers and sellers were located, as well as the contract month of the commodity shipment if it was not sold on the spot market was also obtained from Earl Wright, marketing director of the KOP.

The original data were on printed excel spreadsheets, and as such were scanned into Microsoft Excel. The sheets were organized by buyer, meaning that each buyer had its own piece(s) of paper with the list of commodities which that buyer purchased.

Missing data entries were a small problem. There were many missing entries for the truck/rail number, as well as the commodity weight column. As such, these variables were not included in the analyses. If the producer or shipping date data were missing from the entries, Earl Wright was contacted to see if he could fill in the missing values. If he did not, the entries were deleted. For missing entries of producer's net price per unit, buyer's net cost per unit, net sales, total sales, and total units, calculations based on other reported values were used to compute them where possible. The computations can be found in Table 3.1A.

Sometimes total units needed to be computed before finding one or more of the other values. For example, if total sales, producer's net price per unit, and total units were missing and we wanted to compute them, total units would need to be computed first by dividing the commodity's total weight by the commodity's pound per unit equivalent. The next step was to divide net sales by total units to find producer's net price per unit. Total units would then be multiplied by buyer's cost per unit to get total sales. Obviously, there are various ways to compute missing values, as long as the other values needed to compute those missing are present. If there was not enough information to compute all of the missing values for producer's net price per unit, buyer's net cost per unit, net sales, total sales, and total units, Earl was again contacted to see if he had the information. If he did not, these entries were also deleted.

Table 3.1A Missing Entry Computations

Producer's net $/unit:
(net sales / total units)
[net sales / (total sales / buyer's net cost per unit)]
Buyer's net cost/unit:
(total sales / total units)
[total sales / (net sales / producer's net $/unit)]
Net Sales:
(producer's net $/unit * total units)
[producer's net $/unit * (total sales / buyer's net cost per unit)]
Total Sales:
(buyer's cost per unit * total units)
[buyer's cost per unit * (net sales / producer's net $/unit)]
Total Units:
(net sales / producer's net $/unit)
(total sales / buyer's net cost per unit)
(total weight / the commodity's pound per unit equivalent)

Pound/unit equivalents:

Soybeans	60 lb/bu
Wheat	60 lb/bu
Field Peas	60 lb/bu
Sorghum	56 lb/bu
Corn	56 lb/bu
Barley	47 lb/bu

Expelled soybean meal and extruded soybean meal were originally measured in the data using tons as units. Because the value of the determinants of the price of soybean meal is not desired, but rather the value of the determinants of the price of the soybeans that produce the meal (feed grade soybeans), the average price per ton of each type of soybean meal was divided by 40 to give the equivalent price per bushel of soybeans. This was done because according to Earl Wright, it takes on average about 40 bushels of soybeans to make 1 ton of soybean meal.

Additionally, trucking/processing information was not reported for every data entry. It was only listed if KOP arranged the shipment. However, even if KOP arranged the shipment and incurred the cost, they were essentially reimbursed with a higher price for the commodity sold, which covered the shipping expenses. If there was no cost listed, it meant the buyer of the commodity had arranged and paid for shipment, because the producers never paid it. As such, whenever there was a trucking/processing cost listed, it was meaningful mainly in that it conveyed who arranged the shipping.

After the above adjustments were made, the entire data set was sorted by commodity, and dummy variables were created for commodity type, the states in which buyers and sellers were located, the type of firm the buyer was (e.g., flour mill, dairy, or poultry farm), and for who arranged the commodity shipment. A buyer code and producer code were also created to keep track of which producer sold the commodity and which buyer purchased the commodity, though these were not used in the analysis. Additional dummy variables were also created for the quarterly period and the year of the contract date and for the quarterly period of the shipping date. A variable that represented the time difference in months, between the contract date and shipping date (the contract length), was also created and called "ShipDif" for shipping difference. If the entry represented a commodity sold on the spot market, this variable was given a value of zero.

The types of commodities and the number of observations before and after deletion of incomplete entries for each commodity appear in Table 3.1B. Notice that expelled soybean meal, extruded soybean meal, and soybeans were all grouped together under the category "Soybeans – Feed Grade". This is because both expelled and extruded soybean meal are made with feed grade soybeans, and as mentioned earlier, these were converted from tons of soybean meal to bushels of soybeans to account for the fact that these are indeed made with feed grade soybeans. The entry "soybeans" represents feed grade soybeans and as such, all three are grouped together. After deleting incomplete entries, the total dropped from 112 to 109. Also, the same was done with the categories of whole millet, processed millet, and de-hulled processed millet. De-hulled processed millet and processed millet are the same thing, and whole millet is comparable in price. As such, whole millet was added to the other two to bring the total observations of millet to 16.

Table 3.1B KOP Commodities

Commodity	Number of Original Obs.		Commodity	Observations After Deletions
Expelled Soybean Meal	54	*	Soybeans - Feed Grade	109
Extruded Soybean Meal	7			
Soybeans	51			
Roasted Soybeans	7		Roasted Soybeans	6
Barley	11		Barley	11
Peas - Feed Grade	10		Peas - Feed Grade	10
Grain Sorghum	11		Grain Sorghum	11
Ground Sorghum	4		Ground Sorghum	3
Hard Red Winter Wheat	134	*	Hard Red Winter Wheat	125
Hard Red Winter Wheat - Feed Grade	64	*	Hard Red Winter Wheat - Feed Grade	63
Hard White Winter Wheat	31		Hard White Winter Wheat	31
Soft Red Winter Wheat	30	*	Soft Red Winter Wheat	30
Brown Flax	1		Brown Flax	1
Flax Screenings - Feed Grade	4		Flax Screenings - Feed Grade	3
Whole Millet	9		Whole Millet	16
Processed Millet	1			
Dehulled Processed Millet	6			
Oats	1		Oats	1
Yellow Corn - Food Grade	22	*	Yellow Corn	21
Yellow Corn - Feed Grade	213	*	Yellow Corn - Feed Grade	213
Ground Corn	3		Ground Corn	3
Alfalfa Hay	60	*	Alfalfa Hay	59
Clover Hay	11		Clover Hay	11
Praire Hay	5		Praire Hay	5
Cattle	2		Cattle	2

* Denotes commodities used for analysis.
Commodities are food-grade unless stated otherwise.

Of the commodities presented in Table 3.1B, 8 had more than 20 observations, 7 of which were used for analysis: feed grade soybeans, feed and food grade corn, feed and food grade hard red winter wheat, food grade soft red winter wheat, and alfalfa. In order to compare the same types of data for the hedonic analyses, hard white winter wheat was not used even though it had more than 20 observations because the corresponding conventional grain prices could not be obtained from the USDA.

3.2 ORGANIC BUSINESS NEWS DATA

The data used from Organic Business News spanned roughly 15 years from 1990 through November of 2005 and consisted of prices collected from North Dakota, Montana, California, Colorado, Washington, Illinois, Minnesota, and Kansas, though it is unknown which crops were reported in which states. Data from 1990-2003 contained both farm-gate and wholesale weekly average prices while data from 2004-2005 contained farm-gate and wholesale weekly high and low prices, as well as the average. The commodities whose price data were purchased from Organic Business News are presented in Table 3.2. The average weekly farm prices reported in the original data were used. The data required little processing other than combining the files to one spreadsheet (data for 1990-1995 was given in one file, while each year after that was given in its own file) and inserting additional weeks at the beginning and/or end of a year to ensure each year was composed of 53 weekly observations. This number of observations was chosen because the most observations found in any year of the USDA data were 53, with which the Organic Business News data needed to correspond. These additional rows were left blank to be interpolated after combining this data set with the USDA data set and importing the combined set into SAS.

Table 3.2 List of Organic Business News Grains, Beans, and Oilseeds

Amaranth, farm, per lb.
Amaranth, whol, per lb.
Barley, farm, hulled, per lb.
Barley, whol, hulled, per lb.
Barley, Pearled, whol, per lb.
Beans, Adzuki, farm, per lb.
Beans, Adzuki, whol, per lb.
Beans, Anasazi, farm, per lb.
Beans, Anasazi, whol, per lb.
Beans, Black Turtle, farm, per lb.
Beans, Black Turtle, whol, per lb.
Beans, Garbanzo, farm, per lb.
Beans, Garbanzo, whol, per lb.
Beans, Great Northern, farm, per lb.
Beans, Great Northern, whol, per lb.
Beans, Kidney Dark Red, farm, per lb.
Beans, Kidney Dark Red, whol, per lb.
Beans, Mung, farm, per lb.
Beans, Mung, whol, per lb.
Beans, Navy, farm, per lb.
Beans, Navy, whol, per lb.
Beans, Pinto, farm, per lb.
Beans, Pinto, whol, per lb.
Buckwheat, farm, per lb.
Buckwheat, whol, per lb.
Canola seed, farm, per lb.
Canola seed, whol, per lb.
Corn, Blue, farm, per bu.
Corn, Blue, whol, per lb.
Corn, White, farm, per bu.
Corn, White, whol, per lb.
Corn, Yellow, farm, per bu.
Corn, Yellow, whol, per lb.
Flax, farm, per lb.
Flax, whol, per lb.
Lentils, French, farm, per lb.
Lentils, French, farm, per lb.
Lentils, Green, farm, per lb.
Lentils, Green, whol, per lb.
Millet, farm, per lb.
Millet, whol, per lb.
Oats, farm, per bu.
Oats, whol, per bu.
Oats, whol, per lb.
Peas, Dry Green Split, farm, per lb.
Peas, Dry Green Split, whol, per lb.
Popcorn, farm, per lb.
Popcorn, whol, per lb.
Quinoa, farm, per lb.
Quinoa, whol, per lb.
Rice, brown, farm, per lb.
Rice, brown, whol, per lb .
Rice, wild, farm, per lb.
Rice, wild, whol, per lb.
Rye, farm, per bu.
Rye, whol, per lb.
Sesame seed, unhulled, farm, per lb.
Sesame seed, unhulled, whol, per lb.
Soybeans, Clear Hilum (cleaned), farm, per bu.
Soybeans, Clear Hilum (cleaned), whol, per bu.
Soybeans, Clear Hilum (uncleaned), farm, per bu.
Soybeans, Clear Hilum (uncleaned) whol, per bu.
Soybeans, Natto (cleaned), farm, per bu.
Soybeans, Natto (cleaned), whole, per bu.
Soybeans, transitional (Hilum/Vinton), farm, bu.
Soybeans, transitional (Hilum/Vinton), whol, bu.
Soybeans, Vinton, cleaned, farm, per bu.
Soybeans, Vinton, cleaned, whol, per bu.
Soybeans, Vinton, uncleaned, farm, per bu.
Soybeans, Vinton, uncleaned, whol, per bu.
Spelt, farm, per lb.
Spelt, whol, per lb.
Spelt, hulled, farm, per lb.
Spelt, hulled, whol, per lb.
Sunflower seeds, farm, per lb.
Sunflower seeds, whol, per lb.
Wheat, Durum, farm, per bu.
Wheat, Durum, whol, per bu.
Wheat, Hard Red Spring, farm, per bu.
Wheat, Hard Red Spring, whol, per bu.
Wheat, Hard Red Spring (cleaned), farm, per bu.
Wheat, Hard Red Spring (cleaned), whol, per bu.
Wheat, Hard Red Winter, farm, per bu.
Wheat, Hard Red Winter, whol, per bu.
Wheat, Soft Winter, farm, per bu.
Wheat, Soft Winter, whol, per bu.
Wheat, Soft Red, farm, per bu.
Wheat, Soft Red, whol, per bu.
Wheat, Soft White, farm, per bu.
Wheat, Soft White, whol, per bu.

"whol" stands for wholesale.
"farm" stands for farmgate.

3.3 USDA DATA

The conventional price data were acquired from the USDA's Agricultural Marketing Service division. The data set was extremely large, containing daily high and low prices for 240 different classifications of conventional crops from reporting stations all across the United States. It spanned from 1997 through 2005. To begin managing the USDA data, a program called "Kedit," specifically designed to handle very large data sets, was downloaded from the internet. After opening the file which was stored on a CD, the data were highlighted in chunks of nearly 60,000 rows at a time and then copied and pasted into Microsoft Excel spreadsheets. After copying and pasting the entire file, 27 spreadsheets of data had been created. The data needed for this analysis were then selected.

3.3.1 ORGANIC PREMIUMS

USDA data used for the hedonic analyses were first sorted by crop variety. Price entries from across the U.S. were used to obtain U.S. average prices of grade "good" alfalfa hay, No.2 soybeans, No.2 yellow corn, No.1 ordinary protein content hard red winter wheat, and No.2 soft red winter wheat. These commodities' average prices were computed by averaging their daily high and low prices and then computing the monthly average price from these averages. This was done using the Pivot Table in Microsoft Excel following the subsequent steps. The original data consisted of five columns for each entry: the date of the entry, a crop code representing the specific crop variety, a location code representing the reporting station, and the high and low prices for the reporting station of the entry. Before creating the Pivot Table, three new columns were created. The first column contained the year each entry was reported in. The second column contained the week of the year for which the entry was given. The third column was the average of the daily high and low prices for each entry. The data in these new columns were then imported into a Pivot Table in Excel, designating the "year" column as the column variable in the layout of the Pivot Table, the "yearly week" column as the row variable in the layout, and the average daily prices were designated as the data variables in Pivot Table's layout, assigning the "average" function for the daily prices. The Pivot Table produced the average monthly prices.

Price premiums of the seven KOP commodities were then calculated by subtracting these conventional price averages from the prices that KOP member producers received, according to the month the shipment was contracted in. For example, the price premium associated with a shipment of organic corn that was contracted in January 2004 was computed by subtracting the average price of the No.2 conventional yellow corn in January 2004, regardless of whether the organic corn was of feed or food grade. Similarly, conventional No. 1 ordinary protein content hard red winter wheat monthly price averages were subtracted from both organic food and feed grade hard red winter wheat to derive the hard red winter wheat premiums.

Organic feed grade soybean premiums ranged from \$2.08/bu to \$9.11/bu. Its average premium of \$6.11/bu was 90% of the average conventional No.2 soybean price over the same time period. Organic feed grade corn premiums ranged from \$0.80/bu to \$4.45/bu, with an average premium of \$2.59/bu that was 109% of the average conventional No.2 yellow corn price over the same time period. Organic food grade corn premiums ranged from \$1.99/bu to \$4.16/bu. Its average premium of \$2.88/bu was 134% of the average conventional No.2 yellow corn price over the same time period. Organic feed grade hard red winter wheat premiums ranged from \$0.55/bu to \$3.74/bu, with an average premium of \$2.76/bu that was 86% of the average conventional No.1 hard red winter wheat price over the same time period. Organic food grade hard red winter wheat premiums ranged from \$0.55/bu to \$3.74/bu, with an average of

$1.02/bu that was 31% of the average conventional No.1 hard red winter wheat price over the same time period. Organic food grade soft red winter wheat premiums ranged from $2.14/bu to $2.88/bu, with an average of $2.50/bu that was 78% of the average conventional No.2 soft red winter wheat price over the same time period. Finally, organic alfalfa premiums ranged from -$39.16/ton to $55.18/ton. The average premium was $11.65/ton, which was 13% of the average conventional grade "good" alfalfa over the same time period. Premium summary statistics can be found in Appendix A. Additionally, Figures 3.3.1A–3.3.1E illustrate the monthly average premiums received for all seven of the organic commodities, along with the conventional monthly averages used to compute the premiums.

Figure 3.3.1A

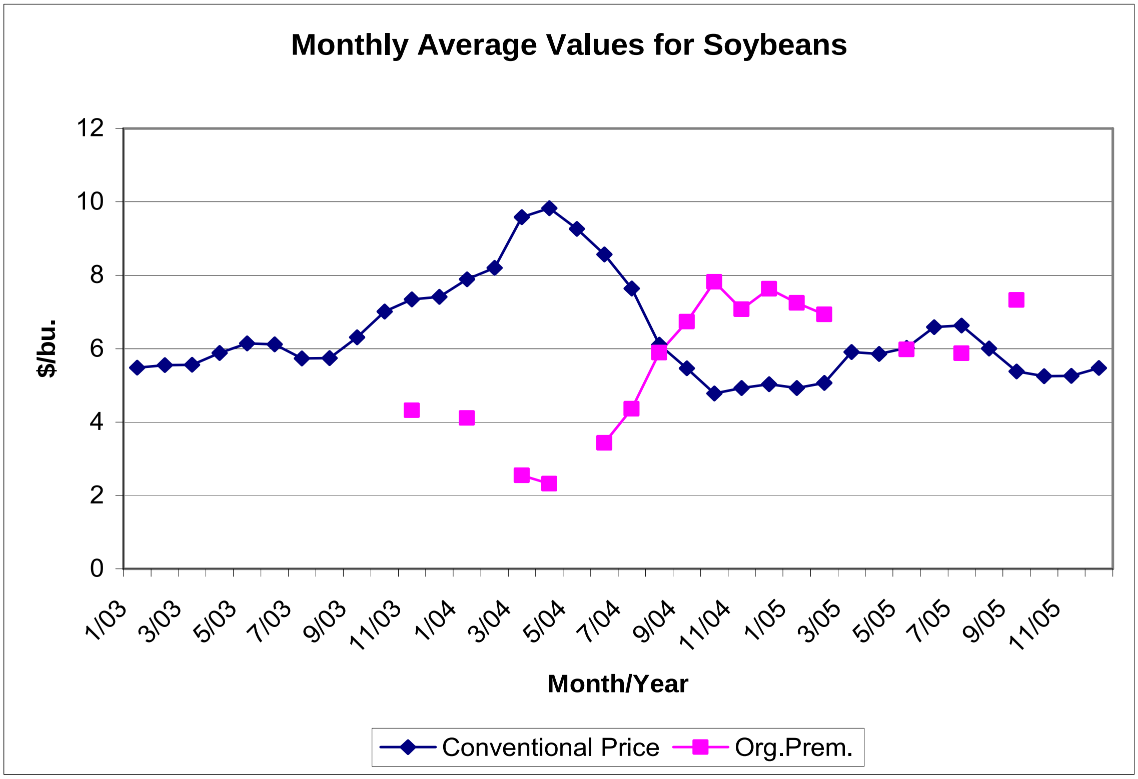


Figure 3.3.1B

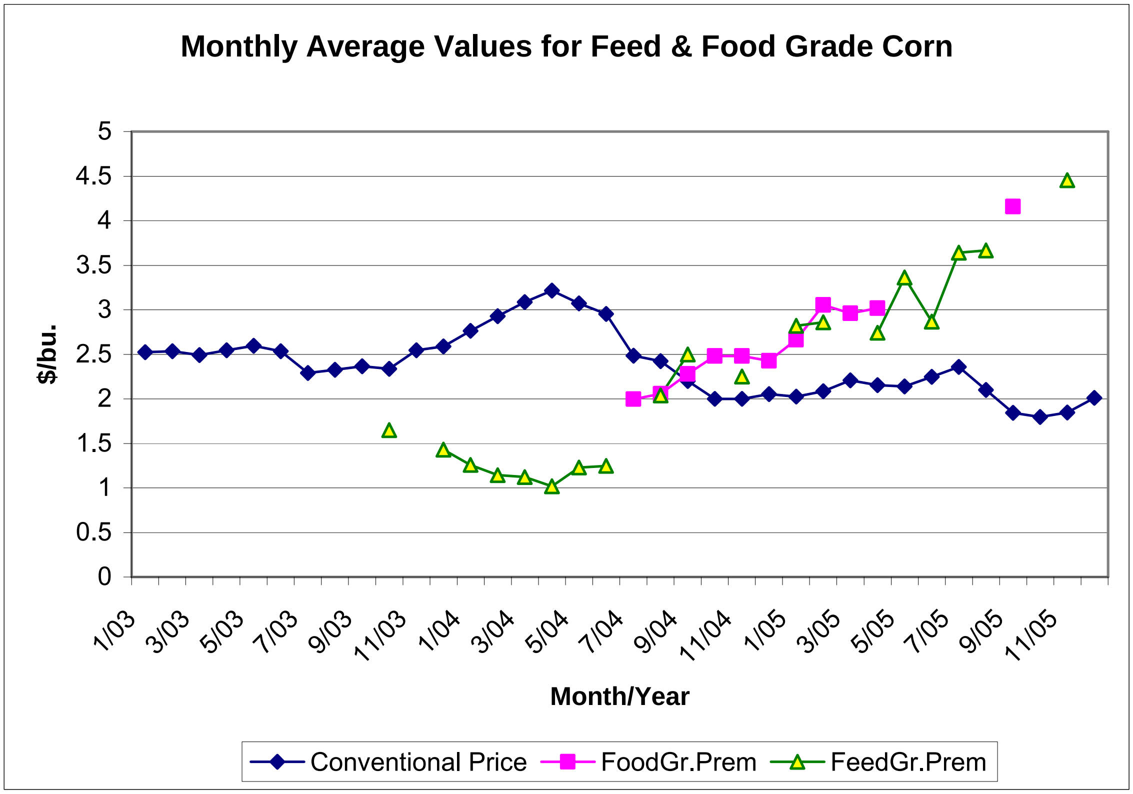


Figure 3.3.1C

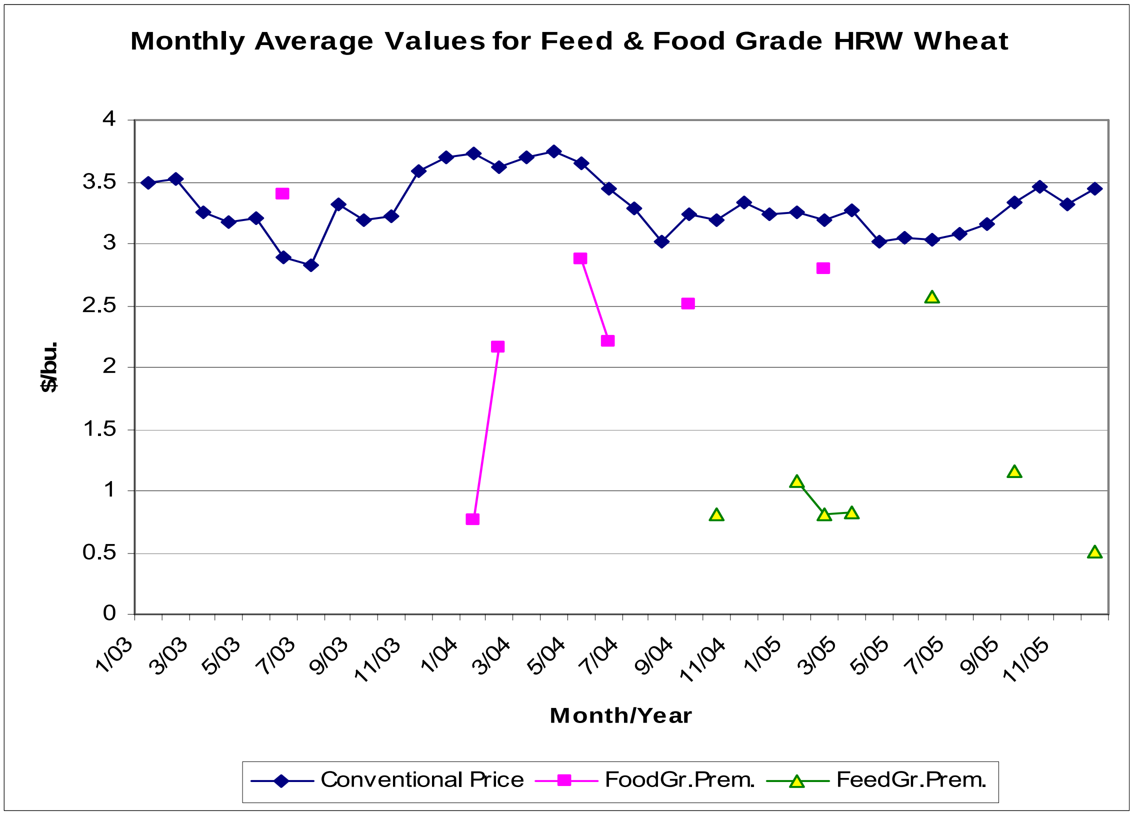


Figure 3.3.1D

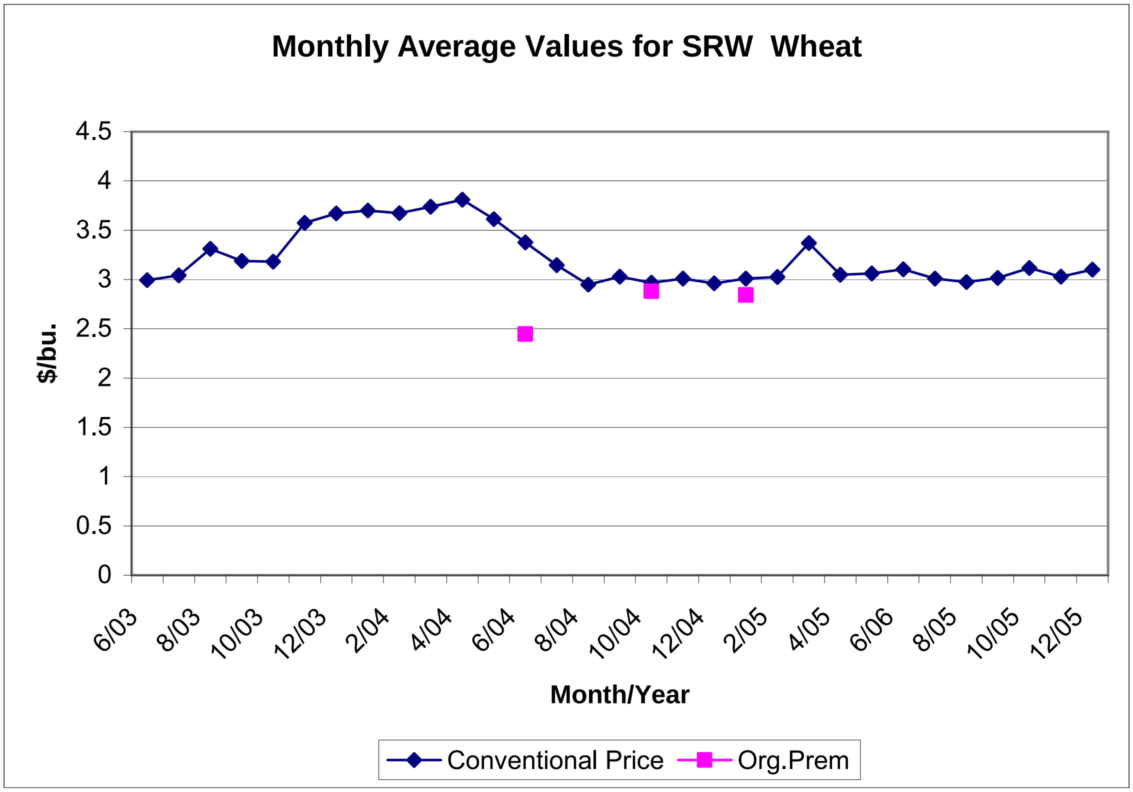
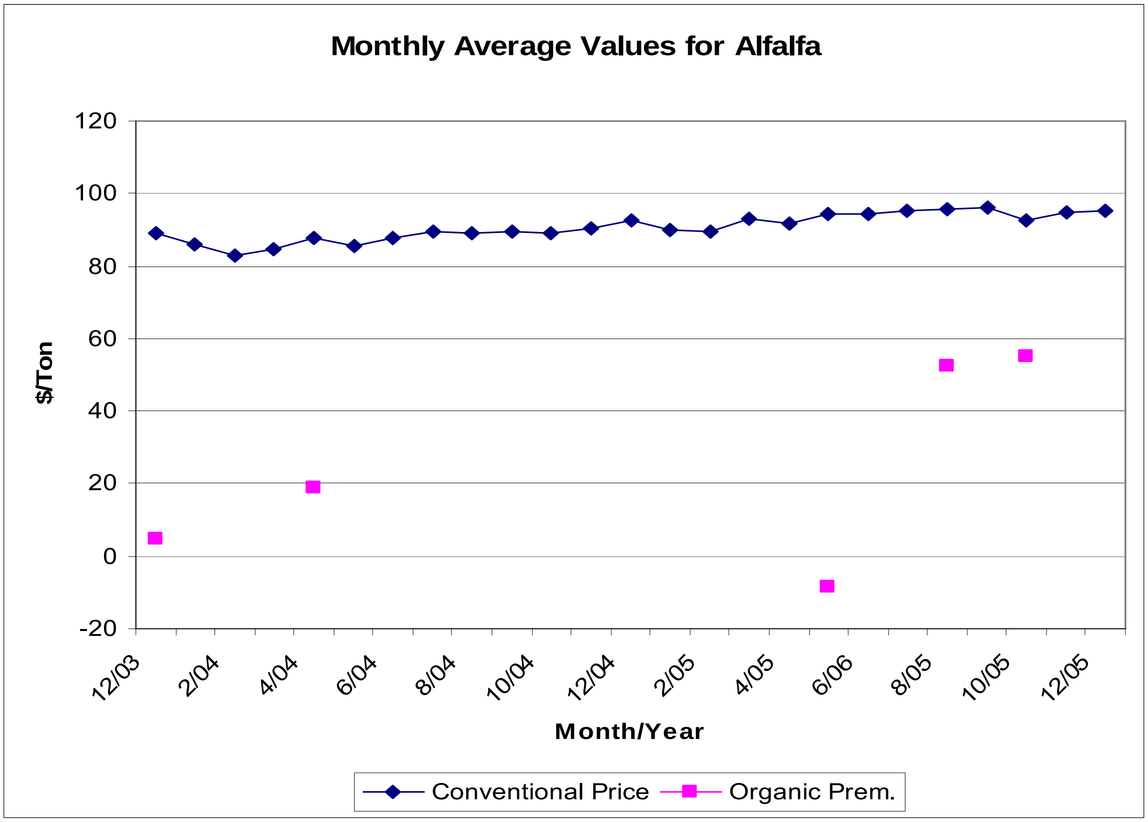


Figure 3.3.1E



3.3.2 TIME SERIES DATA

To ensure consistency with data from Organic Business News, the USDA data used for cointegration testing were first sorted by crop variety, retaining those matching closest to the crops in Table 3.2. USDA commodities used for the cointegration tests are presented in Table 3.3.2. Each of these crop varieties was then sorted by state, only retaining entries from the states of North Dakota, Montana, California, Colorado, Washington, Illinois, Minnesota, and Kansas to match the Organic Business News data as closely as possible.

The next step was to find the high and low weekly price of each selected commodity and then average them to get a single weekly price similar to that of the Organic Business News data. This was also done using the Pivot Table in Microsoft Excel. Before creating the Pivot Table, four new columns were first created. The first column contained the year each entry was reported in. The second column contained the week of the year for which the entry was given. The last two columns were exactly the same as the last two of the original data, containing daily high and low prices for each entry.

Table 3.3.2 Commodities Used from USDA Data

Barley (Feed) per bu.	Rye, no2 per lb.
Barley (Malting) per bu.	Soybean Meal 44% protein, per cwt.
Beans, Black per lb.	Soybean Meal 46.5% protein, per cwt.
Beans, Dk. Red Kidney per lb.	Soybean Meal 47% protein, per cwt.
Beans, Garbonzo per lb.	Soybean Oil per cwt.
Beans, Great Northern per lb.	Soybeans, no1 per bu.
Beans, Pinto per lb.	Soybeans, no2 per bu.
Canola per lb.	Sunflower Crude Oil per cwt.
Canola Meal per lb.	Sunflower Meal per cwt.
Corn, Yellow no.2 per bu.	Sunflower Seeds per lb.
Flaxseed per lb.	Sunflower Seeds, Sun per lb.
Lentils per lb.	Wheat, hard amber durum no1, per bu.
Millet per lb.	Wheat, hard amber durum no2, per bu.
Peas, split green per lb.	Wheat, hard red winter no1 (ordinary), per bu.
Peas, split yellow per lb.	Wheat, hard red winter no1 11%, per bu.
Peas, whole green per lb.	Wheat, hard red winter no1 12%, per bu.
Peas, whole yellow per lb.	Wheat, hard red winter no1 13%, per bu.
Rice, medium per lb.	Wheat, hard red winter no1 14%, per bu.
Rice, short per lb.	Wheat, soft red winter no2, per bu.
Rye, no1 per lb.	Wheat, soft white no1, per bu.

The data in these new columns were then imported into a Pivot Table in Excel, designating the “year” column as the column variable in the layout of the Pivot Table, the “yearly week” column as the row variable in the layout, and the high and low daily prices were designated as the data variables in Pivot Table’s layout, assigning the “min” function for the low daily prices and the “max” function for the high daily prices. The Pivot Table produced the minimum low weekly prices and the maximum high weekly prices, which were averaged to get the average weekly price of the eight states used for this analysis. After each crop variety had its weekly average price computed for the years 1997-2005, the crops were combined into one spreadsheet in the same layout as the data purchased from Organic Business News. These two spreadsheets were then combined to form one spreadsheet containing 131 series of weekly average price data of both conventional and organic commodities.

CHAPTER 4 MODELING AND PROCEDURE

4.1 HEDONIC PRICE ANALYSIS

The essence of hedonic prices arises from the idea that products have certain characteristics that vary for heterogeneous goods. Hedonic prices are those associated with the intrinsic values of heterogeneous goods, specifically, the individual prices associated with each individual characteristic. In a perfectly competitive market (agriculture is about as close as they come), the hedonic price of each characteristic should equal the input price associated with producing that characteristic. In other words, the marginal cost of producing each characteristic will equal the marginal benefit (price associated with the worth of the particular characteristic for a competitive market, i.e., hedonic price) of that characteristic. A hedonic model is used to distinguish individual characteristics of a product and assign unique intrinsic values (hedonic prices) to them.

Hedonic models were used for analyses in this paper to determine the implicit values of certain attributes of seven different organic commodities relative to the price premiums associated with these organic commodities. The commodities used in this study's analyses are feed grade soybeans, feed and food grade corn, feed and food grade hard red winter wheat, food grade soft red winter wheat, and alfalfa. The price premiums the organic producers received are measured as functions of buyer types, buyer's state location, the timing of contracting and shipment, the difference in quarters between the contract and shipping date, the producer's state location, total units sold, and whether or not KOP or the buyer arranged the shipment of the commodity.

