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What Type of Products' Prices Vary More Across Space? An Initial Examination

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ABSTRACT

This paper examines individual products' price variation across space. Sixty-one items from the 2nd quarter of 2005 ACCRA Cost-of-Living Index (COLI) database were acquired by the Economic Research Institute of Erie (ERIE) and analyzed using the coefficient of variation (COV). COVs for each product were regressed on a standardization index and two transportability variables. The standardization was used to account for differences in the products, and was found to be significant at nearly the one percent level. The transportability variable used in the final equation was a classification rating obtained from the National Motor Freight Classification (NMFC) manual and was found to be nearly significant at the ten percent level and had the hypothesized positive relationship. The final regression had an R^2 of 0.217 and an f statistic of 4.42 with 35 observations.

What Type of Products' Prices Vary More Across Space? An Initial Examination

I. Introduction

The study of spatial price differences is of great importance to many individuals. Yet the issue has been relatively under-studied. This project aims to analyze cost of living data compiled by the ACCRA organization to see which goods and services have a greater variation in price. Also, factors that may influence some goods to be more expensive will be examined. The key hypotheses are that goods that are not easily transportable or are more expensive to transport will have a larger variation in price across space. Furthermore, services will have a greater price variation across space, especially if they are not transportable.

To start off, the literature will be examined to see what work has been done on the topic of spatial price variability. The literature review will also examine the availability of data for individual products' prices across space. The final part of the literature review will focus on identifying factors that have been determined statistically to influence cost of living and individual products' prices across space.

The next section of the paper will provide an in-depth analysis of the characteristics of the ACCRA price database. This section will also provide information pertaining to the steps taken by ACCRA to ensure that their price data are as accurate as possible. Another major goal is to provide a detailed description of the housing sector of the ACCRA market basket. This is done because of the importance this item in determining spatial cost differences.

The fourth section develops the theory behind the hypotheses and identifies possible independent variables. Some of the literature review is carried over here so that the claims made may be substantiated. The main topics of this section include transportation costs and the effects of arbitrage on products' prices across space.

The next topic discussed will be the data analysis tools used as well as an overview of actual data from the ACCRA database. This starts with summary statistics to allow the reader to understand the basic characteristics of the database. Next follows a discussion of the statistics used to measure the

variability of these products' prices through space, including standard deviation and the coefficient of variation.

The sixth section is the bulk of the work and is comprised of three subsections, including eleven hypothesis tests. This section discusses each variable that was tested and the characteristics of these variables. Each subsection goes into great detail about each of the variables and the discussion is meant to build upon previous analysis.

The final section presents conclusions and possible areas of further research. Four broad subsections discuss general issues that we believe may be related to products' spatial price variation: government regulation, concentration of supply, location of supply (with an import/export overtone) and market structure.

II. Literature Review

So what makes the study of price variability important? It is commonly agreed that as individuals and businesses travel from one area to another, they will experience a variation in prices. To provide people with price level data in large metropolitan areas, the Bureau of Labor Statistics (BLS) at one time conducted a Family Budget Survey which sampled prices in large metropolitan areas. This series was discontinued decades ago and the U.S. was left with virtually no federal data that compare prices in different regions and cities. But the ACCRA organization has been collecting data on prices of many goods and services quarterly since 1968 which are categorized in six indexes: grocery items, housing, utilities, transportation, miscellaneous goods and services, and health care. These data allow consumers and businesses to compare the prices in one city to those in another.

As mentioned previously, the formal study of products' price variation through space has been minimal. This can possibly be attributed to a general lack of data. The Economic Research Institute of Erie (ERIE) has acquired price data from the ACCRA organization which makes this project possible. Previous literature that examined spatial price data and reasons as to why it is an important field in economics will be addressed in the following section.

In 1984, Hogan and Rex examined the ACCRA data from the 4th quarter of 1980 and found that there were strong regional variations in the indexes of the ACCRA data. They identified population (size)

of the urban area, disposable income and geographic region as significant determinants of spatial price differences. In their study the Pacific region had the highest costs and West North Central had the lowest costs of the nine regions. As population and disposable income increased, the costs of living in the respective region increased, ceteris paribus.

Hogan and Rex's paper shed light on a few variables that may be correlated with cost of living differences. These are important to this study as well. First, the finding that the region one lives in can influence the prices one will pay justifies this study. Second, the findings suggest that population and income are correlated with the Composite Index of the ACCRA database. Do these factors influence individual goods and services in the same way?

