Analysis of Spatial Variation in Prices through Time

By

Benjamin S. Schlosser

Advisor:
Dr. James Kurre
(814) 898-6266
k12@psu.edu

October 2006

Economic Research Institute of Erie
Sam and Irene Black School of Business
Penn State Erie
5091 Station Road
Erie, PA 16563-1400
(814) 898-7150
www.ERIEdata.org

Abstract

It is common knowledge that prices of items across space experience changes over time, but why do some items experience an increase in price, while others experience a decrease in price. The goal of this project is to answer that question and describe why these spatial variations in price take place over time. This paper will utilize various measurements, supply and demand, transport costs, and market characteristics in order to build a theoretical background for spatial price variability over time. After looking at the underlying theories, hypothesis tests and regression models will be created using the actual spatial price variations that took place in the items over time and measurements of the standardization and transportability of the items. Analyzing these models will provide some answers as to why certain items experience increases or decreases in their price through time.

Analysis of Spatial Variation in Prices through Time

I. INTRODUCTION

It is common knowledge that prices for goods and services vary in different locations, but the question is why do they vary? It is also known that prices change over time, but which goods vary more and which less over time? The goal of this study is to look at price data for several goods and services in numerous locations and examine the variations that have occurred in prices between two time periods, specifically the first quarter of 1990 and the first quarter of 2005. The ACCRA Cost of Living Index provides the price data that will be examined.

The first part of this paper explains the theory behind price variability. Several different tools will be used to measure price variations, including mean price, standard deviation, and coefficient of variation (COV). Supply and demand, transport costs, and market characteristics are hypothesized to explain why variations in price occur, and these hypotheses are tested later in the paper.

The next section of the paper lists and describes the data that were used for this study, detailing the MSAs, items, and NMFC class ratings that are used to measure transportability. The measurement techniques explained in the theory section are applied to the data in order to make it comparable through time and space. The actual price patterns are then presented.

After looking at the price variations that took place and the theory behind them, this paper will attempt to explain why these patterns actually occurred. In order to do this, regression analysis will be utilized. COV and change in COV will be regressed against different variables that measure the items' standardization and transportability. These regressions will provide evidence as to which factors explain variations in price over time and space.

The final section of the paper summarizes the findings of this study. It explains which hypotheses were supported and which were rejected. This section also lists additional research ideas for further study in the area

of price variability. Before this paper, very little research was conducted in this field, so there are a variety of supplements to this study that can be performed to examine how prices vary over time and space.

II. LITERATURE REVIEW

While several studies exist that examine spatial price variation, and many studies discuss price changes through time, there are very few studies that look at spatial variation in prices through time. The studies that do look at spatial price variation through time typically are limited to only one good or service such as gasoline (Marvel, 1976) or eggs (Tregarthen, 1988). The goal of this literature review is to gather the sections of various studies that apply to spatial price variation through time. Spatial price variation through time has not been thoroughly researched, but there are several existing studies that provide useful and important information regarding different aspects of this topic. Key themes that relate to the topic of spatial price variation through time include ACCRA's Cost of Living Index, consumer information, spatial price variation, and transport costs. Studies relating to each of these themes are used throughout this paper to further define and explain spatial price variation through time. The literature on this topic will be presented in the discussion of theory below.

III. THEORY

A. Measurement

ACCRA (The Council for Community and Economic Research) was founded in1961 as the American Chamber of Commerce Researchers Association. According to ACCRA's website[1], it is a nonprofit professional organization that promotes excellence in community and economic research by working to improve the availability of data, enhance the quality of data, and advance learning about regional economic analytic methods. The organization accomplishes its mission through professional networks, advocacy, training, research, and delivering innovative services and products. One such product is the ACCRA Cost of Living Index, which was originally titled the Inter-City Cost of Living Indicators Project. This Index provides a useful and relatively accurate measure of the cost of living differences among urban areas. The Index is based on items that have been carefully chosen to reflect the different categories of consumer expenditures. Weights assigned to relative costs are based on survey data on expenditure patterns for midmanagment households

[1] ACCRA The Council for Community and Economic Research. Available online at <http://www.accra.org/index.asp>.

provided by the federal government. All of the items used in the Index are priced at many places at a specific time and according to standardized specifications.

The ACCRA Cost of Living Index has been published each quarter since 1968. The survey includes geographic areas for which chambers of commerce or other local organizations have volunteered to participate. The number of participants varies each quarter, and ACCRA has continued its effort to expand the Index's coverage of metropolitan statistical areas (MSAs). Any MSA that is not represented in the Index is absent because its chamber of commerce or other local organizations chose not to collect data. According to Koo, Phillips, and Sigalla (2000), there are a few weaknesses to the Cost of Living Index. Since the items that the Index consists of are intended to signify a national market basket for a mid-level manager, these items may not be representative of any one region's expenditure pattern. They also believe that the prices would be more informative if they were not just the posted prices, but instead the prices including sales tax (Koo et al).

Data from the ACCRA Cost of Living Index provides the basis for this study. The data in the Index consists of prices for a variety of goods and services across many different MSAs. The level of prices in different areas are not the focus of this study. The goal of this study is to look at the price variations that have occurred across space over time. In order to look at this, it is necessary to identify a way to measure spatial variation consistently. The following section explains how this process is done.

The first step in analyzing each good and service over time is finding the minimum and maximum prices that occurred for each good and service during the time period. After finding the minima and maxima, one must find the mean price of each good and service. The mean (average) price is found by adding up all of the prices that occurred for one particular product or service through space and dividing by the number of locations:

$$\text{Mean} = \frac{(P1 + P2 + \ldots + Pn)}{n} = \sum_i \frac{P_i}{n}$$

where P_i = price in location i

n = number of locations.

The following is an example of how to determine a product's mean price. In the first quarter of 2005, a half-gallon of milk had a price of $1.90 in Buffalo, $1.78 in Philadelphia, and $2.00 in Pittsburgh. The mean price of milk in these three areas is equal to ($1.90 + $1.78 + $2.00)/3. In other words, the average price of milk over these three areas is $1.89.

The differences in prices that occur through space represent price variation. The amount by which prices vary from their mean is known as deviation. Standard deviation measures how spread out the prices of each good and service are from the mean. If all of the prices for a good in different places are very close to the mean price, then the standard deviation is low (closer to zero). If the prices vary greatly from the mean price, then the standard deviation is high (further from zero). To find the standard deviation of a set of numbers, first subtract the mean price from each individual price in the set. This gives each price's distance from the mean, but some of the distances will be positive, while others will be negative. If these distances were added together, the positives and negatives would cancel out giving us a misleading result. Due to this, each of the distances must be squared so that all of the values are positive. Next sum all of the squared values that were calculated. Then divide this value by the number of locations whose prices were used. Since the distances were squared at the beginning, the square root of the value that was just obtained must be calculated. The result is the standard deviation of the set of numbers. The formula for the standard deviation, which is usually denoted by the lowercase Greek letter sigma (σ) is:

$$\text{Standard Deviation} = \sigma = \sqrt{\sum_i \frac{(P_i - \overline{P})^2}{n}}$$

where P_i = price in location i

$\overline{P}$ = mean price

n = number of locations.

Data from the example above for milk can be used to demonstrate the calculation of the standard deviation of the set of prices.

City	Buffalo	Philadelphia	Pittsburgh
Price of Milk	$1.90	$1.78	$2.00
- Mean Price ($1.89)	0.01	-0.11	0.11
Square of above value	0.0001	0.0121	0.0121

First, subtract the mean price of $1.89 from each price to get 0.01, -0.11, and 0.11 in Buffalo, Philadelphia, and Pittsburgh respectively. Next, square each of these values to get 0.0001, 0.0121, and 0.0121 respectively. Now sum these values, which results in 0.0243. Next, dividing 0.0243 by the number of locations in the set, 3, results in 0.0081. Last take the square root of this number to get 0.09. This number represents the standard deviation of the set of prices. In other words, the overall measure of distance of each price from the mean price

for these three areas is 0.09. Since the standard deviation is 0.09 and the mean price is $1.89, prices that are within one standard deviation of the mean lie in the range between $1.80 and $1.98.

The last, and most important, measure used to analyze the prices of products and goods in this study is the coefficient of variation (COV). The COV is defined as the ratio of the standard deviation to the mean and it gives the percent of the mean that the standard deviation represents. The COV is a dimensionless value that does not represent a dollar amount, so it allows for the comparison of the variation of prices that have significantly different means. To find the COV of a set of numbers, divide the standard deviation of the set by the mean of the set. The formula for the COV is:

$$\text{Coefficient of Variation (COV)} = \frac{\sigma}{\bar{P}}$$

where σ = standard deviation

$\bar{P}$ = mean price.

For example, the standard deviation from above was 0.09 and mean value of that set was $1.89. So dividing the first number by the second results in a COV of 0.0476 for a half-gallon of milk. Since the COV measures standard deviation as a fraction of the mean, prices vary across these three areas by 4.76% of the mean price. This value now gives a method for comparing how prices of drastically different products and services vary across space. Men's shirts and housing are two products that are much different than milk. Remember that the mean price for milk is $1.89. In the first quarter of 2005, across the same three MSAs, men's shirts had a mean price of $26.23 and housing had a mean price of $267,972. Next, recall that milk has a standard deviation of $0.09. In the first quarter of 2005, men's shirts had a standard deviation of $4.87 and housing had a standard deviation of $92,914. It is extremely difficult to compare a set of numbers that range from $0.09 to $92,914. This is why the COV is so important. As shown above, milk has a COV of 0.0476. Men's shirts had a COV of 0.1855 and housing had a COV of 0.3467. In other words, the price of milk varied by 4.76% of its mean price, the price of men's shirts varied by 18.55% of its mean price, and the price of housing varied by 34.67% of its mean price. From this, it can be seen that the price of milk varied the least, while the price of housing varied the most. This example demonstrates how the COV provides a measurement of price variation that can be used on products that have prices ranging from a couple dollars to a few hundred thousand dollars.

B. Supply and Demand

In a market economy like the United States, supply and demand determines the prices of goods and services. Since this is a study of product and service prices and their variation, looking at how supply and demand affects prices is a good starting point. First, recall that demand is the willingness and ability of buyers to purchase different quantities of a good at different prices during a specific time period, and that supply is the willingness and ability of sellers to produce and offer to sell different quantities of a good at different prices during a specific time period. The law of demand states that as the price of a good rises (falls), the quantity demanded of the good falls (rises) (Arnold 57). The law of supply states that as the price of a good rises (falls), the quantity supplied of the good rises (falls) (Arnold 68). The equilibrium price, or market-clearing price, is the price at which quantity demanded of the good equals quantity supplied. Several factors contribute to how supply and demand affect the price of a good or service. The following section looks at examples of two goods, housing and frozen corn, that are drastically different and how their prices respond to supply and demand.

The first good to be examined is housing. Suppose the demand for housing in two different MSAs is equal, but that the supply of housing is much lower in MSA A compared to MSA B. The limited amount of housing in MSA A results in a much greater housing price there compared to MSA B. Since there is a large supply of homes in MSA B, consumers are not forced to pay such a high price there, as can be seen in Figure 1.

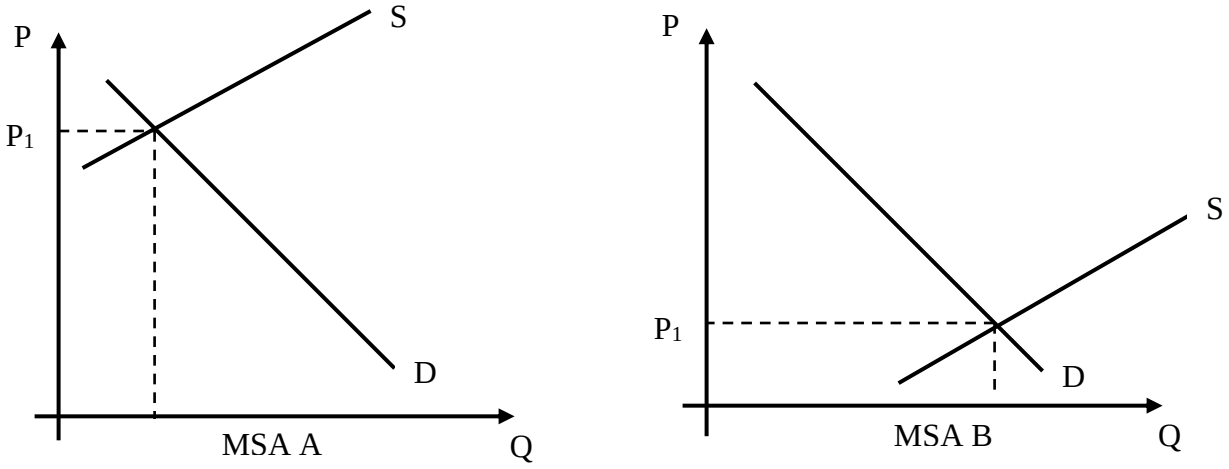


Figure 1: Housing Market

As a second example, suppose the demand for frozen corn is equal in the two MSAs, but the supply of corn is much lower in MSA A compared to MSA B. Like housing, the relative lack of corn in MSA A causes corn

to have a much higher price than in MSA B where there is a larger supply of corn. There is one key difference between corn and housing, however; corn is mobile, meaning it can be transported across space with relatively low transport costs, while housing is not mobile. (It is true that some housing can be moved, but it is not an easy task and it is a very expensive process. Transport costs will be discussed in more detail later in this paper.)