For each commodity, the KOP data were examined to explore empirical specifications of the characteristic variables since buyers and their locations, producers and their locations, and contracting and shipping dates were different for each commodity. This exploration was done using OLS regression. The variables included in each commodity's hedonic model are summarized in Table 4.1A. Notice some characteristics are represented by groups of dummy variables, with the numbers of occurrences reported in the table to indicate how various characteristics were distributed in the samples. Also notice that state abbreviations for producer locations all end in "P," and that producer location of feed grade soybeans has variables representing KS, MO, and MO/KS. Soybeans from the MO/KS producers were sold to a soybean mill, but the individual identity of these producers was not documented. However, it is known that all soybeans that went to this mill came from either MO or KS producers. All three of these producer locations, KS, MO, and MO/KS were grouped together and considered one variable. Note that all dummy variables that are highlighted become the base group for each regression.

Statistical analysis of the eight different KOP commodities began with eliminating perfect multicollinearity amongst the explanatory variables by creating covariance matrices for each commodity. If two variables had a positive or negative covariance of one, one of these variables was temporarily, and in some cases permanently removed from any further analyses, depending on how highly correlated they were after being combined with other variables as discussed below. Perfectly correlated variables are presented in Table 4.1B.

Since some characteristic variables occurred relatively few times (for some only once), and because of a concern with securing adequate degrees of freedom (some of the commodities had as few as 21 observations), some of these characteristic dummy variables were combined. These groupings were based mainly on geographical location for the states, similarity of buyer types, and also on the numbers of observations. The final specifications of the base characteristics used for each model were determined after preliminary regression results indicated no near multicollinearity problems. Combined variables are identified in boxes in Table 4.1A.

Table 4.1A Emperical Specifications of the Different Models

Commodity:	Feed Grade Soybeans		Feed Grade Corn		Food Grade Corn		Food Grade Hard Red Winter Wheat	
Number of Observations:	109		213		21		125	
Characteristics:								
Buyer Type	FeedSupply	12	Broker	5	FlourMill	13	CerealMill	2
	FeedMill	4	BeefFeed	38	Processor	8	FeedMill	1
	PetFoodMill	7	Dairy	130			Mill	15
	Dairy	50	FeedMill	19			FlourMill	107
	SBMill	25	PetFoodMill	1				
	ChickenFarm	11	Processor	1				
			ChickenFarm	10				
			TurkeyFarm	9				
Buyer Location	WI	17	AR	4	MN	8	CO	2
	AR	9	TX	116	CA	13	SD	9
	TX	50	NM	9			TX	6
	KS	17	IL	2			AR	1
	CO	16	SD	1			NC	107
			KS	7				
			CO	51				
			CA	10				
			OR	11				
			NV	2				
Producer Location	KSP	48	NEP	5	KSP	21	TXP	14
	MOP	7	KSP	197			WYP	16
	MO/KSP	39	MOP	1			KSP	67
	MIP	2	COP	10			COP	2
	COP	10					UTP	22
							NEP	4
Contract Quarter	1st	66	1st	68	1st	12	1st	72
	2nd	11	2nd	33	2nd	1	2nd	51
	3rd	18	3rd	89	3rd	5	3rd	2
	4th	14	4th	23	4th	3		
Shipping Quarter	1st	34	1st	50	1st	6	1st	27
	2nd	37	2nd	64	2nd	6	2nd	46
	3rd	20	3rd	50	3rd	9	3rd	23
	4th	18	4th	49			4th	29
Contract Year	ContYearThree	1	ContYearThree	20			ContYearThree	41
	ContYearFour	52	ContYearFour	73	ContYearFour	6	ContYearFour	33
	ContYearFive	56	ContYearFive	120	ContYearFive	15	ContYearFive	51
Shipping Difference	ShipDif		ShipDif		ShipDif		ShipDif	
KOP Ship	KOPShip	25	KOPShip	139	KOPShip	0	KOPShip	119
	BuyerShip	84	BuyerShip	74	BuyerShip	21	BuyerShip	6
Total Units	TotalUnits		TotalUnits		TotalUnits		TotalUnits	

Highlighted dummy variables represent the base characteristics.
Variables with boxes around them were grouped to form one variable.

Table 4.1A Emperical Specifications of the Different Models (Continued)

Commodity:	Feed Grade Hard Red Winter Wheat		Food Grade Soft Red Winter Wheat		Alfalfa	
Number of Observations:	63		30		59	
Characteristics:						
Buyer Type	FeedMill	16	FlourMill	27	Dairy	59
	PetFoodMill	1	Broker	3		
	ChickenFarm	12				
	Dairy	34				
Buyer Location	NV	17	NC	26	NM	2
	WA	2	ONT	3	CO	2
	CO	12	WI	1	TX	55
	KS	10				
	TX	17				
	AR	5				
Producer Location	WYP	5	MOP	22	NEP	11
	SDP	1	KSP	8	KSP	48
	NEP	11				
	COP	1				
	UTP	22				
	MOP	3				
	KSP	20				
Contract Quarter	1st	52	1st	1		
	2nd	1	2nd	26	2nd	29
	3rd	7			3rd	1
	4th	3	4th	3	4th	29
Shipping Quarter	1st	14	1st	7	1st	3
	2nd	20	2nd	17	2nd	24
	3rd	14			3rd	15
	4th	15	4th	6	4th	17
Contract Year			ContYearThree	26	ContYearThree	28
	ContYearFour	2	ContYearFour	3	ContYearFour	25
	ContYearFive	61	ContYearFive	1	ContYearFive	6
Shipping Difference	ShipDif		ShipDif		ShipDif	
KOP Ship	KOPShip	19	KOPShip	30	KOPShip	57
	BuyerShip	44	BuyerShip	0	BuyerShip	2
Total Units	TotalUnits		TotalUnits		TotalUnits	

Highlighted dummy variables represent the base characteristics.
Variables with boxes around them were grouped to form one variable.

Table 4.1B Perfectly Correlated Variables by Commodity

Feed Grade Soybeans
  - TX: Dairy

Feed Grade Corn
  - CA: Chicken Farm
  - NM: Turkey Farm

Food Grade Corn
  - Flour Mill: Processor, MN, & CA
  - Processor: MN, & CA
  - MN: CA
  - Contract Year: Ship Year

Hard Red Winter Wheat
  - Cereal Mill: 3rd Contract Quarter
  - Feed Mill: AR
  - KOPShip: TX

Feed Grade Hard Red Winter Wheat
  - Pet Food Mill: 2nd Contract Quarter
  - Chicken Farm: CO
  - 4th Contract Quarter: Shipping Year

Soft Red Winter Wheat
  - NC: 2nd Contract Quarter, & NC
  - KSP: MOP
  - Contract Year 4: Shipping Quarter 4
  - Contract Year 5: Shipping Quarter 1

Alfalfa
  - NEP: KSP
  - KOPShip: CO

Note: State abbreviations ending in "P" indicate state locations of producers.

Texas and dairy had a perfect correlation with feed grade soybeans because there was only one dairy that purchased feed grade soybeans, and it was the only buyer located in Texas. For feed grade corn, California and chicken farm, and New Mexico and turkey farm were perfectly correlated for the same reasons.

Food grade corn, with the smallest sample size, had the highest number of perfectly correlated variables. Flour mill was perfectly correlated with processor because these were the only two types of buyers, and both flour mill and processor had only one buyer which fit each category. The flour mill was located in California and the processor in Minnesota. Also, all food corn contracted in 2004 was shipped in 2004, and all food corn contracted in 2005 was shipped in 2005.

For hard red winter wheat, there was one cereal mill, which was the only buyer to contract during a third quarter, and there was one feed mill, which was the only buyer located in Arkansas. Also, for each entry with a Texas buyer, shipping arrangements were made by the buyer, and they were the only buyers to do so. Feed grade hard red winter wheat had one pet food mill that contracted only in the second quarter, and one chicken farm that was also the only buyer located in Colorado. All fourth quarter contracts for feed grade hard red winter wheat were made in 2004. All soft red winter wheat sold to the single buyer in North Carolina was contracted during the second quarter of 2003, and all producers were from either Kansas or Missouri. There was one data entry for the contract year 2005 and the first contracting quarter, both of which were in that data entry. Likewise, there were only three entries for both the contract year 2004 and the fourth contracting quarter, which all corresponded to the same three entries. All producers of alfalfa were from either Nebraska or Kansas, and all of the buyers from Colorado shipped their own hay and were the only ones to do so.

After the final sets of variables for each commodity were determined, hedonic price models were estimated with the Ordinary Least Squares (OLS) regression method, using the "proc model" procedure in SAS. Tests were conducted for autocorrelation, heteroskedasticity, and normality in the error terms. Autocorrelation was tested for using the Durbin-Watson test, while heteroskedasticity was tested for with both the White and Breush-Pegan tests. Two limitations exist for the Durbin-Watson test: error terms are assumed to be normally distributed, and second, the Durbin-Watson test is only able to detect first order correlation (Gujarati, 2003). The null hypothesis of the Durbin-Watson test is no autocorrelation. There are also two limitations of the Breush-Pegan test: accurate results require the normality assumption to hold, and second, it is better suited for large sample sizes (Gujarati, 2003). The White test on the other hand ignores normality assumptions, but is influenced by model misspecification. The null hypothesis for both the Breush-Pegan and the White test is the presence of homoskedasticity. Normality was tested for using the Shapiro-Wilk, Mardia Skewness, Mardia Kurtosis, and Henze-Zirkler tests. The null hypothesis for these tests is normally distributed error terms.

Heteroskedasticity, autocorrelation, and normality test results for each OLS regression were examined. The null hypothesis of normally distributed residuals for all four tests could not be rejected at the 5% significance level for food grade corn and soft red winter wheat at. The null hypothesis of homoskedastic error terms could not be rejected at the 5% significance level for both tests for food grade corn and alfalfa. Feed grade corn had positive autocorrelation, while all other commodities' tests for autocorrelation were inconclusive at the 5% significance level. These results are presented in Table 4.1.1.

There are several possible avenues when attempting to correct for non-normality and heteroskedasticity. One avenue is removing outliers from the data set. However, due to the relatively small sample size of a few commodities, this option was not pursued. A second avenue is exploring various functional forms such as log-linear and log-log transformations of the data. Another possibility in correcting for error problems involves plotting residuals against independent variables to determine if weights can be used for a weighted least-squares regression. While this is one method of correcting for heteroskedasticity, no patterns were distinguishable, and weights were unable to be determined.

Two other options for correcting heteroskedasticity exist in SAS under the "proc reg" and "proc model" procedures. The first is using the asymptotic covariance matrix (acov) option in the "proc reg" procedure in SAS. OLS regression produces unbiased estimators but incorrect standard errors under the presence of heteroskedasticity. The asymptotic covariance matrix is used to produce reliable standard errors. However, the problem of non-normality would still remain. The other option is using the generalized method of moments (GMM) estimator. The problem with the GMM estimator however, is that it is suited for large sample sizes (Maddala, 2001).

Bootstrapping became the final option for producing more reliable parameter estimates. Bootstrapping is a re-sampling process whereby random samples are drawn from their observed distribution *T* number of times with replacement, to create a much larger data set. Though bootstrapping is not a cure-all solution, "until proven otherwise, some bootstrap may be better than no bootstrap" (Maddala, 2001). As suggested in Maddala, 2001 (p. 601), the data, as opposed to the residuals were bootstrapped due to heteroskedasticity.

4.1.1 EXPECTED FINDINGS FROM THE HEDONIC ANALYSIS

Because buyers and sellers were spread out across the U.S., the state locations of the producers were expected to contribute little to the differences among the premiums received. Though most of the buyers were located outside of Kansas, producers located in Kansas and neighboring states should be able to compete with producers located closer to the buyers since there should be more opportunities for combining the shipments of organic grain and thereby lowering the shipping costs. Similarly, buyers located closer to Kansas were expected to contribute the highest premium since they should incur lower shipping costs.

Late contracting quarters and years were expected to positively influence the premiums compared to early contracting quarters and years, since over the sample period, organic grain prices have risen faster than those of conventional grains. This would translate into an increasing premium over the given time, which should be reflected in the contracting dates. Late shipping quarters relative to harvest and shipping differences (contract length) were also expected to positively influence the premium compared to early ones, since shipments at later dates should be compensated for increased storage costs. Also, a longer contract period should command some risk premium for producers in organic agriculture, as buyers would likely prefer guaranteed availability farther into the future.

If KOP arranged the shipment instead of the buyer, a larger premium was expected since it may be worth something to the buyers to not have to do it themselves. It was expected that whatever this amount was, it would be passed on to the cooperative members. Finally, the organic premium was expected to increase as total units increased, as the buyer would likely be willing to pay more for a larger volume of guaranteed supply.

Table 4.1.1 Heteroskedasticity, Normality, and Autocorrelation Tests of OLS Residuals

Feed Grade Soybeans

	Statistic	p-value
White Test	88.53	0.0097
Breusch-Pagan Test	43.84	0.0016
Shapiro-Wilk	0.94	<.0001
Mardia Skewness	12.66	0.0004
Mardia Kurtosis	4.81	<.0001
Henze-Zirkler T	3.78	0.0002
		Critical Values
Durbin-Watson	1.6665	1.23-2.16

Feed Grade Hard Red Winter Wheat

	Statistic	p-value
White Test	63	0.025
Breusch-Pagan Test	32.6	0.0033
Shapiro-Wilk	0.97	0.212
Mardia Skewness	0.19	0.6647
Mardia Kurtosis	1.41	0.1581
Henze-Zirkler T	1.58	0.113
		Critical Values
Durbin-Watson	1.6485	1.10-2.16

Feed Grade Corn

	Statistic	p-value
White Test	201.2	<.0001
Breusch-Pagan Test	108.5	<.0001
Shapiro-Wilk	0.99	0.8869
Mardia Skewness	0.49	0.4836
Mardia Kurtosis	4.09	<.0001
Henze-Zirkler T	1.5	0.1344
		Critical Values
Durbin-Watson	1.261	1.55-1.99

Food Grade Soft Red Winter Wheat

	Statistic	p-value
White Test	24.49	0.1066
Breusch-Pagan Test	16.13	0.0239
Shapiro-Wilk	0.95	0.193
Mardia Skewness	2.01	0.1568
Mardia Kurtosis	0.76	0.4469
Henze-Zirkler T	1.12	0.2611
		Critical Values
Durbin-Watson	1.1675	0.85-2.14

Food Grade Corn

	Statistic	p-value
White Test	20.69	0.2955
Breusch-Pagan Test	11.25	0.259
Shapiro-Wilk	0.98	0.8611
Mardia Skewness	0.28	0.5967
Mardia Kurtosis	0.22	0.8228
Henze-Zirkler T	-1.2	0.232
		Critical Values
Durbin-Watson	1.7071	0.5-2.52

Alfalfa

	Statistic	p-value
White Test	26.75	0.5317
Breusch-Pagan Test	6.49	0.7728
Shapiro-Wilk	0.89	<.0001
Mardia Skewness	34.01	<.0001
Mardia Kurtosis	10.01	<.0001
Henze-Zirkler T	2.47	0.0134
		Critical Values
Durbin-Watson	1.8124	1.19-2.03

Food Grade Hard Red Winter Wheat

	Statistic	p-value
White Test	97.96	0.0002
Breusch-Pagan Test	22.86	0.154
Shapiro-Wilk	0.93	<.0001
Mardia Skewness	29.62	<.0001
Mardia Kurtosis	10.11	<.0001
Henze-Zirkler T	1.32	0.1873
		Critical Values
Durbin-Watson	2.107	1.35-2.04

4.2 TIME SERIES ANALYSIS

After forming the single spreadsheet containing 131 series of weekly average price data of both conventional and organic commodities, the first step in beginning to test for cointegration relationships was interpolating the entire data set to fill in missing values. Though most of the USDA data had few missing values, it too needed interpolating since each year was made to contain 53 weeks, and not every week had observations. This was done first using the Proc Expand command in SAS so that the following Dickey-Fuller test would be based on these interpolated price series.

Visual checks for both a time (linear) trend and a random drift were made for each series. The time trend was checked by graphing each series over time, while the random drift was checked visually by using the autocorrelogram created by the identify statement in SAS. No time trend was observed in any of the price series, which was expected since the data started in 1997, covering a relatively short time span. All but 15 series failed the visual test for a random drift.

The Dickey-Fuller test was subsequently performed on each series to confirm the visual stationarity test results. Each series was tested for stationarity in the levels and in the single-differenced series created with the “dif” option of the “%dftest” macro in SAS. Nineteen series were actually found to be stationary, and those that were not became stationary at the 5% significance level after differencing once. The 19 series that were stationary in the levels included both feed and malting barley, organic black turtle beans, organic garbanzo beans, organic dark red kidney beans, organic pinto beans, conventional yellow corn, organic millet, conventional whole green, whole yellow, and split yellow peas, organic rye, No.1 conventional soybeans, 44% and 46.5% protein content conventional soybean meal, organic sunflower seeds, conventional sunflower meal, organic hard red winter wheat, and conventional hard red winter wheat with 13% protein.

In Table 4.2A, a list of series taken from Table 3.2 and Table 3.3.2 are presented in a format which shows which series were matched for cointegration testing. The indented series in Table 4.2A are conventional commodities, while the non-indented series are organic, denoted with an “O” in front of their names. Notice some organic series have more than one conventional series listed below them. This means that each of these conventional series under the organic was tested for cointegration with that organic series, independently from the others listed with it. For example, two tests are used to test cointegration of barley, one test using organic barley and feed barley, and another separate test using organic barley and malting barley. Table 4.2A also presents p-values for stationarity tests, the null hypothesis being non-stationarity.

Table 4.2A List of Cointegration Test Partners

	Dicky-Fuller p-values		
	Before Differencing	After Differencing	Test Periods
O Barley, farm per bushel	0.4908	<.0001	
* Barley (Feed)	0.0040		1997.w1-2005.w49
* Barley (Malting)	0.0050		1997.w1-2005.w49
* O Beans, Black Turtle, farm per lb.	0.0100		
Beans, Black	0.1826	<.0001	1999.w3-2005.w49
* O Beans, Garbanzo, farm per lb.	0.0147		
Beans, Garbanzo	0.7479	<.0001	1997.w1-2005.w49
O Beans, Great Northern, farm per lb.	0.4483	<.0001	
Beans, Great Northern	0.1772	<.0001	1997.w1-2005.w49
* O Beans, Kidney, Dark Red, farm per lb.	0.0087		
Beans, Dark Red Kidney	0.0607	<.0001	1997.w1-2005.w49
* O Beans, Pinto, farm per lb.	0.0183		
Beans, Pinto	0.2250	<.0001	1997.w1-2005.w49
O Corn, Yellow, farm per bu	0.3312	<.0001	
* Corn, Yellow no.2	0.0229		1997.w1-2005.w49
O Flax,, farm per lb. (bushels / 56)	0.7611	<.0001	
Flaxseed	0.5744	<.0001	2003.w1-2005.w49
O Lentils, French, farm per lb.	0.6194	<.0001	
Lentils	0.2385	<.0001	1997.w49-2003.w52
O Lentils, Green, farm per lb.	0.7485	<.0001	
Lentils	0.2385	<.0001	1997.w49-2005.w49
* O Millet, farm per lb.	0.0037		
Millet	0.0923	<.0001	1997.w1-2005.w49
O Peas, Dry Green Split, farm per lb.	0.3692	<.0001	
* Peas, whole green	0.0453		1997.w14-2005.w49
Peas, split green	0.2437	<.0001	1997.w1-2005.w49
* Peas, whole yellow	0.0102		1997.w14-2005.w49
* Peas, split yellow	0.0353		1997.w16-2005.w49

* Denotes series which did not require differencing to become stationary.
Test periods are weeks of the given years.
Null hypothesis of Dickey-Fuller test is non-stationarity.

Table 4.2A (Continued) List of Cointegration Test Partners

	Dicky-Fuller p-values		
	Before Differencing	After Differencing	
O Rice, Brown, farm per lb.	0.7941	<.0001	
Rice, short	0.7704	<.0001	1997.w14-2005.w49
Rice, medium	0.6925	<.0001	1997.w14-2005.w49
* O Rye, farm per bushel	0.0080		
Rye, no1	0.2502	<.0001	1997.w40-2005.w49
Rye, no2	0.1521	<.0001	1997.w1-2005.w49
O Soybeans, Clear Hilum (cleaned), farm per bu	0.2601	<.0001	
* Soybeans, no1	0.0081		1997.w1-2005.w49
Soybeans, no2	0.2261	<.0001	1997.w1-2005.w49
Soybean Oil	0.4633	<.0001	1997.w1-2005.w49
* Soybean Meal 44%	0.0305		1997.w13-2005.w49
* Soybean Meal 46.5%	0.0376		1997.w13-2005.w49
Soybean Meal 47%	0.0580	<.0001	1997.w14-2005.w49
O Soybeans, Vinton (cleaned), farm per bushel	0.1654	<.0001	
* Soybeans, no1	0.0081		1997.w1-2005.w49
Soybeans, no2	0.2261	<.0001	1997.w1-2005.w49
Soybean Oil	0.4633	<.0001	1997.w1-2005.w49
* Soybean Meal 44%	0.0305		1997.w13-2005.w49
* Soybean Meal 46.5%	0.0376		1997.w13-2005.w49
Soybean Meal 47%	0.0580	<.0001	1997.w14-2005.w49
* O Sunflower seeds, farm per lb.	0.0002		
Sunflower Seeds	0.2323	<.0001	1997.w1-2005.w52
Sunflower Seeds, Sun	0.5596	<.0001	1999.w3-2005.w52
* Sunflower Meal	0.0031		1997.w1-2005.w52
O Wheat, durum, farm per bushel	0.3940	<.0001	
Wheat, hard amber durum no1	0.0882	<.0001	1997.w1-2005.w49
* O Wheat, hard red winter, farm per bushel	0.0321		
Wheat, hard red winter no1 (ordinary)	0.1199	<.0001	1997.w1-2005.w49
Wheat, hard red winter no1 11%	0.2318	<.0001	1997.w1-2005.w49
Wheat, hard red winter no1 12%	0.2760	<.0001	1997.w1-2005.w49
* Wheat, hard red winter no1 13%	0.0006		1997.w1-2005.w49
Wheat, hard red winter no1 14%	0.2009	<.0001	2000.w2-2005.w49
O Wheat, soft winter, farm per bushel	0.2245	<.0001	
Wheat, soft white no1	0.4592	<.0001	1997.w1-2005.w52
O Wheat, Soft Red, farm per bushel	0.9564	<.0001	
Wheat, soft red winter no2	0.2145	<.0001	1999.w31-2005.w49

* Denotes series which did not require differencing to become stationary.
Test periods are weeks of the given years.
Null hypothesis of Dickey-Fuller test is non-stationarity.

Before cointegration testing was performed, missing values at the end of each series were truncated so that both series being tested ended with an entry that contained a price average. This was done because SAS would not run if either the starting or ending point were not the same. For example, “O Barley” might start reporting prices in the forth week of 1998 while “Barley” might start reporting prices in the first week of 1997. Table 4.2A also reports the periods over which each test was conducted. For example, organic and feed barley were tested for cointegration over the time period of the 1st week of 1997 to the 49th week of 2005. Lastly, the appropriate lag lengths for each model were determined using both the Akaike Information Criterion (AIC) and Schwartz Bayesian Criterion (SBC) as discussed in section 2.4.4.

Series with different orders of integration can be tested for cointegration (Greene, 2002, p. 652). As such, series in their original levels were tested for cointegration first, which intuitively makes more sense when describing price movements and relationships than using differenced data. If the orders of integration of two series differed (Table 4.2A), it is possible to conclude that the pair is not cointegrated in the usual sense (Enders, p. 336). Nonetheless, if the series were found not to be cointegrated and the orders of integration differed (Table 4.2A), the I(1) series was differenced once to form an equation with two I(0) series, which was again tested for cointegration.

Cointegration tests were performed using lag lengths determined by both AIC and SBC and using both trace and max tests of the Johansen and Juselius cointegration test. Both tests are based on the number of cointegrating vectors, which equals the rank of the matrix of coefficients on the error correction term (Enders, p. 352). The trace tests test the null of being cointegrated at rank 0 against being cointegrated at a rank greater than 0, and also the null of being cointegrated at a rank 1 or less against being cointegrated at a rank greater than 1. The max tests test the null of being cointegrated at rank 0 against being cointegrated at rank 1, and also the null of being cointegrated at rank 1 against being cointegrated at rank 2 (SAS Help and Documentation). If the null of being cointegrated at rank 0 can not be rejected, the series are not cointegrated under both the trace and max tests. Also for both tests, if the null of being cointegrated at rank zero is rejected, but the null of being cointegrated at rank 1 is not, the two series are said to be cointegrated. If either the trace or max tests found two series to be cointegrated, they were assumed to be cointegrated. If both AIC and SBC lag lengths produced cointegrated series, the lag lengths with the most significant test results were used for the remaining exogeneity, causality, and speed of adjustment tests.

If series were found to be cointegrated, exogeneity tests were performed on them to determine if one series was affected by the current price of the opposite series. The exogeneity test basically tests the statistical significance of the speed of adjustment coefficient, with the null hypothesis that one series is weakly exogenous to the other series. Exogeneity tests were conducted using the exogeneity option of the “proc varmax” cointegration model in SAS.

As outlined in section 2.4.3, and following Schroeder (1997), if two series were found to be cointegrated, parameters from the cointegrating regression were used to calculate estimates of the residual errors, which were then plugged into error correction vector autoregressive models like Eqs. 2.4.3C and 2.4.3D (shown here again), to determine speed of price adjustment and causality.

Eq. 2.4.3C $$\Delta y1_t = \alpha_1 + \alpha_{1y} \hat{e}_{t-1} + \sum_{i=1}^{k} \alpha_{11}(i)\Delta y1_{t-1} + \sum_{i=1}^{k} \alpha_{12}(i)\Delta y2_{t-1} + \varepsilon_{1t};$$

Eq. 2.4.3D $$\Delta y2_t = \alpha_1 + \alpha_{2y} \hat{e}_{t-1} + \sum_{i=1}^{k} \alpha_{21}(i)\Delta y1_{t-1} + \sum_{i=1}^{k} \alpha_{22}(i)\Delta y2_{t-1} + \varepsilon_{2t}\ .$$

Wald, likelihood ratio, and Lagrange multiplier tests were used to test the null hypothesis that $y2$ does not Granger-Cause $y1$, i.e., $\alpha_{12}(i) = 0$ and $\alpha_{1y} = 0$, and vice versa. The α_{1y} and α_{2y} coefficients in Eqs.2.4.3C and 2.4.3D are speed of adjustment estimates that estimate how quickly the price of one commodity responds to the other commodity's deviation from long-run equilibrium.

If series were not found to be cointegrated, Granger-Causality was still tested for as described in Enders (p. 285). For non-cointegrated series that were either both I(0), or I(0) and I(1), the following equations were used:

Eq. 4.2B

$$y1_t = \sum_{i=1}^{k} \alpha_{11}(i) y1_{t-1} + \sum_{i=1}^{k} \alpha_{12}(i) y2_{t-1} + \varepsilon_{1t};$$

$$y2_t = \sum_{i=1}^{k} \alpha_{21}(i) y1_{t-1} + \sum_{i=1}^{k} \alpha_{22}(i) y2_{t-1} + \varepsilon_{2t}.$$

However, the statistical tests are only valid for coefficients on stationary series (Enders, p. 285). Thus, pairs that were both I(0) and I(1) could only be tested using the I(1) series as the dependent variable. Series that were both I(0) were tested both ways. For series that were both I(1), the following models in first differences were used (Enders, p. 358):

Eq. 4.2C

$$\Delta y1_t = \sum_{i=1}^{k} \alpha_{11}(i) \Delta y1_{t-1} + \sum_{i=1}^{k} \alpha_{12}(i) \Delta y2_{t-1} + \varepsilon_{1t};$$

$$\Delta y2_t = \sum_{i=1}^{k} \alpha_{21}(i) \Delta y1_{t-1} + \sum_{i=1}^{k} \alpha_{22}(i) \Delta y2_{t-1} + \varepsilon_{2t}.$$

For Equations 4.2B and 4.2C, the null hypothesis for $y2$ not Granger-Causing $y1$ is $\alpha_{12}(i) = 0$, and the null hypothesis for $y1$ not Granger-Causing $y2$ is $\alpha_{21}(i) = 0$.

4.2.1 EXPECTED FINDINGS FROM THE TIME SERIES ANALYSIS

It was expected that if any cointegration relationships existed between conventional and organic commodities, that it would be with the commodities for which a good deal of information is available for the conventional market (i.e., commodities for which futures contracts are offered at exchanges). For example, the conventional corn market has a great deal of public information, which could act as an anchor for the organic sector. Because the organic sector has such little available information, if the conventional sector also does not have much available information, neither market would be expected to act as an anchor for the other.

If cointegrated relationships were found to exist and they were also found to be causal, it was expected that the conventional commodity prices would lead those of the organic, again because typically more information is available for conventional commodities. Additionally, the speed at which the organic market adjusted to the initial shock in the conventional commodity's long run equilibrium was expected to be relatively slow, since information of organic commodities is expected to travel more slowly than that of most conventional commodities.

CHAPTER 5 RESULTS

5.1 HEDONIC PRICE ANALYSIS

Results from the hedonic analysis are presented in Table 5.1 at the end of this section.

Feed Grade Soybeans

Feed grade soybeans produced in Colorado, sold to a chicken farm in either Arkansas or Texas, that were contracted in the fourth quarter of year 2003 and shipped in a fourth quarter by the buyer, contracted for 2.81 months and in quantities of 1,498 bushels received a premium above conventional No.2 soybeans of $5.43/bu. Contracting in the first, second, and third quarters as opposed to the fourth resulted in premium decreases compared to the fourth quarter of $4.53/bu, $4.61/bu, and $2.58/bu respectively. This follows the pattern of conventional grain with smaller quantity and higher prices as time moves closer to harvest. Producers appear to be willing to sell during these quarters after harvest, at a price substantially below the average soybean premium of $6.11/bu. In fact, the premium deduction for contracting in the first quarter as opposed to the fourth is 75% of the average soybean premium, suggesting producers are willing to take a substantial reduction in premiums to ensure they get their grain contracted. This was the general finding for the other crops in this study as well.

Contracting in years 2004 and 2005 as opposed to 2003 resulted in premium increases of $3.05/bu and $4.92/bu respectively. This increase from year to year results from increasing organic prices, as the conventional prices over this time frame have remained rather stagnant. Finally, for every additional month of contract length, 9 cents/bu was added to the premium. This may be explained by the lack of information in the organic grain industry. Buyers of organic grain may be willing to pay a premium to have a guaranteed supply of grain farther into the future.

Characteristics that had no effect on organic soybean premiums were the types of buyers, the buyer and producer locations, the shipping quarters, who arranged the shipping, and the total bushels sold.

Feed Grade Corn

A producer from Kansas or Missouri that contracted feed grade corn in the fourth quarter of 2003, which was shipped by arrangement of the buyer in either the second or fourth quarters to a beef feeder or dairy in Kansas or Colorado, under contract for 4.79 months and in quantities of 2,685 bushels received a premium above the conventional No.2 yellow corn price of $1.20/bu. A broker was willing to pay a 71 cent/bu higher premium than a beef feeder or dairy, while a feed mill and pet food mill were willing to pay a 59 cent/bu higher premium. Producers located in either Arkansas, Texas, or New Mexico received a 37 cent/bu higher premium than those located in Kansas or Colorado, while producers located in California, Oregon, or Nevada received a 62 cent/bu higher premium.

These buyer location premiums may be explained by the dairies. Dairies compose a large portion of the buyers in Colorado and Texas, and of the organic corn in general. The base variable for the buyer state included Colorado, which of the significant buyer location variables, was willing to pay the least. The variable group which contained Texas was willing to contribute more to the premium than that of Colorado, though less than others. This may be thought of as the dairies in Colorado willing to contribute less to the premium than the dairies in Texas. Perhaps the dairies are exerting some small degree of market power since they compose a large portion of the purchases of organic No.2 yellow corn. Alternatively, the dairy farms may be reliable outlets for organic grain producers and enjoy discounts in exchange for long-term relationships.

Similar to soybeans, organic corn contracted in a later quarter received a higher premium, which was expected, since over the time span of this data, organic corn prices have climbed from about $3.75/bu at the end of 2003 to $6.25/bu at the end of 2005. Corn contracted in the first quarter as opposed to the fourth received a $1.08/bu premium discount and corn contracted in the second quarter as opposed to the fourth received a 96 cent/bu premium discount. Additionally, grain shipped in the fourth quarter received the largest premium, which corresponds with having the smallest supply right before harvest. Also, storage costs should add to the premium as the shipping dates approach harvest. As with soybeans, organic corn contracted in 2004 and 2005 received higher premiums than that contracted in 2003, of the magnitudes of $1.12/bu and $2.78/bu respectively. Finally, like the soybeans, longer contracts received a larger premium, adding about 10 cents/bu for each additional month of contract length.

Characteristic variables that had no effect on feed grade organic corn were processor and poultry buyers, the buyer locations of Illinois and South Dakota, producer locations of Nebraska and Colorado, the third contracting quarter, who arranged the shipping, and the total bushels sold.

Food Grade Corn

Food grade corn produced in Kansas, contracted to a processor in the fourth quarter of 2004, shipped in the third quarter with a contract length of 1.33 months and in quantities of 901 bushels received a premium above No.2 conventional yellow corn of $2.50/bu. Food grade corn sold to flour mills earned about a 43 cent/bu higher premium than that sold to processors. The contracting quarter variables tell the same story as organic soybeans and feed grade corn, with corn contracted in the first, second, and third quarters receiving respectively lower premiums of $1.67/bu, $1.58/bu, and $0.34/bu than that contracted in the fourth quarter.

The contracting year variables also tell the same story as feed grade organic corn, since food grade corn contracted in 2005 received a $1.64/bu higher premium than that contracted in 2004.

Characteristic variables that had no effect on the premium of food grade organic corn were the shipping quarters, the contract length, and the total bushels sold. Also, it should be noted that all shipments were arranged by the buyers.

Food Grade Hard Red Winter Wheat

Food grade hard red winter wheat produced in Nebraska, contracted to a flourmill in North Carolina in either the second or third quarters of 2003, shipped in a fourth quarter, that had shipping arranged by the buyer with a contract length of 1.33 months and in quantities of 901 bushels received a premium above that of conventional No.1 hard red winter wheat of $6.12/bu. The buyer in North Carolina was willing to contribute the most to the organic premium, while buyers in Texas and Arkansas contributed $2.46/bu less than the one in North Carolina. Producers in Wyoming and Colorado received the smallest premium for their wheat, with discounts of $1.23/bu and $1.19/bu respectively, compared to those in Nebraska who received the most. Producers in Texas, Kansas, and Utah also received lower premiums than the producers in Nebraska. Wheat contracted in the first quarter received a $1.42/bu smaller premium than that contracted in the second and third quarters. Wheat shipped in the first quarter received about 12 cents/bu less than that shipped in the fourth. Contracting wheat in later years resulted in a larger premium, much like the previous commodities, though for food grade hard red winter wheat, this premium was not as high at 76 cents/bu for contracting in 2005 as compared to 2003. There is a 3 cent/bu premium for each additional month of contract length. Additionally, if KOP arranged the shipment of the commodity, the premium was reduced by

$1.95/bu, which may partially be explained by the buyers being more efficient at organizing shipment to their location.