In 1988, Simmons discussed the creation of the Florida Price Level Index (FPLI). Simmons states that, "… [It] uses a base county and is an index of price relatives from one county to another." For his index, the Bureau of Labor Statistics (BLS) survey of prices for the Orlando, FL MSA was used. This survey created a market basket of prices that could be compared to other counties in the state of Florida. Simmons stressed the fact that items must be identical in quality and quantity. He did express concern about the housing market. The reason for this is because the BLS survey used the average home price as the measure. There was no detailed definition of homes to be priced. This creates a problem since there could be two different types of homes (mansions and condos for example) in two separate geographic areas. In effect, this would be measuring two different standards of living. This is unlike the ACCRA database that will be used in the current study, because ACCRA spends significant effort on pricing similar homes across the country. This will be explained in more detail later.

In 1996, Borooah et all found that alcoholic drink, fuel and housing repairs had substantial variations in price across regions of the United Kingdom. They also found that when the cost of living increased in a region, the above median income class experienced a decrease in their economic well being. The below median income class did not share this negative impact. This is essentially saying that goods and services purchased by the more well-off individuals had more of an increase in price than the goods and services purchased by the less well-off individuals, resulting in a net loss in economic well-being of the upper classes.

The authors also raised some very significant policy implications. First, having a regional cost of living index would allow the government to adjust social transfer payments. Second, a regional cost of living index would allow for a better assessment of the economic health of a region, measured by real disposable income. Finally, the poverty level could be adjusted by accounting for differences in cost of living across regions. Slesnick (2001) agreed and stated that the standard of living, government transfers and poverty levels in an area could be affected by regional cost of living differences.

Slesnick used 1988-1989 BLS price data in 44 urban areas along with the Consumer Expenditure Survey. He raised concern about the ACCRA data by stating that, "ACCRA data has not shown sufficient empirical support to assert their claim of being the purchases of a mid-level manager". ACCRA has since changed its wording (1998) from "midmanagement" standard of living because they say it was misinterpreted to mean "middle class". ACCRA now provides the following characteristics for its specific standard of living: 1) the household consists of both spouses and one child, 2) both spouses hold college degrees; at least one has an established professional or managerial career with a record of growing responsibility and authority, and is salaried rather than paid by the hour, and 3) the household income is in the top 20% for the area.[1]

III. ACCRA Database

Even if the ACCRA database does not reflect a particular standard of living, the database still has valuable characteristics. First, it is a compilation of products' prices from all over the country. Second, the definitions of the products sampled are strictly enforced (discussed below). This allows for analysis of the prices of the same goods from all over the U.S. Finally, there is currently no other database of its kind generally available.

The ACCRA database focuses on metropolitan statistical areas (MSAs), as defined by the Census Bureau. But if a county's population exceeds 50,000 and the city that is to be sampled has a population over 35,000, it may also participate in the database. This database has been published quarterly since 1968. For each city, usually a local chamber of commerce or a government organization will collect price data for well-defined goods and services in six categories. When all of the data are

[1] ACCRA Cost of Living Index Manual, available online at http://www.coli.org/surveyforms/colimanual.pdf

collected by the local organization they are forwarded to ACCRA for a meticulous three-stage review process.

In the first stage, each data reviewer at ACCRA looks for four things: computational errors, atypical prices for an item, unexpected quarter-to-quarter shifts in average item prices, and averages that are unusually high or low within a region. Once the data reviewer examines the data, any questions are referred back to the local agencies for answers. ACCRA says that data collectors can be expected to receive questions almost 100 percent of the time at the first stage.

After the prices for each of the areas are verified they are then forwarded to a quality control manager. He/she then reviews all of the price data once again and checks any problematic price that has yet to be verified by the first stage. ACCRA says participants should expect to be questioned about prices at the second stage 75 percent of the time. During the third and final stage, the project manager prints out a preliminary report of prices and checks to see if they are out of line with other prices in the state/region. This printout notes any price that is more than two standard deviations from the mean. Assuming a normal distribution of prices this should be less than 5% of the prices. Still, at this stage ACCRA says that data collectors receive questions 25% of the time.[2]

It is clear that the prices that get published in the ACCRA database go through a thorough review procedure that will likely eliminate most invalid prices. ACCRA also states that if there is any question or concern not rectified, it will keep the particular locality out of the database. For a legitimate study of products' prices across space, the products must be identical in quality and quantity. If the specifications for products and services were not well defined, then different metro areas would likely be pricing different products and services. This would create a situation where apples are being compared to oranges. It does not make sense to price a 1,000 square foot house in one metro area and price a 3,000 square foot house in another metro area. The 3,000 square foot house would likely cost more in all areas. ACCRA does make exceptions for MSAs with limited land area (such as Manhattan). This is the reason that ACCRA employs a significant amount of effort to ensure the price data collected are for identical goods and services, to the fullest extent possible.