Since corn is commanding a higher price in MSA A, an entrepreneur can make a profit by buying corn from MSA B where it is cheaper and selling it in MSA A where it is more expensive. This process will result in an increase in supply in MSA A and an increase in demand in MSA B as can be seen in Figure 2. In other words, arbitrage will occur for this product. Arbitrage is defined as buying a good in a market where its price is low, and selling the good in another market where its price is higher. In the long run, this process causes the market price for corn to become similar in both MSAs except for transport costs, as can be seen in Figure 2.

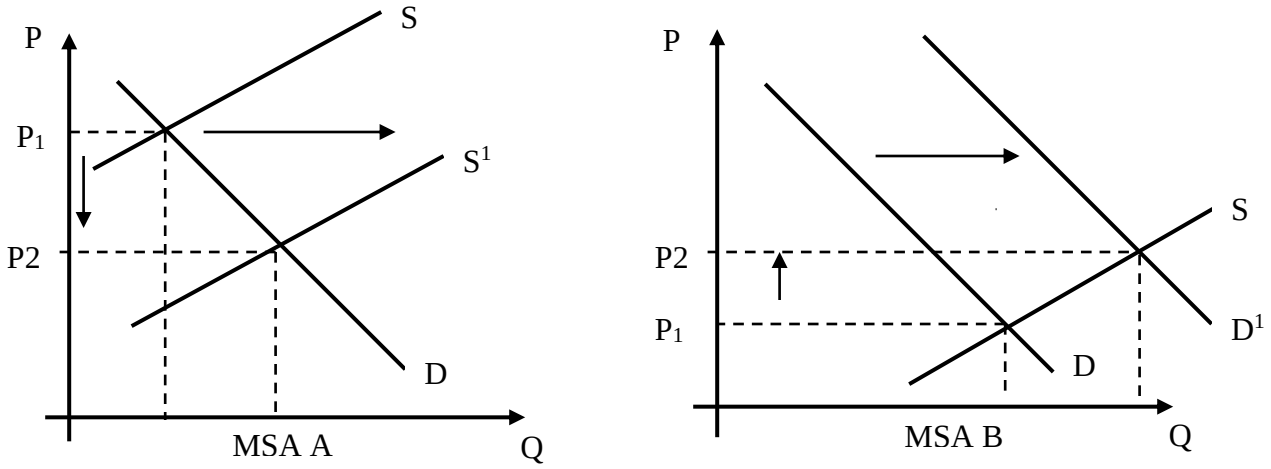


Figure 2: Corn Market

C. Transport Costs

Transport costs are the costs associated with moving a good or service from one market to another. Some goods encounter much higher transport costs than others. Several factors affect how much it will cost to transport a good, such as fragility, hazardousness, shelf life, and value. When a good is fragile, more care must be taken in its form of shipping, so this results in a higher transport cost. Shipping a hazardous product costs more than shipping a normal product because of the risk involved in transporting such a good. Certain goods have a limited shelf life such as fresh fruits and vegetables, milk, eggs, and newspapers. Because of this, these goods must be shipped more quickly than other goods and may involve refrigeration, making them more expensive to ship. High-value goods also encounter higher transport costs because of the risk of theft and resulting security costs involved in shipping them.

The transport costs associated with services are much different than those associated with goods. Services, unlike most goods, are not physical objects. Services include such things as haircuts, doctor and dentist appointments, and dry cleaning. These things are not shipped from place to place, instead they are provided at the supplier's location and consumers come to them. Services typically do not entail shipping costs for the seller, instead they must take into account the travel costs that their consumers experience. As defined by Benson and Faminow (1985), the cost of distance, which is measured both in terms of monetary outlays and the opportunity cost of a consumer's time, can be a major expense for rural residents traveling a great distance or for urban residents who are facing heavy traffic (296). Consumers' travel costs include explicit costs like the price of gas and implicit costs such as opportunity costs. An opportunity cost is defined as the benefit forgone by undertaking a particular activity (Colander 8). The benefit forgone is the benefit that could have been gained from choosing the next-best alternative. In the case of services, opportunity costs deal with choosing one service provider over another, or in other words, taking the time to shop for the service provider that one believes is best. Factors that affect opportunity costs in this case include location, distance, price, and quality of the service. Depending on the consumer, some factors carry a greater weight than others. Benson and Faminow state that spatially distributed consumers do not make their demand and purchasing decisions solely on the basis of prices set by firms (297).

D. Market Characteristics

At the extremes, a market can be either perfectly competitive or a monopoly. In a perfectly competitive market, prices are solely set by the market demand and supply because if a firm charges anything but the market price, there is such intense competition that the firm will lose all of its customers to other firms. Since the market is setting the price in this case, market prices can be different in various regions due to such things as supply and demand differences across the regions, arbitrage, and transport costs, so price variations occur even though the product is the same around the country. In a monopoly there is a single seller, so there is no competition and the firm can set whatever price it desires, limited only by the willingness of customers to pay. Several other kinds of markets that have varying degrees of competition exist between the two extreme market types.

When geography is thrown into the mix, the theory behind market type changes. Market characteristics of a good or service represent the type of regional market in which the products are sold. For our purposes there are two main levels of geographic markets: local and national markets. Local markets are market where the goods and services only compete with other goods and services that are located in the near area. Local markets apply to goods for which transport costs are very high and arbitrage does not occur across markets. Housing is an example of a good that exists in a local market. Goods and services from outside the local market do not compete because they either cannot be physically moved into this market or if they can, transport costs are so high as to be prohibitive. Firms that sell such goods and services may not face intense competition because there may only be a few firms in the local market. According to Capozza and Van Order (1978), the reason that high transportation costs result in less competition is because they give firms monopoly or oligopoly power over customers located close to them (897). A firm that has no direct competition in its area can set a monopoly price unless prevented from doing so by government (Faminow and Benson 53). For local market goods, a seller only considers the nearest businesses to be major competitors. Dorward (1982) proposes that a profit-maximizing firm should adopt a policy of price discrimination in which it charges some variable proportion of the transport cost to different customers (136). This may be one reason why prices of goods that sell in local markets can be significantly different from one local market to another. This is the main change that geography causes in the standard theory behind monopolies. In a local market, a firm can be a monopoly and set its own

price, but each local market is different, so the same firm in different local markets will set varying prices, which causes price variation to occur in its products across the country.

National markets occur for goods for which transport costs are relatively insignificant, and arbitrage can occur. Since goods and services in these can be moved easily, a seller in one area may experience competition from sellers all around the country. Unlike firms selling local market goods, firms with national market goods face intense competition because as Capozza and Van Order state, as transport costs approach zero, perfect competition is also approached and price should move toward marginal cost (897). In theory then, prices for goods sold in national markets should be more similar and exhibit less variation through space. In this case, geography presents little change to the standard theory behind perfect competition. The market sets the price here just as it did before. So the one main difference when geography is taken into account is that local market goods should show greater price variation and national market goods should show less price variation.

It is possible, however, that a good which is sold in a local market can turn into a national market good over time. The broad causes of this transformation deal with transportation costs, consumer information, and technological change. First, for example, consider such goods as milk and eggs. Many years ago, these goods would have been local market goods because they require refrigeration and they have a limited shelf life. These goods could only be sold close to where they were produced because there was no way to cheaply transport them while also keeping them cold and getting them to their destination quickly. With the refrigeration technology that exists today, though, these goods can be transported both quickly and cheaply. This results in today's market for these goods being a national market instead of a local market. The transformation in this example results from cheaper transport costs and advances in refrigeration technology.

A different example of this same transformation of markets can be seen in such goods as mortgages. Before the advent of the Internet, consumers typically went to local banks or made local phone calls in order to shop for a mortgage. The search cost associated with tracking down alternatives outside the local area was high because going to distant banks took a great deal of time and making long-distance phone calls was very expensive. More recently, the creation of the Internet has provided consumers with information about mortgages from lenders all over the country virtually costlessly, which allows consumers to find mortgages at the lowest price and best terms. In this example, mortgages changed from a local market good to a national

market good due to technological change and the resulting decrease in the cost of gathering consumer information.

Grewal and Marmorstein found in their 1994 study that most consumers undertake little prepurchase search and price-comparison shopping, despite the importance of price to consumers' purchasing decisions. Their explanation for this is that consumers simply underestimate the amount of price variation that exists in the market (453). Grewal and Marmorstein (454) feel that consumers' failure to seek out price information causes greater price variation because retailers can successfully use price discrimination, which according to Norman (1983) is possible when the market can be divided into distinct submarkets. In the case where consumers have little price information, the market can easily be separated into submarkets because consumers have no motivation to do comparison-shopping. Grewal and Marmorsteain's study was undertaken in the early 1990s though, so it is quite possible that today's technological advances have made consumers more aware. Marvel (1976) says that the cost of search is made up of the goods used in search, such as gasoline, and the cost of time spent searching (1034). With many consumers now having the Internet in their households, they already have the goods used in the search and the time spent searching is much smaller. Since the Internet has led to more easily accessible price information, consumers are more likely to be aware of the price variation that exists in the market today. Marvel agrees with this idea when he quotes Stigler as saying that "greater amounts of search will lead to a smaller dispersion of observed selling prices by reducing the number of purchasers who will pay high prices" (1034).

E. Hypotheses

The existence of price variation across space and through time is not in question. The reasons for its existence, however, are in question. The economic theory of supply and demand shows how buyers and sellers interact in the market for certain goods and services. Arbitrage explains that specific goods and services can be moved from one market to another while others cannot. Transport costs limit the amount of arbitrage a product might experience by putting a price to the movement of certain goods and services. Market characteristics refer to the specific kind of market that the goods and services are being bought and sold in. Combining the ideas that these theories present results in hypotheses as to why price variation takes place. Items for which transport costs are low and therefore which experience a high degree of arbitrage are bought and sold in a national

market and should have a smaller degree of price variation. Items that have high transport costs resulting in a low degree of arbitrage exist in local markets and should have a higher degree of price variation. Services for the most part have a lower degree of arbitrage because of the associated transport and search costs, and therefore also should have a higher degree of price variation. Advances in technology have also played a role in the variation of prices that have occurred over time. Some types of goods and services, such as mortgages, have experienced a reduction in spatial price variation over time due to factors such as the advent of the Internet.

Standardization of the items used in this study plays another important role in measuring price variability. Although ACCRA has attempted to keep the items it prices identical over the years, conflicts are bound to happen regarding the standardization of the items. Due to this, items that are more standard between the two quarters will incur less price variation, while items that are less standard will incur greater price variation. Now it is time to put these statements to the test and compare them to the actual price variations that have taken place in selected goods and services across the country through time.

IV. DATA

A. MSAs

As mentioned above, ACCRA's Cost of Living Index provides the data used for this study. Each quarter of each year, the Index lists prices for various grocery, housing, utility, transportation, health care, and miscellaneous goods and services for several different MSAs. The average number of participants in each quarter is approximately 300 MSAs. One major problem with performing a study with these data is the MSAs that participate each quarter are not consistent throughout time. In fact, between the first quarter of 1990 and the second quarter of 2005, only nineteen MSAs participated in every quarter. Some MSAs participate in many quarters, while some participate in few quarters. Whatever the case, unless each MSA participates in each quarter under study, it is difficult to compare price variation across space.

Several steps were taken in order to ensure the accuracy of this study. Since the list of MSAs that participated in the Cost of Living Index was not identical in the two quarters used for this study (1990(I) and 2005(I)), the MSAs that did not participate in both quarters were eliminated from this study. All MSAs that did participate in both of the two quarters were used in the study. There were 166 MSAs that were common to both

quarters and they are listed in Table 1 below. These MSAs made up approximately 43 percent of the U.S. population in 1994 and 45 percent of the population in 2005. Their average population growth rate between these two periods was about 15.1 percent, while the US's was 11.6 percent. Their average personal income growth rate during this period was almost 72 percent, while the US's was just over 66 percent. These MSAs had an average per capita personal income of about $20,387 in 1994 and $30,142 in 2004, while the US had per capita personal incomes of $22,172 and $33,050 in those same years. The MSAs had a per capita personal income growth rate of around 48 percent in that time period, while the US growth rate was around 49 percent. These statistics show that the sample of MSAs used in this study appears to be generally representative of the entire US population, although they tended to have lower than average incomes but faster growth rates.