Characteristic variables that had no effect on premiums of food grade organic hard red winter wheat were the buyer types, the second and third shipping quarters, the 2004 contracting year, and the total bushels sold.

Feed Grade Hard Red Winter Wheat

Feed grade hard red winter wheat produced in Missouri or Kansas, contracted and shipped to a dairy in Texas or Arkansas in a fourth quarter with a contract length of 3.67 months and in quantities of 2,071 bushels received a premium above that of conventional No.1 hard red winter wheat of $0.72/bu. Buyers in Colorado and Kansas paid a 63 cent/bu higher premium than buyers in Texas and Arkansas, while producers in Colorado and Utah received a premium discount of 28 cents/bu compared to those in Missouri and Kansas. Feed grade hard red winter wheat is different from the rest of the commodities used in this analysis in that the second quarter contract dates received a $1.32/bu higher premium than those of the fourth contracting quarter. Finally, wheat shipped in the fourth quarter received a higher premium than wheat shipped in a different quarter.

Characteristic variables that had no effect on the premium of feed grade organic hard red winter wheat were the buyer types, the buyer locations of Nevada and Washington, the producer locations of Wyoming, South Dakota, and Nebraska, the first and third contracting quarters, the first and second shipping quarters, the contract length, and the total bushels sold.

Food Grade Soft Red Winter Wheat

Food grade soft red winter wheat produced in Kansas, contracted in 2003 or 2004 to a flour mill or broker in North Carolina, and shipped in a fourth quarter with a contract length of

8.57 months and in quantities of 1,173 bushels received a $2.55/bu premium above that of conventional No.2 soft red winter wheat. Buyers from Ontario and Wisconsin contributed $1.65/bu more to the premium than buyers from North Carolina, while Missouri producers earned a 3 cent/bu higher premium than producers from Kansas. Similar to the previous commodities, for each additional month of contract length, the premium increased 4 cents/bu.

Characteristic variables that had no effect on the premium for food grade organic soft red winter wheat were the contracting and shipping dates, and total bushels sold.

Alfalfa

Organic alfalfa hay produced in Kansas and contracted to a dairy in Texas during the third or fourth quarters of 2003 and 2004, which was shipped in a fourth quarter, and had shipping arranged by the buyer with a contract length of 10.07 months and in quantities of 22.58 tons received a premium above conventional alfalfa hay of $87.34/ton. The "KOPShip" variable, while significant, may be misleading, because only two of the original 59 entries for organic alfalfa hay were shipped by KOP. Nonetheless, the variable's estimate tells us that if KOP arranged the shipping, the hay received a premium reduction of $82.30/ton.

Characteristic variables that had no effect on the premium of organic alfalfa were the producer and buyer locations, contracting and shipping dates, the contract length, and the total number of tons sold.

Table 5.1 Bootstrap Results

Feed Grade Soybeans

	Bootstrap Mean	90% Lower	90% Upper
Intercept	5.1611	2.3879	7.7257
FeedSupply	-1.6302	-3.3043	0.5722
FeedMill	0.0775	-2.1626	3.3585
PetFoodMill	0.1386	-2.1099	2.0658
Dairy	1.3648	-1.7941	4.7394
SBMill	-0.4720	-2.5927	1.7664
WI	-0.3451	-1.5683	0.8740
KS_CO	-0.4701	-1.6025	0.9630
MOKSP	0.2421	-0.0440	0.4067
MIP	0.2333	-0.0968	0.4257
ContQone	-4.5267	-5.0886	-3.7022
ContQtwo	-4.6090	-5.4807	-4.0899
ContQthree	-2.5761	-3.9898	-1.0211
ShipQone	-0.2050	-0.8542	0.6102
ShipQtwo	-0.4206	-0.8562	0.1434
ShipQthree	-0.2106	-0.6876	0.2327
ContYearFour	3.0456	2.2493	3.8524
ContYearFive	4.9185	2.9030	6.2043
ShipDif	0.0901	0.0214	0.1979
KOPship	0.8778	-1.1484	2.5783
TotalUnits	0.0099	-0.0391	0.0466

TotalUnits is measured in 000's of bushels.
Bootstrap confidence intervals are 90%.
All highlighted estimates are significant at the 90% level.

Feed Grade Corn

	Bootstrap Mean	90% Lower	90% Upper
Intercept	0.7790	0.4445	1.1273
Broker	0.7079	0.3693	1.0454
FeedMill_PetFoodMill	0.5851	0.1436	0.8551
Processor	1.0862	-0.5454	1.1279
Poultry	0.1571	-0.2315	0.3995
AR_TX_NM	0.3743	0.2920	0.5074
IL_SD	-0.0515	-0.8729	0.7498
CA_OR_NV	0.6189	0.3565	0.7311
NEP	-0.4184	-0.6031	0.0143
COP	-0.1185	-0.3957	0.1213
ContQone	-1.0767	-2.0886	-0.6536
ContQtwo	-0.9641	-1.9020	-0.4501
ContQthree	-0.2922	-1.7616	0.3390
ShipQone	-0.4032	-0.5203	-0.2755
ShipQtwo	-0.3442	-0.4520	-0.2292
ShipQthree	-0.4088	-0.5146	-0.2571
ContYearFour	1.1206	0.5615	1.8795
ContYearFive	2.7830	2.2206	4.1560
ShipDif	0.0975	0.0754	0.1082
KOPship	-0.0135	-0.2914	0.2551
TotalUnits	-0.0153	-0.0261	0.0004

TotalUnits is measured in 000's of bushels.
Bootstrap confidence intervals are 90%.
All highlighted estimates are significant at the 90% level.

Table 5.1 (Continued) Bootstrap Results

Food Grade Corn

	Bootstrap Mean	90% Lower	90% Upper
Intercept	4.1602	1.9924	6.3292
FlourMill	0.4335	0.3213	0.5518
ContQone	-1.6694	-1.9512	-1.4014
ContQtwo	-1.5830	-1.7585	-1.3578
ContQthree	-0.3380	-0.5000	-0.2047
ShipQone	0.0953	-0.1680	0.3472
ShipQtwo	0.0978	-0.1045	0.2119
ContYearFive	1.6378	1.4845	1.8163
ShipDif	0.0498	-0.0108	0.1060
TotalUnits	-1.9187	-4.2709	0.4983

TotalUnits is measured in 000's of bushels.
Bootstrap confidence intervals are 90%.
All highlighted estimates are significant at the 90% level.

Food Grade Hard Red Winter Wheat

	Bootstrap Mean	90% Lower	90% Upper
Intercept	5.8796	5.6317	6.0671
CerealMill_FeedMill_Mill	-0.1395	-0.3488	0.0922
CO_SD	-0.9412	-1.1435	-0.7239
TX_AR	-2.4593	-2.6551	-2.2627
TXP	-0.3853	-0.5039	-0.2727
WYP	-1.2284	-1.3661	-1.0947
KSP	-0.7320	-0.9072	-0.5659
COP	-1.1947	-1.3811	-0.9644
UTP	-0.3412	-0.4943	-0.1795
ContQone	-1.4187	-1.7484	-1.1572
ShipQone	-0.1234	-0.2053	-0.0125
ShipQtwo	-0.0910	-0.1766	0.0137
ShipQthree	-0.0798	-0.1864	0.0342
ContYearFour	0.0339	-0.1472	0.2397
ContYearFive	0.7580	0.4740	1.1302
ShipDif	0.0293	0.0165	0.0460
KOPship	-1.9469	-2.0989	-1.8127
TotalUnits	0.0203	-0.0092	0.0719

TotalUnits is measured in 000's of bushels.
Bootstrap confidence intervals are 90%.
All highlighted estimates are significant at the 90% level.

Table 5.1 (Continued) Bootstrap Results

Feed Grade Hard Red Winter Wheat

	Bootstrap Mean	90% Lower	90% Upper
Intercept	0.7049	0.4485	1.1673
FeedMill_PetFoodMill	0.0724	-0.4011	0.2742
ChickenFarm	-0.2264	-0.8093	0.1681
NV_WA	0.2234	-0.0589	0.6395
CO_KS	0.6257	0.2632	0.9659
WYP_SDP_NEP	-0.0098	-0.4432	0.3773
COP_UTP	-0.2795	-0.7977	-0.1502
ContQone	0.2508	-0.1292	0.7079
ContQtwo	1.3160	0.8199	1.6525
ContQthree	0.1328	-0.2349	0.4942
ShipQone	-0.1161	-0.3514	0.0635
ShipQtwo	-0.0368	-0.1924	0.0805
ShipQthree	-0.1055	-0.2201	-0.0012
ShipDif	0.0109	-0.0114	0.0307
TotalUnits	-0.0124	-0.0314	0.0015

TotalUnits is measured in 000's of bushels.
Bootstrap confidence intervals are 90%.
All highlighted estimates are significant at the 90% level.

Food Grade Soft Red Winter Wheat

	Bootstrap Mean	90% Lower	90% Upper
Intercept	2.2099	1.8640	2.6727
ONT_WI	1.6506	0.7516	2.8483
MOP	0.0297	0.0036	0.0609
ShipQone	0.0533	-0.0459	0.1316
ShipQtwo	0.0232	-0.1758	0.1447
ContYearFive	-0.0486	-0.1466	0.0718
ShipDif	0.0443	0.0226	0.0764
TotalUnits	-0.3023	-0.7763	0.0506

TotalUnits is measured in 000's of bushels.
Bootstrap confidence intervals are 90%.
All highlighted estimates are significant at the 90% level.

Alfalfa

	Bootstrap Mean	90% Lower	90% Upper
Intercept	55.6041	17.2344	127.6940
NM_CO	-2.9902	-19.4263	8.0280
NEP	-0.9921	-7.6415	5.6640
ContQtwo	10.6851	-8.8607	30.0260
ShipQone	-2.9148	-25.7146	19.4850
ShipQtwo	3.4025	-10.2110	19.2120
ShipQthree	-0.9464	-9.4311	10.1210
ContYearFive	-21.2435	-49.1496	9.9600
ShipDif	0.3237	-2.1428	3.0010
KOPship	-82.3040	-98.2914	-64.3820
TotalUnits	1.2611	-1.9253	2.1380

TotalUnits is measured in tons.
Bootstrap confidence intervals are 90%.
All highlighted estimates are significant at the 90% level.

5.2 TIME SERIES ANALYSIS

Of the 86 different cointegration tests performed using both AIC and SBC lag lengths, 10 pairs of commodities were cointegrated using AIC lags and price levels, and 21 were cointegrated using SBC lags and price levels (see Table 5.2A). Results that found the pairs to be non-cointegrated can be found in Appendix B. Of those pairs not cointegrated in price levels that had differing degrees of integration, 6 were cointegrated using AIC lags and 5 were cointegrated using SBC lags after differencing the I(1) series once (Table 5.2B). In Table 5.2B, cointegrated series from these tests are represented with asterisks. After accounting for pairs of commodities that were cointegrated using both AIC and SBC lags, a total of 29 out of 43 pairs of organic and conventional commodities were found to be cointegrated.

Table 5.2A Cointegrated Commodities Using AIC (Series in Levels)

	Test Type	H0: Rank=r	H1: Rank>r	No. of Lags	Eigenvalue	Statistic	5% Critical Value
O Flax	Trace Test:	0	0	20	0.12	19.98	19.99
Flaxseed		1	1		0.02	2.26	9.13
	Max Test:	0	1		0.12	17.72	15.67
		1	2		0.02	2.26	9.24
O Peas, Dry Split Green	Trace Test:	0	0	2	0.0316	21.0496	19.99
Peas, Split Yellow		1	1		0.0139	6.3953	9.13
	Max Test:	0	1		0.0316	14.6543	15.67
		1	2		0.0139	6.3953	9.24
O Soybeans, Clear Hilum	Trace Test:	0	0	5	0.0452	26.5234	19.99
Soybeans, No.1		1	1		0.0105	4.9239	9.13
	Max Test:	0	1		0.0452	21.5994	15.67
		1	2		0.0105	4.9239	9.24
O Soybeans, Clear Hilum	Trace Test:	0	0	3	0.03	21.45	19.99
Soybeans, No.2		1	1		0.01	6.55	9.13
	Max Test:	0	1		0.03	14.90	15.67
		1	2		0.01	6.55	9.24
O Soybeans, Vinton	Trace Test:	0	0	8	0.0418	28.3471	19.99
Soybean Meal 44%		1	1		0.0196	8.9648	9.13
	Max Test:	0	1		0.0418	19.3824	15.67
		1	2		0.0196	8.9648	9.24
O Soybeans, Vinton	Trace Test:	0	0	10	0.05	31.6226	19.99
Soybean Meal 46.5%		1	1		0.0187	8.494	9.13
	Max Test:	0	1		0.05	23.1286	15.67
		1	2		0.0187	8.494	9.24
O Hard Red Winter Wheat	Trace Test:	0	0	2	0.0534	32.013	19.99
Hard Red Winter Wheat, No.1, Ordinary		1	1		0.0131	6.2072	9.13
	Max Test:	0	1		0.0534	25.8058	15.67
		1	2		0.0131	6.2072	9.24
O Hard Red Winter Wheat	Trace Test:	0	0	9	0.0295	20.0424	19.99
Hard Red Winter Wheat, No.1, 11%		1	1		0.0133	6.2018	9.13
	Max Test:	0	1		0.0295	13.8406	15.67
		1	2		0.0133	6.2018	9.24
O Hard Red Winter Wheat	Trace Test:	0	0	9	0.0292	20.8771	19.99
Hard Red Winter Wheat, No.1, 12%		1	1		0.0153	7.1356	9.13
	Max Test:	0	1		0.0292	13.7415	15.67
		1	2		0.0153	7.1356	9.24
O Hard Red Winter Wheat	Trace Test:	0	0	2	0.0592	21.4612	19.99
Hard Red Winter Wheat, No.1, 14%		1	1		0.0077	2.4145	9.13
	Max Test:	0	1		0.0592	19.0467	15.67
		1	2		0.0077	2.4145	9.24

Table 5.2A Cointegrated Commodities Using SBC (Series in Levels)

	Test Type	H0: Rank=r	H1: Rank>r	No. of Lags	Eigenvalue	Statistic	5% Critical Value
O Barley	Trace Test:	0	0	4	0.0408	22.2943	19.99
Barley (Feed)		1	1		0.006	2.8195	9.13
	Max Test:	0	1		0.0408	19.4748	15.67
		1	2		0.006	2.8195	9.24
O Barley	Trace Test:	0	0	3	0.0352	20.2914	19.99
Barley (Malting)		1	1		0.0074	3.4917	9.13
	Max Test:	0	1		0.0352	16.7997	15.67
		1	2		0.0074	3.4917	9.24
O Beans, Great Northern	Trace Test:	0	0	2	0.03	20.07	19.99
Beans, Great Northern		1	1		0.01	3.89	9.13
	Max Test:	0	1		0.03	16.18	15.67
		1	2		0.01	3.89	9.24
O Beans, Dark Red Kidney	Trace Test:	0	0	2	0.031	20.225	19.99
Beans, Dark Red Kidney		1	1		0.0115	5.4405	9.13
	Max Test:	0	1		0.031	14.7845	15.67
		1	2		0.0115	5.4405	9.24
O Beans, Pinto	Trace Test:	0	0	2	0.0355	20.835	19.99
Beans, Pinto		1	1		0.0082	3.8603	9.13
	Max Test:	0	1		0.0355	16.9748	15.67
		1	2		0.0082	3.8603	9.24
O Corn, Yellow	Trace Test:	0	0	2	0.0625	34.0693	19.99
Corn, Yellow		1	1		0.008	3.7518	9.13
	Max Test:	0	1		0.0625	30.3176	15.67
		1	2		0.008	3.7518	9.24
O Peas, Dry Split Green	Trace Test:	0	0	1	0.0328	20.7804	19.99
Peas, Whole Green		1	1		0.0118	5.4527	9.13
	Max Test:	0	1		0.0328	15.3276	15.67
		1	2		0.0118	5.4527	9.24
O Peas, Dry Split Green	Trace Test:	0	0	2	0.0361	21.9353	19.99
Peas, Whole Yellow		1	1		0.011	5.06	9.13
	Max Test:	0	1		0.0361	16.8753	15.67
		1	2		0.011	5.06	9.24
O Peas, Dry Split Green	Trace Test:	0	0	1	0.0329	20.801	19.99
Peas, Split Yellow		1	1		0.0119	5.4654	9.13
	Max Test:	0	1		0.0329	15.3356	15.67
		1	2		0.0119	5.4654	9.24
O Soybeans, Clear Hilum	Trace Test:	0	0	3	0.0656	36.8958	19.99
Soybeans, No.1		1	1		0.0108	5.0958	9.13
	Max Test:	0	1		0.0656	31.8	15.67
		1	2		0.0108	5.0958	9.24

Table 5.2A (Continued) Cointegrated Commodities Using SBC (Series in Levels)

	Test Type	H0: Rank=r	H1: Rank>r	No. of Lags	Eigenvalue	Statistic	5% Critical Value
O Soybeans, Clear Hilum	Trace Test:	0	0	1	0.05	27.70	19.99
Soybeans, No.2		1	1		0.01	5.86	9.13
	Max Test:	0	1		0.05	21.84	15.67
		1	2		0.01	5.86	9.24
O Soybeans, Clear Hilum	Trace Test:	0	0	2	0.03	19.40	19.99
Soybean Oil		1	1		0.01	2.91	9.13
	Max Test:	0	1		0.03	16.50	15.67
		1	2		0.01	2.91	9.24
O Soybeans, Vinton	Trace Test:	0	0	3	0.0467	27.5001	19.99
Soybeans, No.1		1	1		0.0108	5.0756	9.13
	Max Test:	0	1		0.0467	22.4244	15.67
		1	2		0.0108	5.0756	9.24
O Soybeans, Vinton	Trace Test:	0	0	1	0.0322	22.7424	19.99
Soybean Meal 44%		1	1		0.0165	7.6541	9.13
	Max Test:	0	1		0.0322	15.0884	15.67
		1	2		0.0165	7.6541	9.24
O Soybeans, Vinton	Trace Test:	0	0	1	0.0288	22.1002	19.99
Soybean Meal 46.5%		1	1		0.0187	8.6781	9.13
	Max Test:	0	1		0.0288	13.422	15.67
		1	2		0.0187	8.6781	9.24
O Soybeans, Vinton	Trace Test:	0	0	1	0.03	21.20	19.99
Soybean Meal 47%		1	1		0.02	8.01	9.13
	Max Test:	0	1		0.03	13.20	15.67
		1	2		0.02	8.01	9.24
O Hard Red Winter Wheat	Trace Test:	0	0	1	0.0757	43.8041	19.99
Hard Red Winter Wheat, No.1, Ordinary		1	1		0.0142	6.7504	9.13
	Max Test:	0	1		0.0757	37.0537	15.67
		1	2		0.0142	6.7504	9.24
O Hard Red Winter Wheat	Trace Test:	0	0	1	0.0588	32.7716	19.99
Hard Red Winter Wheat, No.1, 11%		1	1		0.0089	4.2137	9.13
	Max Test:	0	1		0.0588	28.5579	15.67
		1	2		0.0089	4.2137	9.24
O Hard Red Winter Wheat	Trace Test:	0	0	3	0.0534	30.4686	19.99
Hard Red Winter Wheat, No.1, 12%		1	1		0.01	4.7144	9.13
	Max Test:	0	1		0.0534	25.7542	15.67
		1	2		0.01	4.7144	9.24
O Hard Red Winter Wheat	Trace Test:	0	0	2	0.08	46.25	19.99
Hard Red Winter Wheat, No.1, 13%		1	1		0.02	8.69	9.13
	Max Test:	0	1		0.08	37.56	15.67
		1	2		0.02	8.69	9.24
O Hard Red Winter Wheat	Trace Test:	0	0	1	0.0804	29.5672	19.99
Hard Red Winter Wheat, No.1, 14%		1	1		0.0106	3.3307	9.13
	Max Test:	0	1		0.0804	26.2365	15.67
		1	2		0.0106	3.3307	9.24

Table 5.2B Cointegration Results of Differenced Series Using AIC

	Test Type	H0: Rank=r	H1: Rank>r	No. of Lags	Eigenvalue	Statistic	5% Critical Value
O Beans, Black Turtle	Trace Test:	0	0	16	0.11	49.16	19.99
Beans Black		1	1		0.03	9.21	9.13
	Max Test:	0	1		0.11	39.95	15.67
		1	2		0.03	9.21	9.24
O Beans, Garbanzo	Trace Test:	0	0	18	0.06	37.46	19.99
Beans, Garbanzo		1	1		0.02	9.28	9.13
	Max Test:	0	1		0.06	28.18	15.67
		1	2		0.02	9.28	9.24
* O Millet	Trace Test:	0	0	7	0.09	52.10	19.99
Millet		1	1		0.02	8.07	9.13
	Max Test:	0	1		0.09	44.03	15.67
		1	2		0.02	8.07	9.24
* O Rye	Trace Test:	0	0	3	0.22	107.08	19.99
Rye, No.1		1	1		0.01	2.24	9.13
	Max Test:	0	1		0.22	104.85	15.67
		1	2		0.01	2.24	9.24
* O Rye	Trace Test:	0	0	11	0.08	39.95	19.99
Rye, No. 2		1	1		0.00	1.73	9.13
	Max Test:	0	1		0.08	38.21	15.67
		1	2		0.00	1.73	9.24
O Soybeans, Clear Hilum	Trace Test:	0	0	3	0.34	201.64	19.99
Soybean Meal 44%		1	1		0.02	10.28	9.13
	Max Test:	0	1		0.34	191.36	15.67
		1	2		0.02	10.28	9.24
* O Soybeans, Clear Hilum	Trace Test:	0	0	8	0.15	83.85	19.99
Soybean Meal 46.5%		1	1		0.02	8.15	9.13
	Max Test:	0	1		0.15	75.69	15.67
		1	2		0.02	8.15	9.24
* O Sunflower Seeds	Trace Test:	0	0	19	0.12	45.72	19.99
Sunflower Seeds		1	1		0.01	3.08	9.13
	Max Test:	0	1		0.12	42.64	15.67
		1	2		0.01	3.08	9.24
* O Sunflower Seeds	Trace Test:	0	0	2	0.26	49.53	19.99
Sunflower Seeds, Sun		1	1		0.04	5.48	9.13
	Max Test:	0	1		0.26	44.05	15.67
		1	2		0.04	5.48	9.24

* Represents cointegrated series.

Table 5.2B Cointegration Results of Differenced Series Using SBC

	Test Type	H0: Rank=r	H1: Rank>r	No. of Lags	Eigenvalue	Statistic	5% Critical Value
* O Beans, Black Turtle	Trace Test:	0	0	5	0.13	54.77	19.99
Beans Black		1	1		0.02	5.63	9.13
	Max Test:	0	1		0.13	49.13	15.67
		1	2		0.02	5.63	9.24
O Beans, Garbanzo	Trace Test:	0	0	18	0.06	37.46	19.99
Beans, Garbanzo		1	1		0.02	9.28	9.13
	Max Test:	0	1		0.06	28.18	15.67
		1	2		0.02	9.28	9.24
O Millet	Trace Test:	0	0	2	0.26	153.97	19.99
Millet		1	1		0.03	13.62	9.13
	Max Test:	0	1		0.26	140.35	15.67
		1	2		0.03	13.62	9.24
* O Rye	Trace Test:	0	0	2	0.27	138.67	19.99
Rye, No.1		1	1		0.01	2.23	9.13
	Max Test:	0	1		0.27	136.45	15.67
		1	2		0.01	2.23	9.24
* O Rye	Trace Test:	0	0	11	0.08	39.95	19.99
Rye, No. 2		1	1		0.00	1.73	9.13
	Max Test:	0	1		0.08	38.21	15.67
		1	2		0.00	1.73	9.24
O Soybeans, Clear Hilum	Trace Test:	0	0	1	0.52	352.85	19.99
Soybean Meal 44%		1	1		0.02	11.09	9.13
	Max Test:	0	1		0.52	341.76	15.67
		1	2		0.02	11.09	9.24
O Soybeans, Clear Hilum	Trace Test:	0	0	1	0.52	350.86	19.99
Soybean Meal 46.5%		1	1		0.02	9.61	9.13
	Max Test:	0	1		0.52	341.26	15.67
		1	2		0.02	9.61	9.24
* O Sunflower Seeds	Trace Test:	0	0	19	0.12	45.72	19.99
Sunflower Seeds		1	1		0.01	3.08	9.13
	Max Test:	0	1		0.12	42.64	15.67
		1	2		0.01	3.08	9.24
* O Sunflower Seeds	Trace Test:	0	0	2	0.26	49.53	19.99
Sunflower Seeds, Sun		1	1		0.04	5.48	9.13
	Max Test:	0	1		0.26	44.05	15.67
		1	2		0.04	5.48	9.24

* Represents cointegrated series.

Exogeneity tests were then performed on all cointegrated series. Of the 29 pair-wise tests, all but 8 pairs of cointegrated commodities had a series that was found to be weakly exogenous to its counterpart at the 5% significance level. Seven pairs had an exogenous conventional commodity, and 15 pairs had an exogenous organic commodity (see Table 5.2C). Prices for organic Vinton soybeans and for conventional soybean meal with 47% protein were weakly exogenous to each other. The eight pairs of commodities exhibiting no exogenous relationships are organic black turtle beans and black beans, organic and conventional pinto beans, organic clear Hilum soybeans and No.1 and No.2 soybeans, organic Vinton soybeans and No.1 soybeans, organic hard red winter wheat and ordinary, 13%, and 14% protein content hard red winter wheat. For these pairs, the organic and conventional sectors share the information reflected in current prices. Pairs with one weakly exogenous commodity, such as organic barley and feed grade barley, can be interpreted as follows: organic barley is weakly exogenous to feed grade barley since the null hypothesis that organic barley prices are weakly exogenous to conventional feed grade barley prices could not be rejected. This means that the price of organic barley is not affected by the current price information of conventional feed grade barley, and an econometric model for conventional feed grade barley prices can be estimated independently from a model of organic barley prices (Enders, p. 334).

Table 5.2C Exogeneity Results

	DF	Chi-Square	Pr > Chi-Square
O Barley	1	2.18	0.1403
Barley (Feed)	1	13.98	0.0002
O Barley	1	0.29	0.5933
Barley (Malting)	1	12.78	0.0004
O Beans, Black Turtle	1	6.99	0.0082
Beans Black	1	35.73	<.0001
O Beans, Great Northern	1	2.36	0.1245
Beans, Great Northern	1	9.36	0.0022
O Beans, Dark Red Kidney	1	6.51	0.0108
Beans, Dark Red Kidney	1	1.49	0.2226
O Beans, Pinto	1	6.7	0.0096
Beans, Pinto	1	7.16	0.0074
O Corn, Yellow	1	2.51	0.1133
Corn, Yellow	1	23.28	<.0001
O Flax	1	13.84	0.0002
Flaxseed	1	1.16	0.2805
O Millet	1	0.01	0.9271
Millet	1	36.18	<.0001
O Peas, Dry Split Green	1	0.11	0.7411
Peas, Whole Green	1	7.86	0.005
O Peas, Dry Split Green	1	0.01	0.9322
Peas, Whole Yellow	1	10.97	0.0009
O Peas, Dry Split Green	1	0.17	0.6821
Peas, Split Yellow	1	6.96	0.0083
O Rye	1	0	0.9947
Rye, No.1	1	134.24	<.0001
O Rye	1	0.24	0.6236
Rye, No. 2	1	36.22	<.0001
O Soybeans, Clear Hilum	1	14.3	0.0002
Soybeans, No.1	1	12.99	0.0003
O Soybeans, Clear Hilum	1	13.36	0.0003
Soybeans, No.2	1	3.87	0.0492

For each pair of commodities, the null hypothesis is that one commodity is weakly exogenous for the other.

Table 5.2C (Continued) Exogeneity Results

	DF	Chi-Square	Pr > Chi-Square
O Soybeans, Clear Hilum	1	13.6	0.0002
Soybean Oil	1	0.13	0.7171
O Soybeans, Clear Hilum	1	62.81	<.0001
Soybean Meal 46.5%	1	1.79	0.181
O Soybeans, Vinton	1	5.43	0.0198
Soybeans, No.1	1	12.14	0.0005
O Soybeans, Vinton	1	2.5	0.1139
Soybean Meal 44%	1	7.11	0.0077
O Soybeans, Vinton	1	3.31	0.069
Soybean Meal 46.5%	1	10.61	0.0011
O Soybeans, Vinton	1	3.3	0.0692
Soybean Meal 47%	1	1.84	0.1748
O Sunflower Seeds	1	0.48	0.4897
Sunflower Seeds	1	39.23	<.0001
O Sunflower Seeds	1	0.19	0.6628
Sunflower Seeds, Sun	1	36.47	<.0001
O Hard Red Winter Wheat	1	21.26	<.0001
Hard Red Winter Wheat, No.1, Ordinary	1	9.52	0.002
O Hard Red Winter Wheat	1	24.34	<.0001
Hard Red Winter Wheat, No.1, 11%	1	0	0.9754
O Hard Red Winter Wheat	1	18.23	<.0001
Hard Red Winter Wheat, No.1, 12%	1	2.18	0.1396
O Hard Red Winter Wheat	1	7.47	0.0063
Hard Red Winter Wheat, No.1, 13%	1	22.61	<.0001
O Hard Red Winter Wheat	1	11.8	0.0006
Hard Red Winter Wheat, No.1, 14%	1	10.72	0.0011

For each pair of commodities, the null hypothesis is that one commodity is weakly exogenous for the other.

Parameters of the cointegrated equation (Eq. 2.4.3B), presented in Table 5.2D, were used to compute the residuals used in Eq. 2.4.3C and Eq. 2.4.3D. Additionally, the remaining estimates from the error correction models are presented in Appendix C. Tables 5.2E and 5.2F present the speed of adjustment coefficient (α_{1y}, and α_{2y}) estimates and the Granger-Causality results (i.e., $\alpha_{12}(i) = 0, \alpha_{1y} = 0$,) derived from Eq. 2.4.3C and Eq. 2.4.3D. Note that for Table 5.2E and Table 5.2F, the first commodity listed in each tested series is the dependent variable.

Table 5.2D Cointegration Parameters

	Vectors	Constant
O Barley	1.039	5.485
Barley (Feed)	-2.590	
O Barley	-0.081	6.565
Barley (Malting)	-1.467	
O Beans, Black Turtle	10.584	-4.199
Beans Black	211.132	
O Beans, Great Northern	-9.125	-10.658
Beans, Great Northern	71.047	
O Beans, Dark Red Kidney	16.600	-11.135
Beans, Dark Red Kidney	10.135	
O Beans, Pinto	22.431	-9.105
Beans, Pinto	2.486	
O Corn, Yellow	0.762	5.067
Corn, Yellow	-2.207	
O Flax	-0.668	23.702
Flaxseed	-0.650	
O Millet	-0.436	0.084
Millet	472.053	
O Peas, Dry Split Green	12.530	-4.846
Peas, Whole Green	31.725	
O Peas, Dry Split Green	8.238	-6.025
Peas, Whole Yellow	55.107	
O Peas, Dry Split Green	15.307	-6.634
Peas, Split Yellow	31.517	
O Rye	-0.014	0.070
Rye, No.1	11.785	
O Rye	-0.305	1.308
Rye, No. 2	25.918	
O Soybeans, Clear Hilum	-0.293	-0.512
Soybeans, No.1	0.849	
O Soybeans, Clear Hilum	-0.441	3.443
Soybeans, No.2	0.561	

Denoting the parameters in the “Vectors” column as a_1 and a_2 and the constants as a_0, the errors from the cointegration equation Eq. 2.4.3A were computed as $a_1 y1_t - a_0 - a_2 y2_t$.

Table 5.2D (Continued) Cointegration Parameters

	Vectors	Constant's
O Soybeans, Clear Hilum	-0.507	3.313
Soybean Oil	0.199	
O Soybeans, Clear Hilum	6.014	1.895
Soybean Meal 46.5%	-0.011	
O Soybeans, Vinton	-0.274	0.232
Soybeans, No.1	0.823	
O Soybeans, Vinton	-0.018	4.511
Soybean Meal 44%	-0.025	
O Soybeans, Vinton	-0.011	4.517
Soybean Meal 46.5%	-0.025	
O Soybeans, Vinton	0.243	0.419
Soybean Meal 47%	-0.023	
O Sunflower Seeds	6.655	-1.466
Sunflower Seeds	759.224	
O Sunflower Seeds	-11.620	2.437
Sunflower Seeds, Sun	672.953	
O Hard Red Winter Wheat	-2.184	4.064
Hard Red Winter Wheat, No.1, Ordinary	2.454	
O Hard Red Winter Wheat	-2.225	5.797
Hard Red Winter Wheat, No.1, 11%	1.834	
O Hard Red Winter Wheat	-2.405	4.095
Hard Red Winter Wheat, No.1, 12%	2.562	
O Hard Red Winter Wheat	0.869	2.329
Hard Red Winter Wheat, No.1, 13%	-1.429	
O Hard Red Winter Wheat	3.016	-0.373
Hard Red Winter Wheat, No.1, 14%	-1.990	

Denoting the parameters in the “Vectors” column as a_1 and a_2 and the constants as a_0, the errors from the cointegration equation Eq. 2.4.3A were computed as $a_1 y1_t - a_0 - a_2 y2_t$.