[2] ACCRA Cost of Living Index Manual, available online at http://www.coli.org/surveyforms/colimanual.pdf

In the ACCRA Cost of Living Index Manual, which each data collector receives, each good and service is carefully defined. For example, in the Miscellaneous Goods and Services Index, the hamburger sandwich is defined as the average price in the area for a McDonald's Quarter-Pounder with cheese. Since there is likely a McDonalds (with the product) in almost every urban area, this is an excellent product to be priced. Another example is Advil, defined as 200mg, 50 tablets. This product is in the health care index. Again, Advil is a national brand and is likely to be found in virtually every locality.

Most concerns regarding identical products' prices across the country are with the price of housing. ACCRA takes this category more seriously than any other for good reason: the purchase price of a home represents 23.7 percent of the composite index. ACCRA specifies that in order to participate in the index, an area must be able to price a home with these exact characteristics (with a few regional exceptions):

-*Location:* Good subdivision or other area convenient for schools and shopping, within an area offering full municipal services – water, sewer, police and fire protection; area typical for professional and managerial households in the top income quintile.
-*Lot size:* 8,000 square feet
-*Living area:* 2,400 square feet (excluding garage), fully finished basements count towards living area
-*General house description:* single-family detached house; newly built and not previously occupied. The house conforms with Marshall & Swift's rating of "Very Good Quality" as set forth in its *Residential Cost Handbook*.
  -Four bedrooms (three okay if the unit meets the minimum size requirement)
  -Two full baths
  -Living room
  -Dining room
  -Kitchen with built-in cabinetry and cooking island
  -Finished family room
  -One fireplace (if standard in your area)
  -Utility room
  -Attached two-car garage
-*Age*: Newly built, not previously occupied.

Along with these basic house descriptions ACCRA has several detailed requirements for the homes to be priced. Some of these requirements include what type of roof cover (asphalt shingle), foundation (poured concrete, 8 inches) and where closets should be located (hall, bedrooms, kitchen, linen).

All this information on the products and services to be priced are specified in the ACCRA Cost of Living Index Manual which can be accessed at their website, http://www.coli.org/. Along with the definition of homes, apartments are also acceptable for single-person families that meet other requirements. The definition of apartments is not as thorough as houses but is still very detailed. Every product in the ACCRA sample is explicitly defined and there is little room for ambiguity. If the

product/service does not exist in the area, it will be left out for the locality. If the data collectors substitute another similar product/service, it will likely be caught by the review process and omitted. This attention to detail in the price collection process makes the ACCRA database such a good source for this project.

IV. Theory

There are various costs associated with bringing a product or service to market. One factor that helps explain the differences in prices as individuals move across the country are transportation costs. So how will these costs affect the prices of different goods and services? Economic theory suggests that transportation costs have a significant effect on the final price that consumers will pay for goods and services. In 1976, Finger and Yeats state that "The overall results indicate that, whether measured in terms of nominal or effective rates, transportation costs pose a barrier at least equal to post-Kennedy round tariffs in the U.S."

Although their findings are most closely associated with international shipping costs, they show that transportation costs can have a significant impact on the final prices that are paid by consumers. Finger and Yeats also find that transport costs tend to increase as a product proceeds through the different stages of production. In other words, transportation costs will be lower per unit for raw materials than for the final product they are used in. One final major point made by Finger and Yeats is that after their analysis of several transportation costs indices, they find that all of the costs associated with transportation since 1965 could possibly have offset all of the tariff reductions due to the Kennedy Round of trade talks.[3] Although tariffs are not important to the current study, their findings suggest that transportation costs are influential in the final price of products, which is relevant to this study.