Table 1: MSAs Included in This Study

Akron OH	Fargo-Moorhead ND-MN	Laramie WY	Pueblo CO
Amarillo TX	Farmington NM	Las Cruces NM	Reno-Sparks NV
Americus GA	Fayetteville AR	Las Vegas NV	Richland-Kennewick-Pasco WA
Ames IA	Fayetteville NC	Lawrence KS	Riverside City CA
Anchorage AK	Findlay OH	Lexington KY	Rochester MN
Anderson SC	Flagstaff AZ	Longview TX	Rome GA
Appleton WI	Florence AL	Los Alamos NM	Round Rock TX
Asheville NC	Fort Smith AR	Los Angeles-Long Beach CA	Salina KS
Atlanta GA	Fort Walton Beach FL	Louisville KY	San Antonio TX
Augusta-Aiken GA-SC	Fort Worth TX	Lubbock TX	San Diego CA
Baltimore MD	Fresno CA	Marion-McDowell County NC	San Jose CA
Beaumont TX	Gainesville FL	Marshfield WI	Savannah GA
Boise ID	Garden City KS	Mason City IA	Seattle WA
Bowling Green KY	Gillette WY	McAllen TX	South Bend IN
Buffalo NY	Glens Falls NY	Memphis TN	Springfield IL
Carlsbad NM	Grand Junction CO	Miami-Dade County FL	Springfield MO
Carson City NV	Green Bay WI	Midland TX	St. Cloud MN
Cedar City UT	Greenville NC	Milwaukee-Waukesha WI	St. George UT
Cedar Rapids IA	Hampton Roads-SE Virginia VA	Mobile AL	St. Joseph MO
Champaign-Urbana IL	Harlingen TX	Monroe LA	St. Louis MO-IL
Charleston WV	Hartford CT	Montgomery AL	Stevens Point-Plover WI
Charleston-N Charleston SC	Hastings NE	Morristown TN	Syracuse NY
Charlotte NC	Hays KS	Myrtle Beach SC	Tacoma WA
Chattanooga TN	Hickory NC	Nassau County NY	Terre Haute IN
Clarksville TN	Hot Springs AR	Nevada MO	Texarkana TX-AR
Cleveland OH	Houston TX	New London CT	Toledo OH
Cleveland TN	Huntington WV	Odessa TX	Tucson AZ
Colorado Springs CO	Huntsville AL	Oklahoma City OK	Tyler TX
Columbia MO	Indianapolis-Marion County IN	Olympia WA	Vermillion SD
Columbia SC	Jackson-Madison County TN	Omaha NE	Waco TX
Columbus OH	Jacksonville FL	Orange County CA	Waterloo-Cedar Falls IA
Corpus Christi TX	Janesville WI	Orlando FL	Wausau WI
Dallas TX	Jefferson City MO	Paducah KY	Weatherford TX
Dayton OH	Jonesboro AR	Palm Springs CA	West Palm Beach FL
Decatur IL	Joplin MO	Peoria IL	Wichita KS
Decatur-Hartselle AL	Juneau AK	Philadelphia PA	Wilmington NC
Denver CO	Kansas City MO-KS	Phoenix AZ	Yakima WA
Des Moines IA	Kingsport TN	Pittsburgh PA	York County PA
Eau Claire WI	Klamath Falls OR	Plano TX	Youngstown-Warren OH
El Paso TX	Knoxville TN	Pocatello ID	Yuma AZ
Eugene OR	Lafayette IN	Portland OR	
Fairbanks AK	Lake Charles LA	Pryor Creek OK	

B. Goods and Services Studied

ACCRA changed the items in its COLI basket from time to time over this period. The number of goods and services included in the basket was usually in the upper fifties or lower sixties. The goods and services were not consistent throughout the quarters though, and even if two quarters had the same number of goods and services listed, the goods and services could still vary. A specific good or service may not even be consistent throughout the quarters. Eggs have consistently been a dozen grade A large eggs in ACCRA's Cost of Living Index, but orange juice in the first quarter of 1990 was a frozen 12-ounce can of Minute Maid orange juice, while it was 64 ounces of fresh Tropicana or Florida Natural Brand orange juice in the first quarter of 2005. This further complicates the explanation of a good's or service's price variation through time.

The first step in making sure that the goods and services used, like the MSAs, were consistent in the two quarters was eliminating the items that were not present in both time periods. These items included bacon, cigarettes, tomatoes, detergent, baby food, bus fare, hospital room, aspirin, underwear, Monopoly game, and liquor in the first quarter of 1990 and sausage, Cascade, frozen meal, potato chips, optometrist, ibuprofen, Lipitor, women's slacks, and veterinarian services in the first quarter of 2005.

A few items that were present in both quarters had to be eliminated for various reasons. There was price data for orange in juice in 1990 and 2005, but its definition varied greatly between the two periods as stated above. These differences were too great to allow comparison of this item. Other items were eliminated because they did not have prices reported for most of the MSAs. These items included three energy types: all electricity, part electricity, and other energy[2]. These items were defined consistently over the two quarters, but since prices for these items were not present for most of the MSAs in each quarter, the resulting price variations would be incorrectly weighted.

So which items were included? The goods and services that were used for this research were common to most of the MSAs and they had consistent definitions in the two quarters. Table 2 provides a list of all 47 goods and services included in this study and their definitions in 1900(I) and 2005(I). The only inconsistencies present in these items were possible lack of precision in their definitions, or minor size differences. Services are an example of items in which major differences can occur across space and time. They can vary in such factors as quality and what tasks are actually involved in the service, so it is difficult to provide an exact definition. For

[2] All electricity is defined as average monthly cost for all-electric homes. Part electricity is defined as average monthly cost for homes using other types of energy as well. Other energy is defined as average monthly cost at current rates for natural gas, fuel oil, coal, wood, etc.

example, doctor visit and dentist visit are defined by specific procedure numbers, but despite this, these services still vary across space due to differences in such factors as skill level and regulations. Some items changed in size between the two periods such as tuna, which was a 6.5-ounce can in 1990(I) and a 6.0-ounce can in 2005(I). Such size differences do not affect the COV though because the change of price is reflected in both the item's mean price and standard deviation equally, so the resulting COV is the same no matter the size. This means that even though certain items' sizes were not defined exactly the same in the two periods, they still result in comparable COVs. Other items were included even though they were completely different brands in the two periods. An example of this is shampoo, which was an 11-ounce bottle of Johnson's Baby Shampoo in 1990(I) and a 15-ounce bottle of Alberto VO-5 in 2005(I). These two brands may be quite a bit different, but they are both shampoo and they serve the same purpose. This means that even though the brands are different, they should still show similar variations in price. Man's dress shirt, beer, and wine are other examples of items that are different brands in the two periods. The analysis section of this paper will explain how this study accounts for the differences in items.

Table 2: Included Items

Item	1990(I) Definition	2005(I) Definition
Grocery		
T-Bone Steak	Price per pound, USDA Choice	Price per pound
Ground Beef or Hamburger	Price per pound, lowest price	Price per pound, lowest price, min 80% lean
Frying Chicken	Price per pound, whole fryer	Price per pound, whole fryer
Chunk Light Tuna	6.5 oz can, Starkist or Chicken of the Sea, packed in oil	6.0 oz can, Starkist or Chicken of the Sea
Whole Milk	Half-Gallon carton	Half-Gallon carton
Eggs	One Dozen, Grade A, Large	One Dozen, Grade A, Large
Margarine	One Pound, Blue Bonnet or Parkay	One Pound, cubes, Blue Bonnet or Parkay
Parmesan Cheese, Grated	8 oz. Canister, Kraft Brand	8 oz. Canister, Kraft Brand
Potatoes	10 pound sack, white or red	10 lb. white or red
Bananas	Price per pound	Price per pound
Head Lettuce	Head, approximately 1-1/4 pound	Head, approximately 1.25 pounds
Bread, White	24 oz. loaf, lowest price	24 oz. loaf, lowest price, or prorated 24-oz. equivalent, lowest
Coffee, Vacuum-Packed	13 oz. can, Maxwell House, Hills Brothers, or Foldgers	11.5 oz. can, Maxwell House, Hills Brothers, or Foldgers
Sugar	5 pounds, Cane or Beet, lowest price	4 pound sack, Cane or Beet, lowest price
Corn Flakes	18 oz., Kellogg's or Post Toasties	18 oz., Kellogg's or Post Toasties
Sweet Peas	17 oz. can, Del Monte or Green Giant	15-17 oz. can, Del Monte or Green Giant
Peaches	29 oz. can, Hunt's, Del Monte, or Libby's, halves or slices	29 oz. can, Hunt's, Del Monte, or Libby's or Lady Alberta, halves or slices
Facial Tissues	175-count box, Kleenex brand	160-count box, Kleenex brand
Shortening	3 pound can, all-vegetable, Crisco brand	3 pound can, all-vegetable, Crisco brand
Frozen Corn	10 oz., Whole Kernel, lowest price	16 oz., Whole Kernel, lowest price
Soft Drink	2 liter Coca Cola, excluding any deposit	2 liter Coca Cola, excluding any deposit
Housing		
Apartment, Monthly Rent	Two-Bedroom, unfurnished, excluding all utilities except water, 1-1/2 baths, approximately 950 sq.ft.	Two-Bedroom, unfurnished, excluding all utilities except water, 1-1/2 baths, approximately 950 sq.ft.
Total Purchase Price	1,800 sq.ft. living area new house, 8,000 sq.ft. lot, urban area with all utilities	2,400 sq.ft. living area new house, 8,000 sq.ft. lot, urban area with all utilities
Mortgage Rate	Effective rate, including points and origination fee, for 30-year conventional fixed- or adjustable-rate mortgage	Effective rate, including points and origination fee, for 30-year conventional fixed rate mortgage
Monthly Payment	Principal and Interest, using mortgage rate from above and assuming 25% down payment	Principal and Interest, using mortgage rate from above and assuming 25% down payment
Utilities		
Total Home Energy Cost	Monthly Cost, at current rates, for average monthly consumption of all types of energy during the previous 12 months for the type of home specified above.	Monthly Cost, at current rates, for average monthly consumption of all types of energy during the previous 12 months for the type of home specified above.
Telephone	Private residential line; Customer owns instruments. Price includes: basic monthly rate; additional local use charges, if any, incurred by a family of four; Touch Tone fee; all other mandatory monthly charges, such as long distance access fee and 911 fee; and all taxes foregoing	Private residential line; Customer owns instruments. Price includes: basic monthly rate; additional local use charges, if any, incurred by a family of four; Touch Tone fee; all other mandatory monthly charges, such as long distance access fee and 911 fee; and all taxes foregoing
Transportation		
Auto Maintenance	Average price to computer- or spin balance - one front wheel	Average price to computer- or spin balance - one front wheel
Gasoline	One Gallon regular unleaded, national brand, including all taxes; cash price at self service pump if available	One Gallon regular unleaded, national brand, including all taxes; cash price at self service pump if available
HealthCare		
Office Visit, Doctor	American Medical Association procedure 90050: general practitioner's routine examination of established patient	American Medical Association procedure 99213 (general practitioner's routine examination of established patient)
Office Visit, Dentist	American Dental Association procedure 1110 (adult teeth cleaning) and 0120 (periodic oral examination)	American Dental Association procedure 1110 (adult teeth cleaning) and 0120 (periodic oral examination)
Miscellaneous		
Hamburger Sandwich	1/4 pound patty with cheese. McDonald's Quarter-Pounder with Cheese, where available	1/4 pound patty with cheese, pickle, onion, mustard, and catsup. McDonald's Quarter-Pounder with Cheese, where available
Pizza	12"-13" thin crust cheese pizza. Pizza Hut or Pizza Inn, where available	11"-12" thin crust cheese pizza. Pizza Hut or Pizza Inn, where available
Fried Chicken	Thigh and Drumstick, with or without extras. Kentucky Fried Chicken or Church's where available	Thigh and Drumstick, with or without extras, whichever is less expensive. Kentucky Fried Chicken or Church's, where available
Haircut	Man's barber shop haircut, no styling	Man's barber shop haircut, no styling
Beauty Salon	Woman's shampoo, trim, and blow dry	Woman's shampoo, trim, and blow dry
Toothpaste	6 oz.-7oz. tube, Crest or Colgate	6 oz.-7oz. tube, Crest or Colgate
Shampoo	11 oz. Bottle, Johnson's Baby Shampoo	15 oz. Bottle, Alberto VO-5
Dry Cleaning	Man's two-piece suit	Man's two-piece suit
Man's Dress Shirt	Arrow, Enro, Van Huesen, or J.C Penny's Stafford, White, cotton/polyester blend (at least 55% cotton), long sleeves	Cotton/Polyester, pinpoint weave, long sleeves
Major Appliance Repair	Home service call, clothes washing machine; minimum labor charge, excluding parts	Home service call, clothes washing machine; minimum labor charge, excluding parts
Newspaper Subscription	Daily and Sunday home delivery, large-city newspaper, monthly	Daily and Sunday home delivery, large-city newspaper
Movie	First-run, indoor, evening	First-run, indoor, evening, no discount
Bowling	Price per line (game), evening rate	Price per line (game), satuday evening, non-league rate
Tennis Balls	Can of three extra duty, yellow, Wilson or Penn Brand	Can of three extra duty, yellow, Wilson or Penn Brand
Beer	Budweiser or Miller Lite, 6-pack, 12 oz. containers, excluding any deposit	Heineken's, 6-pack, 12-oz. containers, excluding any deposit
Wine	Paul Masson Chablis, 1.5 litre Bottle	Livingston Cellars or Gallo chablis or chenin blanc, 1.5-liter bottle

C. NMFC Class Ratings

Another source of data for this study comes from the National Motor Freight Classification (NMFC). The National Motor Freight Traffic Association (NMFTA) publishes the NMFC. According to the NMFTA's website[3], it is a nonprofit membership organization founded in 1956 that is dedicated to advancing the interests of its more than 1,100 member motor carriers. The NMFC is a pricing tool that compares commodities moving in interstate, intrastate, and foreign commerce. Commodities are grouped into one of 18 different rating classes, which range from a low of class 50 to a high of class 500. Each of the classes is based on four transportation characteristics. The first characteristic is density, which is the shipping weight of the item per cubic foot. The second is stowability, which takes into account excessive weight or length. The third is handling, which measures the care and attention necessary to handle the item. The last characteristic is liability, which measures the item's value per pound, susceptibility to theft, susceptibility to damage, propensity to damage other items, propensity to combust or explode, and perishability (Winter 1997). These characteristics together make up a commodity's "transportability". The purpose of the NMFC is to provide shippers with a standard on which to base pricing negotiations.