Table 5.2E Speed of Adjustment Coefficients

Commodity	# of Lags	Estimate	Std. Error	t-value	Pr > t
O Barley - Barley (Feed)	4	-0.0062	0.0039	-1.6	0.1111
Barley (Feed) - O Barley	4	0.0498	0.0151	3.29	0.0011
O Barley - Barley (Malting)	3	-0.0029	0.0039	-0.73	0.4634
Barley (Malting) - O Barley	3	0.0545	0.0139	3.92	0.0001
O Beans, Black Turtle - Beans, Black	5	-0.0015	0.0007	-2.32	0.0207
Beans, Black - O Beans, Black Turtle	5	-0.0036	0.0006	-5.97	<.0001
O Beans, Great Northern - Beans, Great Northern	2	0.0011	0.0006	1.79	0.0744
Beans, Great Northern - O Beans, Great Northern	2	-0.0009	0.0003	-2.84	0.0047
O Beans, Dark Red Kidney - Beans, Dark Red Kidney	2	-0.0021	0.0006	-3.28	0.0011
Beans, Dark Red Kidney - O Beans, Dark Red Kidney	2	-0.0009	0.0006	-1.48	0.1403
O Beans, Pinto - Beans, Pinto	2	-0.0017	0.0006	-3	0.0029
Beans, Pinto - O Beans, Pinto	2	-0.0007	0.0003	-2.48	0.0137
O Corn, Yellow - Corn, Yellow	2	-0.0128	0.0067	-1.9	0.0581
Corn, Yellow - O Corn, Yellow	2	0.0739	0.0174	4.24	<.0001
O Flax - Flaxseed	20	0.2401	0.0704	3.41	0.0010
Flaxseed - O Flax	20	-0.0200	0.0379	-0.53	0.5985
O Millet - Millet	7	-0.0008	0.0018	-0.43	0.6701
Millet - O Millet	7	-0.0012	0.0002	-6.56	<.0001
O Peas, Dry Split Green - Peas, Whole Green	1	-0.0002	0.0003	-0.54	0.5912
Peas, Whole Green - O Peas, Dry Split Green	1	-0.0006	0.0002	-3.86	0.0001
O Peas, Dry Split Green - Peas, Whole Yellow	2	0.0000	0.0003	0.03	0.9762
Peas, Whole Yellow - O Peas, Dry Split Green	2	-0.0010	0.0002	-4.04	<.0001
O Peas, Dry Split Green - Peas, Split Yellow	2	-0.0002	0.0003	-0.64	0.5210
Peas, Split Yellow - O Peas, Dry Split Green	2	-0.0007	0.0002	-3.63	0.0003
O Rye - Rye, No.1	2	0.0000	0.0016	0.01	0.9938
Rye, No.1 - O Rye	2	-0.0640	0.0059	-10.82	<.0001
O Rye - Rye, No.2	11	-0.0007	0.0014	-0.48	0.6318
Rye, No.2 - O Rye	11	-0.0288	0.0049	-5.95	<.0001
O Soybeans, Clear Hilum - Soybeans, No.1	3	0.1223	0.0301	4.06	<.0001
Soybeans, No.1 - O Soybeans, Clear Hilum	3	-0.1494	0.0454	-3.29	0.0011
O Soybeans, Clear Hilum - Soybeans, No.2	1	0.0331	0.0310	1.07	0.2854
Soybeans, No.2 - O Soybeans, Clear Hilum	1	-0.0196	0.0088	-2.23	0.0263
O Soybeans, Clear Hilum - Soybean Oil	2	0.0968	0.0297	3.26	0.0012
Soybean Oil - O Soybeans, Clear Hilum	2	0.0078	0.0277	0.28	0.7796

Table 5.2E (Continued) Speed of Adjustment Coefficients

Commodity	# of Lags	Estimate	Std. Error	t-value	Pr > t
O Soybeans, Clear Hilum - Soybean Meal 46.5%	8	-0.2555	0.0323	-7.9	<.0001
Soybean Meal 46.5% - O Soybeans, Clear Hilum	8	0.5525	0.5026	1.1	0.2723
O Soybeans, Vinton - Soybeans, No.1	3	0.0538	0.0201	2.68	0.0077
Soybeans, No.1 - O Soybeans, Vinton	3	-0.1530	0.0449	-3.4	0.0007
O Soybeans, Vinton - Soybean Meal 44%	8	-0.0382	0.0206	-1.85	0.0645
Soybean Meal 44% - O Soybeans, Vinton	8	2.0727	0.5538	3.74	0.0002
O Soybeans, Vinton - Soybean Meal 46.5%	10	-0.0442	0.0207	-2.14	0.0330
Soybean Meal 46.5% - O Soybeans, Vinton	10	1.7701	0.4691	3.77	0.0002
O Soybeans, Vinton - Soybean Meal 47%	1	-0.0568	0.0203	-2.8	0.0053
Soybean Meal 47% - O Soybeans, Vinton	1	1.2102	0.5088	2.38	0.0178
O Hard Red Winter Wheat - Hard Red Winter Wheat, No.1, Ordinary	19	0.0386	0.0084	4.62	<.0001
Hard Red Winter Wheat, No.1, Ordinary - O Hard Red Winter Wheat	19	-0.0144	0.0069	-2.08	0.0379
O Hard Red Winter Wheat - Hard Red Winter Wheat, No.1, 11%	2	0.0413	0.0083	5	<.0001
Hard Red Winter Wheat, No.1, 11% - O Hard Red Winter Wheat	2	-0.0012	0.0049	-0.25	0.8062
O Hard Red Winter Wheat - Hard Red Winter Wheat, No.1, 12%	1	0.0406	0.0083	4.87	<.0001
Hard Red Winter Wheat, No.1, 12% - O Hard Red Winter Wheat	1	-0.0083	0.0054	-1.54	0.1252
O Hard Red Winter Wheat - Hard Red Winter Wheat, No.1, 13%	1	-0.0241	0.0085	-2.83	0.0049
Hard Red Winter Wheat, No.1, 13% - O Hard Red Winter Wheat	1	0.1194	0.0247	4.84	<.0001
O Hard Red Winter Wheat - Hard Red Winter Wheat, No.1, 14%	3	-0.0233	0.0079	-2.93	0.0036
Hard Red Winter Wheat, No.1, 14% - O Hard Red Winter Wheat	3	0.0351	0.0112	3.14	0.0018
O Sunflower Seeds - Sunflower Seeds	2	-0.0001	0.0001	-0.64	0.5220
Sunflower Seeds - O Sunflower Seeds	2	-0.0016	0.0003	-5.9	<.0001
O Sunflower Seeds - Sunflower Seeds, Sun	1	0.0001	0.0003	0.36	0.7193
Sunflower Seeds, Sun - O Sunflower Seeds	1	-0.0009	0.0002	-5.41	<.0001

Table 5.2F Granger-Causality Tests Under the Assumption of Cointegration

O Barley - Barley (Feed)

Test	Statistic	Pr > Chi-Sq.
Wald	0.19	0.6666
L.R.	0.19	0.6666
L.M.	0.19	0.6633

Barley (Feed) - O Barley

Test	Statistic	Pr > Chi-Sq.
Wald	0.30	0.5833
L.R.	0.30	0.5833
L.M.	0.31	0.5793

O Barley - Barley (Malting)

Test	Statistic	Pr > Chi-Sq.
Wald	1.70	0.1918
L.R.	1.70	0.1918
L.M.	1.73	0.1888

Barley (Malting) - O Barley

Test	Statistic	Pr > Chi-Sq.
Wald	33.64	<.0001
L.R.	33.64	<.0001
L.M.	31.89	<.0001

O Beans, Black Turtle - Beans, Black

Test	Statistic	Pr > Chi-Sq.
Wald	0.44	0.5055
L.R.	0.44	0.5055
L.M.	0.46	0.4985

Beans, Black - O Beans, Black Turtle

Test	Statistic	Pr > Chi-Sq.
Wald	0.10	0.7550
L.R.	0.10	0.7550
L.M.	0.10	0.7509

O Soybeans, Clear Hilum - Soybeans, No.1

Test	Statistic	Pr > Chi-Sq.
Wald	2.02	0.1549
L.R.	2.02	0.1549
L.M.	2.05	0.1522

Soybeans, No.1 - O Soybeans, Clear Hilum

Test	Statistic	Pr > Chi-Sq.
Wald	1.21	0.2708
L.R.	1.21	0.2708
L.M.	1.23	0.2674

O Soybeans, Clear Hilum - Soybeans, No.2

Test	Statistic	Pr > Chi-Sq.
Wald	0.85	0.3577
L.R.	0.85	0.3577
L.M.	0.85	0.3561

Soybeans, No.2 - O Soybeans, Clear Hilum

Test	Statistic	Pr > Chi-Sq.
Wald	4.45	0.0348
L.R.	4.45	0.0348
L.M.	4.45	0.0349

O Soybeans, Clear Hilum - Soybean Oil

Test	Statistic	Pr > Chi-Sq.
Wald	11.89	0.0006
L.R.	11.89	0.0006
L.M.	11.74	0.0006

Soybean Oil - O Soybeans, Clear Hilum

Test	Statistic	Pr > Chi-Sq.
Wald	0.52	0.4703
L.R.	0.52	0.4703
L.M.	0.53	0.4677

The first commodity listed is the dependent variable.

The null hypothesis is that the independent variable's present and past price information has no effect on the current price of th dependent variable.

Table 5.2F (Continued) Granger-Causality Tests Under the Assumption of Cointegration

O Beans, Great Northern -
Beans, Great Northern

Test	Statistic	Pr > Chi-Sq.
Wald	0.39	0.5338
L.R.	0.39	0.5338
L.M.	0.39	0.5313

Beans, Great Northern -
O Beans, Great Northern

Test	Statistic	Pr > Chi-Sq.
Wald	0.62	0.4316
L.R.	0.62	0.4316
L.M.	0.63	0.4289

O Beans, Dark Red Kidney -
Beans, Dark Red Kidney

Test	Statistic	Pr > Chi-Sq.
Wald	0.30	0.5857
L.R.	0.30	0.5857
L.M.	0.30	0.5834

Beans, Dark Red Kidney -
O Beans, Dark Red Kidney

Test	Statistic	Pr > Chi-Sq.
Wald	0.00	0.9470
L.R.	0.00	0.9470
L.M.	0.00	0.9467

O Beans, Pinto - Beans, Pinto

Test	Statistic	Pr > Chi-Sq.
Wald	0.00	0.9438
L.R.	0.00	0.9438
L.M.	0.01	0.9434

Beans, Pinto - O Beans, Pinto

Test	Statistic	Pr > Chi-Sq.
Wald	0.05	0.8188
L.R.	0.05	0.8188
L.M.	0.05	0.8176

O Soybeans, Clear Hilum -
Soybean Meal 46.5%

Test	Statistic	Pr > Chi-Sq.
Wald	61.21	<.0001
L.R.	61.21	<.0001
L.M.	55.87	<.0001

Soybean Meal 46.5% -
O Soybeans, Clear Hilum

Test	Statistic	Pr > Chi-Sq.
Wald	1.40	0.2371
L.R.	1.40	0.2371
L.M.	1.45	0.2284

O Soybeans, Vinton -
Soybeans, No.1

Test	Statistic	Pr > Chi-Sq.
Wald	0.41	0.5205
L.R.	0.41	0.5205
L.M.	0.42	0.5170

Soybeans, No.1 -
O Soybeans, Vinton

Test	Statistic	Pr > Chi-Sq.
Wald	0.13	0.7193
L.R.	0.13	0.7193
L.M.	0.13	0.7170

O Soybeans, Vinton -
Soybean Meal 44%

Test	Statistic	Pr > Chi-Sq.
Wald	2.59	0.1073
L.R.	2.59	0.1073
L.M.	2.68	0.1013

Soybean Meal 44% -
O Soybeans, Vinton

Test	Statistic	Pr > Chi-Sq.
Wald	7.43	0.0064
L.R.	7.43	0.0064
L.M.	7.60	0.0058

The first commodity listed is the dependent variable.

The null hypothesis is that the independent variable's present and past price information has no effect on the current price of th dependent variable.

Table 5.2F (Continued) Granger-Causality Tests Under the Assumption of Cointegration

O Corn, Yellow - Corn, Yellow

Test	Statistic	Pr > Chi-Sq.
Wald	4.44	0.0352
L.R.	4.44	0.0352
L.M.	4.45	0.0349

Corn, Yellow - O Corn, Yellow

Test	Statistic	Pr > Chi-Sq.
Wald	1.42	0.2342
L.R.	1.42	0.2342
L.M.	1.43	0.2319

O Flax - Flaxseed

Test	Statistic	Pr > Chi-Sq.
Wald	8.39	0.0038
L.R.	8.39	0.0038
L.M.	11.17	0.0008

Flaxseed - O Flax

Test	Statistic	Pr > Chi-Sq.
Wald	0.20	0.6526
L.R.	0.20	0.6526
L.M.	0.29	0.5880

O Millet - Millet

Test	Statistic	Pr > Chi-Sq.
Wald	1.19	0.2760
L.R.	1.19	0.2760
L.M.	1.23	0.2682

Millet - O Millet

Test	Statistic	Pr > Chi-Sq.
Wald	0.15	0.6971
L.R.	0.15	0.6971
L.M.	0.16	0.6921

O Soybeans, Vinton - Soybean Meal 46.5%

Test	Statistic	Pr > Chi-Sq.
Wald	2.46	0.1165
L.R.	2.46	0.1165
L.M.	2.57	0.1086

Soybean Meal 46.5% - O Soybeans, Vinton

Test	Statistic	Pr > Chi-Sq.
Wald	7.29	0.0069
L.R.	7.29	0.0069
L.M.	7.54	0.0060

O Soybeans, Vinton - Soybean Meal 47%

Test	Statistic	Pr > Chi-Sq.
Wald	7.16	0.0075
L.R.	7.16	0.0075
L.M.	7.11	0.0077

Soybean Meal 47% - O Soybeans, Vinton

Test	Statistic	Pr > Chi-Sq.
Wald	0.35	0.5539
L.R.	0.35	0.5539
L.M.	0.35	0.5523

O Hard Red Winter Wheat - Hard Red Winter Wheat, No.1, Ordinary

Test	Statistic	Pr > Chi-Sq.
Wald	2.48	0.1150
L.R.	2.48	0.1150
L.M.	2.49	0.1144

Hard Red Winter Wheat, No.1, Ordinary - O Hard Red Winter Wheat

Test	Statistic	Pr > Chi-Sq.
Wald	0.92	0.3387
L.R.	0.92	0.3387
L.M.	0.92	0.3371

The first commodity listed is the dependent variable.

The null hypothesis is that the independent variable's present and past price information has no effect on the current price of th dependent variable.

Table 5.2F (Continued) Granger-Causality Tests Under the Assumption of Cointegration

O Peas, Dry Split Green -
Peas, Whole Green

Test	Statistic	Pr > Chi-Sq.
Wald	0.06	0.7993
L.R.	0.06	0.7993
L.M.	0.07	0.7985

Peas, Whole Green -
O Peas, Dry Split Green

Test	Statistic	Pr > Chi-Sq.
Wald	0.53	0.4678
L.R.	0.53	0.4678
L.M.	0.53	0.4661

O Peas, Dry Split Green -
Peas, Whole Yellow

Test	Statistic	Pr > Chi-Sq.
Wald	0.00	0.9944
L.R.	0.00	0.9944
L.M.	0.00	0.9944

Peas, Whole Yellow -
O Peas, Dry Split Green

Test	Statistic	Pr > Chi-Sq.
Wald	0.62	0.4308
L.R.	0.62	0.4308
L.M.	0.63	0.4281

O Peas, Dry Split Green -
Peas, Split Yellow

Test	Statistic	Pr > Chi-Sq.
Wald	1.15	0.2840
L.R.	1.15	0.2840
L.M.	1.16	0.2814

Peas, Split Yellow -
O Peas, Dry Split Green

Test	Statistic	Pr > Chi-Sq.
Wald	0.14	0.7096
L.R.	0.14	0.7096
L.M.	0.14	0.7078

O Hard Red Winter Wheat -
Hard Red Winter Wheat, No.1, 11%

Test	Statistic	Pr > Chi-Sq.
Wald	1.34	0.2466
L.R.	1.34	0.2466
L.M.	1.35	0.2452

Hard Red Winter Wheat, No.1, 11% -
O Hard Red Winter Wheat

Test	Statistic	Pr > Chi-Sq.
Wald	2.80	0.0944
L.R.	2.80	0.0944
L.M.	2.81	0.0940

O Hard Red Winter Wheat -
Hard Red Winter Wheat, No.1, 12%

Test	Statistic	Pr > Chi-Sq.
Wald	0.05	0.8240
L.R.	0.05	0.8240
L.M.	0.05	0.8225

Hard Red Winter Wheat, No.1, 12% -
O Hard Red Winter Wheat

Test	Statistic	Pr > Chi-Sq.
Wald	0.02	0.8805
L.R.	0.02	0.8805
L.M.	0.02	0.8794

O Hard Red Winter Wheat -
Hard Red Winter Wheat, No.1, 13%

Test	Statistic	Pr > Chi-Sq.
Wald	1.02	0.3115
L.R.	1.02	0.3115
L.M.	1.04	0.3089

Hard Red Winter Wheat, No.1, 13% -
O Hard Red Winter Wheat

Test	Statistic	Pr > Chi-Sq.
Wald	0.48	0.4862
L.R.	0.48	0.4862
L.M.	0.49	0.4836

The first commodity listed is the dependent variable.

The null hypothesis is that the independent variable's present and past price information has no effect on the current price of th dependent variable.

Table 5.2F (Continued) Granger-Causality Tests Under the Assumption of Cointegration

O Rye - Rye, No.1

Test	Statistic	Pr > Chi-Sq.
Wald	0.00	0.9956
L.R.	0.00	0.9956
L.M.	0.00	0.9956

Rye, No.1 - O Rye

Test	Statistic	Pr > Chi-Sq.
Wald	8.40	0.0038
L.R.	8.40	0.0038
L.M.	8.35	0.0039

O Rye - Rye, No.2

Test	Statistic	Pr > Chi-Sq.
Wald	0.05	0.8276
L.R.	0.05	0.8276
L.M.	0.05	0.8230

Rye, No.2 - O Rye

Test	Statistic	Pr > Chi-Sq.
Wald	0.93	0.3352
L.R.	0.93	0.3352
L.M.	0.98	0.3227

O Hard Red Winter Wheat - Hard Red Winter Wheat, No.1, 14%

Test	Statistic	Pr > Chi-Sq.
Wald	1.25	0.2643
L.R.	1.25	0.2643
L.M.	1.26	0.2622

Hard Red Winter Wheat, No.1, 14% - O Hard Red Winter Wheat

Test	Statistic	Pr > Chi-Sq.
Wald	0.00	0.9639
L.R.	0.00	0.9639
L.M.	0.00	0.9637

O Sunflower Seeds - Sunflower Seeds

Test	Statistic	Pr > Chi-Sq.
Wald	0.07	0.7890
L.R.	0.07	0.7890
L.M.	0.08	0.7760

Sunflower Seeds - O Sunflower Seeds

Test	Statistic	Pr > Chi-Sq.
Wald	4.44	0.0350
L.R.	4.44	0.0350
L.M.	4.95	0.0261

O Sunflower Seeds - Sunflower Seeds, Sun

Test	Statistic	Pr > Chi-Sq.
Wald	0.33	0.5660
L.R.	0.33	0.5660
L.M.	0.34	0.5583

Sunflower Seeds, Sun - O Sunflower Seeds

Test	Statistic	Pr > Chi-Sq.
Wald	3.74	0.0530
L.R.	3.74	0.0530
L.M.	3.80	0.0512

The first commodity listed is the dependent variable.

The null hypothesis is that the independent variable's present and past price information has no effect on the current price of th dependent variable.

After examining the exogeneity tests, causality tests, and speed of adjustment parameters, it is interesting to compare their results of these tests together. For example, the Granger-Causality test in Table 5.2F for "Barley (Malting) – O Barley" tells us that current and past price information of organic barley has an impact on the current price of malting barley. The exogeneity test for these commodities follow the causality test, and tells us that current price information of organic barley has an effect on the current price of malting barley. However, when we then look at the other Granger-Causality results for these commodities, "O Barley – Barley (Malting)," we find that we fail to reject the null hypothesis of current and past prices of malting barley having no effect on current prices of organic barley. Summing these three tests, we conclude that current and past price information of organic barley appears to lead prices of malting barley. The speed of adjustment estimate for "Barley (Malting) – O Barley" is significant at 0.0545, which suggests that about 5% of malting barley's price reaction to a divergence in the long-run equilibrium of organic barley's prices occurs within one week.

Visual summaries for the Granger-Causality and exogeneity tests, as well as the speed of adjustment parameters for each pair of cointegrated commodities are presented in Figure 5.2A. The commodities are presented using their abbreviations presented in Appendix A. The speed of adjustment coefficients involving soybean meal prices have been adjusted from Table 5.2E, because the prices for organic Vinton and Hilum soybeans were measured in \$/bu, while the soybean meals prices were measured in \$/ton. All of the cointegration regressions used the organic series as the dependent variable. Therefore, the error terms used for the error correction VAR model were measured in \$/bu. To remedy this problem without going back to manipulate the data, the speed of adjustment coefficients for the soybean meals were divided by 40, since as stated earlier in this thesis, it takes on average 40 bushels of organic soybeans to make 1 ton of soybean meal.

Using OBarley and BarleyF as an example, their interpretation is as follows: Current information of organic barley affects the current price of conventional feed barley. The speed of adjustment coefficient representing conventional feed barley's reaction speed to organic barley's divergence from a long-run equilibrium between the two prices is 0.0498, suggesting a slow response where about 5% of the reaction of conventional barley's prices to organic barley's divergence from long-run equilibrium occurs in one week. On the other hand, no price information of conventional feed barley affects the price of organic barley. The speed of adjustment coefficient representing organic barley's reaction speed to conventional feed barley's divergence from long run equilibrium is not statistically significant at the 5% level, and no price information of feed barley affects the price of organic barley. Though not significant, the coefficient's value is -0.0062, suggesting a very slow response, if any (as stated previously, absolute values are used for interpretation). Notice that two asterisks denote a causal relationship that is statistically significant at the 5% level in Figure 5.2A. These asterisks are presented beside the information (i.e., past, current, and current and past) that cause, or lead the other. For example, current and past price information of organic barley leads the prices of conventional malting barley. Having discussed the organic and conventional malting barley prices above, the remaining pairs with statistically significant causal relationships are now discussed in turn.

Granger-Causality tests for corn imply organic corn is a price follower of conventional corn, which is consistent with original expectations. The speed of adjustment parameter for "O Corn, Yellow – Corn, Yellow," significant at the 10% level with a value of -0.0128, suggests about 1% of the response of organic corn's price to shocks in conventional corn prices occurs in 1 week. Exogeneity tests for corn imply current price information of conventional corn does not affect the price of organic corn, but that the hypothesis of the current prices of organic corn not affecting the price of conventional corn can not be rejected. Also, the speed of adjustment coefficient for conventional corn's reaction to organic corn's diversion in long-run equilibrium is statistically significant, telling us that about 7% of conventional corn's price adjustment occurs in 1 week.

Clear Hilum organic soybean prices are led by those of conventional soybean oil. Organic Hilum soybeans' speed of adjustment parameter of 0.0968 is statistically significant. Exogeneity results confirm that current prices of soybean oil affect this price lead. Clear Hilum organic soybean prices were also found to follow those of 46.5% protein content soybean meal. The speed of adjustment parameter suggests that about 26% of organic Hilum soybeans' price reaction to a divergence in 46.5% protein content soybean meal's long-run price equilibrium occurs in 1 week.

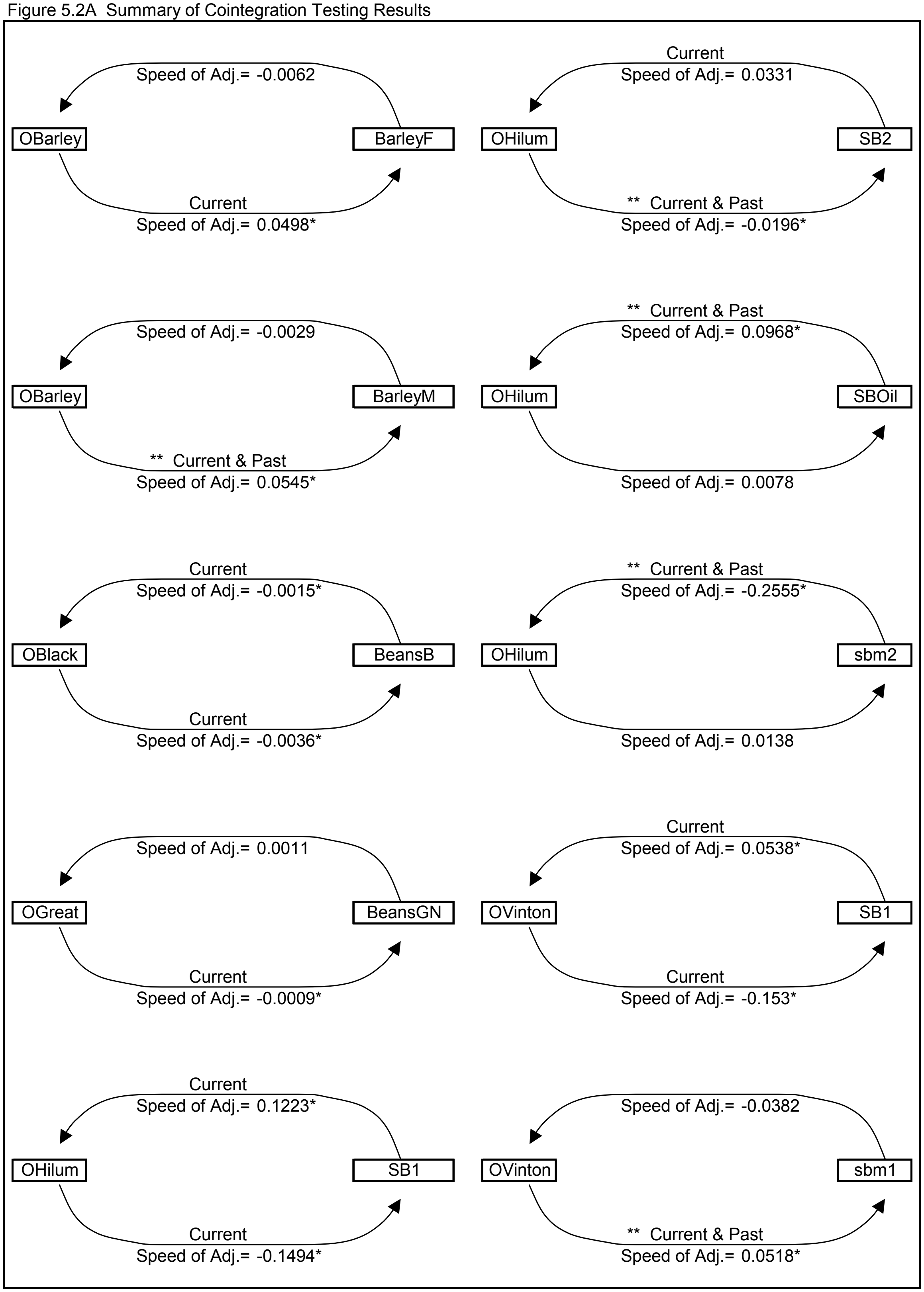
In turn, clear Hilum organic soybean prices led the number two conventional soybean prices, with a statistically significant speed of adjustment coefficient of -0.0196. Neither of these two commodities was found to be weakly exogenous for the other, suggesting that current market information is shared between the organic and conventional sectors for soybeans.

Similar causal relationships were found for those involving organic Vinton soybeans. Current and past prices of organic Vinton soybeans were found to lead prices of 44% and 46.5% protein content soybean meal. Both speed of adjustment coefficients were statistically significant at the 5% level and were 0.0518 and 0.0443, respectively, suggesting about 5% of the reaction of conventional soybean meal's price to a divergence in organic Vinton's long run equilibrium occurs in 1 week. In turn, prices of the organic Vinton soybeans were led by current and past prices of 47% protein content soybean meal. The speed of adjustment parameter of -0.0568 was statistically significant at the 5% level, suggesting that about 6% of organic Vinton soybeans' price reaction to a divergence in the 47% protein content soybean meal's long-run equilibrium price occurs in one week.

Causal relationships for three other relatively minor commodities were found to be statistically significant. Similar to corn, organic flaxseed prices were found to follow prices of conventional flax. The speed of adjustment coefficient of 0.2401 is statistically different from zero suggesting that 24% of organic flax's reaction to a divergence in conventional flax's long-run equilibrium price occurs in 1 week. To the contrary, and similar to barley prices, No.1 conventional rye prices were found to follow those of organic rye, with a significant speed of adjustment coefficient for conventional rye of -0.0640, while conventional sunflower seed prices were found to follow the organic prices, with a significant speed of adjustment parameter of -0.0016.

In summary, commodities with a cointegrated, causal relationship were conventional malting and organic barley, conventional and organic No.2 yellow corn, organic and conventional flax, organic and conventional No.1 rye, various conventional soybean products and organic Hilum and Vinton soybeans, and conventional and organic sunflower seeds. As expected, for the major commodity corn, organic prices were led by conventional prices, as was for flax. For commodities with relatively small markets, which included rye, barley, and sunflower, conventional prices were led by organic prices. In the soybean complex, organic prices were part of seemingly complex causal loops across the oil and meal sectors.

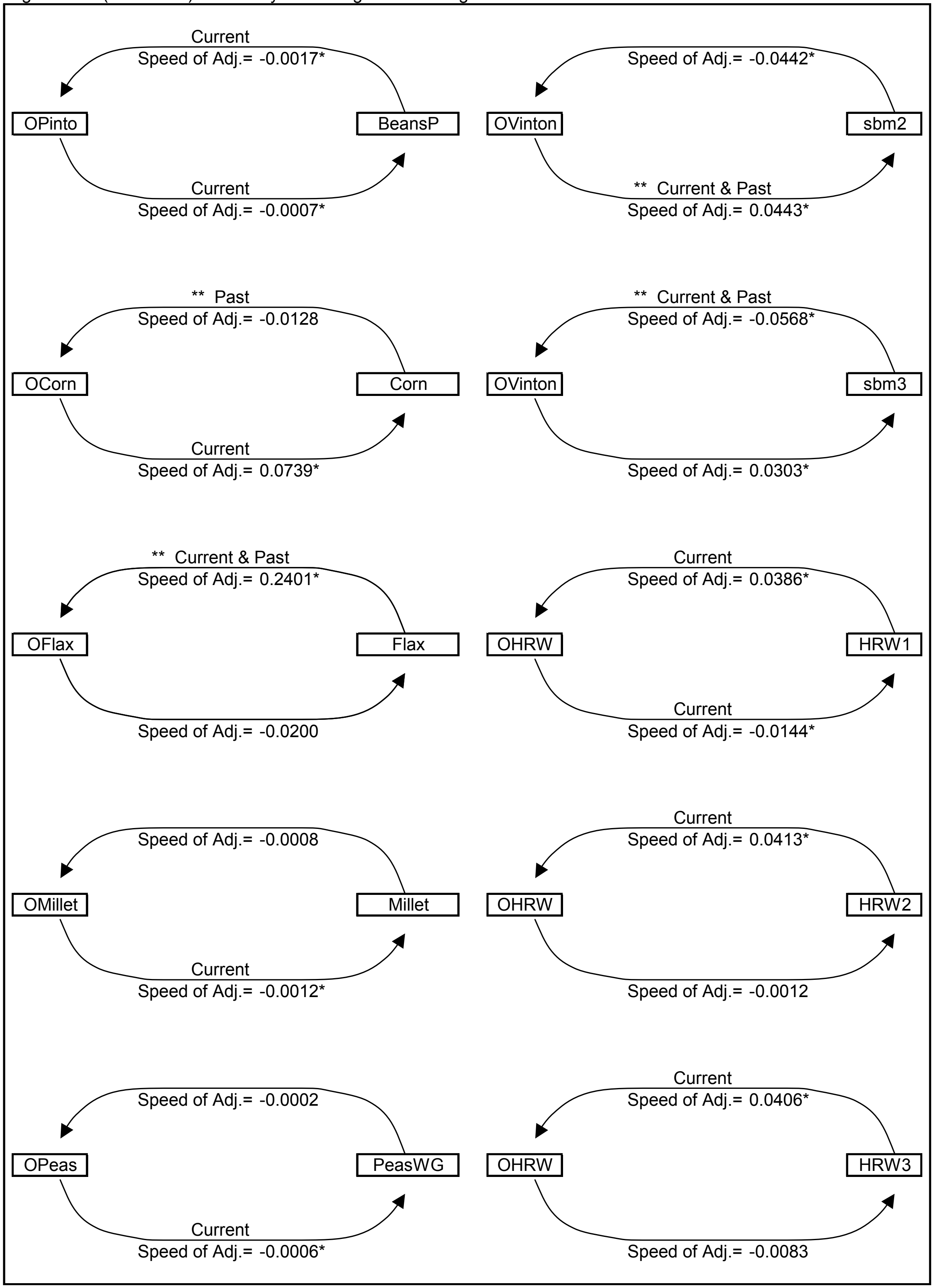
Figure 5.2A Summary of Cointegration Testing Results



* Coefficient is significant at the 5% level.