So which goods will have a larger price difference from place to place and which goods will have a smaller difference? Theory says that goods and services that cannot be transported should have greater price disparities from one place to another. For example, the price of a home should vary substantially from place to place. This is because a home cannot be picked up and moved from one area

[3] The Kennedy Round was an international conference of countries that were part of the General Agreement on Tariffs and Trade (GATT). It was held between 1964 and 1967 in Geneva, Switzerland.

to another very easily (or cheaply). Therefore, price differences between places will be determined by supply and demand conditions.[4]

A. Transportation Costs

In the ACCRA database for the second quarter of 2005, the price of a home in the Manhattan metropolitan area was $985,750. At the same time, the price of a comparable home in the Erie, PA metropolitan area was $264,000. These large differences can be due to many factors such as differences in population, population density, population growth, supply conditions, demand conditions, and income per capita. The point is that if these two houses were easily (and cheaply) transportable, individuals and businesses would buy the homes in Erie, PA and sell them in Manhattan, making a huge profit. This type of transactions is known as arbitrage, and it would tend to raise prices in Erie and reduce them in Manhattan.[5]

Consider the price of milk in the second quarter of 2005.[6] In the Manhattan metro area the price was $2.24, and in the Erie metro area it was $1.62. Milk, unlike homes, can be transported from place to place relatively easily. If there were a substantial difference in the price of milk between the two cities, individuals would buy milk where it is cheap, pay transportation costs, sell it in the market where it is expensive and make a profit.

These two goods are extreme examples. Homes are one of the most expense goods that consumers purchase and milk is one of the cheapest. Nevertheless they portray a clear picture of what this study will examine. There are many goods and services that would fall between milk and homes in terms of price. So what makes homes 273% more expensive in Manhattan than in Erie and milk only 38% higher? For one, homes cannot be bought in one geographic area and sold in another. If homes could be moved easily, they would be bought where they were cheap (Erie) and sold where they are expensive (Manhattan). This would increase supply where prices are high (Manhattan), which would

[4] Consumer income, population, expectations, price of substitutes, price of complements, consumer tastes and preferences, and severa; other factors determine demand. Supply is determined by the level of technology, price of factors of production, number of suppliers, firms' expectations, and several other factors.
[5] Arbitrage is the act of taking advantage of known market discrepancies (usually price) and a known profit incentive. This is different from market speculation, where individuals think that they might make a profit. There is no guarantee of profit in speculation, but there is a guarantee of profit in arbitrage. Buying low in one market and selling high in another characterize arbitrage.
[6] Milk is defined by ACCRA as a half-gallon carton.

bring the price down. At the same time, supply would decrease in Erie, which would cause the price to increase. The overall effect of such artibrage would be a national convergence of prices. This can be seen with the example of milk. Milk can be loaded onto a truck and shipped to geographic areas where the price is higher. This is one reason that the price of milk is only 38% greater in Manhattan than Erie.

So what causes the price of milk not to be equal across areas? The key variable that makes some products' price more similar across space than others are transportation costs. If the price of milk became 200% greater in Manhattan than it is in Erie, arbitrageurs would purchase milk in Erie, pay transportation costs and sell it in Manhattan. This would increase supply in Manhattan (decrease the price) and decrease supply in Erie (increasing the price). The same cannot be done for homes. Since homes cannot be transported from Erie to Manhattan, the prices of homes are determined by the supply and demand conditions of the area.