Each of the commodities contained in the NMFC is assigned an article description and a five-digit item number. The item numbers are a very important aspect of the NMFC because a specific item number identifies each article and the articles are catalogued in the manual in numerical order by their item numbers. Some articles are broken down into subcategories depending on how they are defined. Each subcategory has the same item number, but they may have different class ratings. These ratings measure the "transportability" of an item, ranging from a score of 50, which is the cheapest to transport, to 500, which the most expensive to transport. Class ratings come in two forms, which are based on minimum weight factors. Minimum weight factors (MW) are stated in thousands of pounds and apply per vehicle, no shorter than 35 feet in length, but they are not to be constructed as affording shippers the exclusive use of such vehicles. Truckload (TL) classes or rates are those for which a truckload minimum weight is provided. Charges will be assessed at the truckload minimum weight shown in the NMFC or in tariffs governed hereby, except that actual weight will apply when in excess of the truckload minimum weight. Less than truckload (LTL) classes or rates are applicable to freight less than the volume or truckload minimum specified for the same article (NMFC 1990). For each item, both forms of class rating are assigned a specific rating depending on the four characteristics listed above. The

[3] National Motor Freight Transportation Association, Inc. Available online at <http://www.nmfta.org/>.

higher the ratings, the lower the degree of transportability the item has. The lower the ratings, the higher the degree of transportability the item has. Table 3 lists the items that have class ratings along with their actual ratings.

Table 3: NMFC Class Ratings

Items	1990 Rating	2005 Rating
T-Bone Steak	100	100
Ground Beef or hamburger	100	100
Frying Chicken	77.5	Exempt
Chunk Light Tuna	60	60
Whole Milk	100	Exempt
Eggs	85	Exempt
Margarine	77.5	77.5
Parmesan Cheese, Grated	77.5	77.5
Potatoes	60	Exempt
Bananas	92.5	92.5
Head Lettuce	100	Exempt
Bread, White	70	70
Coffee, Vacuum-Packed	60	60
Sugar	55	55
Corn Flakes	100	100
Sweet Peas	60	60
Peaches	60	60
Facial Tissues	85	85
Shortening	65	65
Frozen Corn	100	100
Soft Drink	60	60
Gasoline	65	85
Toothpaste	85	85
Shampoo	60	60
Man's Dress Shirt	100	100
Tennis Balls	85	85
Beer	65	65
Wine	100	100

Between 1990 and 2005, the truckload (TL) rating and minimum weight factors (MW) were removed from the NMFC and the less than truckload (LTL) rating was converted to the rating labeled CLASS. The following statement is the reasoning provided by the NMFTA: “To comply with the Order of the Interstate Commerce Commission in MC-98 (Sub-No. 1), Investigation into Motor Carrier Classification, dated February 25, 1983 (served March 9, 1983), as amended August 8, 1983 (served August 12, 1983) and with Title VI of the Federal Aviation Administration Authorization Act of 1994, all truckload classes and minimum weights published in the Classification were canceled” (Winter). Another difference that is present between the two versions of the

NMFC is the “Exempt” rating that some items now receive. The following definition of Exempt was provided by the NMFTA: “When 'Exempt' is shown in the rating column, it means that the commodity or commodities are not subject to economic regulation, and the tariff user should consult with the individual carrier for the applicable provisions” (Winter).

V. DESCRIPTIVE STATISTICS

Using the price data from ACCRA’s Cost of Living Index and the measurement techniques explained in the theory section, several useful statistics were calculated. The minimum, maximum, and mean prices were found for each good and service and then used to calculate the standard deviation and coefficient of variation (COV) for each. Once the COVs were calculated, they were then used to find the change in COV and the percent change in COV that has occurred between the first quarter of 1990 and the first quarter of 2005. Appendix I lists summary statistics for each item including the maximum, minimum, and mean price, along with the standard deviation.

As was stated at the beginning of this paper, the prices of the goods and services are not the basis of this study, however, the price variations are. This means that the actual COVs that were calculated for each good and service are essential to this study. The COV of each good and service by itself represents the amount of price variation that has occurred for only that good or service. This value by itself does not mean a great deal though. What is important is the relative price variability of goods and services, which is defined by Lapp and Smith (1992) as the variance, across a set of one specific good or service, of the rates of change of individual prices relative to each other. By looking at relative price variation, the price variation that has occurred in one good or service can be easily compared to the variation that has occurred in another good or service. It is very difficult to tell if one COV by itself represents a small or large amount of variation. Table 4 shows the COVs for each item in 1990 (I) and 2005 (I) and the change in COV and the percent change in COV that occurred in each item between 1990 and 2005. This study is not as concerned with the COVs of each item in one time period as it is with the change in COVs that has occurred over time. A study by Alex Kazmierczak (2006) on price variability across space explains why price variations occur in items across the country during one specific time period.

Table 4: Change in COV & Percent Change in COV

Item	COV 1990 (I)	COV 2005 (I)	Change in COV	% Change in COV
Grocery				
T-Bone Steak	0.123	0.135	0.012	9.8
Ground Beef or	0.106	0.176	0.070	66.3
Frying Chicken	0.192	0.223	0.031	16.0
Chunk Light Tuna	0.170	0.221	0.050	29.5
Whole Milk	0.109	0.128	0.019	17.2
Eggs	0.149	0.359	0.211	141.7
Margarine	0.190	0.263	0.073	38.5
Parmesan Cheese, Grated	0.098	0.177	0.079	80.1
Potatoes	0.188	0.251	0.063	33.7
Bananas	0.188	0.219	0.031	16.5
Head Lettuce	0.195	0.209	0.014	7.1
Bread, White	0.186	0.213	0.027	14.4
Coffee, Vacuum-Packed	0.127	0.178	0.051	40.3
Sugar	0.100	0.119	0.020	19.6
Corn Flakes	0.125	0.163	0.038	30.3
Sweet Peas	0.102	0.216	0.113	110.7
Peaches	0.087	0.152	0.064	73.8
Facial Tissues	0.093	0.148	0.055	60.0
Shortening	0.111	0.104	-0.007	-6.4
Frozen Corn	0.085	0.225	0.139	163.1
Soft Drink	0.180	0.136	-0.044	-24.4
Housing				
Apartment, Monthly Rent	0.244	0.293	0.049	20.1
Total Purchase Price	0.295	0.347	0.051	17.4
Mortgage Rate	0.018	0.020	0.002	12.8
Monthly Payment	0.303	0.352	0.049	16.0
Utilities				
Total Home Energy Cost	0.215	0.188	-0.027	-12.6
Telephone	0.209	0.184	-0.024	-11.7
Transportation				
Auto Maintenance	0.153	0.172	0.020	13.0
Gasoline	0.069	0.063	-0.006	-8.8
HealthCare				
Office Visit, Doctor	0.198	0.162	-0.036	-18.1
Office Visit, Dentist	0.283	0.198	-0.085	-30.0
Miscellaneous				
Hamburger Sandwich	0.068	0.091	0.023	33.9
Pizza	0.083	0.102	0.019	23.3
Fried Chicken	0.121	0.131	0.010	8.4
Haircut	0.194	0.174	-0.020	-10.3
Beauty Salon	0.227	0.244	0.017	7.6
Toothpaste	0.117	0.165	0.048	41.0
Shampoo	0.093	0.148	0.055	58.7
Dry Cleaning	0.143	0.166	0.024	16.5
Man's Dress Shirt	0.117	0.186	0.069	59.0
Major Appliance Repair	0.171	0.193	0.022	12.9
Newspaper Subscription	0.245	0.253	0.008	3.3
Movie	0.143	0.108	-0.035	-24.3
Bowling	0.165	0.185	0.020	12.0
Tennis Balls	0.170	0.157	-0.013	-7.8
Beer	0.104	0.065	-0.039	-37.5
Wine	0.163	0.179	0.016	9.9
Mean	0.153	0.182	0.028	24.3
Minimum	0.018	0.020	-0.085	-37.5
Maximum	0.303	0.359	0.211	163.1

VI. ANALYSIS

In order to examine which goods and services experienced increases in variation and which ones experienced decreases in variation, the goods and services were ranked by their COV. This was done by COV in 1990(I) and COV in 2005(I). Not only does this allow for the comparison of relative price variation in each quarter, it also makes it possible to see which goods and services have shown large changes between the two quarters. Ranking each good and service by percent change in COV is very important in looking at how price variation has occurred through time. Percent change in COV shows a good's or service's change in COV between 1990(I) and 2005(I) as a percentage of its COV from 1990(I). The rankings of these measurements can be seen in graphic form in Appendix II and Appendix III.

Table 5: COV Rankings

Item	COV 1990 (I)	Item	COV 2005 (I)	Item	% Change in COV
Monthly Payment	0.303	Eggs	0.359	Frozen Corn	163.1
Total Purchase Price	0.295	Monthly Payment	0.352	Eggs	141.7
Office Visit, Dentist	0.283	Total Purchase Price	0.347	Sweet Peas	110.7
Newspaper Subscription	0.245	Apartment, Monthly Rent	0.293	Parmesan Cheese, Grated	80.1
Apartment, Monthly Rent	0.244	Margarine	0.263	Peaches	73.8
Beauty Salon	0.227	Newspaper Subscription	0.253	Ground Beef or Hamburger	66.3
Total Home Energy Cost	0.215	Potatoes	0.251	Facial Tissues	60.0
Telephone	0.209	Beauty Salon	0.244	Man's Dress Shirt	59.0
Office Visit, Doctor	0.198	Frozen Corn	0.225	Shampoo	58.7
Head Lettuce	0.195	Frying Chicken	0.223	Toothpaste	41.0
Haircut	0.194	Chunk Light Tuna	0.221	Coffee, Vacuum-Packed	40.3
Frying Chicken	0.192	Bananas	0.219	Margarine	38.5
Margarine	0.190	Sweet Peas	0.216	Hamburger Sandwich	33.9
Potatoes	0.188	Bread, White	0.213	Potatoes	33.7
Bananas	0.188	Head Lettuce	0.209	Corn Flakes	30.3
Bread, White	0.186	Office Visit, Dentist	0.198	Chunk Light Tuna	29.5
Soft Drink	0.180	Major Appliance Repair	0.193	Pizza	23.3
Major Appliance Repair	0.171	Total Home Energy Cost	0.188	Apartment, Monthly Rent	20.1
Chunk Light Tuna	0.170	Man's Dress Shirt	0.186	Sugar	19.6
Tennis Balls	0.170	Bowling	0.185	Total Purchase Price	17.4
Bowling	0.165	Telephone	0.184	Whole Milk	17.2
Wine	0.163	Wine	0.179	Dry Cleaning	16.5
Auto Maintenance	0.153	Coffee, Vacuum-Packed	0.178	Bananas	16.5
Eggs	0.149	Parmesan Cheese, Grated	0.177	Monthly Payment	16.0
Dry Cleaning	0.143	Ground Beef or Hamburger	0.176	Frying Chicken	16.0
Movie	0.143	Haircut	0.174	Bread, White	14.4
Coffee, Vacuum-Packed	0.127	Auto Maintenance	0.172	Auto Maintenance	13.0
Corn Flakes	0.125	Dry Cleaning	0.166	Major Appliance Repair	12.9
T-Bone Steak	0.123	Toothpaste	0.165	Mortgage Rate	12.8
Fried Chicken	0.121	Corn Flakes	0.163	Bowling	12.0
Toothpaste	0.117	Office Visit, Doctor	0.162	Wine	9.9
Man's Dress Shirt	0.117	Tennis Balls	0.157	T-Bone Steak	9.8
Shortening	0.111	Peaches	0.152	Fried Chicken	8.4
Whole Milk	0.109	Facial Tissues	0.148	Beauty Salon	7.6
Ground Beef or Hamburger	0.106	Shampoo	0.148	Head Lettuce	7.1
Beer	0.104	Soft Drink	0.136	Newspaper Subscription	3.3
Sweet Peas	0.102	T-Bone Steak	0.135	Shortening	-6.4
Sugar	0.100	Fried Chicken	0.131	Tennis Balls	-7.8
Parmesan Cheese, Grated	0.098	Whole Milk	0.128	Gasoline	-8.8
Shampoo	0.093	Sugar	0.119	Haircut	-10.3
Facial Tissues	0.093	Movie	0.108	Telephone	-11.7
Peaches	0.087	Shortening	0.104	Total Home Energy Cost	-12.6
Frozen Corn	0.085	Pizza	0.102	Office Visit, Doctor	-18.1
Pizza	0.083	Hamburger Sandwich	0.091	Movie	-24.3
Gasoline	0.069	Beer	0.065	Soft Drink	-24.4
Hamburger Sandwich	0.068	Gasoline	0.063	Office Visit, Dentist	-30.0
Mortgage Rate	0.018	Mortgage Rate	0.020	Beer	-37.5