** A causal relationship exists at the 5% significance level.

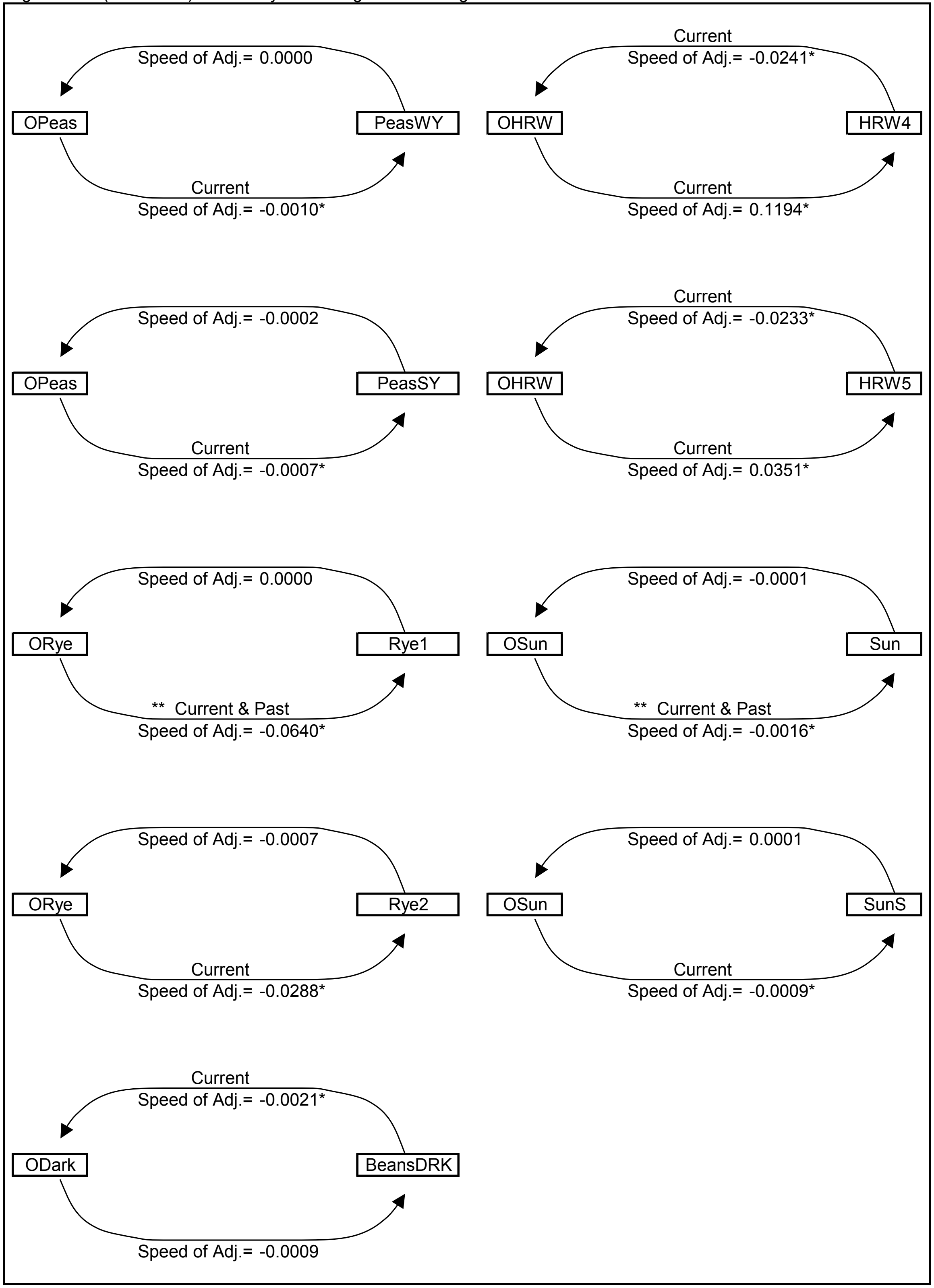
Figure 5.2A (Continued) Summary of Cointegration Testing Results



* Coefficient is significant at the 5% level.

** A causal relationship exists at the 5% significance level.

Figure 5.2A (Continued) Summary of Cointegration Testing Results



* Coefficient is significant at the 5% level.

** A causal relationship exists at the 5% significance level.

Table 5.2G Granger-Causality Tests Under the Assumption of No Cointegration

* **Beans, Garbanzo - O Beans, Garbanzo**

Test	Statistic	Pr > Chi-Sq.
Wald	1.38	0.2396
L.R.	1.38	0.2396
L.M.	1.5	0.2211

O Lentils, French - Lentils

Test	Statistic	Pr > Chi-Sq.
Wald	0.31	0.5774
L.R.	0.31	0.5774
L.M.	0.31	0.5762

Lentils - O Lentils, French

Test	Statistic	Pr > Chi-Sq.
Wald	2.29	0.1299
L.R.	2.29	0.1299
L.M.	2.29	0.1301

O Lentils, Green - Lentils

Test	Statistic	Pr > Chi-Sq.
Wald	0.16	0.6904
L.R.	0.16	0.6904
L.M.	0.16	0.6853

Lentils - O Lentils, Green

Test	Statistic	Pr > Chi-Sq.
Wald	0.86	0.3542
L.R.	0.86	0.3542
L.M.	0.89	0.3462

O Peas, Dry Split Green - Peas, Split Green

Test	Statistic	Pr > Chi-Sq.
Wald	0	0.9767
L.R.	0	0.9767
L.M.	0	0.9766

Peas, Split Green - O Peas, Dry Split Green

Test	Statistic	Pr > Chi-Sq.
Wald	0	0.9487
L.R.	0	0.9487
L.M.	0	0.9486

O Rice, Brown - Rice, Short

Test	Statistic	Pr > Chi-Sq.
Wald	1.05	0.3049
L.R.	1.05	0.3049
L.M.	1.15	0.2838

Rice, Short - O Rice, Brown

Test	Statistic	Pr > Chi-Sq.
Wald	0.54	0.4616
L.R.	0.54	0.4616
L.M.	0.59	0.4415

O Rice, Brown - Rice, Medium

Test	Statistic	Pr > Chi-Sq.
Wald	0.07	0.798
L.R.	0.07	0.798
L.M.	0.07	0.7905

Rice, Medium - O Rice, Brown

Test	Statistic	Pr > Chi-Sq.
Wald	0.66	0.4167
L.R.	0.66	0.4167
L.M.	0.72	0.3959

* **O Soybeans, Clear Hilum - Soybean Meal 44%**

Test	Statistic	Pr > Chi-Sq.
Wald	13.2	0.0003
L.R.	13.2	0.0003
L.M.	13	0.0003

O Soybeans, Clear Hilum - Soybean Meal 47%

Test	Statistic	Pr > Chi-Sq.
Wald	0.02	0.8768
L.R.	0.02	0.8768
L.M.	0.02	0.8746

Soybean Meal 47% - O Soybeans, Clear Hilum

Test	Statistic	Pr > Chi-Sq.
Wald	0.02	0.9008
L.R.	0.02	0.9008
L.M.	0.02	0.899

* Represents series that were I(0) and I(1).

** Represents series that were both I(1).

Table 5.2G (Continued) Granger-Causality Tests Under the Assumption of No Cointegration

O Soybeans, Vinton - Soybeans, No.2

Test	Statistic	Pr > Chi-Sq.
Wald	5.97	0.0146
L.R.	5.97	0.0146
L.M.	5.95	0.0148

Soybeans, No.2 - O Soybeans, Vinton

Test	Statistic	Pr > Chi-Sq.
Wald	0.44	0.5058
L.R.	0.44	0.5058
L.M.	0.45	0.5041

O Soybeans, Vinton - Soybean Oil

Test	Statistic	Pr > Chi-Sq.
Wald	5	0.0253
L.R.	5	0.0253
L.M.	5.01	0.0251

Soybean Oil - O Soybeans, Vinton

Test	Statistic	Pr > Chi-Sq.
Wald	1.76	0.1846
L.R.	1.76	0.1846
L.M.	1.78	0.1826

** **O Sunflower Seeds - Sunflower Meal**

Test	Statistic	Pr > Chi-Sq.
Wald	0.85	0.3578
L.R.	0.85	0.3578
L.M.	0.93	0.3355

Sunflower Meal - O Sunflower Seeds

Test	Statistic	Pr > Chi-Sq.
Wald	8.88	0.0029
L.R.	8.88	0.0029
L.M.	9.5	0.0021

O Wheat, Durum - Wheat, Hard Amber Durum No.1

Test	Statistic	Pr > Chi-Sq.
Wald	0.07	0.7941
L.R.	0.07	0.7941
L.M.	0.07	0.7924

Wheat, Hard Amber Durum No.1 - O Wheat, Durum

Test	Statistic	Pr > Chi-Sq.
Wald	0.45	0.5018
L.R.	0.45	0.5018
L.M.	0.46	0.4983

O Soft Winter Wheat - Soft Winter Wheat No.1

Test	Statistic	Pr > Chi-Sq.
Wald	2.11	0.1464
L.R.	2.11	0.1464
L.M.	2.44	0.1182

Soft Winter Wheat No.1 - O Soft Winter Wheat

Test	Statistic	Pr > Chi-Sq.
Wald	0.64	0.4224
L.R.	0.64	0.4224
L.M.	0.75	0.3866

O Soft Red Wheat - Soft Red Winter Wheat No.2

Test	Statistic	Pr > Chi-Sq.
Wald	2.95	0.086
L.R.	2.95	0.086
L.M.	2.96	0.0856

Soft Red Winter Wheat No.2 - O Soft Red Wheat

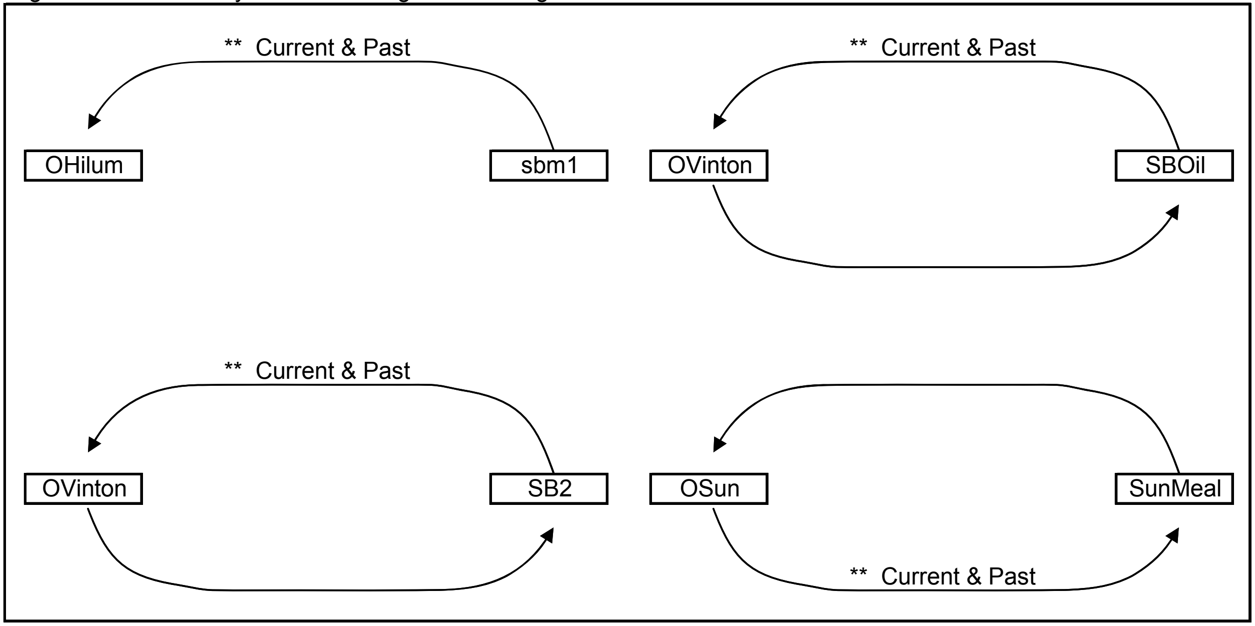
Test	Statistic	Pr > Chi-Sq.
Wald	0.03	0.864
L.R.	0.03	0.864
L.M.	0.03	0.8632

* Represents series that were I(0) and I(1).

** Represents series that were both I(1).

Of the 14 different sets of non-cointegrated commodities that were tested for causality, there were 4 relationships that rejected the null hypothesis at the 5% significance level (see Table 5.2G). The first of these sets, "O Soybeans, Clear Hilum – Soybean Meal 44%," was only tested one way since the organic soybeans prices were I(1) and the soybean meal prices were I(0). Prices of the 44% protein content soybean meal were found to lead prices of the organic soybeans. Organic Vinton soybean prices were found to follow those of No.2 conventional soybeans, and also those of conventional soybean oil. Finally, conventional sunflower meal prices were found to follow those of organic sunflower seeds. These four relationships are summarized in Figure 5.2B.

Figure 5.2B Summary of Non-Cointegrated Testing Results



** A causal relationship exists at the 5% significance level.

CHAPTER 6 SUMMARY AND CONCLUSIONS

6.1 SUMMARY OF HEDONIC PRICE ANALYSIS

Organic price data for seven different organic commodities, ranging from the last half of 2003 to the end of 2005 were obtained from an organic marketing cooperative called Kansas Organic Producers (KOP). These commodities' premiums over the conventional market were calculated by subtracting corresponding conventional commodity prices reported by the USDA from the prices received by KOP member producers. Using hedonic price modeling and bootstrapping statistical techniques, these premiums were measured as a function of buyer types, buyer state locations, the timing of contracting and shipment, the difference in quarters between the contract and shipping date, the producer's state location, total units sold, and whether or not KOP or the buyer arranged the shipment of the commodity.

It is difficult to draw conclusions regarding the affects of the different types of buyers, their locations, and producer locations on the premiums because of the different model specifications for each commodity and also the sporadic significance of these variables. Still, a few inferences may be drawn from the analyses. First, dairies seemed to provide less of a premium for feed grade corn and hard red winter wheat compared to other types of buyers. Dairies composed a significant portion of the entries for these two crops, and as such, it may be possible that they were exhibiting some sort of market power, enabling them to pay less. Alternatively, they might be serving as a ready-market for organic grains that enjoy discounts from organic grain producers.

Second, buyers located in Kansas (closest to the majority of the producers and KOP itself) tended to provide less of a premium than buyers located elsewhere. This was contrary to what was expected and hints that supply may be greater than demand for some organic commodities.

Results of the contracting and shipping dates, as well as the shipping difference in months between the contract and shipping dates seemed to exhibit fairly robust patterns. Commodities contracted in the first two quarters usually received a smaller premium than commodities contracted in the last two, and additionally, those contracted in the third quarter received a smaller premium than those in the fourth. This seems to suggest that organic grain producers were eager to contract their grains soon after the harvest in order to secure buyers. Trends of the shipping quarters were much the same, with again, the commodities shipped in the fourth shipping quarter receiving the largest premium. Commodities contracted in 2004 received larger premiums than those in 2003, and commodities contracted in 2005 received larger premiums than those in 2004. These increases resulted from higher organic prices each year since the conventional commodities used in this analysis remained relatively flat, with the exception of alfalfa, which increased.

If KOP arranged shipment of the commodity, a lower premium was acquired. This may partially be explained by the buyers being more efficient at organizing shipment to their location. Finally, a longer contract resulted in a larger premium, again, because it is likely worth more to the buyers to have a guaranteed source of input in an industry with so little information.

6.2 SUMMARY OF TIME SERIES ANALYSIS

Weekly organic price data collected from Organic Business News, along with corresponding conventional price data from the USDA, ranging from 1997-2005, were used in bivariate time series analyses to test for cointegration, causality, speed of adjustment, and exogeneity by using error correction vector autoregressive models. For each bivariate analysis, an organic price series was paired with a corresponding conventional price series.

Of the 43 pairs of organic and conventional commodities tested for cointegration, 29 were found to be cointegrated. Of those cointegrated pairs, 11 causal relationships were also found. Conventional malting barley prices were found to follow organic barley prices, No.1 conventional rye prices were found to follow organic rye prices, and conventional sunflower seed prices were found to follow those of organic sunflower seeds. On the other hand, organic corn prices were found to follow conventional corn prices, and organic flaxseed prices were found to follow conventional flaxseed prices. No.2 conventional soybean prices were found to follow organic clear Hilum soybean prices, but clear Hilum organic soybean prices followed those of conventional soybean oil and 46.5% protein content soybean meal. 44% and 46.5% protein content conventional soybean meal prices followed organic Vinton soybean prices, though organic Vinton soybean prices were found to follow 47% protein content soybean meal prices. For most of these relationships, the speed of adjustment to a shock, or divergence from long run equilibrium was quite slow, suggesting that about 5% of the adjustment occurred in 1 week. For relationships involving organic Hilum soybeans and flax, adjustments up to about 25% in a week were found.

6.3 SUGGESTIONS FOR FURTHER RESEARCH

Many directions can be taken to extend the current study that would make for interesting result comparisons with the findings of this thesis. For the hedonic analyses using the KOP and USDA data, it may be worthwhile to compute the KOP commodity premiums using different conventional crop varieties.

Exploring alternative ways to deal with error problems in these models may also provide interesting comparisons with the results in this study. For example, preliminary analyses explored functional forms that produced the best results for autocorrelation, normality, and heteroskedasticity using the KOP producer price as the dependent variable. If heteroskedasticity remained after trying different functional forms, an asymptotic covariance matrix was used to compute reliable standard errors. Bootstrapping was then performed, and the optimal functional form of the model for each commodity was used in conjunction with the bootstrapped data. For curiosity's sake, these bootstrap estimates were compared to the results of the OLS estimates that were computed using the original (non-bootstrapped) data set, using the optimal functional form (again the ACOV estimates were used if heteroskedasticity remained after using a different functional form).

These measures were not pursued in the final draft of this study, because after making a few small changes in the models, the use of the optimal functional form had only a very small impact on the results in these analyses, and the bootstrapped results were almost identical to the non-bootstrapped results. As such, this study computed and presented only bootstrapped results.

There is also room for change associated with the time series analysis in this study. Perhaps the most obvious thing to do is to locate organic and conventional price data from different locations and/or different sources, run the same tests, and see if similar results are obtained. Different lag lengths and cointegration tests could also be explored for this analysis. Finally, if other organic price series could be obtained, bivariate or possibly multivariate analyses could be performed using the same tests as those in this study, if more than two organic series could be located representing different spatial markets.

6.4 CLOSING THOUGHTS

This study is one of the few studies that analyze the organic grain market. There are many unanswered questions about the organic grain market due to its lack of information. However, this study suggests that there are similarities between the organic and conventional grain markets. For example, like conventional grains the proximity to harvest time seems to have an effect on the premium organic grains received. Also, the other part of this study suggests that there are many pairs of conventional and organic markets that move together over time. While results of this paper suggest different organic and conventional markets are cointegrated, and that some of these relationships are even causal, more research is needed in this area to validate these findings. These findings provide excellent starting points for trying to determine if the conventional grain market could be used as a market indicator/predictor for the organic grain market, and vice versa, and also if it could be used as a risk management tool for organics using methods such as hedging in the conventional grain market.

The single largest limitation to both parts of this study, and the reason for the small amount of literature on organic grains, is the lack of data. For example, the KOP data set was compiled from a single organic cooperative, and as such, the results from the hedonic analyses of this study are valid only for crops marketed through this cooperative. While these results provide a valuable insight on some of the organic grain markets at this cooperative, we can not be sure how they compare to the organic grain market as a whole. As organic agriculture evolves, it is sure to incorporate better record keeping systems, which according to Earl Wright, are already being implemented. More abundant and diverse data will allow for the completion of more studies such as this one, so that we can eventually turn the unknown of organic agriculture into a thing of the past.

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APPENDIX A: SUMMARY STATISTICS

Summary statistics of the data used for the cointegration analyses use the following abbreviations.

Organic Commodities

Abbreviation	Commodity and Measurment Units
OBarley	Barley $/bu.
OBlack	Beans, Black Turtle $/lb.
OGarbanzo	Beans, Garbanzo $/lb.
OGreat	Beans, Great Northern $/lb.
ODark	Beans, Kidney Dark Red $/lb.
OPinto	Beans, Pinto $/lb.
OCorn	Corn, Yellow $/bu.
OFlax	Flax $/bu.
OLentilsF	Lentils, French $/lb.
OLentilsG	Lentils, Green $/lb.
OMillet	Millet $/lb.
OPeas	Peas, Dry Green Split $/lb.
ORice	Rice, Brown $/lb.
ORye	Rye $/bu.
OHilum	Soybeans, Clear Hilum $/bu.
OVinton	Soybeans, Vinton $/bu.
OSun	Sunflower, Seeds $/lb.
OWheatD	Wheat, Durum $/lb.
OHRW	Wheat, Hard Red Winter $/lb.
OSWW	Wheat, Soft Winter $/lb.
OSRW	Wheat, Soft Red $/lb.

Conventional Commodities

Abbreviation	Commodity and Measurment Units
BarleyF	Barley, Feed $/bu.
BarleyM	Barley, Malting $/bu.
BeansB	Beans, Black $/lb.
Garbanzo	Beans, Garbonzo $/lb.
BeansGN	Beans, Great Northern $/lb.
BeansDRK	Beans, Dark RedKidney $/lb.
BeansP	Beans, Pinto $/lb.
Corn	Corn, Yellow No.2 $/bu.
Flax	Flaxseed $/bu.
Lentils	Lentils $/lb.
Millet	Millet $/lb.
PeasWG	Peas, Whole Green $/lb.
PeasSG	Peas, Split Green $/lb.
PeasWY	Peas, Whole Yellow $/lb.
PeasSY	Peas, Split Yellow $/lb.
RiceS	Rice, Short $/lb.
RiceM	Rice, Med $/lb.
Rye1	Rye, No.1 $/bu.
Rye2	Rye, No.2 $/bu.
SB1	Soybeans, No.1 $/bu.
SB2	Soybeans, No.2 $/bu.
SBOil	Soybean, Oil $/cwt.
sbm1	Soybean, Meal 44% $/cwt.
sbm2	Soybean, Meal 46.5% $/cwt.
sbm3	Soybean, Meal 47% $/cwt.
Sun	Sunflower, Seeds $/lb.
SunS	Sunflower, Seeds Sun $/lb.
SunMeal	Sunflower, Meal $/cwt.
WheatD	Wheat, Hard Amber Durum No.1 $/bu.
HRW1	Wheat, Hard Red Winter No.1 (Ordinary) $/bu.
HRW2	Wheat, Hard Red Winter No.1 11% $/bu.
HRW3	Wheat, Hard Red Winter No.1 12% $/bu.
HRW4	Wheat, Hard Red Winter No.1 13% $/bu.
HRW5	Wheat, Hard Red Winter No.1 14% $/bu.
SWW	Wheat, Soft White No.1 $/bu.
SRW	Wheat, Soft Red Winter No.2 $/bu.

Summary Statistics of the Organic Commodities Used for the Cointegration Analyses

	OBarley	OBlack	OGarbanzo	OGreat	ODark	OPinto	OCorn	OFlax	OLentilsF	OLentilsG	OMillet
Mean	3.866	0.420	0.528	0.465	0.521	0.385	4.053	17.760	0.355	0.385	0.230
Standard Error	0.022	0.004	0.002	0.003	0.003	0.002	0.035	0.360	0.004	0.004	0.006
Median	3.500	0.408	0.510	0.425	0.500	0.380	4.125	12.600	0.310	0.340	0.160
Mode	3.500	0.425	0.510	0.425	0.490	0.370	4.000	12.320	0.310	0.330	0.160
Standard Dev.	0.482	0.079	0.052	0.073	0.059	0.045	0.759	7.821	0.067	0.081	0.125
Sample Var.	0.232	0.006	0.003	0.005	0.003	0.002	0.577	61.161	0.005	0.007	0.016
Kurtosis	-0.680	8.267	1.490	0.278	0.832	3.461	-0.967	-1.114	-0.538	0.093	-0.340
Skewness	0.892	2.456	0.883	1.201	0.977	1.269	-0.617	0.802	1.143	1.233	0.998
Range	1.750	0.530	0.335	0.285	0.275	0.260	2.635	23.660	0.175	0.285	0.495
Minimum	3.000	0.320	0.365	0.375	0.425	0.310	2.600	9.940	0.300	0.315	0.080
Maximum	4.750	0.850	0.700	0.660	0.700	0.570	5.235	33.600	0.475	0.600	0.575
Sum	1824.675	198.448	249.040	219.391	245.932	181.770	1912.797	8382.584	114.460	181.640	108.691
Count	472	472	472	472	472	472	472	472	322	472	472

	OPeas	ORice	ORye	OHilum	OVinton	OSun	OWheatD	OHRW	OSWW	OSRW
Mean	0.186	0.400	4.168	14.806	17.958	0.213	6.617	5.037	5.201	4.933
Standard Error	0.002	0.001	0.012	0.122	0.098	0.001	0.028	0.030	0.035	0.018
Median	0.185	0.405	4.000	14.750	18.500	0.215	6.750	5.225	4.750	4.925
Mode	0.150	0.380	4.000	12.500	21.000	0.215	5.500	4.625	4.750	4.625
Standard Dev.	0.048	0.020	0.254	2.653	2.136	0.023	0.614	0.641	0.670	0.333
Sample Var.	0.002	0.000	0.065	7.040	4.561	0.001	0.377	0.412	0.450	0.111
Kurtosis	-1.148	-1.701	0.643	0.050	-1.355	8.669	-0.685	-0.246	-0.073	0.055
Skewness	0.491	0.182	-0.492	0.739	0.064	2.539	-0.650	0.509	1.131	1.088
Range	0.135	0.045	1.150	13.000	6.000	0.115	2.250	2.900	2.700	1.375
Minimum	0.130	0.380	3.300	11.000	15.000	0.190	5.500	3.850	4.550	4.625
Maximum	0.265	0.425	4.450	24.000	21.000	0.305	7.750	6.750	7.250	6.000
Sum	87.785	188.965	1967.350	6988.479	8475.959	78.320	3123.078	2377.527	1913.850	1667.418
Count	472	472	472	472	472	368	472	472	368	338

Summary Statistics of the Conventional Commodities Used for the Cointegration Analyses

	BarleyF	BarleyM	Corn	BeansP	BeansGN	BeansDRK	Garbanzo	BeansB	Flax	sbm1
Mean	3.708	4.383	3.725	0.210	0.209	0.267	0.282	0.203	7.329	178.002
Standard Error	0.023	0.033	0.026	0.002	0.001	0.002	0.003	0.004	0.102	2.045
Median	3.600	4.225	3.574	0.190	0.210	0.255	0.283	0.194	6.875	165.500
Mode	3.500	4.325	3.300	0.185	0.220	0.220	0.350	0.135	7.500	168.500
Standard Dev.	0.502	0.721	0.571	0.053	0.017	0.045	0.057	0.070	1.270	43.966
Sample Var.	0.252	0.519	0.326	0.003	0.000	0.002	0.003	0.005	1.612	1932.993
Kurtosis	5.113	1.889	1.150	-0.077	-0.422	-0.832	-0.585	0.242	-0.401	1.548
Skewness	1.045	1.460	-0.078	0.987	0.401	0.498	0.124	1.063	0.837	1.421
Range	4.825	4.270	4.196	0.200	0.085	0.190	0.235	0.252	4.525	267.950
Minimum	2.425	2.480	1.744	0.145	0.170	0.200	0.180	0.128	5.600	88.750
Maximum	7.250	6.750	5.940	0.345	0.255	0.390	0.415	0.380	10.125	356.700
Sum	1757.443	2077.465	1765.612	99.205	99.142	126.266	133.619	74.242	1143.315	82236.900
Count	474	474	474	473	474	473	473	366	156	462

	sbm3	sbm2	SunMeal	Lentils	Millet	Sun	SBOil	SunS	PeasWG	PeasSG
Mean	212.609	180.752	87.725	0.151	0.056	0.087	21.070	0.076	0.092	0.136
Standard Error	2.131	2.100	0.833	0.001	0.001	0.001	0.242	0.001	0.001	0.001
Median	199.750	165.600	85.000	0.140	0.045	0.090	22.005	0.074	0.085	0.130
Mode	206.300	144.000	85.000	0.118	0.041	0.105	13.235	0.070	0.080	0.118
Standard Dev.	45.804	45.089	18.123	0.032	0.026	0.024	5.261	0.010	0.020	0.025
Sample Var.	2097.963	2033.017	328.440	0.001	0.001	0.001	27.680	0.000	0.000	0.001
Kurtosis	1.006	1.469	0.655	-0.013	4.124	-1.136	-0.434	-0.300	1.046	0.112
Skewness	1.232	1.438	0.691	0.964	2.079	-0.124	0.304	0.620	1.230	1.082
Range	275.700	241.800	118.200	0.132	0.136	0.088	23.540	0.043	0.106	0.109
Minimum	107.000	121.900	44.000	0.108	0.034	0.041	12.085	0.060	0.059	0.104
Maximum	382.700	363.700	162.200	0.240	0.170	0.129	35.625	0.103	0.165	0.213
Sum	98225.200	83326.550	41493.700	71.437	26.363	32.028	9986.995	11.515	42.245	64.426
Count	462	461	473	473	474	370	474	151	461	473

Summary Statistics of the Conventional Commodities Used for the Cointegration Analyses (Continued)

	PeasWY	PeasSY	RiceS	RiceM	SB1	SB2	WheatD	HRW1
Mean	0.087	0.131	0.200	0.176	5.733	5.417	4.018	2.830
Standard Error	0.001	0.001	0.002	0.002	0.070	0.060	0.032	0.026
Median	0.083	0.125	0.208	0.178	5.402	5.102	3.900	2.784
Mode	0.079	0.115	0.140	0.178	6.875	4.600	3.900	2.705
Standard Dev.	0.016	0.020	0.042	0.039	1.514	1.303	0.697	0.564
Sample Var.	0.000	0.000	0.002	0.002	2.291	1.697	0.486	0.318
Kurtosis	2.265	0.053	-0.908	-0.239	13.708	0.783	1.046	0.111
Skewness	1.172	0.992	-0.268	0.334	2.341	1.124	0.840	0.390
Range	0.103	0.090	0.165	0.165	16.403	6.040	3.770	2.770
Minimum	0.056	0.105	0.110	0.110	2.921	3.730	2.625	1.765
Maximum	0.159	0.195	0.275	0.275	19.324	9.770	6.395	4.535
Sum	40.024	60.290	92.216	81.366	2717.206	2567.816	1904.595	1341.304
Count	461	459	461	461	474	474	474	474

	HRW2	HRW3	HRW4	HRW5	SRW	SWW	Rye1	Rye2
Mean	2.935	3.119	4.690	7.380	2.881	2.497	3.107	3.151
Standard Error	0.029	0.024	0.037	0.045	0.025	0.029	0.030	0.029
Median	2.883	3.100	4.640	7.380	2.940	2.355	3.050	3.150
Mode	3.170	2.936	4.485	8.390	3.035	2.165	2.750	2.750
Standard Dev.	0.628	0.531	0.801	0.798	0.534	0.522	0.620	0.625
Sample Var.	0.394	0.282	0.641	0.637	0.285	0.273	0.384	0.391
Kurtosis	-0.285	0.098	0.222	-0.405	-1.029	-0.283	-0.478	-0.432
Skewness	0.260	0.385	-0.141	0.538	0.138	0.823	-0.182	-0.203
Range	3.076	2.905	4.864	3.515	2.154	2.193	2.750	3.100
Minimum	1.710	1.901	2.071	6.190	1.905	1.670	1.500	1.500
Maximum	4.786	4.806	6.935	9.705	4.059	3.863	4.250	4.600
Sum	1391.204	1478.479	2223.130	2317.275	1365.699	791.411	1351.654	1493.675
Count	474	474	474	314	474	317	435	474

Summary Statistics of the Prices Associated with KOP Crops Used for the Hedonic Analyses

	Soybeans Feed	Corn Feed	Corn Food	HRW Feed	HRW Food	SRW Food	Alfalfa
Time Span	11/03 - 7/05	10/03 - 11/05	7/04 - 9/05	10/04 - 12/05	6/03 - 2/05	6/03 - 12/05	12/03 - 10/05
Mean	12.20	4.81	4.97	4.29	5.97	5.49	100.82
Standard Error	0.05	0.05	0.10	0.04	0.05	0.03	1.95
Median	12.00	4.65	5.17	4.21	6.10	5.50	100.00
Mode	12.00	4.85	5.17	4.00	6.10	5.50	100.00
Standard Deviation	0.50	0.67	0.46	0.31	0.59	0.18	14.96
Sample Variance	0.25	0.45	0.21	0.10	0.35	0.03	223.85
Kurtosis	5.02	-0.39	0.43	4.59	1.88	0.71	3.85
Skewness	2.09	0.70	0.75	1.74	-1.53	0.40	0.33
Range	3.06	2.63	1.55	1.66	2.75	0.72	98.00
Minimum	11.51	3.67	4.45	3.95	4.00	5.13	50.00
Maximum	14.57	6.30	6.00	5.61	6.75	5.85	148.00
Count	109	213	21	63	125	30	59

Alfalfa is measured in $/ton, everything else in $/bu.

Summary Statistics of the Units Associated with KOP Crops Used for the Hedonic Analyses

	Soybeans Feed	Corn Feed	Corn Food	HRW Feed	HRW Food	SRW Food	Alfalfa
Time Span	11/03 - 7/05	10/03 - 11/05	7/04 - 9/05	10/04 - 12/05	6/03 - 2/05	6/03 - 12/05	12/03 - 10/05
Mean	1497.91	2685.37	901.28	2850.01	2071.01	1172.96	22.58
Standard Error	143.99	205.27	4.48	381.77	113.39	158.95	0.30
Median	982.46	1030.00	900.71	1282.00	2910.33	851.50	22.76
Mode	966.00	1036.79	915.00	#N/A	864.00	839.00	20.78
Standard Deviation	1503.28	2995.86	20.51	3030.17	1267.79	870.63	2.34
Sample Variance	2259855.48	8975168.93	420.60	9181932.63	1607299.53	757993.25	5.48
Kurtosis	-0.61	2.84	-0.30	1.42	-1.92	3.38	4.95
Skewness	0.97	1.91	-0.25	1.58	-0.08	2.27	-1.41
Range	5154.71	12984.32	75.00	11455.94	3597.84	2652.33	15.56
Minimum	39.57	130.36	865.00	171.33	117.83	752.00	12.66
Maximum	5194.29	13114.68	940.00	11627.27	3715.67	3404.33	28.22
Sum	163272.61	571982.83	18926.79	179550.64	258876.36	35188.67	1332.15
Count	109.00	213.00	21.00	63.00	125.00	30.00	59.00

Alfalfa is measured in tons, everything else in bushels.

Summary Statistics of the Premiums Associated with KOP Crops Used for the Hedonic Analyses

	Soybeans Feed	Corn Feed	Corn Food	HRW Feed	HRW Food	SRW Food	Alfalfa
Time Span	11/03 - 7/05	10/03 - 11/05	7/04 - 9/05	10/04 - 12/05	6/03 - 2/05	6/03 - 12/05	12/03 - 10/05
Mean	6.11	2.59	2.88	2.76	1.02	2.50	11.65
Standard Error	0.19	0.05	0.12	0.07	0.04	0.03	1.97
Median	7.07	2.50	2.96	3.00	0.96	2.51	10.84
Mode	7.07	2.82	3.08	3.21	0.88	2.51	10.84
Standard Deviation	1.98	0.80	0.56	0.78	0.32	0.18	15.12
Sample Variance	3.90	0.64	0.31	0.60	0.11	0.03	228.55
Kurtosis	-0.32	-0.45	1.22	1.65	7.63	0.79	2.60
Skewness	-1.04	0.37	0.79	-1.44	2.16	0.48	-0.04
Range	7.03	3.65	2.16	3.19	2.07	0.74	94.34
Minimum	2.08	0.80	1.99	0.55	0.50	2.14	-39.16
Maximum	9.11	4.45	4.16	3.74	2.57	2.88	55.18
Sum	665.70	551.17	60.45	345.30	64.48	75.04	687.48
Count	109	213	21	125	63	30	59

Alfalfa is measured in $/ton, everything else in $/bu.

Summary Statistics of the Monthly Average USDA Crop Prices Used for the Hedonic Analyses

	No.2 Soybeans	No.2 Yellow Corn	No.2 Yellow Corn	No.1 Ord. Hard Red Winter Wheat	No.1 Ord. Hard Red Winter Wheat	No.2 Soft Red Winter Wheat	Grade "Good" Alfalfa
Time Span	11/03 - 7/05	10/03 - 11/05	7/04 - 9/05	10/04 - 12/05	6/03 - 2/05	6/03 - 12/05	12/03 - 10/05
Mean	6.81	2.36	2.15	3.23	3.35	3.22	90.28
Standard Error	0.35	0.08	0.04	0.04	0.06	0.05	0.76
Median	6.59	2.23	2.14	3.24	3.29	3.10	89.53
Standard Deviation	1.62	0.42	0.17	0.14	0.27	0.28	3.64
Sample Variance	2.63	0.17	0.03	0.02	0.07	0.08	13.23
Kurtosis	-0.96	-0.62	-0.05	-0.82	-0.77	-0.56	-0.57
Skewness	0.47	0.68	0.36	0.09	-0.11	0.99	-0.18
Range	5.05	1.42	0.64	0.44	0.91	0.86	13.40
Minimum	4.78	1.80	1.84	3.02	2.83	2.95	82.80
Maximum	9.83	3.22	2.49	3.46	3.74	3.81	96.20
Sum	143.03	61.45	32.32	48.39	70.33	99.80	2076.47
Count	21	26	15	15	21	31	23

Alfalfa is measured in $/ton, everything else in $/bu.

APPENDIX B: COINTEGRATION RESULTS

Cointegration Results of Levels Using AIC (Series in Levels)

	Test Type	H0: Rank=r	H1: Rank>r	No. of Lags	Eigenvalue	Statistic	5% Critical Value
O Barley	Trace Test:	0	0	5	0.0298	17.09	19.99
Barley (Feed)		1	1		0.0064	2.98	9.13
	Max Test:	0	1		0.0298	14.11	15.67
		1	2		0.0064	2.98	9.24
O Barley	Trace Test:	0	0	25	0.0243	14.33	19.99
Barley (Malting)		1	1		0.0075	3.35	9.13
	Max Test:	0	1		0.0243	10.97	15.67
		1	2		0.0075	3.35	9.24
O Beans, Black Turtle	Trace Test:	0	0	16	0.0402	18.42	19.99
Beans Black		1	1		0.0115	4.05	9.13
	Max Test:	0	1		0.0402	14.37	15.67
		1	2		0.0115	4.05	9.24
O Beans, Garbanzo	Trace Test:	0	0	18	0.0249	13.12	19.99
Beans, Garbanzo		1	1		0.0036	1.66	9.13
	Max Test:	0	1		0.0249	11.46	15.67
		1	2		0.0036	1.66	9.24
O Beans, Great Northern	Trace Test:	0	0	5	0.0252	14.74	19.99
Beans, Great Northern		1	1		0.0060	2.83	9.13
	Max Test:	0	1		0.0252	11.91	15.67
		1	2		0.0060	2.83	9.24
O Beans, Dark Red Kidney	Trace Test:	0	0	13	0.0240	16.24	19.99
Beans, Dark Red Kidney		1	1		0.0110	5.06	9.13
	Max Test:	0	1		0.0240	11.17	15.67
		1	2		0.0110	5.06	9.24
O Beans, Pinto	Trace Test:	0	0	3	0.0302	19.40	19.99
Beans, Pinto		1	1		0.0107	5.03	9.13
	Max Test:	0	1		0.0302	14.37	15.67
		1	2		0.0107	5.03	9.24
O Corn, Yellow	Trace Test:	0	0	16	0.0234	14.65	19.99
Corn, Yellow		1	1		0.0085	3.87	9.13
	Max Test:	0	1		0.0234	10.78	15.67
		1	2		0.0085	3.87	9.24
O Lentils, French	Trace Test:	0	0	13	0.0162	5.11	19.99
Lentils		1	1		0.0035	0.90	9.13
	Max Test:	0	1		0.0162	4.20	15.67
		1	2		0.0035	0.90	9.24

Cointegration Results of Levels Using AIC (Series in Levels)

	Test Type	H0: Rank=r	H1: Rank>r	No. of Lags	Eigenvalue	Statistic	5% Critical Value
O Lentils, Green	Trace Test:	0	0	8	0.0315	17.48	19.99
Lentils		1	1		0.0057	2.65	9.13
	Max Test:	0	1		0.0315	14.83	15.67
		1	2		0.0057	2.65	9.24
O Millet	Trace Test:	0	0	7	0.0216	18.18	19.99
Millet		1	1		0.0171	8.03	9.13
	Max Test:	0	1		0.0216	10.16	15.67
		1	2		0.0171	8.03	9.24
O Peas, Dry Split Green	Trace Test:	0	0	15	0.0131	10.31	19.99
Peas, Whole Green		1	1		0.0099	4.42	9.13
	Max Test:	0	1		0.0131	5.89	15.67
		1	2		0.0099	4.42	9.24
O Peas, Dry Split Green	Trace Test:	0	0	1	0.0138	11.48	19.99
Peas, Split Green		1	1		0.0104	4.92	9.13
	Max Test:	0	1		0.0138	6.56	15.67
		1	2		0.0104	4.92	9.24
O Peas, Dry Split Green	Trace Test:	0	0	12	0.0247	16.62	19.99
Peas, Whole Yellow		1	1		0.0119	5.38	9.13
	Max Test:	0	1		0.0247	11.24	15.67
		1	2		0.0119	5.38	9.24
O Rice, Brown	Trace Test:	0	0	19	0.0215	12.39	19.99
Rice Short		1	1		0.0062	2.77	9.13
	Max Test:	0	1		0.0215	9.62	15.67
		1	2		0.0062	2.77	9.24
O Rice, Brown	Trace Test:	0	0	16	0.0160	10.14	19.99
Rice, Medium		1	1		0.0067	2.98	9.13
	Max Test:	0	1		0.0160	7.17	15.67
		1	2		0.0067	2.98	9.24
O Rye	Trace Test:	0	0	3	0.0257	13.54	19.99
Rye, No.1		1	1		0.0053	2.28	9.13
	Max Test:	0	1		0.0257	11.25	15.67
		1	2		0.0053	2.28	9.24
O Rye	Trace Test:	0	0	11	0.0333	17.50	19.99
Rye, No. 2		1	1		0.0041	1.88	9.13
	Max Test:	0	1		0.0333	15.62	15.67
		1	2		0.0041	1.88	9.24

Cointegration Results of Levels Using AIC (Series in Levels)

	Test Type	H0: Rank=r	H1: Rank>r	No. of Lags	Eigenvalue	Statistic	5% Critical Value
O Soybeans, Clear Hilum	Trace Test:	0	0	3	0.0226	13.61	19.99
Soybean Oil		1	1		0.0062	2.92	9.13
	Max Test:	0	1		0.0226	10.70	15.67
		1	2		0.0062	2.92	9.24
O Soybeans, Clear Hilum	Trace Test:	0	0	3	0.0361	26.13	19.99
Soybean Meal 44%		1	1		0.0199	9.24	9.13
	Max Test:	0	1		0.0361	16.89	15.67
		1	2		0.0199	9.24	9.24
O Soybeans, Clear Hilum	Trace Test:	0	0	8	0.0524	38.09	19.99
Soybean Meal 46.5%		1	1		0.0298	13.72	9.13
	Max Test:	0	1		0.0524	24.36	15.67
		1	2		0.0298	13.72	9.24
O Soybeans, Clear Hilum	Trace Test:	0	0	8	0.0526	38.43	19.99
Soybean Meal 47%		1	1		0.0302	13.91	9.13
	Max Test:	0	1		0.0526	24.52	15.67
		1	2		0.0302	13.91	9.24
O Soybeans, Vinton	Trace Test:	0	0	8	0.0267	17.94	19.99
Soybeans, No.1		1	1		0.0115	5.39	9.13
	Max Test:	0	1		0.0267	12.55	15.67
		1	2		0.0115	5.39	9.24
O Soybeans, Vinton	Trace Test:	0	0	2	0.0218	16.23	19.99
Soybeans, No.2		1	1		0.0124	5.86	9.13
	Max Test:	0	1		0.0218	10.37	15.67
		1	2		0.0124	5.86	9.24
O Soybeans, Vinton	Trace Test:	0	0	3	0.0185	11.94	19.99
Soybean Oil		1	1		0.0068	3.20	9.13
	Max Test:	0	1		0.0185	8.74	15.67
		1	2		0.0068	3.20	9.24
O Soybeans, Vinton	Trace Test:	0	0	8	0.0386	27.82	19.99
Soybean Meal 47%		1	1		0.0217	9.94	9.13
	Max Test:	0	1		0.0386	17.88	15.67
		1	2		0.0217	9.94	9.24
O Sunflower Seeds	Trace Test:	0	0	19	0.0190	8.58	19.99
Sunflower Seeds		1	1		0.0054	1.90	9.13
	Max Test:	0	1		0.0190	6.68	15.67
		1	2		0.0054	1.90	9.24

Cointegration Results of Levels Using AIC (Series in Levels)

	Test Type	H0: Rank=r	H1: Rank>r	No. of Lags	Eigenvalue	Statistic	5% Critical Value
O Sunflower Seeds	Trace Test:	0	0	2	0.0390	6.59	19.99
Sunflower Seeds, Sun		1	1		0.0045	0.66	9.13
	Max Test:	0	1		0.0390	5.93	15.67
		1	2		0.0045	0.66	9.24
O Sunflower Seeds	Trace Test:	0	0	16	0.0316	15.23	19.99
Sunflower Meal		1	1		0.0111	3.93	9.13
	Max Test:	0	1		0.0316	11.30	15.67
		1	2		0.0111	3.93	9.24
O Wheat, Durum	Trace Test:	0	0	4	0.0192	13.58	19.99
Wheat, Hard Amber Durum No.1		1	1		0.0095	4.49	9.13
	Max Test:	0	1		0.0192	9.09	15.67
		1	2		0.0095	4.49	9.24
O Hard Red Winter Wheat	Trace Test:	0	0	13	0.0356	27.43	19.99
Hard Red Winter Wheat, No.1, 13%		1	1		0.0232	10.80	9.13
	Max Test:	0	1		0.0356	16.64	15.67
		1	2		0.0232	10.80	9.24
O Soft Winter Wheat	Trace Test:	0	0	21	0.0355	15.14	19.99
Soft Winter Wheat, No.1		1	1		0.0153	4.52	9.13
	Max Test:	0	1		0.0355	10.62	15.67
		1	2		0.0153	4.52	9.24
O Soft Red Wheat	Trace Test:	0	0	2	0.0182	8.75	19.99
Soft Red Winter Wheat, No.2		1	1		0.0076	2.57	9.13
	Max Test:	0	1		0.0182	6.18	15.67
		1	2		0.0076	2.57	9.24

Cointegration Results of Levels Using SBC (Series in Levels)

	Test Type	H0: Rank=r	H1: Rank>r	No. of Lags	Eigenvalue	Statistic	5% Critical Value
O Beans, Black Turtle	Trace Test:	0	0	5	0.0436	27.05	19.99
Beans Black		1	1		0.0299	10.95	9.13
	Max Test:	0	1		0.0436	16.09	15.67
		1	2		0.0299	10.95	9.24
O Beans, Garbanzo	Trace Test:	0	0	18	0.0249	13.12	19.99
Beans, Garbanzo		1	1		0.0036	1.66	9.13
	Max Test:	0	1		0.0249	11.46	15.67
		1	2		0.0036	1.66	9.24
O Flax	Trace Test:	0	0	2	0.0317	8.66	19.99
Flaxseed		1	1		0.0238	3.70	9.13
	Max Test:	0	1		0.0317	4.96	15.67
		1	2		0.0238	3.70	9.24
O Lentils, French	Trace Test:	0	0	1	0.0123	4.77	19.99
Lentils		1	1		0.0053	1.43	9.13
	Max Test:	0	1		0.0123	3.33	15.67
		1	2		0.0053	1.43	9.24
O Lentils, Green	Trace Test:	0	0	8	0.0315	17.48	19.99
Lentils		1	1		0.0057	2.65	9.13
	Max Test:	0	1		0.0315	14.83	15.67
		1	2		0.0057	2.65	9.24
O Millet	Trace Test:	0	0	2	0.0315	19.99	19.99
Millet		1	1		0.0105	4.95	9.13
	Max Test:	0	1		0.0315	15.04	15.67
		1	2		0.0105	4.95	9.24
O Peas, Dry Split Green	Trace Test:	0	0	1	0.0138	11.48	19.99
Peas, Split Green		1	1		0.0104	4.92	9.13
	Max Test:	0	1		0.0138	6.56	15.67
		1	2		0.0104	4.92	9.24
O Rice, Brown	Trace Test:	0	0	1	0.0052	3.87	19.99
Rice Short		1	1		0.0032	1.48	9.13
	Max Test:	0	1		0.0052	2.39	15.67
		1	2		0.0032	1.48	9.24

Cointegration Results of Levels Using SBC (Series in Levels)

	Test Type	H0: Rank=r	H1: Rank>r	No. of Lags	Eigenvalue	Statistic	5% Critical Value
O Rice, Brown	Trace Test:	0	0	1	0.0055	4.62	19.99
Rice, Medium		1	1		0.0045	2.07	9.13
	Max Test:	0	1		0.0055	2.55	15.67
		1	2		0.0045	2.07	9.24
O Rye	Trace Test:	0	0	2	0.0273	14.04	19.99
Rye, No.1		1	1		0.0047	2.04	9.13
	Max Test:	0	1		0.0273	12.00	15.67
		1	2		0.0047	2.04	9.24
O Rye	Trace Test:	0	0	11	0.0333	17.50	19.99
Rye, No. 2		1	1		0.0041	1.88	9.13
	Max Test:	0	1		0.0333	15.62	15.67
		1	2		0.0041	1.88	9.24
O Soybeans, Clear Hilum	Trace Test:	0	0	1	0.0368	28.66	19.99
Soybean Meal 44%		1	1		0.0243	11.36	9.13
	Max Test:	0	1		0.0368	17.30	15.67
		1	2		0.0243	11.36	9.24
O Soybeans, Clear Hilum	Trace Test:	0	0	1	0.0365	29.45	19.99
Soybean Meal 46.5%		1	1		0.0265	12.37	9.13
	Max Test:	0	1		0.0365	17.08	15.67
		1	2		0.0265	12.37	9.24
O Soybeans, Clear Hilum	Trace Test:	0	0	1	0.0354	27.58	19.99
Soybean Meal 47%		1	1		0.0235	10.98	9.13
	Max Test:	0	1		0.0354	16.60	15.67
		1	2		0.0235	10.98	9.24
O Soybeans, Vinton	Trace Test:	0	0	2	0.0218	16.23	19.99
Soybeans, No.2		1	1		0.0124	5.86	9.13
	Max Test:	0	1		0.0218	10.37	15.67
		1	2		0.0124	5.86	9.24
O Soybeans, Vinton	Trace Test:	0	0	2	0.0213	12.84	19.99
Soybean Oil		1	1		0.0058	2.73	9.13
	Max Test:	0	1		0.0213	10.11	15.67
		1	2		0.0058	2.73	9.24

Cointegration Results of Levels Using SBC (Series in Levels)

	Test Type	H0: Rank=r	H1: Rank>r	No. of Lags	Eigenvalue	Statistic	5% Critical Value
O Sunflower Seeds	Trace Test:	0	0	19	0.0190	8.58	19.99
Sunflower Seeds		1	1		0.0054	1.90	9.13
	Max Test:	0	1		0.0190	6.68	15.67
		1	2		0.0054	1.90	9.24
O Sunflower Seeds	Trace Test:	0	0	2	0.0390	6.59	19.99
Sunflower Seeds, Sun		1	1		0.0045	0.66	9.13
	Max Test:	0	1		0.0390	5.93	15.67
		1	2		0.0045	0.66	9.24
O Sunflower Seeds	Trace Test:	0	0	16	0.0316	15.23	19.99
Sunflower Meal		1	1		0.0111	3.93	9.13
	Max Test:	0	1		0.0316	11.30	15.67
		1	2		0.0111	3.93	9.24
O Wheat, Durum	Trace Test:	0	0	1	0.0300	19.27	19.99
Wheat, Hard Amber Durum No.1		1	1		0.0104	4.92	9.13
	Max Test:	0	1		0.0300	14.35	15.67
		1	2		0.0104	4.92	9.24
O Soft Winter Wheat	Trace Test:	0	0	1	0.0201	8.39	19.99
Soft Winter Wheat, No.1		1	1		0.0064	2.01	9.13
	Max Test:	0	1		0.0201	6.38	15.67
		1	2		0.0064	2.01	9.24
O Soft Red Wheat	Trace Test:	0	0	2	0.0182	8.75	19.99
Soft Red Winter Wheat, No.2		1	1		0.0076	2.57	9.13
	Max Test:	0	1		0.0182	6.18	15.67
		1	2		0.0076	2.57	9.24

APPENDIX C: ERROR CORRECTION VAR ESTIMATES

For the results in Appendices C and D, the first sets of L's in the parameter estimates represent the lags of the dependent variable (the first variable listed for each set of results). The second sets of L's represent the lags of the independent variable.

O Barley - Barley (Feed)

D.F. Model	D.F. Error	SSE	MSE	Root MSE	R-Sq.	Adj. R-Sq.
10	457	3.0799	0.0067	0.08	0.0282	0.0091

Parameter	Estimate	Std. Error	t-value	Pr > t
b0	-0.0003	0.0038	-0.08	0.9380
Spd. of Adj.	-0.0062	0.0039	-1.60	0.1111
L1	-0.0010	0.0467	-0.02	0.9822
L2	-0.0012	0.0461	-0.03	0.9797
L3	-0.1471	0.0461	-3.19	0.0015
L4	-0.0065	0.0467	-0.14	0.8898
L1	-0.0070	0.0141	-0.49	0.6225
L2	-0.0030	0.0148	-0.20	0.8414
L3	-0.0015	0.0141	-0.11	0.9130
L4	-0.0022	0.0119	-0.18	0.8560

Barley (Feed) - O Barley

D.F. Model	D.F. Error	SSE	MSE	Root MSE	R-Sq.	Adj. R-Sq.
10	457	46.3687	0.1015	0.32	0.3890	0.3770

Parameter	Estimate	Std. Error	t-value	Pr > t
b0	-0.0024	0.0148	-0.16	0.8713
Spd. of Adj.	0.0498	0.0151	3.29	0.0011
L1	0.0265	0.1811	0.15	0.8839
L2	-0.1336	0.1789	-0.75	0.4556
L3	0.2186	0.1790	1.22	0.2226
L4	0.0438	0.1813	0.24	0.8093
L1	-0.6300	0.0548	-11.49	<.0001
L2	-0.4308	0.0575	-7.50	<.0001
L3	-0.3908	0.0548	-7.13	<.0001
L4	-0.1726	0.0462	-3.73	0.0002

O Barley - Barley (Malting)

D.F. Model	D.F. Error	SSE	MSE	Root MSE	R-Sq.	Adj. R-Sq.
8	460	3.0723	0.0067	0.08	0.0306	0.0159

Parameter	Estimate	Std. Error	t-value	Pr > t
b0	-0.0004	0.0038	-0.11	0.9143
Spd. of Adj.	-0.0029	0.0039	-0.73	0.4634
L1	-0.0008	0.0460	-0.02	0.9854
L2	-0.0017	0.0460	-0.04	0.9703
L3	-0.1544	0.0461	-3.35	0.0009
L1	-0.0054	0.0131	-0.41	0.6831
L2	-0.0071	0.0135	-0.53	0.5991
L3	-0.0244	0.0127	-1.92	0.0560

Barley (Malting) - O Barley

D.F. Model	D.F. Error	SSE	MSE	Root MSE	R-Sq.	Adj. R-Sq.
8	460	39.3224	0.0855	0.29	0.1910	0.1787

Parameter	Estimate	Std. Error	t-value	Pr > t
b0	-0.0018	0.0137	-0.13	0.8974
Spd. of Adj.	0.0545	0.0139	3.92	0.0001
L1	0.0897	0.1645	0.55	0.5857
L2	-0.2421	0.1645	-1.47	0.1419
L3	0.3070	0.1649	1.86	0.0633
L1	-0.3562	0.0469	-7.59	<.0001
L2	-0.2200	0.0483	-4.56	<.0001
L3	-0.1090	0.0455	-2.40	0.0170

O Beans, Black Turtle - Beans, Black

D.F. Model	D.F. Error	SSE	MSE	Root MSE	R-Sq.	Adj. R-Sq.
12	347	0.0463	0.0001	0.01	0.0370	0.0065

Parameter	Estimate	Std. Error	t-value	Pr > t
b0	0.0000	0.0006	0.00	0.9982
Spd. of Adj.	-0.0015	0.0007	-2.32	0.0207
L1	-0.0084	0.0531	-0.16	0.8745
L2	0.0007	0.0531	0.01	0.9889
L3	-0.0477	0.0462	-1.03	0.3023
L4	-0.0108	0.0462	-0.23	0.8158
L5	-0.0072	0.0462	-0.16	0.8759
L1	0.2770	0.1306	2.12	0.0346
L2	0.1153	0.1224	0.94	0.3470
L3	-0.0107	0.1094	-0.10	0.9218
L4	-0.0410	0.0860	-0.48	0.6337
L5	-0.0419	0.0560	-0.75	0.4551

Beans, Black - O Beans, Black Turtle

D.F. Model	D.F. Error	SSE	MSE	Root MSE	R-Sq.	Adj. R-Sq.
12	347	0.0405	0.0001	0.01	0.5727	0.5591

Parameter	Estimate	Std. Error	t-value	Pr > t
b0	0.0000	0.0006	0.07	0.9403
Spd. of Adj.	-0.0036	0.0006	-5.97	<.0001
L1	0.0464	0.0497	0.93	0.3508
L2	-0.1084	0.0497	-2.18	0.0298
L3	0.0034	0.0432	0.08	0.9371
L4	-0.0045	0.0432	-0.10	0.9175
L5	0.0340	0.0432	0.79	0.4318
L1	-0.3440	0.1222	-2.82	0.0051
L2	-0.3427	0.1145	-2.99	0.0030
L3	-0.1742	0.1023	-1.70	0.0897
L4	-0.0614	0.0805	-0.76	0.4460
L5	-0.0148	0.0524	-0.28	0.7777

O Beans, Great Northern - Beans, Great Northern

D.F. Model	D.F. Error	SSE	MSE	Root MSE	R-Sq.	Adj. R-Sq.
6	463	0.0749	0.0002	0.01	0.0180	0.0074

Parameter	Estimate	Std. Error	t-value	Pr > t
b0	-0.0003	0.0006	-0.42	0.6763
Spd. of Adj.	0.0011	0.0006	1.79	0.0744
L1	-0.0006	0.0464	-0.01	0.9900
L2	-0.0036	0.0461	-0.08	0.9380
L1	0.1280	0.0897	1.43	0.1544
L2	-0.0368	0.0872	-0.42	0.6728

Beans, Great Northern - O Beans, Great Northern

D.F. Model	D.F. Error	SSE	MSE	Root MSE	R-Sq.	Adj. R-Sq.
6	463	0.0213	0.0000	0.01	0.1787	0.1699

Parameter	Estimate	Std. Error	t-value	Pr > t
b0	-0.0001	0.0003	-0.23	0.8144
Spd. of Adj.	-0.0009	0.0003	-2.84	0.0047
L1	0.0307	0.0248	1.24	0.2164
L2	-0.0022	0.0246	-0.09	0.9282
L1	-0.3933	0.0479	-8.22	<.0001
L2	-0.1534	0.0465	-3.30	0.0010

O Beans, Dark Red Kidney - Beans, Dark Red Kidney

D.F. Model	D.F. Error	SSE	MSE	Root MSE	R-Sq.	Adj. R-Sq.
6	463	0.0813	0.0002	0.01	0.0240	0.0135

Parameter	Estimate	Std. Error	t-value	Pr > t
b0	0.0000	0.0006	0.01	0.9896
Spd. of Adj.	-0.0021	0.0006	-3.28	0.0011
L1	-0.0100	0.0462	-0.22	0.8297
L2	0.0002	0.0462	0.00	0.9971
L1	-0.0245	0.0494	-0.50	0.6204
L2	-0.0165	0.0494	-0.33	0.7381

Beans, Dark Red Kidney - O Beans, Dark Red Kidney

D.F. Model	D.F. Error	SSE	MSE	Root MSE	R-Sq.	Adj. R-Sq.
6	463	0.0708	0.0002	0.01	0.0987	0.0890

Parameter	Estimate	Std. Error	t-value	Pr > t
b0	0.0000	0.0006	0.04	0.9672
Spd. of Adj.	-0.0009	0.0006	-1.48	0.1403
L1	-0.0190	0.0432	-0.44	0.6595
L2	0.0240	0.0431	0.56	0.5779
L1	-0.2375	0.0461	-5.15	<.0001
L2	0.1368	0.0461	2.97	0.0032

O Beans, Pinto - Beans, Pinto

D.F. Model	D.F. Error	SSE	MSE	Root MSE	R-Sq.	Adj. R-Sq.
6	463	0.0660	0.0001	0.01	0.0270	0.0165

Parameter	Estimate	Std. Error	t-value	Pr > t
b0	0.0001	0.0006	0.09	0.9259
Spd. of Adj.	-0.0017	0.0006	-3.00	0.0029
L1	0.1014	0.0466	2.18	0.0300
L2	0.0078	0.0440	0.18	0.8589
L1	0.0316	0.0922	0.34	0.7319
L2	-0.0217	0.0920	-0.24	0.8138

Beans, Pinto - O Beans, Pinto

D.F. Model	D.F. Error	SSE	MSE	Root MSE	R-Sq.	Adj. R-Sq.
6	463	0.0159	0.0000	0.01	0.1074	0.0977

Parameter	Estimate	Std. Error	t-value	Pr > t
b0	0.0000	0.0003	-0.08	0.9354
Spd. of Adj.	-0.0007	0.0003	-2.48	0.0137
L1	0.0107	0.0229	0.47	0.6394
L2	-0.0171	0.0216	-0.79	0.4307
L1	0.1544	0.0453	3.40	0.0007
L2	0.2135	0.0453	4.72	<.0001

O Corn, Yellow - Corn, Yellow

D.F. Model	D.F. Error	SSE	MSE	Root MSE	R-Sq.	Adj. R-Sq.
6	463	8.9703	0.0194	0.14	0.0242	0.0137

Parameter	Estimate	Std. Error	t-value	Pr > t
b0	-0.0006	0.0065	-0.09	0.9298
Spd. of Adj.	-0.0128	0.0067	-1.90	0.0581
L1	-0.0680	0.0462	-1.47	0.1416
L2	-0.0637	0.0449	-1.42	0.1572
L1	-0.0495	0.0203	-2.45	0.0148
L2	-0.0181	0.0186	-0.97	0.3328

Corn, Yellow - O Corn, Yellow

D.F. Model	D.F. Error	SSE	MSE	Root MSE	R-Sq.	Adj. R-Sq.
6	463	59.8648	0.1293	0.36	0.3463	0.3392

Parameter	Estimate	Std. Error	t-value	Pr > t
b0	-0.0024	0.0167	-0.14	0.8874
Spd. of Adj.	0.0739	0.0174	4.24	<.0001
L1	0.0797	0.1194	0.67	0.5046
L2	0.0510	0.1161	0.44	0.6606
L1	-0.5383	0.0523	-10.29	<.0001
L2	-0.1243	0.0481	-2.58	0.0101

O Flax - Flaxseed

D.F. Model	D.F. Error	SSE	MSE	Root MSE	R-Sq.	Adj. R-Sq.
42	93	48.9275	0.5261	0.73	0.3925	0.1247

Parameter	Estimate	Std. Error	t-value	Pr > t
b0	0.0073	0.0676	0.11	0.9141
Spd. of Adj.	0.2401	0.0704	3.41	0.0010
L1	0.1473	0.1005	1.47	0.1460
L2	0.0150	0.0906	0.17	0.8689
L3	0.0241	0.0866	0.28	0.7813
L4	0.0508	0.0867	0.59	0.5595
L5	-0.0145	0.0869	-0.17	0.8678
L6	0.1694	0.0857	1.98	0.0512
L7	0.0302	0.0843	0.36	0.7210
L8	0.0698	0.0839	0.83	0.4079
L9	0.0970	0.0828	1.17	0.2440
L10	0.0267	0.0824	0.32	0.7464
L11	0.1031	0.0821	1.26	0.2126
L12	0.0472	0.0845	0.56	0.5776
L13	0.1375	0.0846	1.63	0.1074
L14	0.1606	0.0866	1.85	0.0668
L15	0.0851	0.0891	0.95	0.3422
L16	0.1543	0.0900	1.71	0.0899
L17	0.0980	0.0928	1.06	0.2936
L18	-0.1032	0.0961	-1.07	0.2855
L19	0.0488	0.0961	0.51	0.6132
L20	-0.0084	0.0633	-0.13	0.8944
L1	0.3435	0.2006	1.71	0.0902
L2	0.0674	0.2039	0.33	0.7415
L3	0.3115	0.2041	1.53	0.1304
L4	0.3604	0.2031	1.77	0.0792
L5	0.1191	0.1962	0.61	0.5451
L6	0.1588	0.1804	0.88	0.3808
L7	0.0584	0.1697	0.34	0.7314
L8	0.1515	0.1684	0.90	0.3707
L9	0.0447	0.1682	0.27	0.7911
L10	-0.0788	0.1686	-0.47	0.6414
L11	0.1958	0.1686	1.16	0.2485
L12	0.1337	0.1753	0.76	0.4474
L13	0.7299	0.1729	4.22	<.0001
L14	0.4149	0.1891	2.19	0.0307
L15	0.4023	0.1910	2.11	0.0378
L16	0.4347	0.1969	2.21	0.0297
L17	0.2987	0.1976	1.51	0.1340
L18	0.5596	0.1981	2.83	0.0058
L19	-0.3533	0.1987	-1.78	0.0787
L20	0.2261	0.2059	1.10	0.2750

Flaxseed - O Flax

D.F. Model	D.F. Error	SSE	MSE	Root MSE	R-Sq.	Adj. R-Sq.
42	93	14.1390	0.1520	0.39	0.4092	0.1487

Parameter	Estimate	Std. Error	t-value	Pr > t
b0	0.0114	0.0363	0.31	0.7547
Spd. of Adj.	-0.0200	0.0379	-0.53	0.5985
L1	0.0086	0.0540	0.16	0.8742
L2	0.0086	0.0487	0.18	0.8607
L3	-0.0062	0.0466	-0.13	0.8941
L4	-0.0179	0.0466	-0.38	0.7017
L5	0.0067	0.0467	0.14	0.8860
L6	0.0317	0.0461	0.69	0.4927
L7	0.0772	0.0453	1.70	0.0917
L8	0.0433	0.0451	0.96	0.3396
L9	0.0246	0.0445	0.55	0.5824
L10	-0.0396	0.0443	-0.89	0.3740
L11	-0.0292	0.0441	-0.66	0.5105
L12	0.0123	0.0454	0.27	0.7877
L13	-0.0407	0.0455	-0.90	0.3725
L14	0.0996	0.0465	2.14	0.0349
L15	-0.0422	0.0479	-0.88	0.3811
L16	-0.1160	0.0484	-2.40	0.0185
L17	0.1018	0.0499	2.04	0.0440
L18	0.0373	0.0517	0.72	0.4722
L19	0.0143	0.0517	0.28	0.7823
L20	-0.0065	0.0340	-0.19	0.8493
L1	-0.1538	0.1079	-1.43	0.1574
L2	-0.1131	0.1096	-1.03	0.3048
L3	-0.0115	0.1097	-0.10	0.9166
L4	0.0073	0.1092	0.07	0.9470
L5	0.0659	0.1055	0.63	0.5335
L6	-0.0025	0.0970	-0.03	0.9796
L7	0.0663	0.0912	0.73	0.4692
L8	0.1924	0.0905	2.13	0.0362
L9	-0.1501	0.0904	-1.66	0.1001
L10	-0.1805	0.0906	-1.99	0.0493
L11	-0.0830	0.0906	-0.92	0.3625
L12	-0.0501	0.0942	-0.53	0.5962
L13	-0.0172	0.0929	-0.18	0.8540
L14	0.0413	0.1017	0.41	0.6854
L15	-0.1419	0.1026	-1.38	0.1701
L16	-0.0585	0.1058	-0.55	0.5815
L17	0.0445	0.1062	0.42	0.6764
L18	0.0106	0.1065	0.10	0.9210
L19	-0.0830	0.1068	-0.78	0.4392
L20	0.1471	0.1107	1.33	0.1870

O Millet - Millet

D.F. Model	D.F. Error	SSE	MSE	Root MSE	R-Sq.	Adj. R-Sq.
16	448	0.6425	0.0014	0.04	0.1025	0.0724

Parameter	Estimate	Std. Error	t-value	Pr > t
b0	-0.0009	0.0018	-0.49	0.6274
Spd. of Adj.	-0.0008	0.0018	-0.43	0.6701
L1	-0.0439	0.0472	-0.93	0.3529
L2	0.0013	0.0458	0.03	0.9780
L3	-0.0117	0.0452	-0.26	0.7952
L4	0.0021	0.0452	0.05	0.9629
L5	-0.1558	0.0452	-3.44	0.0006
L6	-0.2487	0.0455	-5.47	<.0001
L7	-0.0146	0.0469	-0.31	0.7564
L1	1.2729	0.8529	1.49	0.1363
L2	1.2330	0.8278	1.49	0.1370
L3	0.2035	0.8032	0.25	0.8001
L4	0.4394	0.7641	0.58	0.5655
L5	0.4503	0.6945	0.65	0.5171
L6	0.3257	0.5948	0.55	0.5842
L7	0.5249	0.4644	1.13	0.2590

Millet - O Millet

D.F. Model	D.F. Error	SSE	MSE	Root MSE	R-Sq.	Adj. R-Sq.
16	448	0.0068	0.0000	0.00	0.4073	0.3874

Parameter	Estimate	Std. Error	t-value	Pr > t
b0	0.0000	0.0002	-0.03	0.9765
Spd. of Adj.	-0.0012	0.0002	-6.56	<.0001
L1	0.0015	0.0048	0.31	0.7595
L2	0.0005	0.0047	0.12	0.9084
L3	-0.0021	0.0046	-0.45	0.6526
L4	-0.0017	0.0046	-0.37	0.7099
L5	0.0009	0.0046	0.20	0.8390
L6	0.0009	0.0047	0.20	0.8422
L7	-0.0041	0.0048	-0.86	0.3906
L1	-0.2167	0.0874	-2.48	0.0135
L2	-0.1970	0.0848	-2.32	0.0207
L3	-0.1041	0.0823	-1.26	0.2067
L4	0.0389	0.0783	0.50	0.6196
L5	0.0947	0.0712	1.33	0.1841
L6	0.0785	0.0610	1.29	0.1982
L7	0.0332	0.0476	0.70	0.4862