Figure 1: Coefficients of Variation 1990 & 2005

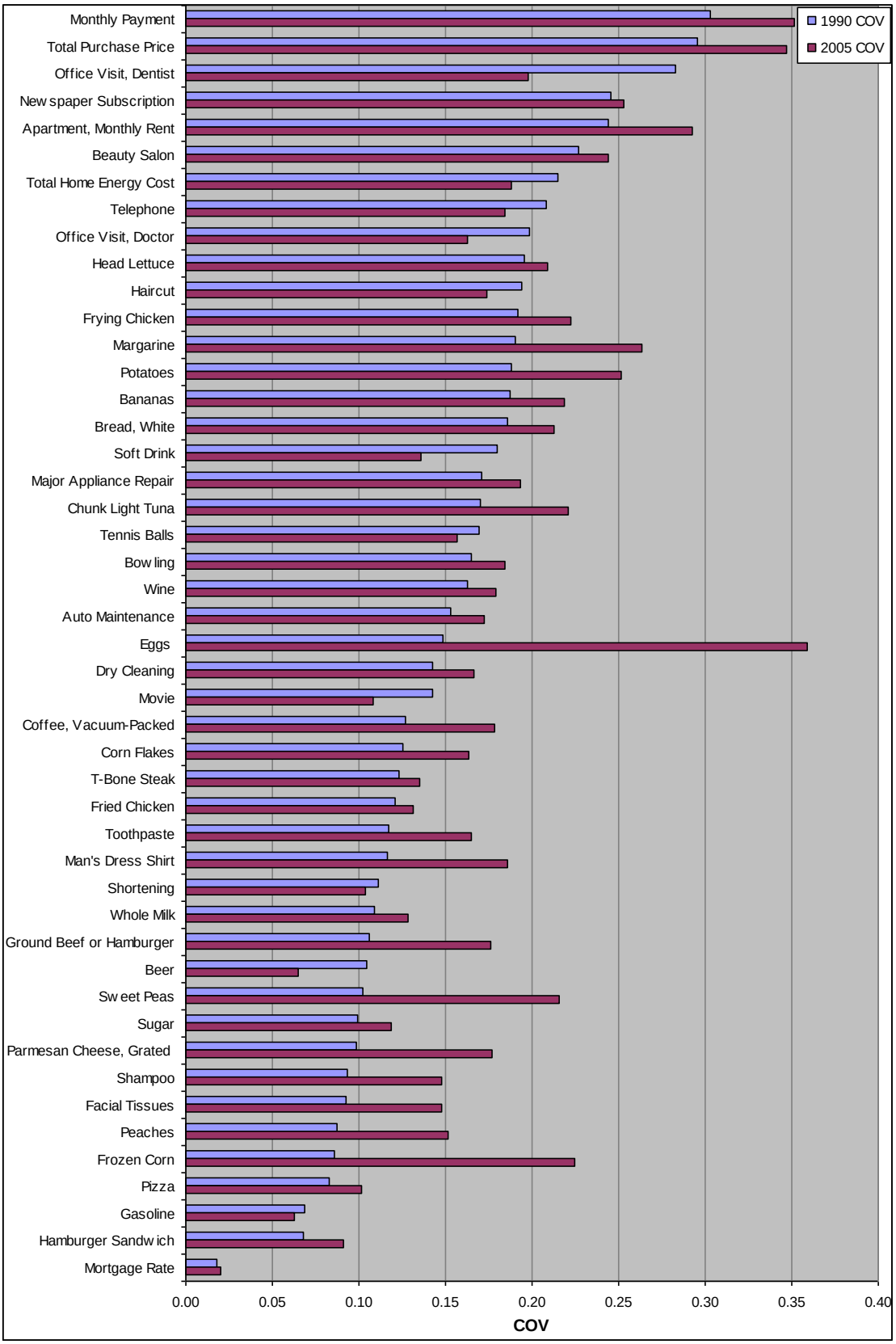
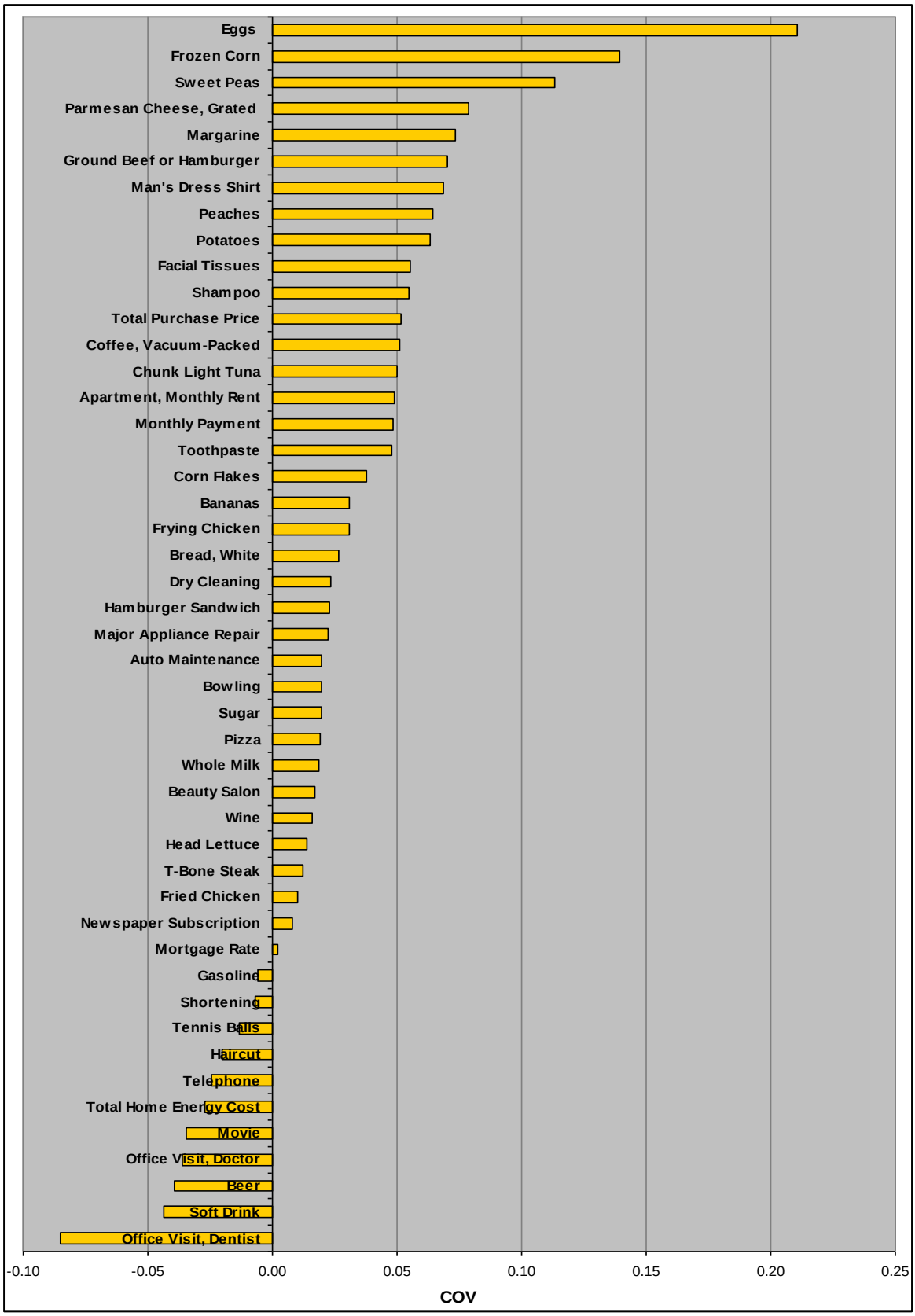


Figure 2: Change in Coefficient of Variation



As can be seen in Table 5 and the two Figures, Monthly House Payment, Total House Purchase Price, Office Visit Dentist, Newspaper Subscription, and Apartment Monthly Rent are the items with the highest COVs and Mortgage Rate, Hamburger Sandwich, Gasoline, Pizza, and Frozen Corn are the items with the lowest COVs in 1990. Eggs, Monthly Payment, Total Purchase Price, Apartment Monthly Rent, and Margarine are the items with the highest COVs and Mortgage Rate, Gasoline, Beer, Hamburger Sandwich, and Pizza are the items with the lowest COVs in 2005. Frozen Corn, Eggs, Sweet Peas, Parmesan Cheese, and Peaches are the items whose COVs increased the most between the two periods. Office Visit Doctor, Movie, Soft Drink, Office Visit Dentist, and Beer are the items whose COVs decreased the most between the two periods. Beauty Salon, Head Lettuce, Newspaper Subscription, Shortening, and Tennis Ball are the items whose COVs stayed the most consistent in this time span.

Ranking the COVs for the two periods and the percent change that occurred in them results in some conflicting results. The items with the highest COVs in 1990 are all local market items, are not easily transportable, and therefore are not subject to arbitrage. This fits our hypotheses. Frozen Corn and Gasoline are both transportable goods that exist in a national market and are subject to arbitrage had low COVs in 1990. This again is an expected result. However, Pizza, Hamburger Sandwich, and Mortgage Rate are not subject to arbitrage because they are not transportable and exist in a local market. Despite this, these items had low COVs in 1990.

In 2005, Eggs and Margarine had high COVs despite both items being transportable, existing in a national market, and being subject to arbitrage. Beer, Gasoline, and Mortgage Rate (now transportable and existing in a national market due to the advent of the Internet) had low COVs in 2005, which was expected. Pizza and Hamburger Sandwich still had unexpectedly low COVs in 2005.

A. Regression Analysis

As Table 5 shows, different items have varying COVs. The first part of this study discussed theoretical reasons as to why this occurs. The second part showed the actual price variations that have occurred across time between 1900(I) and 2005(I), many of which did not agree with the theoretical predictions. Because of this, it is obvious that factors other than just the ones predicted by theory must also play a role in determining why

items' prices vary. This section attempts to find other factors that affect items' COVs and set up a model using these factors, along with the ones utilized by theory, to explain why prices vary over time.

1. Goods/Services

The first factor that was examined was simply whether each item was a good or a service. Goods are more uniformly defined and are typically more transportable, so by theory they should experience less price variation. Services are not as standard and they are not usually transportable. By theory, they should experience greater price variation.

A dummy variable was used to define each item as either a good or a service. If an item is a good, the dummy variable is equal to 1. If an item is a service, the dummy variable is equal to 0. It is expected that if an item is a good it will have a lower COV and if it is a service it will have a higher COV, so it is expected that the sign on this variable will be negative.

Regression equation: $COV_i = B_0 - B_1GS_i + e_i$

Where COV_i = Coefficient of variation for item i,

GS_i = Dummy variable equal to 1 if the item is a good and 0 if the item is a service,

e_i = error term for item i.

Hypothesis test:

For coefficient B_1, H_0: $B_1 > 0$

H_A: $B_1 \leq 0$.

Result 1990(I): $COV_i = 0.176793 - 0.03776GS_i + e_i$

(t-stat) (12.45) (-2.09)

$R^2 = 0.088$ n = 47

Result 2005(I): $COV_i = 0.178762 + 0.004764GS_i + e_i$

(t-stat) (10.64) (0.22)

$R^2 = 0.001$ n = 47

Regressing the COVs against the good or service dummy variable showed that in 1990(I), the null hypothesis can be rejected and that the good or service variable is statistically significant, but in 2005(I), the null hypothesis cannot be rejected. In 1990(I), the good or service variable has a negative coefficient, which agrees

with the theory that if an item is a good then it experiences less price variation. The good or service variable has a positive coefficient in 2005(I), which contradicts theory, but it is not statistically significant. The two quarters also had drastically different R^2 values. In 1990(I), 8.8 percent of the difference in COV was explained by the item being either a good or service. In 2005(I), only 0.1 percent of the difference in COV was explained by the good or service dummy variable. The results provided by this regression are a good start, but they show that a closer look at standardization and transportability is necessary.

2. Standardization

The second factor that was explored was the standardization of the goods and services in both periods and through time. Due to the definitions of some of the items, it is inevitable that some items are more standard or less standard than other items. For example, Parmesan Cheese is defined as an 8 oz. canister of Kraft brand. This definition is very clear and this item will be exactly the same in every MSA. An example of an item that can vary greatly between MSAs is Apartment, Monthly Rate. This item is defined as two-bedroom, unfurnished, excluding all utilities except water, 1-1/2 baths, approximately 950 sq. ft. This definition sounds very clear, but there are many possible variations such as location, quality, and neighborhood characteristics.

Each good or service was assigned a standardization rating ranging from 0 to 1. A rating of 0 means that the item may vary drastically from MSA to MSA. The benchmark item assigned a rating of 0 was Total Purchase Price of a House. Different houses serve the same purpose, but no two houses are the same and they vary in many different ways. On the other extreme, several items were assigned a rating of 1, including Whole Milk, Parmesan Cheese, Facial Tissues, Soft Drink, Hamburger Sandwich, and Shampoo. These items received a rating of 1 because they were defined so clearly that the items priced in each MSA virtually had to be identical. The remaining items were rated accordingly based on number of suppliers, physical characteristics, and service level. The standardization ratings were assigned by this research team and may be somewhat subjective, but the only other alternative is to not take standardization into account at all, which we considered a worse approach. The standardization values assigned to each item can be found in Appendix II.

After assigning a standardization rating to each of the items, a hypothesis test was used to measure the significance of the standardization values. Items that are more standard across the MSAs should experience

lower amounts of price variation, while items that are less standard across the MSAs should experience greater price variability. This means the coefficient of the standardization variable should be negative.

Regression equation: $COV_i = B_0 - B_1 STANDARD_i + e_i$

Where COV_i = Coefficient of variation for item i,

$STANDARD_i$ = Standardization rating for item i,

e_i = error term for item i.

Hypothesis test:

For coefficient B_1, H_0: $B_1 > 0$

H_A: $B_1 \leq 0$.

Result 1990(I): $COV_i = 0.279005 - 0.17007 STANDARD_i + e_i$

(t-stat) (13.47) (-6.40)

$R^2 = 0.476$ n = 47

Result 2005(I): $COV_i = 0.277679 - 0.1319 STANDARD_i + e_i$

(t-stat) (9.71) (-3.55)

$R^2 = 0.218$ n = 47

Regressing COVs against the standardization ratings for each item showed that the null hypothesis can be rejected and that the standardization ratings are statistically significant in both periods. In 1990(I), 47.6 percent of the change in COV was explained by the standardization ratings. In 2005(I), 21.8 percent of the change in COV was explained by the standardization ratings. In both quarters, the standardization rating has a negative coefficient, which follows the theory that an increase in standardization results in a decrease in the COV.

The results obtained above imply that a significant portion of the differences in COVs is due to a lack of standardization in the items being priced. This lack of standardization is the result of immeasurable differences that occur in many of the items. While most of the goods are very standard due to exact definitions, it is impossible to precisely define all characteristics of such things as houses, apartments, and services such that they are identical in every MSA. For example, defining doctor and dentist visits by their American Medical Association and American Dental Association procedure numbers is as exact a definition as possible for these

services, yet differences across MSAs will still inevitably occur due to the abilities and characteristics of the providers.

3. Transportability

The next factor that was examined was transportability. A dummy variable was created that assigned the items a 1 if they were transportable and a 0 if they were not transportable. Transportability means that the items should be subject to arbitrage because they could be transported from one MSA to another. This means that the items that are transportable are national market goods and services, while the items that are not transportable are local market goods and services. This characteristic typically did not change over the period, but two items, Mortgage Rate and Telephone, changed from non-transportable items in 1990(I) to transportable items in 2005(I) due to changes in technology. In 1990, the Internet did not exist as it does today and people were typically limited to only their local market when shopping for mortgages. With the advent of the Internet, people could shop online for mortgages making the market for this service a national market, which resulted in greater competition. In 1990, limitations in technology and the law gave local telephone service providers monopoly power in their market. Increases in technology however have led to a change in the structure of the market for telephone services. Now companies exist that offer these services nationwide, which has caused the market for telephone services to become a competitive, national market.

Certain items that might usually be considered transportable are defined as non-transportable in this study. These items include Hamburger Sandwich, Pizza, Fried Chicken, and Newspaper Subscription. The reason these items are categorized as not transportable is because they are not subject to arbitrage. An entrepreneur is not realistically able to go to McDonald's, Pizza Hut, or Kentucky Fried Chicken, buy a food item, take it to another MSA, and sell it for a higher price. These items are not defined only by the actual physical product, but also the service and convenience that are provided by the restaurant they come from. The Newspaper Subscription is very similar to the convenience food items just described. Newspapers themselves are transportable, but they are not subject to arbitrage because people in one MSA would not typically buy a newspaper from a different MSA because the local news would not be relevant for them.

According to theory, items that are transportable and therefore subject to arbitrage should experience a lower degree of price variability because of more intense competition in a national market. Items that are not

transportable and not subject to arbitrage should experience a higher degree of price variability because of less intense competition in a local market. Therefore, we would expect a negative sign on this variable.

Regression equation: $COV_i = B_0 - B_1 TRANSPORT_i + e_i$

Where COV_i = Coefficient of variation for item i,

$TRANSPORT_i$ = Dummy variable equal to 1 if transportable and 0 if not transportable,

e_i = error term for item i.

Hypothesis test:

For coefficient B_1, H_0: $B_1 > 0$

H_A: $B_1 \leq 0$.

Result 1990(I): $COV_i = 0.183035 - 0.04959 TRANSPORT_i + e_i$

(t-stat) (13.76) (-2.88)

$R^2 = 0.155$ n = 47

Result 2005(I): $COV_i = 0.197661 - 0.025 TRANSPORT_i + e_i$

(t-stat) (11.60) (-1.17)

$R^2 = 0.029$ n = 47

Regressing the COVs against the transportability variable led to different results in the two quarters. In 1990(I), the null hypothesis can be rejected, the transportability variable is statistically significant, and 15.5 percent of the change in COV is explained by the transportability variable. However, in 2005(I), the null hypothesis cannot be rejected and the transportability variable is not statistically significant. In both quarters, the transportability variable has a negative coefficient, which agrees with the theory that if an item is transportable, it will experience less price variation.

4. NMFC Class Ratings

Using National Motor Freight Classification (NMFC) class ratings takes transportability one step further. As stated above, the NMFC class ratings measure the transportability of commodities. For this part, the transportability dummy variable was replaced with the NMFC class rating for each of the transportable goods.[4]

[4] When "Exempt" appears as the class rating for certain items in 2005, the LTL rating from 1990 is utilized. The reason for this, as Lisa Winters from the National Motor Freight Traffic Association (NMFTA) wrote is that individual carriers must be consulted for the applicable provisions for these items and "individual carriers generally use the class that had been in the NMFC."

Between the two quarters, gasoline was the only item that experienced a change in its NMFC class rating. In 1990, gasoline had a rating of 65. In 2005, it had a rating of 65 for amounts less than 119 gallons and a rating of 85 for amounts greater than 119 gallons.[5] Since most shipments of gasoline would exceed 119 gallons, the rating of 85 is used for this study. According to Lisa Winter from the NMFTA (1997), the reason for the change in gasoline's rating was because petroleum products that were hazardous and subject to federal regulation were rated the same as nonhazardous, unregulated petroleum products. The increase in the rating from 65 to 85 represents the transportation problems that carriers undergo when transporting gasoline. Mortgage Rate and Telephone, although transportable, are not included in the NMFC ratings because they are services and they are not transported on trucks, trains, boats, airplanes, or any other form of motor vehicle.

The theory applied to the transportability section applies to this section as well. Items with higher NMFC class ratings should experience higher price variation because they are less "transportable." Items with lower NMFC class ratings should experience lower price variation because they are more "transportable." This means we expect a positive sign on this variable.

Regression equation: $COV_i = B_0 + B_1 NMFC_i + e_i$

Where COV_i = Coefficient of variation for item i,

$NMFC_i$ = NMFC class rating for item i,

e_i = error term for item i.

Hypothesis test:

For coefficient B_1, H_0: $B_1 < 0$

H_A: $B_1 \geq 0$.

Result 1990(I): $COV_i = 0.119341 + 0.000179 NMFC_i + e_i$

(t-stat) (3.17) (0.38)

$R^2 = 0.006$ n = 28

Result 2005(I): $COV_i = 0.15044 + 0.000343 NMFC_i + e_i$

(t-stat) (2.58) (0.48)

$R^2 = 0.009$ n = 28

[5] The amount of 119 gallons is used to determine the rating of gasoline because the US Department of Transportation defines combustible materials as flammable materials shipped in bulk containers holding 119 gallons or more.

Regressing the COVs against class ratings gave unexpected results. In both quarters, the null hypothesis cannot be rejected, but the NMFC class ratings are not statistically significant. NMFC's positive coefficient did follow theory however because the higher the rating, the higher the resulting COV. The R^2 values are less than one percent in each quarter though.

The poor results achieved above may have been caused by the sample size used. Since only transportable goods have NMFC class ratings, goods were the only items that could be used for this part and all services were excluded. This means the sample size was decreased from 47 items to 28 items. When using regression analysis, a larger sample size is preferred, but in this case, 28 items was the largest possible sample size. Another cause of the results obtained above could have been the lack of variation in the NMFC class ratings in the items used. NMFC ratings vary from 50 to 500, with lower ratings meaning that the items are of low value, can be densely packed together, and/or require no special care, and higher ratings meaning that the items are of high value, cannot be packed together, and require special care. Examples of items with a class rating of 50 are brick and tile and an example of an item with a class rating of 500 is a crash protection air bag deploying detonator. The items used in this study have ratings that only vary from 55 to 100, meaning that all of the items are relatively transportable. The lack of variation in the ratings probably also contributed to the statistical insignificance of this model.

Since the last model suffered from a small sample size and lack of rating variation, a new model was created with the NMFC class ratings. Services were not included in the original model because they do not receive class ratings. In order to use the original sample size of 47, all of the items that could not be used before were assigned a rating of 600. The highest NMFC rating is 500, so giving the excluded items a rating of 600 reflects the fact that they are all less transportable than the items covered by the NMFC. Including these items also eliminates the lack of variation in rating. The class ratings now vary from 50 to 600, a much larger range than before. As before, the sign expected for this variable is positive.

Regression equation: $COV_i = B_0 + B_1 NMFC_i + e_i$

Where COV_i = Coefficient of variation for item i,

$NMFC_i$ = NMFC class rating for item i,

e_i = error term for item i.

Hypothesis test:

For coefficient B_1, H_0: $B_1 < 0$

H_A: $B_1 \geq 0$.

Result 1990(I): $COV_i = 0.125894 + 0.000095NMFC_i + e_i$

(t-stat) (9.87) (2.89)

$R^2 = 0.156$ n = 47

Result 2005(I): $COV_i = 0.175957 + 0.0000198NMFC_i + e_i$

(t-stat) (11.22) (0.49)

$R^2 = 0.005$ n = 47

Regressing COV against NMFC class ratings in this new model gave better results than that of the last model. In both cases, the coefficient for the NMFC variable is positive, which means that the COV increases as the ratings increase and agrees with theory. In 1990(I), the NMFC variable was statistically significant and about 15.6 percent of the variation in COV was explained by differences in the class rating. In 2005(I) however, the NMFC variable was not statistically significant and less than one percent of the change in COV was explained by changes in the class rating.

Ideally, the standardization variable would be included in the equations with the transportability variable and the NMFC class rating varible, but there is a mutlicollinearity problem when it is used with these variables. The standardization variable is highly correlated with these two variables, meaning that it tends to parallel their behavior. Items with a higher standardization rating tend to be transportable and have a lower NMFC class rating. Items with a lower standardization rating tend to be non-transportable and have a higher NMFC class rating. When correlation between variables occurs, the effect that each of the variables has on the COV is minimized, resulting in inaccurate results.

5. Change in COV

Now that differences in the static COVs have been analyzed, it is time to examine the change in COV that has occurred over time. Change in COV will be regressed against the same variables as above (good or service, standardization, transportability, and NMFC class ratings). The goal of this section is to create models that explain the variation in COV that occurs over time.

The first model regresses change in COV over time against the good or service dummy variable. By doing this, it can be seen whether goods or services experienced an increase or decrease in price variability over time. We have no expectations for the sign on this variable.

Regression equation: $CHANGEinCOV_i = B_0 \pm B_1GS_i + e_i$

Where $CHANGEinCOV_i$ = Change in coefficient of variation between 1990 and 2005 for item i,

GS_i = Dummy variable equal to 1 if the item is a good and 0 if the item is a service,

e_i = error term for item i.

Hypothesis test:

For coefficient B_1, H_0: $B_1 = 0$

H_A: $B_1 \neq 0$.

Result: $CHANGEinCOV_i = 0.001969601 + 0.042525874GS_i + e_i$

(t-stat) (0.184) (3.11)

$R^2 = 0.177$ n = 47

The results of this regression show that the change in COV over time behaves differently than static COVs with regards to goods and services. The good or service variable is statistically significant and it has a positive coefficient, which means that goods (variable = 1) have experienced an increase in price variation over the 1990-2005 period. When regressing static COVs against the good or service variable, the coefficient was negative, meaning that goods experienced less price variation.

The second model regresses change in COV over time against the change in standardization variables used before along with a standardization through time variable. The change in standardization variable represents the difference in the standardization ratings assigned to each item between the two periods. The standardization through time varible measures how standard the goods and services were between the two time periods. Items that were essentially the same and defined similarly in both quarters were assigned a value of 1. The items that did not receive a 1 were the ones that were defined differently in the two quarters. These items included Shampoo, Man's Dress Shirt, Bowling, Beer, and Wine. The higher the value of this variable, the more standard the items were through time. The purpose of this rating is to account for price variation that occurred due to differences in the products in the two quarters. We would expect negative signs for these variables.

Regression equation: $CHANGEinCOV_i = B_0 - B_1STANDARDtime_i - B_2CHANGEinSTANDARD_i + e_i$

Where $CHANGEinCOV_i$ = Change in coefficient of variation for item i,

$STANDARDtime_i$ = Standardization rating through time for item i,

$CHANGEinSTANDARD_i$ = Change in Standardization rating between 1990 and 2005 for item i,

e_i = error term for item i.

Hypothesis test:

For coefficient B_1, H_0: $B_1 > 0$

H_A: $B_1 \leq 0$.

For coefficient B_2, H_0: $B_2 > 0$

H_A: $B_2 \leq 0$.

Result: $CHANGEinCOV_i = 0.038517 - 0.01051STANDARDtime_i - 0.005932CHANGEinSTANDARD_i + e_i$

(t-stat) (-0.385) (-0.103) (-0.036)

$R^2 = 0.002$ n = 47

The results of this model show that standardization is far less important to change in COV over time as it is to static COVs. Both the standardization through time and change in standardization variables are not statistically significant and only 0.2 percent of the change in COV over time is explained by standardization through time and change in standardization.

The next model regresses change in COV over time against change in transportability. Change in transportability measures the changes that took place in the transportability dummy variable between 1990(I) and 2005(I). An increase in TRANSPORT means that the good changed from untransportable to transportable over the period. As explained above, this happened for only two goods, mortgage rate and telephone. We would expect a negative sign for this variable.

Regression equation: $CHANGEinCOV_i = B_0 - B_1CHANGEinTRANSPORT_i + e_i$

Where $CHANGEinCOV_i$ = Change in coefficient of variation between 1990 and 2005 for item i,

$CHANGEinTRANSPORT_i$ = Change in dummy transportability variable between 1990 and 2005 for item i,

e_i = error term for item i.

Hypothesis test:

For coefficient B_1, H_0: $B_1 > 0$

H_A: $B_1 \leq 0$.

Result: $CHANGEinCOV_i = 0.029954 - 0.04101CHANGEinTRANSPORT_i + e_i$

(t-stat) (4.06) (-1.15)

$R^2 = 0.028$ n = 47

The results from this model show that the change in transportability variable is not statistically significant. The coefficient for the change in transportability variables is negative, meaning that items experienced a decrease in COV over time as they changed from nontransportable to transportable. The model also shows that approximately 3 percent of the change in COV over time is explained by change in the transportability of an item. Given that this variance applied to only two items, the lack of significance is not surprising.