O Peas, Dry Split Green - Peas, Whole Green

D.F. Model	D.F. Error	SSE	MSE	Root MSE	R-Sq.	Adj. R-Sq.
4	455	0.0151	0.0000	0.01	0.0007	-0.0058

Parameter	Estimate	Std. Error	t-value	Pr > t
b0	-0.0001	0.0003	-0.38	0.7029
Spd. of Adj.	-0.0002	0.0003	-0.54	0.5912
L1	0.0004	0.0469	0.01	0.9936
L1	-0.0206	0.0816	-0.25	0.8009

Peas, Whole Green - O Peas, Dry Split Green

D.F. Model	D.F. Error	SSE	MSE	Root MSE	R-Sq.	Adj. R-Sq.
4	455	0.0048	0.0000	0.00	0.0437	0.0374

Parameter	Estimate	Std. Error	t-value	Pr > t
b0	0.0000	0.0002	0.02	0.9831
Spd. of Adj.	-0.0006	0.0002	-3.86	0.0001
L1	0.0198	0.0264	0.75	0.4537
L1	-0.1177	0.0459	-2.56	0.0107

O Peas, Dry Split Green - Peas, Whole Yellow

D.F. Model	D.F. Error	SSE	MSE	Root MSE	R-Sq.	Adj. R-Sq.
6	452	0.0151	0.0000	0.01	0.0000	-0.0110

Parameter	Estimate	Std. Error	t-value	Pr > t
b0	-0.0002	0.0003	-0.59	0.5549
Spd. of Adj.	0.0000	0.0003	0.03	0.9762
L1	-0.0008	0.0471	-0.02	0.9867
L2	-0.0010	0.0471	-0.02	0.9832
L1	0.0035	0.0557	0.06	0.9501
L2	-0.0029	0.0554	-0.05	0.9588

Peas, Whole Yellow - O Peas, Dry Split Green

D.F. Model	D.F. Error	SSE	MSE	Root MSE	R-Sq.	Adj. R-Sq.
6	452	0.0102	0.0000	0.00	0.1646	0.1553

Parameter	Estimate	Std. Error	t-value	Pr > t
b0	0.0000	0.0002	-0.11	0.9098
Spd. of Adj.	-0.0010	0.0002	-4.04	<.0001
L1	0.0106	0.0388	0.27	0.7844
L2	0.0336	0.0388	0.87	0.3869
L1	-0.3681	0.0458	-8.03	<.0001
L2	-0.1540	0.0456	-3.37	0.0008

O Peas, Dry Split Green - Peas, Split Yellow

D.F. Model	D.F. Error	SSE	MSE	Root MSE	R-Sq.	Adj. R-Sq.
6	450	0.0149	0.0000	0.01	0.0098	-0.0013

Parameter	Estimate	Std. Error	t-value	Pr > t
b0	-0.0001	0.0003	-0.44	0.6585
Spd. of Adj.	-0.0002	0.0003	-0.64	0.5210
L1	0.0038	0.0472	0.08	0.9358
L2	0.0007	0.0470	0.01	0.9887
L1	-0.1307	0.0676	-1.93	0.0537
L2	0.0225	0.0678	0.33	0.7397

Peas, Split Yellow - O Peas, Dry Split Green

D.F. Model	D.F. Error	SSE	MSE	Root MSE	R-Sq.	Adj. R-Sq.
6	450	0.0071	0.0000	0.00	0.0419	0.0312

Parameter	Estimate	Std. Error	t-value	Pr > t
b0	0.0000	0.0002	0.11	0.9115
Spd. of Adj.	-0.0007	0.0002	-3.63	0.0003
L1	0.0050	0.0325	0.15	0.8776
L2	0.0128	0.0323	0.40	0.6923
L1	-0.1236	0.0465	-2.66	0.0081
L2	-0.0219	0.0466	-0.47	0.6386

O Rye - Rye, No.1

D.F. Model	D.F. Error	SSE	MSE	Root MSE	R-Sq.	Adj. R-Sq.
6	425	0.3300	0.0008	0.03	0.0000	-0.0118

Parameter	Estimate	Std. Error	t-value	Pr > t
b0	0.0002	0.0013	0.17	0.8628
Spd. of Adj.	0.0000	0.0016	0.01	0.9938
L1	-0.0001	0.0485	0.00	0.9989
L2	-0.0001	0.0485	0.00	0.9988
L1	-0.0001	0.0161	-0.01	0.9952
L2	-0.0001	0.0127	0.00	0.9967

Rye, No.1 - O Rye

D.F. Model	D.F. Error	SSE	MSE	Root MSE	R-Sq.	Adj. R-Sq.
6	425	4.6854	0.0110	0.11	0.4129	0.4060

Parameter	Estimate	Std. Error	t-value	Pr > t
b0	0.0002	0.0051	0.03	0.9746
Spd. of Adj.	-0.0640	0.0059	-10.82	<.0001
L1	0.0412	0.1828	0.23	0.8219
L2	-0.7266	0.1828	-3.97	<.0001
L1	-0.0304	0.0606	-0.50	0.6164
L2	-0.0100	0.0477	-0.21	0.8346

O Rye - Rye, No.2

D.F. Model	D.F. Error	SSE	MSE	Root MSE	R-Sq.	Adj. R-Sq.
24	436	0.3374	0.0008	0.03	0.0078	-0.0445

Parameter	Estimate	Std. Error	t-value	Pr > t
b0	0.0000	0.0013	-0.03	0.9784
Spd. of Adj.	-0.0007	0.0014	-0.48	0.6318
L1	0.0011	0.0479	0.02	0.9812
L2	0.0004	0.0307	0.01	0.9890
L3	-0.0007	0.0307	-0.02	0.9816
L4	-0.0007	0.0307	-0.02	0.9808
L5	-0.0026	0.0312	-0.08	0.9347
L6	0.0051	0.0319	0.16	0.8736
L7	0.0172	0.0319	0.54	0.5895
L8	-0.0123	0.0319	-0.39	0.6995
L9	0.0110	0.0319	0.34	0.7306
L10	-0.0005	0.0319	-0.02	0.9872
L11	-0.0036	0.0319	-0.11	0.9101
L1	0.0198	0.0338	0.59	0.5585
L2	0.0150	0.0321	0.47	0.6406
L3	0.0024	0.0302	0.08	0.9365
L4	0.0171	0.0286	0.60	0.5508
L5	0.0060	0.0272	0.22	0.8263
L6	-0.0034	0.0255	-0.13	0.8939
L7	-0.0030	0.0239	-0.12	0.9015
L8	-0.0012	0.0218	-0.05	0.9566
L9	-0.0015	0.0194	-0.07	0.9407
L10	-0.0014	0.0166	-0.08	0.9344
L11	0.0004	0.0128	0.03	0.9721

Rye, No.2 - O Rye

D.F. Model	D.F. Error	SSE	MSE	Root MSE	R-Sq.	Adj. R-Sq.
24	436	4.3422	0.0100	0.10	0.4730	0.4452

Parameter	Estimate	Std. Error	t-value	Pr > t
b0	0.0002	0.0047	0.05	0.9602
Spd. of Adj.	-0.0288	0.0049	-5.95	<.0001
L1	0.0303	0.1719	0.18	0.8599
L2	-0.0942	0.1101	-0.86	0.3923
L3	0.0086	0.1101	0.08	0.9378
L4	0.4201	0.1101	3.82	0.0002
L5	-0.5001	0.1119	-4.47	<.0001
L6	0.0669	0.1143	0.59	0.5587
L7	0.0159	0.1144	0.14	0.8893
L8	-0.0038	0.1144	-0.03	0.9738
L9	-0.0125	0.1143	-0.11	0.9130
L10	-0.1299	0.1143	-1.14	0.2561
L11	-0.1459	0.1144	-1.28	0.2027
L1	-0.0451	0.1212	-0.37	0.7101
L2	-0.0034	0.1151	-0.03	0.9763
L3	0.0045	0.1085	0.04	0.9671
L4	0.0148	0.1027	0.14	0.8854
L5	0.0767	0.0977	0.79	0.4329
L6	0.0304	0.0916	0.33	0.7400
L7	0.0823	0.0857	0.96	0.3375
L8	0.0114	0.0782	0.15	0.8847
L9	-0.0596	0.0698	-0.85	0.3937
L10	-0.0546	0.0597	-0.92	0.3606
L11	0.0070	0.0460	0.15	0.8785

O Soybeans, Clear Hilum - Soybeans, No.1

D.F. Model	D.F. Error	SSE	MSE	Root MSE	R-Sq.	Adj. R-Sq.
8	460	182.7000	0.3972	0.63	0.0947	0.0809

Parameter	Estimate	Std. Error	t-value	Pr > t
b0	-0.0028	0.0291	-0.09	0.9249
Spd. of Adj.	0.1223	0.0301	4.06	<.0001
L1	-0.0434	0.0458	-0.95	0.3439
L2	-0.2026	0.0445	-4.56	<.0001
L3	-0.0392	0.0454	-0.86	0.3880
L1	-0.1065	0.0364	-2.93	0.0036
L2	-0.1217	0.0382	-3.18	0.0016
L3	-0.0074	0.0315	-0.23	0.8156

Soybeans, No.1 - O Soybeans, Clear Hilum

D.F. Model	D.F. Error	SSE	MSE	Root MSE	R-Sq.	Adj. R-Sq.
8	460	415.8000	0.9038	0.95	0.3674	0.3578

Parameter	Estimate	Std. Error	t-value	Pr > t
b0	-0.0060	0.0440	-0.14	0.8911
Spd. of Adj.	-0.1494	0.0454	-3.29	0.0011
L1	0.0028	0.0691	0.04	0.9681
L2	-0.0009	0.0671	-0.01	0.9892
L3	-0.0037	0.0685	-0.05	0.9564
L1	-0.6232	0.0549	-11.36	<.0001
L2	-0.3311	0.0577	-5.74	<.0001
L3	-0.0992	0.0476	-2.08	0.0377

O Soybeans, Clear Hilum - Soybeans, No.2

D.F. Model	D.F. Error	SSE	MSE	Root MSE	R-Sq.	Adj. R-Sq.
4	466	200.8000	0.4310	0.66	0.0050	-0.0014

Parameter	Estimate	Std. Error	t-value	Pr > t
b0	-0.0057	0.0308	-0.18	0.8544
Spd. of Adj.	0.0331	0.0310	1.07	0.2854
L1	-0.0434	0.0466	-0.93	0.3521
L1	0.1151	0.1593	0.72	0.4704

Soybeans, No.2 - O Soybeans, Clear Hilum

D.F. Model	D.F. Error	SSE	MSE	Root MSE	R-Sq.	Adj. R-Sq.
4	466	16.1461	0.0346	0.19	0.0590	0.0529

Parameter	Estimate	Std. Error	t-value	Pr > t
b0	0.0002	0.0087	0.02	0.9828
Spd. of Adj.	-0.0196	0.0088	-2.23	0.0263
L1	-0.0125	0.0132	-0.95	0.3427
L1	0.2237	0.0452	4.95	<.0001

O Soybeans, Clear Hilum - Soybean Oil

D.F. Model	D.F. Error	SSE	MSE	Root MSE	R-Sq.	Adj. R-Sq.
6	463	184.8000	0.3990	0.63	0.0847	0.0748

Parameter	Estimate	Std. Error	t-value	Pr > t
b0	0.0001	0.0292	0.00	0.9972
Spd. of Adj.	0.0968	0.0297	3.26	0.0012
L1	-0.0303	0.0452	-0.67	0.5026
L2	-0.2009	0.0452	-4.45	<.0001
L1	-0.0035	0.0503	-0.07	0.9440
L2	0.1240	0.0506	2.45	0.0147

Soybean Oil - O Soybeans, Clear Hilum

D.F. Model	D.F. Error	SSE	MSE	Root MSE	R-Sq.	Adj. R-Sq.
6	463	161.1000	0.3479	0.59	0.0704	0.0603

Parameter	Estimate	Std. Error	t-value	Pr > t
b0	-0.0022	0.0272	-0.08	0.9344
Spd. of Adj.	0.0078	0.0277	0.28	0.7796
L1	-0.0381	0.0422	-0.90	0.3671
L2	-0.0216	0.0422	-0.51	0.6093
L1	0.2572	0.0470	5.48	<.0001
L2	0.0179	0.0473	0.38	0.7051

O Soybeans, Clear Hilum - Soybean Meal 46.5%

D.F. Model	D.F. Error	SSE	MSE	Root MSE	R-Sq.	Adj. R-Sq.
18	434	173.8000	0.4005	0.63	0.5725	0.5558

Parameter	Estimate	Std. Error	t-value	Pr > t
b0	-0.0038	0.0299	-0.13	0.8994
Spd. of Adj.	-0.2555	0.0323	-7.90	<.0001
L1	0.4306	0.1813	2.37	0.0180
L2	0.1737	0.1665	1.04	0.2974
L3	0.0870	0.1504	0.58	0.5634
L4	0.0651	0.1322	0.49	0.6226
L5	-0.0281	0.1135	-0.25	0.8043
L6	-0.0038	0.0926	-0.04	0.9672
L7	-0.0155	0.0687	-0.23	0.8217
L8	-0.0138	0.0468	-0.30	0.7679
L1	0.0037	0.0031	1.21	0.2270
L2	0.0027	0.0031	0.88	0.3796
L3	0.0018	0.0031	0.59	0.5545
L4	-0.0004	0.0031	-0.13	0.9003
L5	0.0019	0.0031	0.61	0.5454
L6	-0.0036	0.0031	-1.18	0.2393
L7	-0.0080	0.0031	-2.58	0.0103
L8	-0.0002	0.0031	-0.05	0.9619

Soybean Meal 46.5% - O Soybeans, Clear Hilum

D.F. Model	D.F. Error	SSE	MSE	Root MSE	R-Sq.	Adj. R-Sq.
18	434	41981.7000	96.7320	9.84	0.1038	0.0687

Parameter	Estimate	Std. Error	t-value	Pr > t
b0	-0.2638	0.4648	-0.57	0.5706
Spd. of Adj.	0.5525	0.5026	1.10	0.2723
L1	-3.3660	2.8181	-1.19	0.2330
L2	-3.2345	2.5874	-1.25	0.2119
L3	-3.2382	2.3378	-1.39	0.1667
L4	-2.3691	2.0546	-1.15	0.2495
L5	-2.4021	1.7639	-1.36	0.1740
L6	-1.4582	1.4385	-1.01	0.3113
L7	-0.0244	1.0683	-0.02	0.9818
L8	0.1444	0.7266	0.20	0.8426
L1	0.0417	0.0480	0.87	0.3856
L2	0.0192	0.0480	0.40	0.6895
L3	-0.0531	0.0478	-1.11	0.2672
L4	-0.2240	0.0478	-4.68	<.0001
L5	-0.0300	0.0478	-0.63	0.5310
L6	0.0407	0.0478	0.85	0.3950
L7	0.0350	0.0479	0.73	0.4652
L8	0.0781	0.0484	1.62	0.1068

O Soybeans, Vinton - Soybeans, No.1

D.F. Model	D.F. Error	SSE	MSE	Root MSE	R-Sq.	Adj. R-Sq.
8	460	83.1772	0.1808	0.43	0.0437	0.0291

Parameter	Estimate	Std. Error	t-value	Pr > t
b0	-0.0041	0.0197	-0.21	0.8363
Spd. of Adj.	0.0538	0.0201	2.68	0.0077
L1	-0.0967	0.0461	-2.10	0.0364
L2	0.0456	0.0462	0.99	0.3244
L3	-0.0601	0.0459	-1.31	0.1918
L1	0.0074	0.0241	0.31	0.7594
L2	-0.0130	0.0255	-0.51	0.6098
L3	-0.0140	0.0210	-0.67	0.5050

Soybeans, No.1 - O Soybeans, Vinton

D.F. Model	D.F. Error	SSE	MSE	Root MSE	R-Sq.	Adj. R-Sq.
8	460	414.9000	0.9020	0.95	0.3687	0.3590

Parameter	Estimate	Std. Error	t-value	Pr > t
b0	-0.0050	0.0439	-0.11	0.9093
Spd. of Adj.	-0.1530	0.0449	-3.40	0.0007
L1	0.0233	0.1029	0.23	0.8210
L2	0.0480	0.1033	0.46	0.6422
L3	0.0131	0.1026	0.13	0.8988
L1	-0.6256	0.0539	-11.62	<.0001
L2	-0.3365	0.0569	-5.92	<.0001
L3	-0.1062	0.0469	-2.26	0.0240

O Soybeans, Vinton - Soybean Meal 44%

D.F. Model	D.F. Error	SSE	MSE	Root MSE	R-Sq.	Adj. R-Sq.
18	435	78.7479	0.1810	0.43	0.0809	0.0450

Parameter	Estimate	Std. Error	t-value	Pr > t
b0	-0.0066	0.0203	-0.32	0.7470
Spd. of Adj.	-0.0382	0.0206	-1.85	0.0645
L1	-0.1022	0.0480	-2.13	0.0340
L2	0.0228	0.0477	0.48	0.6335
L3	-0.0360	0.0477	-0.75	0.4512
L4	0.0709	0.0474	1.50	0.1356
L5	-0.0965	0.0475	-2.03	0.0427
L6	-0.0688	0.0479	-1.44	0.1515
L7	-0.1361	0.0479	-2.84	0.0047
L8	0.0485	0.0480	1.01	0.3126
L1	0.0031	0.0018	1.74	0.0818
L2	0.0008	0.0018	0.43	0.6658
L3	-0.0023	0.0018	-1.30	0.1927
L4	0.0008	0.0018	0.43	0.6709
L5	-0.0002	0.0018	-0.10	0.9228
L6	0.0004	0.0018	0.22	0.8274
L7	-0.0018	0.0018	-1.02	0.3091
L8	0.0012	0.0018	0.68	0.4937

Soybean Meal 44% - O Soybeans, Vinton

D.F. Model	D.F. Error	SSE	MSE	Root MSE	R-Sq.	Adj. R-Sq.
18	435	56722.2000	130.4000	11.42	0.0861	0.0503

Parameter	Estimate	Std. Error	t-value	Pr > t
b0	-0.0961	0.5446	-0.18	0.8601
Spd. of Adj.	2.0727	0.5538	3.74	0.0002
L1	0.7527	1.2896	0.58	0.5597
L2	2.3349	1.2809	1.82	0.0690
L3	0.3062	1.2813	0.24	0.8112
L4	-0.4754	1.2733	-0.37	0.7091
L5	2.6599	1.2737	2.09	0.0373
L6	1.4846	1.2844	1.16	0.2484
L7	0.8815	1.2864	0.69	0.4936
L8	1.8057	1.2873	1.40	0.1614
L1	-0.0714	0.0475	-1.50	0.1334
L2	-0.0367	0.0478	-0.77	0.4429
L3	-0.0563	0.0477	-1.18	0.2385
L4	-0.1371	0.0476	-2.88	0.0042
L5	-0.0505	0.0474	-1.06	0.2876
L6	0.0570	0.0473	1.20	0.2289
L7	0.0248	0.0473	0.52	0.6003
L8	0.0209	0.0471	0.44	0.6573

O Soybeans, Vinton - Soybean Meal 46.5%

D.F. Model	D.F. Error	SSE	MSE	Root MSE	R-Sq.	Adj. R-Sq.
22	428	77.0060	0.1799	0.42	0.0906	0.0460

Parameter	Estimate	Std. Error	t-value	Pr > t
b0	-0.0024	0.0203	-0.12	0.9078
Spd. of Adj.	-0.0442	0.0207	-2.14	0.0330
L1	-0.1076	0.0483	-2.23	0.0264
L2	0.0202	0.0482	0.42	0.6758
L3	-0.0302	0.0484	-0.62	0.5329
L4	0.0761	0.0478	1.59	0.1127
L5	-0.0987	0.0478	-2.07	0.0393
L6	-0.0732	0.0478	-1.53	0.1264
L7	-0.1366	0.0479	-2.85	0.0046
L8	0.0316	0.0483	0.65	0.5132
L9	-0.0246	0.0484	-0.51	0.6110
L10	0.0235	0.0482	0.49	0.6259
L1	0.0042	0.0021	2.00	0.0459
L2	-0.0008	0.0021	-0.38	0.7054
L3	-0.0024	0.0021	-1.13	0.2596
L4	0.0018	0.0021	0.85	0.3982
L5	0.0010	0.0021	0.45	0.6556
L6	-0.0001	0.0021	-0.07	0.9468
L7	-0.0017	0.0021	-0.84	0.4000
L8	0.0018	0.0021	0.87	0.3873
L9	0.0008	0.0021	0.38	0.7064
L10	0.0021	0.0021	1.01	0.3130

Soybean Meal 46.5% - O Soybeans, Vinton

D.F. Model	D.F. Error	SSE	MSE	Root MSE	R-Sq.	Adj. R-Sq.
22	428	39728.9000	92.8246	9.63	0.1484	0.1066

Parameter	Estimate	Std. Error	t-value	Pr > t
b0	-0.0237	0.4603	-0.05	0.9590
Spd. of Adj.	1.7701	0.4691	3.77	0.0002
L1	0.3297	1.0973	0.30	0.7639
L2	2.3601	1.0949	2.16	0.0317
L3	0.1844	1.0991	0.17	0.8669
L4	0.6813	1.0869	0.63	0.5311
L5	1.4070	1.0847	1.30	0.1953
L6	1.3883	1.0861	1.28	0.2018
L7	0.7928	1.0881	0.73	0.4667
L8	1.2751	1.0971	1.16	0.2458
L9	2.5512	1.0985	2.32	0.0207
L10	-1.1470	1.0942	-1.05	0.2951
L1	0.0490	0.0474	1.03	0.3017
L2	0.0171	0.0473	0.36	0.7187
L3	-0.0638	0.0472	-1.35	0.1769
L4	-0.2151	0.0473	-4.55	<.0001
L5	-0.0049	0.0484	-0.10	0.9194
L6	0.0594	0.0481	1.23	0.2180
L7	0.0436	0.0470	0.93	0.3545
L8	0.0941	0.0469	2.01	0.0453
L9	0.0653	0.0470	1.39	0.1657
L10	0.0560	0.0471	1.19	0.2358

O Soybeans, Vinton - Soybean Meal 47%

D.F. Model	D.F. Error	SSE	MSE	Root MSE	R-Sq.	Adj. R-Sq.
4	456	83.6705	0.1835	0.43	0.0326	0.0262

Parameter	Estimate	Std. Error	t-value	Pr > t
b0	-0.0045	0.0200	-0.22	0.8232
Spd. of Adj.	-0.0568	0.0203	-2.80	0.0053
L1	-0.1178	0.0461	-2.55	0.0109
L1	0.0016	0.0019	0.84	0.4002

Soybean Meal 47% - O Soybeans, Vinton

D.F. Model	D.F. Error	SSE	MSE	Root MSE	R-Sq.	Adj. R-Sq.
4	456	52673.3000	115.5000	10.75	0.0133	0.0069

Parameter	Estimate	Std. Error	t-value	Pr > t
b0	-0.1743	0.5022	-0.35	0.7287
Spd. of Adj.	1.2102	0.5088	2.38	0.0178
L1	-0.4543	1.1565	-0.39	0.6947
L1	0.0417	0.0469	0.89	0.3750

O Hard Red Winter Wheat - Hard Red Winter Wheat, No.1, Ordinary

D.F. Model	D.F. Error	SSE	MSE	Root MSE	R-Sq.	Adj. R-Sq.
4	466	14.1614	0.0304	0.17	0.0562	0.0501

Parameter	Estimate	Std. Error	t-value	Pr > t
b0	-0.0013	0.0080	-0.16	0.8746
Spd. of Adj.	0.0386	0.0084	4.62	<.0001
L1	-0.0370	0.0457	-0.81	0.4185
L1	0.0467	0.0553	0.84	0.3993

Hard Red Winter Wheat, No.1, Ordinary - O Hard Red Winter Wheat

D.F. Model	D.F. Error	SSE	MSE	Root MSE	R-Sq.	Adj. R-Sq.
4	466	9.6787	0.0208	0.14	0.0737	0.0678

Parameter	Estimate	Std. Error	t-value	Pr > t
b0	-0.0020	0.0067	-0.30	0.7635
Spd. of Adj.	-0.0144	0.0069	-2.08	0.0379
L1	0.0522	0.0378	1.38	0.1677
L1	-0.2199	0.0457	-4.81	<.0001

O Hard Red Winter Wheat - Hard Red Winter Wheat, No.1, 11%

D.F. Model	D.F. Error	SSE	MSE	Root MSE	R-Sq.	Adj. R-Sq.
4	466	14.0893	0.0302	0.17	0.0610	0.0549

Parameter	Estimate	Std. Error	t-value	Pr > t
b0	-0.0002	0.0080	-0.02	0.9853
Spd. of Adj.	0.0413	0.0083	5.00	<.0001
L1	-0.0397	0.0455	-0.87	0.3832
L1	0.0478	0.0781	0.61	0.5403

Hard Red Winter Wheat, No.1, 11% - O Hard Red Winter Wheat

D.F. Model	D.F. Error	SSE	MSE	Root MSE	R-Sq.	Adj. R-Sq.
4	466	5.0351	0.0108	0.10	0.0215	0.0152

Parameter	Estimate	Std. Error	t-value	Pr > t
b0	-0.0007	0.0048	-0.14	0.8904
Spd. of Adj.	-0.0012	0.0049	-0.25	0.8062
L1	0.0487	0.0272	1.79	0.0739
L1	0.1201	0.0467	2.57	0.0104

O Hard Red Winter Wheat - Hard Red Winter Wheat, No.1, 12%

D.F. Model	D.F. Error	SSE	MSE	Root MSE	R-Sq.	Adj. R-Sq.
8	460	14.1169	0.0307	0.18	0.0592	0.0448

Parameter	Estimate	Std. Error	t-value	Pr > t
b0	-0.0003	0.0081	-0.04	0.9665
Spd. of Adj.	0.0406	0.0083	4.87	<.0001
L1	-0.0295	0.0465	-0.63	0.5266
L2	0.0273	0.0464	0.59	0.5560
L3	0.0249	0.0461	0.54	0.5891
L1	-0.0302	0.0731	-0.41	0.6800
L2	0.0264	0.0701	0.38	0.7068
L3	-0.0659	0.0655	-1.01	0.3146

Hard Red Winter Wheat, No.1, 12% - O Hard Red Winter Wheat

D.F. Model	D.F. Error	SSE	MSE	Root MSE	R-Sq.	Adj. R-Sq.
8	460	5.9718	0.0130	0.11	0.0269	0.0121

Parameter	Estimate	Std. Error	t-value	Pr > t
b0	-0.0006	0.0053	-0.12	0.9029
Spd. of Adj.	-0.0083	0.0054	-1.54	0.1252
L1	0.0337	0.0303	1.11	0.2666
L2	-0.0321	0.0302	-1.06	0.2879
L3	0.0155	0.0300	0.52	0.6052
L1	-0.0783	0.0475	-1.65	0.1001
L2	0.0718	0.0456	1.58	0.1159
L3	0.0195	0.0426	0.46	0.6466

O Hard Red Winter Wheat - Hard Red Winter Wheat, No.1, 13%

D.F. Model	D.F. Error	SSE	MSE	Root MSE	R-Sq.	Adj. R-Sq.
6	463	14.6007	0.0315	0.18	0.0269	0.0164

Parameter	Estimate	Std. Error	t-value	Pr > t
b0	-0.0011	0.0082	-0.13	0.8935
Spd. of Adj.	-0.0241	0.0085	-2.83	0.0049
L1	-0.0695	0.0461	-1.51	0.1325
L2	0.0003	0.0461	0.01	0.9953
L1	-0.0197	0.0177	-1.12	0.2654
L2	0.0091	0.0163	0.56	0.5777

Hard Red Winter Wheat, No.1, 13% - O Hard Red Winter Wheat

D.F. Model	D.F. Error	SSE	MSE	Root MSE	R-Sq.	Adj. R-Sq.
6	463	122.1000	0.2637	0.51	0.2737	0.2659

Parameter	Estimate	Std. Error	t-value	Pr > t
b0	-0.0034	0.0237	-0.14	0.8850
Spd. of Adj.	0.1194	0.0247	4.84	<.0001
L1	-0.1241	0.1333	-0.93	0.3524
L2	-0.1320	0.1332	-0.99	0.3225
L1	-0.4214	0.0511	-8.25	<.0001
L2	-0.0862	0.0472	-1.83	0.0686

O Hard Red Winter Wheat - Hard Red Winter Wheat, No.1, 14%

D.F. Model	D.F. Error	SSE	MSE	Root MSE	R-Sq.	Adj. R-Sq.
4	308	5.5472	0.0180	0.13	0.0832	0.0743

Parameter	Estimate	Std. Error	t-value	Pr > t
b0	0.0036	0.0076	0.47	0.6393
Spd. of Adj.	-0.0233	0.0079	-2.93	0.0036
L1	-0.2043	0.0559	-3.65	0.0003
L1	-0.0242	0.0403	-0.60	0.5482

Hard Red Winter Wheat, No.1, 14% - O Hard Red Winter Wheat

D.F. Model	D.F. Error	SSE	MSE	Root MSE	R-Sq.	Adj. R-Sq.
4	308	11.0074	0.0357	0.19	0.0439	0.0346

Parameter	Estimate	Std. Error	t-value	Pr > t
b0	0.0046	0.0107	0.43	0.6661
Spd. of Adj.	0.0351	0.0112	3.14	0.0018
L1	-0.0386	0.0787	-0.49	0.6248
L1	-0.0804	0.0568	-1.42	0.1575

O Sunflower Seeds - Sunflower Seeds

D.F. Model	D.F. Error	SSE	MSE	Root MSE	R-Sq.	Adj. R-Sq.
40	308	0.0013	0.0000	0.00	0.0738	-0.0435

Parameter	Estimate	Std. Error	t-value	Pr > t
b0	0.0001	0.0001	0.45	0.6507
Spd. of Adj.	-0.0001	0.0001	-0.64	0.5220
L1	0.0221	0.0570	0.39	0.6989
L2	0.0040	0.0570	0.07	0.9447
L3	-0.0147	0.0570	-0.26	0.7964
L4	0.0069	0.0570	0.12	0.9031
L5	0.0035	0.0184	0.19	0.8485
L6	-0.0028	0.0184	-0.15	0.8781
L7	0.0004	0.0184	0.02	0.9835
L8	0.0014	0.0184	0.08	0.9389
L9	-0.0015	0.0184	-0.08	0.9362
L10	0.0024	0.0184	0.13	0.8983
L11	-0.0003	0.0184	-0.02	0.9877
L12	0.0011	0.0184	0.06	0.9529
L13	-0.0007	0.0184	-0.04	0.9719
L14	0.0449	0.0184	2.45	0.0150
L15	0.0006	0.0185	0.03	0.9726
L16	0.0012	0.0185	0.06	0.9503
L17	0.0011	0.0185	0.06	0.9529
L18	0.0001	0.0185	0.01	0.9945
L19	0.0021	0.0219	0.10	0.9225
L1	0.0512	0.0831	0.62	0.5385
L2	0.0597	0.0799	0.75	0.4556
L3	0.0512	0.0781	0.66	0.5125
L4	0.0393	0.0764	0.51	0.6074
L5	0.0328	0.0745	0.44	0.6602
L6	0.0305	0.0727	0.42	0.6750
L7	0.0296	0.0705	0.42	0.6752
L8	0.0042	0.0685	0.06	0.9512
L9	0.0537	0.0662	0.81	0.4178
L10	0.0009	0.0639	0.01	0.9892
L11	-0.0271	0.0613	-0.44	0.6594
L12	-0.0159	0.0585	-0.27	0.7859
L13	-0.0174	0.0556	-0.31	0.7549
L14	-0.0180	0.0520	-0.35	0.7290
L15	-0.0028	0.0479	-0.06	0.9532
L16	-0.0052	0.0430	-0.12	0.9047
L17	-0.0011	0.0377	-0.03	0.9763
L18	-0.0045	0.0310	-0.14	0.8850
L19	-0.0008	0.0211	-0.04	0.9706

Sunflower Seeds - O Sunflower Seeds

D.F. Model	D.F. Error	SSE	MSE	Root MSE	R-Sq.	Adj. R-Sq.
40	308	0.0066	0.0000	0.00	0.6951	0.6565

Parameter	Estimate	Std. Error	t-value	Pr > t
b0	0.0000	0.0003	-0.04	0.9691
Spd. of Adj.	-0.0016	0.0003	-5.90	<.0001
L1	0.0210	0.1295	0.16	0.8715
L2	-0.0595	0.1295	-0.46	0.6459
L3	0.0717	0.1295	0.55	0.5801
L4	0.0655	0.1295	0.51	0.6136
L5	0.0061	0.0418	0.14	0.8849
L6	0.0136	0.0418	0.32	0.7456
L7	-0.0107	0.0418	-0.25	0.7991
L8	-0.0098	0.0418	-0.23	0.8158
L9	0.0301	0.0418	0.72	0.4728
L10	0.0117	0.0418	0.28	0.7794
L11	-0.0158	0.0418	-0.38	0.7048
L12	0.0323	0.0417	0.77	0.4396
L13	0.0055	0.0417	0.13	0.8959
L14	-0.0123	0.0417	-0.29	0.7691
L15	0.0114	0.0421	0.27	0.7866
L16	-0.0173	0.0421	-0.41	0.6812
L17	-0.0102	0.0421	-0.24	0.8088
L18	0.4735	0.0421	11.26	<.0001
L19	0.0145	0.0497	0.29	0.7703
L1	0.1224	0.1889	0.65	0.5174
L2	0.1224	0.1815	0.67	0.5007
L3	0.1263	0.1774	0.71	0.4772
L4	0.1381	0.1736	0.80	0.4271
L5	0.1610	0.1693	0.95	0.3423
L6	0.2031	0.1651	1.23	0.2197
L7	0.2460	0.1603	1.53	0.1259
L8	0.2328	0.1557	1.50	0.1359
L9	0.2705	0.1505	1.80	0.0733
L10	0.2643	0.1451	1.82	0.0695
L11	0.3109	0.1394	2.23	0.0264
L12	0.3280	0.1330	2.47	0.0142
L13	0.3051	0.1263	2.42	0.0163
L14	0.3389	0.1182	2.87	0.0044
L15	0.3124	0.1089	2.87	0.0044
L16	0.3528	0.0978	3.61	0.0004
L17	0.3268	0.0856	3.82	0.0002
L18	0.0333	0.0705	0.47	0.6373
L19	-0.0117	0.0481	-0.24	0.8081