The fourth model regresses change in COV over time against the NMFC ratings from 2005 and changes in the NMFC ratings between 1990 and 2005. In this case, gasoline is the only item that experienced a change in its class rating. An increase in NMFC rating means the good is more difficult/costly to transport and this should mean a greater COV, so we would expect a positive sign for this variable.

Regression equation: $CHANGEinCOV_i = B_0 + B_1NMFC_i + B_2CHANGEinNMFC_i + e_i$

Where $NMFC_i$ = NMFC class rating from 2005 for item i,

$CHANGEinCOV_i$ = Change in coefficient of variation between 1990 and 2005 for item i,

e_i = error term for item i.

Hypothesis test:

For coefficient B_1, H_0: $B_1 < 0$

H_A: $B_1 \geq 0$.

For coefficient B_2, H_0: $B_2 < 0$

H_A: $B_2 \geq 0$.

Result: $CHANGEinCOV_i = 0.01651 + 0.000373NMFC_i - 0.00271CHANGEinNMFC_i + e_i$

(t-stat) (0.332) (0.608) (-1.004)

$R^2 = 0.0496$ n = 28

This model results in statistically insignificant NMFC and change in NMFC variables. The NMFC variable has a positive coefficient, so items with a higher NMFC rating tended to have increases in COV over time. The change in NMFC variable has a negative coefficient, meaning that if an item experiences an increase in its rating, it will experience a decrease in its COV over time. This is contrary to expectation.

Once again the NMFC model above suffers from a smaller sample size and lack of variation in the ratings. Because of this, the alterations used before to increase the sample size and variation are once again utilized. The last model regresses change in COV over time against the NMFC ratings from 2005, including services with ratings of 600, and changes in the NMFC ratings between 1990 and 2005.

Regression equation: $CHANGEinCOV_i = B_0 + B_1NMFC_i + B_2CHANGEinNMFC_i + e_i$

Where $NMFC_i$ = NMFC class rating from 2005 for item i,

$CHANGEinCOV_i$ = Change in coefficient of variation between 1990 and 2005 for item i,

e_i = error term for item i.

Hypothesis test:

For coefficient B_1, H_0: $B_1 < 0$

H_A: $B_1 \geq 0$.

For coefficient B_2, H_0: $B_2 < 0$

H_A: $B_2 \geq 0$.

Result: $CHANGEinCOV_i = 0.052109 - 0.000078669NMFC_i - 0.00257CHANGEinNMFC_i + e_i$

(t-stat) (5.04) (-2.97) (-1.097)

$R^2 = 0.176$ n = 47

This model results in a statistically significant NMFC variable and statistically insignificant change in NMFC variable. The coefficients of both variables are negative, which means that items with a higher NMFC rating have decreases in COV over time and as the NMFC rating of an item increases over time, its COV over time decreases. About 17.6 percent of the change in COV over time is explained by changes in the NMFC rating and changes in the NMFC rating over time. Both of these signs are contrary to expectations.

VII. CONCLUSIONS

At the beginning of this paper, the question that was asked was why do prices vary over time? Using several different theories, measurements, statistics, and analysis, this question has been at least partly answered. This section summarizes the findings of this study by examining each of the hypotheses and analyzing the results that were obtained for each.

A. Hypothesis 1: Items for which transport costs are low and therefore which experience a high degree of arbitrage are bought and sold in a national market and have a smaller degree of price variation. Items that have high transport costs resulting in a low degree of arbitrage exist in local markets and have a higher degree of price variation.

In both 1990 and 2005, items that were defined as transportable experienced a lower COV, while items that were not transportable experienced a higher COV, as expected by theory. The model was statistically significant in 1990, but not in 2005. When the transportability variable were replaced with NMFC class ratings, similar behavior was shown with higher ratings (lower transportability) resulting in a higher COV and lower ratings (higher transportability) resulting in a lower COV, again as expected by theory. However, the model was not statistically significant in either year. Over time, the model found that as items changed from nontransportable to transportable, they experienced an increase in their COV, the opposite of our expectations. This model was not statistically significant however. When NMFC class ratings were used over time, it was found that as an item's rating in 2005 and change in rating over time increased their COV decreased and as its rating in 2005 and change in rating over time decreased their COV increased. In this model, the static class rating was statistically significant, but the change in class rating over time was not significant.

B. Hypothesis 2: Services for the most part have a lower degree of arbitrage because of the associated transport and search costs, and therefore also have a higher degree of price variation.

In 1990, it was found that if an item was a good then it had a lower COV and if it was a service it had a higher COV, as expected. In 2005, the results were opposite with services having a lower COV and goods

having a higher COV. The model was significant in 1990 though and not in 2005. Over time, goods experienced a higher COV, while services experienced a lower COV.

C. **Hypothesis 3:** Advances in technology have led to a decrease in the price variation experienced by certain items.

Advances in technology were represented in the change in transportability variable. The only two items where technology changed the way people shop for them were mortgages and telephone services. These were also the only two items that changed from nontransportable in 1990 to transportable in 2005. As explained previously, technology was reason for these items' change in transportability. Since technology was measured through transportability, the results were already explained above. Items that changed from nontransportable to transportable over time actually experienced an increase in their COV, the opposite of our expectations. This model was not statistically significant though.

D. **Hypothesis 4:** Items that are more standard between the two quarters will incur less price variation, while items that are less standard will incur greater price variation.

In both 1990 and 2005, it was found that standardization plays a large role in determining an item's COV. This hypothesis was proven with the model being statistically significant in both years and showing that the more standard an item is the lower its COV and the less standard an item is the higher its COV. Over time, the more standard an item was both statically and dynamically the lower its COV. This model was not statistically significant though.

This study shows that the standardization and transportability of goods and services play a very important role in determining the price variations that they experience, but the resulting behaviors were not all accurately predicted using theory. From the results to the hypothesis tests, it can be seen that further research needs to be done in the field of spatial price variation over time. This study was a good starting point and provided important results and findings, but it was not completely successful in explaining why variations in price

take place over time. This suggests that further research needs to be conducted in order to discover exactly why price variation over time occurs.

VIII. FURTHER RESEARCH

Future research in the area of spatial price variation over time can build upon the items and MSAs used in this paper. There are 47 goods and services used in this study, but a larger sample size is always better. The ACCRA Cost of Living Index, which was used as the source for this study, is currently the only existing source of such a wide variety of items and MSAs, but in the future a new source may exist. The difficulty in finding such a source is caused by the need for identical items and MSAs throughout the period of time covered by the study.

Along with obtaining a larger sample size, future research should attempt to use a sample of items that has a greater degree of variation in transportability. As mentioned above, the items in this study with NMFC class ratings were all relatively transportable and covered only a small range of the possible ratings. Using items that vary greatly in their degree of transportability will result in better models and more accurate findings. Once again, the difficulty in finding such items arises from the need for identical items throughout time.

Measures of items' actual transport costs and distances transported could also be very useful in developing models for a study on price variation over time. The NMFC provided a great source of items' transportability, but actual transport costs and the distances each item was transported could be used along with the class ratings in an attempt to explain a greater degree of the price variation that took place. At the time this research was conducted, measures such as these could not be found, and even if they could be found, they would have made the regression models extremely complicated to use and understand. Hopefully, the research ideas in this section will be utilized in the further research of price variation through time. The goal of this study was to reveal some of the causes of price variability over time and initiate new research in this field.

IX. Bibliography

ACCRA The Council for Community and Economic Research. 2006. *ACCRA Cost of Living Index*. <http://www.accra.org/index.asp>.

Arnold, Roger A. 2001. *Microeconomics*. Cincinnati: South-Western College Publishing.

Benson, Bruce L., and Merle D. Faminow. 1985. An Alternative View of Pricing in Retail Food Markets. *American Journal of Agricultural Economics* 67 (2): 49-62.

Capozza, Dennis R., and Robert Van Order. 1978. A Generalized Model of Spatial Competition. *The American Economic Review* 68 (5): 896-908.

Colander, David C. 2001. *Microeconomics*. New York: Irwin/McGraw-Hill.

Dorward, Neil. 1982. Recent Developments in the Analysis of Spatial Competition and their Implications for Industrial Economics. *The Journal of Industrial Economics* 31 (1/2): 131-151.

Faminow, Merle D., and Bruce L. Benson. 1990. Integration of Spatial Markets. *American Journal of Agricultural Economics* 72 (1): 49-62.

Grewal, Dhruv, and Howard Marmorstein. 1994. Market Price Variation, Perceived Price Variation, and Consumers' Price Search Decisions for Durable Goods. *The Journal of Consumer Research* 21 (3): 453-460.

Kazmierczak, Alex. 2006. What Type of Product's Prices Vary More Across Space? An Initial Examination.

Koo, Jahyeong, Keith R. Phillips, and Fiona D. Sigalla. 2000. Measuring Regional Cost of Living. *Journal of Business & Economic Statistics* 18 (1): 127-136.

Kurre, James A. 2003. Is the Cost of Living Less in Rural Areas? *International Regional Science Review* 26 (1): 86-116.

Lapp, John S., and Vincent H. Smith. 1992. Aggregate Sources of Relative Price Variability among Agricultural Commodities. *American Journal of Agricultural Economics* 74 (1): 1-9.

Marvel, Howard P. 1976. The Economics of Information and Retail Gasoline Price Behavior: An Empirical Analysis. *The Journal of Political Economy* 84 (5): 1033-1060.

National Motor Freight Classification (NMFC). NMF 100-Q, effective May 5, 1990. NMF 100-AF, effective December 24, 2005. National Motor Freight Classification Traffic Association, Inc.

National Motor Freight Traffic Association, Inc. 2006. <http://www.nmfta.org/>.

Norman, George. 1983. Spatial Pricing with Differentiated Products. *The Quarterly Journal of Economics* 98 (2): 291-310.

Tregarthen, Timothy. 1988. The Monks of St. Benedict's: Getting out of the Egg Business. *The Margin* Sep./Oct.: 14-15.

Winter, Lisa. 1997. Petroleum Products Verified Statement. National Motor Freight Traffic Association, Inc. Email Correspondence.

Appendix I: Summary Statistics

	1990 (I)				2005 (I)			
Item	**Max Price ($)**	**Min Price ($)**	**Mean Price ($)**	**Standard Deviation**	**Max Price ($)**	**Min Price ($)**	**Mean Price ($)**	**Standard Deviation**
Grocery								
T-Bone Steak	6.25	3.46	4.71	0.580	11.69	5.36	8.32	1.124
Ground Beef or Hamburger	2.09	1.01	1.51	0.160	3.47	1.34	2.38	0.419
Frying Chicken	1.36	0.50	0.78	0.150	1.79	0.63	1.08	0.241
Chunk Light Tuna	1.17	0.49	0.75	0.128	1.29	0.44	0.71	0.156
Whole Milk	2.01	1.10	1.42	0.155	2.99	1.30	1.98	0.253
Eggs	2.11	0.68	1.21	0.180	2.61	0.60	1.07	0.385
Margarine	1.09	0.42	0.64	0.122	1.89	0.54	0.86	0.226
Parmesan Cheese, Grated	3.99	2.44	3.05	0.300	4.99	2.42	3.44	0.610
Potatoes	3.76	1.24	2.35	0.442	5.73	1.49	3.00	0.755
Bananas	0.83	0.27	0.43	0.081	0.99	0.26	0.49	0.108
Head Lettuce	1.17	0.36	0.76	0.148	2.49	0.78	1.14	0.238
Bread, White	1.22	0.39	0.68	0.127	2.19	0.60	1.04	0.220
Coffee, Vacuum-Packed	3.59	1.80	2.52	0.321	4.39	1.96	2.88	0.512
Sugar	2.58	1.24	1.80	0.179	2.48	1.24	1.60	0.190
Corn Flakes	2.47	1.19	1.79	0.225	4.19	1.73	2.86	0.466
Sweet Peas	0.82	0.46	0.63	0.065	1.47	0.50	0.83	0.179
Peaches	1.61	0.94	1.28	0.112	2.59	1.03	1.70	0.259
Facial Tissues	1.54	0.93	1.12	0.104	2.04	0.95	1.35	0.200
Shortening	3.72	1.80	2.64	0.293	4.67	2.69	3.40	0.354
Frozen Corn	0.83	0.56	0.68	0.058	2.85	0.68	1.14	0.256
Soft Drink	2.43	0.89	1.25	0.224	2.22	0.91	1.26	0.171
Housing								
Apartment, Monthly Rent	930.00	277.00	440.14	107.364	1,775.00	489.60	689.22	201.844
Total Purchase Price	249,498.00	72,140.00	102,574.49	30299.281	794,450.00	184,922.00	267,972.88	92,914.076
Mortgage Rate	10.71	9.57	10.11	0.180	6.00	5.42	5.70	0.114
Monthly Payment	1,789.00	491.00	705.58	213.758	3,524.60	827.00	1,167.23	410.326
Utilities								
Total Home Energy Cost	243.60	58.57	108.22	23.263	254.83	97.24	140.33	26.365
Telephone	34.40	10.98	18.94	3.950	37.16	16.32	24.49	4.509
Transportation								
Auto Maintenance	9.65	4.00	6.24	0.953	13.20	5.00	8.70	1.500
Gasoline	1.45	0.85	1.03	0.071	2.17	1.47	1.77	0.111
HealthCare								
Office Visit, Doctor	60.00	21.00	30.51	6.053	115.40	50.50	75.09	12.198
Office Visit, Dentist	110.00	23.67	39.81	11.266	125.25	46.00	65.43	12.953
Miscellaneous								
Hamburger Sandwich	2.23	0.99	1.73	0.118	3.45	1.50	2.44	0.223
Pizza	10.99	6.10	7.80	0.644	13.06	6.99	10.14	1.032
Fried Chicken	2.97	0.99	2.02	0.245	3.70	1.95	2.75	0.361
Haircut	12.33	4.50	7.24	1.407	17.75	3.38	11.26	1.962
Beauty Salon	34.60	9.83	17.12	3.881	53.00	15.00	27.97	6.817
Toothpaste	2.40	1.01	1.84	0.215	3.49	1.15	2.37	0.390
Shampoo	4.16	2.08	2.73	0.254	1.68	0.87	1.09	0.161
Dry Cleaning	8.79	4.00	5.64	0.806	12.33	5.32	8.81	1.466
Man's Dress Shirt	28.50	15.57	21.84	2.547	39.50	17.50	26.23	4.866
Major Appliance Repair	47.33	18.00	29.35	5.027	91.80	24.50	48.97	9.471
Newspaper Subscription	19.57	4.50	9.51	2.334	35.49	6.17	13.76	3.487
Movie	6.75	2.74	5.01	0.715	9.80	5.00	7.56	0.817
Bowling	2.70	0.95	1.81	0.298	6.06	1.50	3.29	0.608
Tennis Balls	4.52	1.88	2.46	0.417	3.20	1.80	2.21	0.346
Beer	4.83	2.19	3.37	0.351	9.46	6.49	7.59	0.495
Wine	7.26	3.39	4.93	0.802	10.38	3.97	6.17	1.104