O Sunflower Seeds - Sunflower Seeds, Sun

D.F. Model	D.F. Error	SSE	MSE	Root MSE	R-Sq.	Adj. R-Sq.
6	142	0.0013	0.0000	0.00	0.0103	-0.0245

Parameter	Estimate	Std. Error	t-value	Pr > t
b0	0.0002	0.0003	0.70	0.4840
Spd. of Adj.	0.0001	0.0003	0.36	0.7193
L1	0.0122	0.0855	0.14	0.8870
L2	-0.0348	0.0889	-0.39	0.6962
L1	-0.1639	0.1748	-0.94	0.3500
L2	0.0025	0.1398	0.02	0.9858

Sunflower Seeds, Sun - O Sunflower Seeds

D.F. Model	D.F. Error	SSE	MSE	Root MSE	R-Sq.	Adj. R-Sq.
6	142	0.0005	0.0000	0.00	0.4294	0.4093

Parameter	Estimate	Std. Error	t-value	Pr > t
b0	0.0000	0.0001	0.19	0.8526
Spd. of Adj.	-0.0009	0.0002	-5.41	<.0001
L1	-0.1794	0.0507	-3.53	0.0006
L2	0.0436	0.0528	0.83	0.4097
L1	-0.0705	0.1037	-0.68	0.4978
L2	-0.0497	0.0830	-0.60	0.5500

APPENDIX D: NON-COINTEGRATED CAUSAL TEST RESULTS

Beans, Garbanzo - O Beans, Garbanzo

D.F. Model	D.F. Error	SSE	MSE	Root MSE	R-Sq.	Adj. R-Sq.
36	418	0.0858	0.0002	0.01	0.9438	0.9391

Parameter	Estimate	Std. Error	t-value	Pr > t
L1	0.6763	0.0488	13.85	<.0001
L2	0.1016	0.0589	1.73	0.0851
L3	0.0606	0.0591	1.02	0.3061
L4	-0.0083	0.0592	-0.14	0.8886
L5	0.0807	0.0591	1.36	0.1731
L6	0.1548	0.0594	2.61	0.0094
L7	-0.0602	0.0598	-1.01	0.3152
L8	0.0208	0.0599	0.35	0.7285
L9	-0.0105	0.0599	-0.18	0.8610
L10	0.0518	0.0599	0.86	0.3883
L11	-0.0355	0.0600	-0.59	0.5546
L12	-0.0353	0.0598	-0.59	0.5552
L13	-0.0194	0.0594	-0.33	0.7444
L14	-0.0216	0.0593	-0.36	0.7155
L15	0.0091	0.0602	0.15	0.8804
L16	0.0144	0.0608	0.24	0.8128
L17	-0.0460	0.0606	-0.76	0.4486
L18	0.0507	0.0509	1.00	0.3190
L1	0.0338	0.0459	0.74	0.4616
L2	-0.0162	0.0422	-0.38	0.7006
L3	-0.0040	0.0403	-0.10	0.9213
L4	-0.0030	0.0398	-0.07	0.9407
L5	0.0097	0.0396	0.25	0.8056
L6	0.0015	0.0399	0.04	0.9699
L7	-0.0368	0.0397	-0.93	0.3540
L8	0.0120	0.0395	0.30	0.7624
L9	0.0136	0.0395	0.34	0.7306
L10	0.0070	0.0395	0.18	0.8589
L11	0.0169	0.0395	0.43	0.6684
L12	-0.0038	0.0395	-0.10	0.9234
L13	0.0164	0.0394	0.42	0.6769
L14	0.0096	0.0393	0.25	0.8065
L15	-0.0220	0.0393	-0.56	0.5764
L16	-0.0242	0.0392	-0.62	0.5375
L17	0.0177	0.0384	0.46	0.6447
L18	-0.0194	0.0336	-0.58	0.5639

O Lentils, French - Lentils

D.F. Model	D.F. Error	SSE	MSE	Root MSE	R-Sq.	Adj. R-Sq.
2	268	0.0361	0.0001	0.01	0.0010	-0.0027

Parameter	Estimate	Std. Error	t-value	Pr > t
L1	0.0003	0.0611	0.00	0.9967
L1	-0.1519	0.2726	-0.56	0.5779

Lentils - O Lentils, French

D.F. Model	D.F. Error	SSE	MSE	Root MSE	R-Sq.	Adj. R-Sq.
2	268	0.0018	0.0000	0.00	0.0034	-0.0004

Parameter	Estimate	Std. Error	t-value	Pr > t
L1	-0.0208	0.0137	-1.51	0.1311
L1	-0.0175	0.0612	-0.29	0.7746

O Lentils, Green - Lentils

D.F. Model	D.F. Error	SSE	MSE	Root MSE	R-Sq.	Adj. R-Sq.
16	447	0.0396	0.0001	0.01	0.0283	-0.0043

Parameter	Estimate	Std. Error	t-value	Pr > t
L1	0.0104	0.0474	0.22	0.8269
L2	-0.0075	0.0473	-0.16	0.8738
L3	0.0006	0.0468	0.01	0.9896
L4	0.0013	0.0467	0.03	0.9782
L5	-0.0023	0.0468	-0.05	0.9611
L6	0.0066	0.0468	0.14	0.8884
L7	-0.0271	0.0469	-0.58	0.5628
L8	-0.0033	0.0469	-0.07	0.9434
L1	0.0046	0.0914	0.05	0.9598
L2	0.0439	0.0805	0.54	0.5860
L3	0.0680	0.0730	0.93	0.3521
L4	0.0523	0.0731	0.72	0.4743
L5	0.0561	0.0730	0.77	0.4428
L6	-0.2330	0.0727	-3.21	0.0014
L7	-0.0859	0.0735	-1.17	0.2433
L8	0.0113	0.0725	0.16	0.8757

Lentils - O Lentils, Green

D.F. Model	D.F. Error	SSE	MSE	Root MSE	R-Sq.	Adj. R-Sq.
16	447	0.0106	0.0000	0.00	0.0333	0.0008

Parameter	Estimate	Std. Error	t-value	Pr > t
L1	0.0053	0.0246	0.22	0.8277
L2	-0.0080	0.0245	-0.33	0.7441
L3	-0.0098	0.0242	-0.40	0.6859
L4	0.0199	0.0242	0.82	0.4106
L5	0.0058	0.0242	0.24	0.8114
L6	0.0337	0.0242	1.39	0.1647
L7	0.0084	0.0243	0.35	0.7281
L8	0.0086	0.0243	0.35	0.7245
L1	0.0312	0.0474	0.66	0.5100
L2	0.0646	0.0417	1.55	0.1224
L3	0.1008	0.0378	2.66	0.0080
L4	0.0470	0.0379	1.24	0.2150
L5	0.0191	0.0378	0.51	0.6134
L6	0.0268	0.0377	0.71	0.4775
L7	-0.0132	0.0381	-0.35	0.7300
L8	0.0125	0.0376	0.33	0.7405

O Peas, Dry Split Green - Peas, Split Green

D.F. Model	D.F. Error	SSE	MSE	Root MSE	R-Sq.	Adj. R-Sq.
2	468	0.0151	0.0000	0.01	-0.0008	-0.0029

Parameter	Estimate	Std. Error	t-value	Pr > t
L1	0.0000	0.0462	0.00	0.9999
L1	-0.0018	0.0628	-0.03	0.9767

Peas, Split Green - O Peas, Dry Split Green

D.F. Model	D.F. Error	SSE	MSE	Root MSE	R-Sq.	Adj. R-Sq.
2	468	0.0081	0.0000	0.00	0.0038	0.0017

Parameter	Estimate	Std. Error	t-value	Pr > t
L1	-0.0022	0.0339	-0.06	0.9488
L1	0.0715	0.0461	1.55	0.1216

O Rice, Brown - Rice, Short

D.F. Model	D.F. Error	SSE	MSE	Root MSE	R-Sq.	Adj. R-Sq.
38	403	0.0010	0.0000	0.00	0.0661	-0.0197

Parameter	Estimate	Std. Error	t-value	Pr > t
L1	-0.0089	0.0498	-0.18	0.8579
L2	0.0007	0.0481	0.01	0.9882
L3	0.0000	0.0481	0.00	0.9994
L4	-0.0004	0.0481	-0.01	0.9937
L5	0.0014	0.0351	0.04	0.9682
L6	0.0076	0.0351	0.22	0.8291
L7	-0.0007	0.0351	-0.02	0.9848
L8	-0.0012	0.0351	-0.04	0.9717
L9	-0.0080	0.0351	-0.23	0.8207
L10	0.0001	0.0351	0.00	0.9967
L11	-0.0017	0.0351	-0.05	0.9604
L12	-0.0025	0.0351	-0.07	0.9425
L13	-0.0008	0.0351	-0.02	0.9827
L14	0.0007	0.0351	0.02	0.9847
L15	-0.0002	0.0351	0.00	0.9962
L16	-0.0024	0.0353	-0.07	0.9449
L17	0.0027	0.0353	0.08	0.9392
L18	0.0028	0.0353	0.08	0.9372
L19	-0.0011	0.0353	-0.03	0.9750
L1	0.0129	0.0177	0.73	0.4671
L2	0.0080	0.0177	0.45	0.6500
L3	-0.0051	0.0177	-0.29	0.7748
L4	-0.0033	0.0176	-0.19	0.8517
L5	0.0035	0.0176	0.20	0.8405
L6	-0.0010	0.0178	-0.06	0.9556
L7	0.0019	0.0178	0.10	0.9171
L8	0.0072	0.0179	0.40	0.6880
L9	0.0033	0.0179	0.19	0.8530
L10	0.0017	0.0178	0.10	0.9222
L11	0.0044	0.0179	0.25	0.8063
L12	0.0052	0.0183	0.28	0.7769
L13	0.0043	0.0183	0.23	0.8154
L14	0.0059	0.0183	0.32	0.7478
L15	-0.0024	0.0184	-0.13	0.8943
L16	0.0033	0.0184	0.18	0.8563
L17	-0.0117	0.0184	-0.63	0.5259
L18	-0.0994	0.0184	-5.39	<.0001
L19	0.0067	0.0191	0.35	0.7272

Rice, Short - O Rice, Brown

D.F. Model	D.F. Error	SSE	MSE	Root MSE	R-Sq.	Adj. R-Sq.
38	403	0.0076	0.0000	0.00	0.0717	-0.0136

Parameter	Estimate	Std. Error	t-value	Pr > t
L1	0.0042	0.1406	0.03	0.9759
L2	0.0410	0.1358	0.30	0.7629
L3	-0.0064	0.1356	-0.05	0.9624
L4	-0.0049	0.1356	-0.04	0.9712
L5	-0.0086	0.0991	-0.09	0.9313
L6	-0.0098	0.0991	-0.10	0.9212
L7	0.0044	0.0991	0.04	0.9647
L8	-0.0031	0.0990	-0.03	0.9749
L9	-0.0059	0.0990	-0.06	0.9522
L10	0.1019	0.0990	1.03	0.3043
L11	0.0951	0.0991	0.96	0.3376
L12	-0.0113	0.0992	-0.11	0.9093
L13	0.0010	0.0992	0.01	0.9922
L14	-0.0013	0.0992	-0.01	0.9892
L15	0.1755	0.0992	1.77	0.0775
L16	-0.0283	0.0996	-0.28	0.7767
L17	-0.0166	0.0996	-0.17	0.8680
L18	0.0434	0.0996	0.44	0.6632
L19	-0.0211	0.0996	-0.21	0.8323
L1	0.0764	0.0498	1.53	0.1258
L2	0.0048	0.0500	0.10	0.9235
L3	-0.0098	0.0500	-0.20	0.8448
L4	0.0544	0.0497	1.09	0.2747
L5	0.0208	0.0497	0.42	0.6764
L6	0.0871	0.0502	1.73	0.0836
L7	0.0661	0.0503	1.31	0.1899
L8	0.0070	0.0505	0.14	0.8901
L9	0.0537	0.0504	1.07	0.2874
L10	0.0827	0.0503	1.64	0.1009
L11	0.0073	0.0504	0.14	0.8857
L12	-0.0132	0.0517	-0.26	0.7983
L13	0.0403	0.0516	0.78	0.4360
L14	-0.0477	0.0516	-0.93	0.3550
L15	-0.0393	0.0519	-0.76	0.4492
L16	0.1043	0.0518	2.01	0.0446
L17	0.0128	0.0520	0.25	0.8055
L18	0.0042	0.0520	0.08	0.9360
L19	0.0125	0.0538	0.23	0.8158

O Rice, Brown - Rice, Medium

D.F. Model	D.F. Error	SSE	MSE	Root MSE	R-Sq.	Adj. R-Sq.
32	412	0.0009	0.0000	0.00	0.0966	0.0287

Parameter	Estimate	Std. Error	t-value	Pr > t
L1	0.0460	0.0492	0.93	0.3512
L2	0.0022	0.0351	0.06	0.9502
L3	-0.0006	0.0351	-0.02	0.9864
L4	0.0002	0.0351	0.01	0.9950
L5	0.0005	0.0351	0.01	0.9888
L6	-0.0012	0.0351	-0.03	0.9726
L7	-0.0052	0.0351	-0.15	0.8823
L8	0.0061	0.0351	0.17	0.8627
L9	-0.0005	0.0352	-0.02	0.9880
L10	-0.0004	0.0347	-0.01	0.9911
L11	0.0011	0.0342	0.03	0.9747
L12	-0.0004	0.0342	-0.01	0.9907
L13	-0.0015	0.0342	-0.04	0.9652
L14	0.0073	0.0342	0.21	0.8310
L15	-0.0090	0.0342	-0.26	0.7926
L16	0.0017	0.0344	0.05	0.9604
L1	0.0098	0.0148	0.66	0.5091
L2	-0.0016	0.0148	-0.10	0.9168
L3	-0.0019	0.0148	-0.13	0.8969
L4	-0.0032	0.0148	-0.21	0.8309
L5	-0.0071	0.0148	-0.48	0.6342
L6	-0.0672	0.0150	-4.48	<.0001
L7	0.0670	0.0154	4.34	<.0001
L8	0.0071	0.0156	0.46	0.6473
L9	0.0009	0.0159	0.05	0.9567
L10	0.0022	0.0159	0.14	0.8916
L11	0.0082	0.0159	0.52	0.6041
L12	0.0038	0.0157	0.24	0.8096
L13	-0.0129	0.0157	-0.82	0.4123
L14	0.0101	0.0157	0.64	0.5218
L15	-0.0008	0.0161	-0.05	0.9590
L16	-0.0023	0.0160	-0.14	0.8883

Rice, Medium - O Rice, Brown

D.F. Model	D.F. Error	SSE	MSE	Root MSE	R-Sq.	Adj. R-Sq.
38	403	0.0099	0.0000	0.00	0.0984	0.0156

Parameter	Estimate	Std. Error	t-value	Pr > t
L1	0.0564	0.1655	0.34	0.7332
L2	0.0077	0.1641	0.05	0.9625
L3	0.0172	0.1638	0.11	0.9163
L4	-0.0492	0.1637	-0.30	0.7641
L5	0.0347	0.1164	0.30	0.7660
L6	0.0061	0.1163	0.05	0.9580
L7	-0.0218	0.1163	-0.19	0.8512
L8	0.1044	0.1164	0.90	0.3704
L9	-0.0299	0.1166	-0.26	0.7979
L10	-0.0122	0.1166	-0.10	0.9167
L11	0.0479	0.1167	0.41	0.6813
L12	0.1413	0.1167	1.21	0.2265
L13	-0.0147	0.1156	-0.13	0.8987
L14	-0.0061	0.1135	-0.05	0.9570
L15	0.2574	0.1135	2.27	0.0239
L16	-0.1302	0.1142	-1.14	0.2551
L17	-0.0503	0.1144	-0.44	0.6607
L18	0.0060	0.1144	0.05	0.9585
L19	-0.0021	0.1144	-0.02	0.9852
L1	-0.1057	0.0497	-2.13	0.0340
L2	-0.0024	0.0494	-0.05	0.9618
L3	0.0210	0.0494	0.42	0.6715
L4	0.0251	0.0494	0.51	0.6122
L5	0.1693	0.0492	3.44	0.0006
L6	0.1070	0.0499	2.14	0.0327
L7	0.0733	0.0514	1.43	0.1547
L8	0.0325	0.0525	0.62	0.5368
L9	0.0373	0.0540	0.69	0.4910
L10	-0.0129	0.0541	-0.24	0.8118
L11	0.0146	0.0533	0.27	0.7844
L12	-0.0410	0.0527	-0.78	0.4375
L13	-0.0430	0.0527	-0.82	0.4148
L14	0.0171	0.0527	0.33	0.7453
L15	-0.0005	0.0534	-0.01	0.9925
L16	-0.0243	0.0533	-0.46	0.6492
L17	0.0146	0.0533	0.27	0.7844
L18	0.1624	0.0535	3.03	0.0026
L19	0.0842	0.0544	1.55	0.1226

O Soybeans, Clear Hilum - Soybean Meal 44%

D.F. Model	D.F. Error	SSE	MSE	Root MSE	R-Sq.	Adj. R-Sq.
6	453	182.0000	0.4018	0.63	0.9440	0.9434

Parameter	Estimate	Std. Error	t-value	Pr > t
L1	0.9163	0.0458	20.01	<.0001
L2	-0.1620	0.0624	-2.60	0.0097
L3	0.2133	0.0451	4.73	<.0001
L1	0.0045	0.0026	1.74	0.0831
L2	-0.0009	0.0035	-0.25	0.8058
L3	-0.0009	0.0026	-0.36	0.7159

O Soybeans, Clear Hilum - Soybean Meal 47%

D.F. Model	D.F. Error	SSE	MSE	Root MSE	R-Sq.	Adj. R-Sq.
16	437	179.6000	0.4109	0.64	0.0819	0.0504

Parameter	Estimate	Std. Error	t-value	Pr > t
L1	-0.0703	0.0480	-1.47	0.1432
L2	-0.2249	0.0474	-4.75	<.0001
L3	-0.0578	0.0485	-1.19	0.2341
L4	-0.0121	0.0485	-0.25	0.8038
L5	-0.0769	0.0484	-1.59	0.1125
L6	0.0361	0.0484	0.75	0.4558
L7	0.0022	0.0470	0.05	0.9632
L8	0.0188	0.0470	0.40	0.6892
L1	0.0044	0.0029	1.52	0.1284
L2	0.0012	0.0029	0.42	0.6745
L3	0.0012	0.0029	0.43	0.6707
L4	0.0030	0.0028	1.06	0.2906
L5	0.0000	0.0029	0.01	0.9924
L6	-0.0010	0.0029	-0.35	0.7269
L7	-0.0073	0.0029	-2.54	0.0115
L8	-0.0001	0.0029	-0.04	0.9667

Soybean Meal 47% - O Soybeans, Clear Hilum

D.F. Model	D.F. Error	SSE	MSE	Root MSE	R-Sq.	Adj. R-Sq.
16	437	49741.0000	113.8000	10.67	0.0563	0.0239

Parameter	Estimate	Std. Error	t-value	Pr > t
L1	-0.5794	0.7980	-0.73	0.4682
L2	-0.3440	0.7884	-0.44	0.6628
L3	-0.4058	0.8075	-0.50	0.6155
L4	0.2604	0.8066	0.32	0.7470
L5	0.0812	0.8053	0.10	0.9197
L6	0.2783	0.8059	0.35	0.7300
L7	1.4776	0.7817	1.89	0.0594
L8	-0.4121	0.7824	-0.53	0.5987
L1	0.0044	0.0479	0.09	0.9276
L2	-0.0483	0.0478	-1.01	0.3130
L3	-0.0595	0.0475	-1.25	0.2116
L4	-0.1095	0.0473	-2.31	0.0212
L5	-0.1097	0.0474	-2.31	0.0212
L6	0.0793	0.0476	1.66	0.0967
L7	0.0240	0.0477	0.50	0.6155
L8	0.0269	0.0479	0.56	0.5754

O Soybeans, Vinton - Soybeans, No.2

D.F. Model	D.F. Error	SSE	MSE	Root MSE	R-Sq.	Adj. R-Sq.
4	465	85.0424	0.1829	0.43	0.0278	0.0215

Parameter	Estimate	Std. Error	t-value	Pr > t
L1	-0.1108	0.0462	-2.40	0.0169
L2	0.0519	0.0460	1.13	0.2604
L1	0.1788	0.1058	1.69	0.0917
L2	0.1452	0.1062	1.37	0.1723

Soybeans, No.2 - O Soybeans, Vinton

D.F. Model	D.F. Error	SSE	MSE	Root MSE	R-Sq.	Adj. R-Sq.
4	465	16.3419	0.0351	0.19	0.0476	0.0414

Parameter	Estimate	Std. Error	t-value	Pr > t
L1	0.0120	0.0203	0.59	0.5541
L2	0.0081	0.0202	0.40	0.6900
L1	0.2217	0.0464	4.78	<.0001
L2	-0.0284	0.0466	-0.61	0.5425

O Soybeans, Vinton - Soybean Oil

D.F. Model	D.F. Error	SSE	MSE	Root MSE	R-Sq.	Adj. R-Sq.
6	462	82.3295	0.1782	0.42	0.0534	0.0432

Parameter	Estimate	Std. Error	t-value	Pr > t
L1	-0.1081	0.0461	-2.34	0.0196
L2	0.0521	0.0460	1.13	0.2584
L3	-0.0581	0.0456	-1.27	0.2040
L1	0.0574	0.0333	1.72	0.0859
L2	0.1082	0.0344	3.14	0.0018
L3	-0.0587	0.0337	-1.74	0.0828

Soybean Oil - O Soybeans, Vinton

D.F. Model	D.F. Error	SSE	MSE	Root MSE	R-Sq.	Adj. R-Sq.
6	462	160.2000	0.3468	0.59	0.0752	0.0652

Parameter	Estimate	Std. Error	t-value	Pr > t
L1	0.0128	0.0644	0.20	0.8423
L2	0.1179	0.0642	1.84	0.0671
L3	0.0251	0.0637	0.39	0.6934
L1	0.2552	0.0465	5.49	<.0001
L2	0.0225	0.0480	0.47	0.6400
L3	-0.0361	0.0471	-0.77	0.4439

O Sunflower Seeds - Sunflower Meal

D.F. Model	D.F. Error	SSE	MSE	Root MSE	R-Sq.	Adj. R-Sq.
32	320	0.0013	0.0000	0.00	0.9760	0.9737

Parameter	Estimate	Std. Error	t-value	Pr > t
L1	1.0019	0.0185	54.18	<.0001
L2	-0.0002	0.0260	-0.01	0.9949
L3	-0.0007	0.0259	-0.03	0.9797
L4	-0.0003	0.0259	-0.01	0.9898
L5	-0.0010	0.0259	-0.04	0.9680
L6	0.0000	0.0259	0.00	0.9987
L7	0.0005	0.0259	0.02	0.9845
L8	0.0008	0.0259	0.03	0.9743
L9	0.0005	0.0259	0.02	0.9858
L10	-0.0008	0.0259	-0.03	0.9756
L11	-0.0005	0.0258	-0.02	0.9846
L12	-0.0005	0.0258	-0.02	0.9853
L13	-0.0001	0.0259	0.00	0.9977
L14	0.0435	0.0259	1.68	0.0933
L15	-0.0410	0.0259	-1.58	0.1144
L16	0.0021	0.0188	0.11	0.9129
L1	0.0000	0.0000	-0.34	0.7354
L2	0.0000	0.0000	-0.09	0.9245
L3	0.0000	0.0000	0.32	0.7487
L4	0.0000	0.0000	0.57	0.5713
L5	0.0000	0.0000	0.50	0.6147
L6	0.0000	0.0000	-0.77	0.4440
L7	0.0000	0.0000	-0.53	0.5967
L8	0.0000	0.0000	-0.79	0.4275
L9	0.0000	0.0000	-1.18	0.2390
L10	0.0000	0.0000	0.47	0.6361
L11	0.0000	0.0000	0.29	0.7683
L12	0.0000	0.0000	0.34	0.7340
L13	0.0000	0.0000	0.33	0.7398
L14	0.0000	0.0000	0.28	0.7817
L15	0.0000	0.0000	-0.04	0.9676
L16	0.0000	0.0000	-0.14	0.8886

Sunflower Meal - O Sunflower Seeds

D.F. Model	D.F. Error	SSE	MSE	Root MSE	R-Sq.	Adj. R-Sq.
32	320	23881.8000	74.6307	8.64	0.7026	0.6738

Parameter	Estimate	Std. Error	t-value	Pr > t
L1	2.3856	78.5659	0.03	0.9758
L2	31.7612	110.3000	0.29	0.7735
L3	-1.9247	110.2000	-0.02	0.9861
L4	-19.1206	110.2000	-0.17	0.8623
L5	38.9247	110.1000	0.35	0.7240
L6	-29.5450	110.1000	-0.27	0.7886
L7	36.9308	110.1000	0.34	0.7375
L8	81.2859	110.1000	0.74	0.4607
L9	-28.0320	109.9000	-0.26	0.7988
L10	-17.8457	109.9000	-0.16	0.8711
L11	12.2123	109.8000	0.11	0.9115
L12	-42.2153	109.8000	-0.38	0.7009
L13	-50.1192	109.8000	-0.46	0.6485
L14	-8.3559	109.9000	-0.08	0.9394
L15	20.3013	109.9000	0.18	0.8536
L16	30.8346	79.7829	0.39	0.6994
L1	0.4746	0.0557	8.51	<.0001
L2	0.2692	0.0607	4.44	<.0001
L3	0.0893	0.0579	1.54	0.1238
L4	0.0602	0.0581	1.04	0.3009
L5	0.0038	0.0582	0.06	0.9484
L6	-0.0240	0.0582	-0.41	0.6796
L7	0.0103	0.0581	0.18	0.8587
L8	-0.0355	0.0582	-0.61	0.5421
L9	-0.0027	0.0582	-0.05	0.9636
L10	-0.0672	0.0582	-1.15	0.2493
L11	-0.0223	0.0583	-0.38	0.7025
L12	-0.0051	0.0582	-0.09	0.9305
L13	-0.0159	0.0582	-0.27	0.7847
L14	0.4232	0.0580	7.29	<.0001
L15	-0.2034	0.0607	-3.35	0.0009
L16	-0.0974	0.0553	-1.76	0.0794

O Wheat, Durum - Wheat, Hard Amber Durum No.1

D.F. Model	D.F. Error	SSE	MSE	Root MSE	R-Sq.	Adj. R-Sq.
8	459	5.6571	0.0123	0.11	0.0132	-0.0018

Parameter	Estimate	Std. Error	t-value	Pr > t
L1	-0.0022	0.0467	-0.05	0.9617
L2	-0.0396	0.0455	-0.87	0.3846
L3	-0.0475	0.0456	-1.04	0.2982
L4	0.0110	0.0455	0.24	0.8091
L1	-0.0342	0.0236	-1.45	0.1485
L2	0.0109	0.0244	0.45	0.6562
L3	0.0236	0.0243	0.97	0.3320
L4	0.0151	0.0235	0.64	0.5201

Wheat, Hard Amber Durum No.1 - O Wheat, Durum

D.F. Model	D.F. Error	SSE	MSE	Root MSE	R-Sq.	Adj. R-Sq.
8	459	22.0570	0.0481	0.22	0.0726	0.0584

Parameter	Estimate	Std. Error	t-value	Pr > t
L1	0.0223	0.0921	0.24	0.8086
L2	0.0907	0.0899	1.01	0.3135
L3	0.0213	0.0900	0.24	0.8131
L4	-0.0086	0.0899	-0.10	0.9240
L1	-0.2630	0.0467	-5.63	<.0001
L2	-0.1194	0.0483	-2.47	0.0137
L3	0.0176	0.0480	0.37	0.7135
L4	0.0240	0.0464	0.52	0.6050

O Soft Winter Wheat - Soft Winter Wheat No.1

D.F. Model	D.F. Error	SSE	MSE	Root MSE	R-Sq.	Adj. R-Sq.
42	251	1.6229	0.0065	0.08	0.1806	0.0468

Parameter	Estimate	Std. Error	t-value	Pr > t
L1	0.0689	0.0629	1.09	0.2747
L2	-0.0270	0.0547	-0.49	0.6220
L3	-0.0063	0.0547	-0.12	0.9079
L4	-0.0020	0.0544	-0.04	0.9709
L5	-0.1358	0.0543	-2.50	0.0130
L6	0.0089	0.0545	0.16	0.8698
L7	0.0815	0.0545	1.50	0.1356
L8	-0.1667	0.0543	-3.07	0.0024
L9	0.0090	0.0551	0.16	0.8704
L10	0.0158	0.0543	0.29	0.7718
L11	0.0185	0.0538	0.34	0.7314
L12	-0.0098	0.0537	-0.18	0.8558
L13	-0.0813	0.0531	-1.53	0.1269
L14	-0.1070	0.0498	-2.15	0.0324
L15	0.0448	0.0498	0.90	0.3700
L16	-0.0679	0.0497	-1.37	0.1733
L17	0.0923	0.0487	1.89	0.0593
L18	0.0399	0.0490	0.81	0.4164
L19	0.0078	0.0484	0.16	0.8721
L20	0.0915	0.0486	1.88	0.0608
L21	-0.0150	0.0484	-0.31	0.7574
L1	0.0389	0.0635	0.61	0.5408
L2	0.0772	0.0637	1.21	0.2266
L3	-0.0744	0.0638	-1.17	0.2449
L4	-0.0414	0.0636	-0.65	0.5154
L5	0.1501	0.0640	2.34	0.0199
L6	0.0779	0.0649	1.20	0.2317
L7	-0.0430	0.0651	-0.66	0.5097
L8	-0.0088	0.0652	-0.13	0.8933
L9	-0.0131	0.0648	-0.20	0.8403
L10	0.0995	0.0646	1.54	0.1249
L11	-0.0073	0.0649	-0.11	0.9112
L12	0.0213	0.0646	0.33	0.7413
L13	-0.0350	0.0652	-0.54	0.5915
L14	0.0774	0.0656	1.18	0.2395
L15	-0.0089	0.0656	-0.14	0.8919
L16	-0.0771	0.0695	-1.11	0.2681
L17	-0.0082	0.0695	-0.12	0.9067
L18	0.0590	0.0676	0.87	0.3832
L19	0.0015	0.0665	0.02	0.9818
L20	0.0371	0.0670	0.55	0.5804
L21	0.0498	0.0665	0.75	0.4543

Soft Winter Wheat No.1 - O Soft Winter Wheat

D.F. Model	D.F. Error	SSE	MSE	Root MSE	R-Sq.	Adj. R-Sq.
42	251	1.5758	0.0063	0.08	0.1406	0.0002

Parameter	Estimate	Std. Error	t-value	Pr > t
L1	-0.0227	0.0620	-0.37	0.7142
L2	0.0308	0.0539	0.57	0.5687
L3	0.0314	0.0539	0.58	0.5611
L4	0.1006	0.0536	1.88	0.0614
L5	-0.0626	0.0535	-1.17	0.2432
L6	-0.0832	0.0537	-1.55	0.1229
L7	0.0084	0.0537	0.16	0.8763
L8	-0.0104	0.0535	-0.20	0.8455
L9	-0.0792	0.0543	-1.46	0.1458
L10	-0.0270	0.0535	-0.51	0.6137
L11	0.0303	0.0530	0.57	0.5679
L12	0.0392	0.0529	0.74	0.4596
L13	-0.0331	0.0523	-0.63	0.5270
L14	-0.0372	0.0490	-0.76	0.4491
L15	-0.0170	0.0491	-0.35	0.7300
L16	0.0282	0.0490	0.58	0.5653
L17	-0.0418	0.0480	-0.87	0.3851
L18	-0.0028	0.0483	-0.06	0.9545
L19	-0.0253	0.0477	-0.53	0.5958
L20	-0.0031	0.0479	-0.07	0.9480
L21	-0.0371	0.0477	-0.78	0.4380
L1	0.1246	0.0626	1.99	0.0476
L2	0.0325	0.0628	0.52	0.6047
L3	0.0010	0.0629	0.02	0.9874
L4	-0.1206	0.0627	-1.92	0.0555
L5	0.1043	0.0631	1.65	0.0995
L6	-0.0156	0.0640	-0.24	0.8071
L7	0.1153	0.0642	1.80	0.0736
L8	-0.0274	0.0642	-0.43	0.6701
L9	-0.0582	0.0639	-0.91	0.3635
L10	0.0557	0.0637	0.87	0.3826
L11	-0.0026	0.0640	-0.04	0.9673
L12	-0.1501	0.0636	-2.36	0.0192
L13	0.0378	0.0643	0.59	0.5573
L14	0.0498	0.0647	0.77	0.4422
L15	0.0936	0.0647	1.45	0.1488
L16	-0.0600	0.0685	-0.88	0.3820
L17	-0.0353	0.0685	-0.51	0.6073
L18	-0.0108	0.0666	-0.16	0.8708
L19	-0.0116	0.0655	-0.18	0.8595
L20	0.0024	0.0660	0.04	0.9712
L21	-0.1032	0.0655	-1.57	0.1166

O Soft Red Wheat - Soft Red Winter Wheat No.2

D.F. Model	D.F. Error	SSE	MSE	Root MSE	R-Sq.	Adj. R-Sq.
4	331	0.3891	0.0012	0.03	0.0022	-0.0069

Parameter	Estimate	Std. Error	t-value	Pr > t
L1	-0.0054	0.0549	-0.10	0.9220
L2	0.0008	0.0227	0.04	0.9715
L1	0.0217	0.0130	1.67	0.0957
L2	0.0132	0.0130	1.02	0.3099

Soft Red Winter Wheat No.2 - O Soft Red Wheat

D.F. Model	D.F. Error	SSE	MSE	Root MSE	R-Sq.	Adj. R-Sq.
4	331	6.9395	0.0210	0.14	0.0571	0.0486

Parameter	Estimate	Std. Error	t-value	Pr > t
L1	-0.0821	0.2318	-0.35	0.7233
L2	0.0392	0.0960	0.41	0.6829
L1	-0.2411	0.0548	-4.40	<.0001
L2	-0.0849	0.0549	-1.55	0.1231