Appendix II: Standardization Index

Item	1990 Rating	1990 Description	2005 Rating	2005 Description
Grocery				
T-Bone Steak	0.9	Clear description, but lacks standardization in supplier or brand.	0.9	Clear description, but lacks standardization in supplier or brand.
Ground Beef or Hamburger	0.9	Clear description, but lacks standardization in supplier or brand.	0.9	Clear description, but lacks standardization in supplier or brand.
Frying Chicken	0.9	Clear description, but lacks standardization in supplier or brand.	0.9	Clear description, but lacks standardization in supplier or brand.
Chunk Light Tuna	0.9	Clear description with two brand alternatives.	0.9	Clear description with two brand alternatives.
Whole Milk	1.0	Clear description with only one major supplier per MSA.	1.0	Clear description with only one major supplier per MSA.
Eggs	0.9	Clear description, but lacks standardization in supplier or brand.	0.9	Clear description, but lacks standardization in supplier or brand.
Margarine	0.9	Clear description with two brand alternatives.	0.9	Clear description with two brand alternatives.
Parmesan Cheese, Grated	1.0	Very clear description with only one possible brand.	1.0	Very clear description with only one possible brand.
Potatoes	0.8	Clear description, but lists two alternatives and lack of standardization in supplier or brand.	0.8	Clear description, but lists two alternatives and lack of standardization in supplier or brand.
Bananas	0.9	Clear description, but lacks standardization of supplier or brand.	0.9	Clear description, but lacks standardization of supplier or brand.
Head Lettuce	0.9	Clear description, but lacks standardization of supplier or brand.	0.9	Clear description, but lacks standardization of supplier or brand.
Bread, White	0.8	Clear description, but lacks standardization of supplier or brand.	0.7	Clear description, but lacks standardization of supplier or brand and includes prorated alternative.
Coffee, Vacuum-Packed	0.7	Clear description, but lists three brand alternatives.	0.7	Clear description, but lists three brand alternatives.
Sugar	0.9	Clear description, but lacks standardization in supplier or brand.	0.9	Clear description, but lacks standardization in supplier or brand.
Corn Flakes	0.9	Clear description with two brand alternatives.	0.9	Clear description with two brand alternatives.
Sweet Peas	0.7	Clear description, but variation in size and two brand alternatives.	0.7	Clear description, but variation in size and two brand alternatives.
Peaches	0.8	Clear description, but lists three brand alternatives.	0.7	Clear description, but lists four brand alternatives.
Facial Tissues	1.0	Very clear description with only one possible brand.	1.0	Very clear description with only one possible brand.
Shortening	1.0	Very clear description with only one possible brand.	1.0	Very clear description with only one possible brand.
Frozen Corn	0.8	Clear description, but lack of standardization in supplier or brand.	0.8	Clear description, but lack of standardization in supplier or brand.
Soft Drink	1.0	Very clear description with only one possible brand.	1.0	Very clear description with only one possible brand.
Housing				
Apartment, Monthly Rent	0.3	Clear description, but many variations can occur between different apartment such as quality and location.	0.3	Clear description, but many variations can occur between different apartment such as quality and location.
Total Purchase Price	0.0	Description tries to make housing as standard as possible, but countless variations can occur between different houses such as quality, location, and personal taste.	0.0	Description tries to make housing as standard as possible, but countless variations can occur between different houses such as quality, location, and personal taste.
Mortgage Rate	0.7	Clear description, but lack of lender information creates variations.	0.7	Clear description, but lack of lender information creates variations.
Monthly Payment	0.4	This is a combination of the previous two items of which both are subject to variation.	0.4	This is a combination of the previous two items of which both are subject to variation.

Utilities				
Total Home Energy Cost	0.5	Clear description, but lacks standardization of supplier.	0.5	Clear description, but lacks standardization of supplier.
Telephone	0.5	Clear description, but lack of standardization in supplier. Different service providers offer varying features and customer service.	0.5	Clear description, but lack of standardization in supplier. Different service providers offer varying features and customer service.
Transportation				
Auto Maintenance	0.6	Clear description, but lack of standardization in supplier. Service standards may vary across space.	0.6	Clear description, but lack of standardization in supplier. Service standards may vary across space.
Gasoline	0.9	Clear description, but lack of standardization in supplier.	0.9	Clear description, but lack of standardization in supplier.
Health Care				
Office Visit, Doctor	0.3	Standard procedure, but skill level may vary. Regulations may vary across space.	0.3	Standard procedure, but skill level may vary. Regulations may vary across space.
Office Visit, Dentist	0.3	Standard procedure, but skill level may vary. Regulations may vary across space.	0.3	Standard procedure, but skill level may vary. Regulations may vary across space.
Miscellaneous				
Hamburger Sandwich	1.0	Very clear description with only one possible choice.	1.0	Very clear description with only one possible choice.
Pizza	0.9	Clear description, but variation in size and two brand alternatives.	0.9	Clear description, but variation in size and two brand alternatives.
Fried Chicken	0.8	Clear description, but variation in sides and two brand alternatives.	0.8	Clear description, but variation in sides and two brand alternatives.
Haircut	0.4	Clear description, but various levels of skill involved.	0.4	Clear description, but various levels of skill involved.
Beauty Salon	0.2	Clear description, but various levels of skill and techniques involved.	0.2	Clear description, but various levels of skill and techniques involved.
Toothpaste	0.8	Clear description, but variation in size and two brand alternatives.	0.8	Clear description, but variation in size and two brand alternatives.
Shampoo	1.0	Very clear description with only one possible brand.	1.0	Very clear description with only one possible brand.
Dry Cleaning	0.7	Clear description with standard process, but lack of standardization in supplier which can result in quality variance.	0.7	Clear description with standard process, but lack of standardization in supplier which can result in quality variance.
Man's Dress Shirt	0.7	Clear description, but lack of standardization in supplier or brand.	0.7	Clear description, but lack of standardization in supplier or brand.
Major Appliance Repair	0.5	Standard service, but some variations possible.	0.5	Standard service, but some variations possible.
Newspaper Subscription	0.4	Clear description, but variations in coverage and quality exist.	0.4	Clear description, but variations in coverage and quality exist.
Movie	0.6	Clear description, but lack of standardization in supplier. Different movie theatres differ in such factors as atmosphere, seating, screen quality, and sound technology.	0.6	Clear description, but lack of standardization in supplier. Different movie theatres differ in such factors as atmosphere, seating, screen quality, and sound technology.
Bowling	0.7	Clear description, but some variation in services provided at venue.	0.7	Clear description, but some variation in services provided at venue.
Tennis Balls	0.9	Clear description with two brand alternatives.	0.9	Clear description with two brand alternatives.
Beer	1.0	Clear description with only one possible brand.	1.0	Clear description with only one possible brand.
Wine	1.0	Clear description with only one brand alternative.	0.7	Clear description, but lists two brand and two type alternatives.

Appendix III: Regression Variables

Item	1990 COV	2005 COV	CHANGE in COV	GOOD or SERVICE	1990 STANDARD	2005 STANDARD	STANDARD time	1990 TRANSPORT	2005 TRANSPORT	1990 NMFC	2005 NMFC
T-Bone Steak	0.123	0.135	0.012	1	0.9	0.9	1	1	1	100.0	100.0
Ground Beef or Hamburger	0.106	0.176	0.070	1	0.9	0.9	1	1	1	100.0	100.0
Frying Chicken	0.192	0.223	0.031	1	0.9	0.9	1	1	1	77.5	77.5
Chunk Light Tuna	0.170	0.221	0.050	1	0.9	0.9	1	1	1	60.0	60.0
Whole Milk	0.109	0.128	0.019	1	1.0	1.0	1	1	1	100.0	100.0
Eggs	0.149	0.359	0.211	1	0.9	0.9	1	1	1	85.0	85.0
Margarine	0.190	0.263	0.073	1	0.9	0.9	1	1	1	77.5	77.5
Parmesan Cheese, Grated	0.098	0.177	0.079	1	1.0	1.0	1	1	1	77.5	77.5
Potatoes	0.188	0.251	0.063	1	0.8	0.8	1	1	1	60.0	60.0
Bananas	0.188	0.219	0.031	1	0.9	0.9	1	1	1	92.5	92.5
Head Lettuce	0.195	0.209	0.014	1	0.9	0.9	1	1	1	100.0	100.0
Bread, White	0.186	0.213	0.027	1	0.8	0.7	1	1	1	70.0	70.0
Coffee, Vacuum-Packed	0.127	0.178	0.051	1	0.7	0.7	1	1	1	60.0	60.0
Sugar	0.100	0.119	0.020	1	0.9	0.9	1	1	1	55.0	55.0
Corn Flakes	0.125	0.163	0.038	1	0.9	0.9	1	1	1	100.0	100.0
Sweet Peas	0.102	0.216	0.113	1	0.7	0.7	1	1	1	60.0	60.0
Peaches	0.087	0.152	0.064	1	0.8	0.7	1	1	1	60.0	60.0
Facial Tissues	0.093	0.148	0.055	1	1.0	1.0	1	1	1	85.0	85.0
Shortening	0.111	0.104	-0.007	1	1.0	1.0	1	1	1	65.0	65.0
Frozen Corn	0.085	0.225	0.139	1	0.8	0.8	1	1	1	100.0	100.0
Soft Drink	0.180	0.136	-0.044	1	1.0	1.0	1	1	1	60.0	60.0
Apartment, Monthly Rent	0.244	0.293	0.049	0	0.3	0.3	1	0	0	600.0	600.0
Total Purchase Price	0.295	0.347	0.051	1	0.0	0.0	1	0	0	600.0	600.0
Mortgage Rate	0.018	0.020	0.002	0	0.7	0.7	1	0	1	600.0	600.0
Monthly Payment	0.303	0.352	0.049	0	0.4	0.4	1	0	0	600.0	600.0
Total Home Energy Cost	0.215	0.188	-0.027	0	0.5	0.5	1	0	0	600.0	600.0
Telephone	0.209	0.184	-0.024	0	0.5	0.5	1	0	1	600.0	600.0
Auto Maintenance	0.153	0.172	0.020	0	0.6	0.6	1	0	0	600.0	600.0
Gasoline	0.069	0.063	-0.006	1	0.9	0.9	1	1	1	65.0	85.0
Office Visit, Doctor	0.198	0.162	-0.036	0	0.3	0.3	1	0	0	600.0	600.0
Office Visit, Dentist	0.283	0.198	-0.085	0	0.3	0.3	1	0	0	600.0	600.0
Hamburger Sandwich	0.068	0.091	0.023	0	1.0	1.0	1	0	0	600.0	600.0
Pizza	0.083	0.102	0.019	0	0.9	0.9	1	0	0	600.0	600.0
Fried Chicken	0.121	0.131	0.010	0	0.8	0.8	1	0	0	600.0	600.0
Haircut	0.194	0.174	-0.020	0	0.4	0.4	1	0	0	600.0	600.0
Beauty Salon	0.227	0.244	0.017	0	0.2	0.2	1	0	0	600.0	600.0
Toothpaste	0.117	0.165	0.048	1	0.8	0.8	1	1	1	85.0	85.0
Shampoo	0.093	0.148	0.055	1	1.0	1.0	0.7	1	1	60.0	60.0
Dry Cleaning	0.143	0.166	0.024	0	0.7	0.7	1	0	0	600.0	600.0
Man's Dress Shirt	0.117	0.186	0.069	1	0.7	0.7	0.7	1	1	100.0	100.0
Major Appliance Repair	0.171	0.193	0.022	0	0.5	0.5	1	0	0	600.0	600.0
Newspaper Subscription	0.245	0.253	0.008	0	0.4	0.4	1	0	0	600.0	600.0
Movie	0.143	0.108	-0.035	0	0.6	0.6	1	0	0	600.0	600.0
Bowling	0.165	0.185	0.020	0	0.7	0.7	0.8	0	0	600.0	600.0
Tennis Balls	0.170	0.157	-0.013	1	0.9	0.9	1	1	1	85.0	85.0
Beer	0.104	0.065	-0.039	1	1.0	1.0	0.8	1	1	65.0	65.0
Wine	0.163	0.179	0.016	1	1.0	0.7	0.8	1	1	100.0	100.0