Figure 1. Effect of Arbitrage

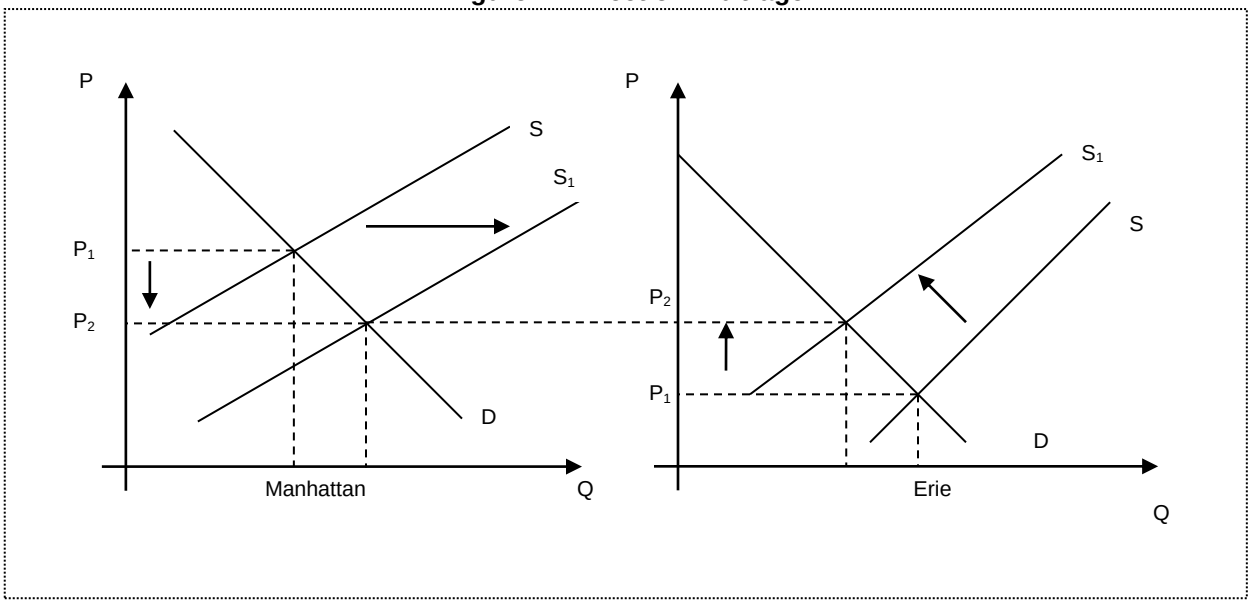
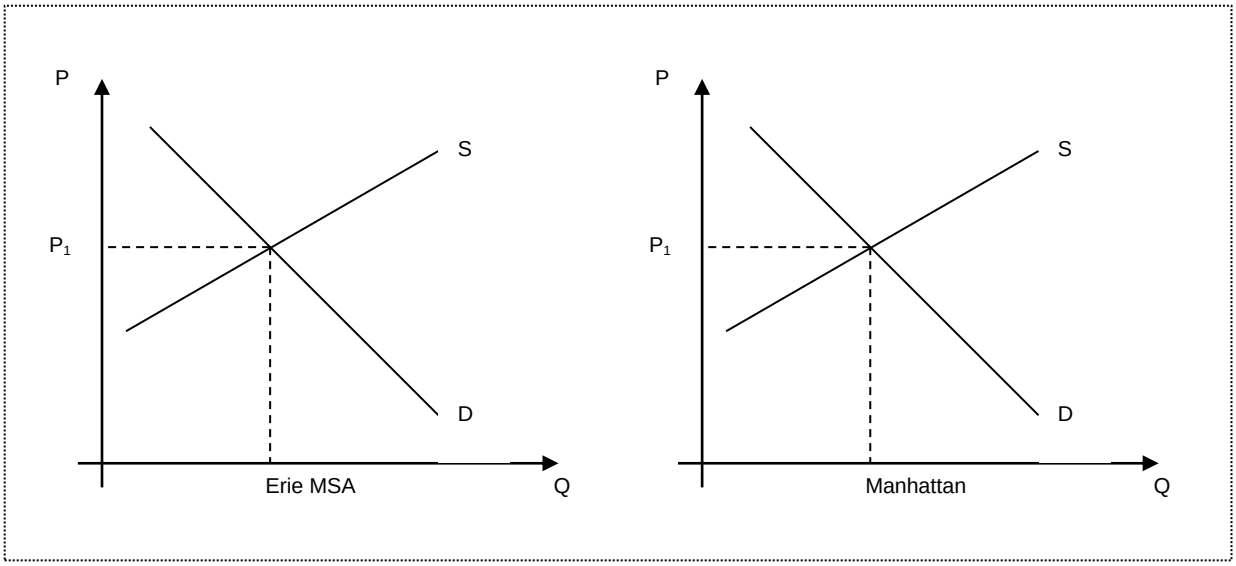


Figure 1 portrays a situation in which home prices are initially high in Manhattan and low in Erie. If homes could be transported with no costs, over time arbitrage would result in an increase in supply in Manhattan which would cause the price there to fall. At the same time, prices would be rising in Erie because supply would be decreasing. This would continue until the prices of homes were equal in Erie and Manhattan, as shown in Figure 2.

Figure 2. Identical Prices



B. Services

Services, such as a visit to the dentist or doctor, should also tend to display a relatively large price variation from place to place. This is because most services are unable to be moved from one place to another. It does not make sense to hire someone five hundred miles away to come and cut lawns or travel five hundred miles to cut hair. An individual would have to pay an enormous fee to have these services imported from out of town. Some exceptions include financial (mortgage rates, investment, etc.), insurance and a few others in which the transaction can be conducted long-distance, without the need for face-to-face interaction.

In the second quarter of 2005, the price of visiting a doctor was $107.00 in Manhattan and $63.40 in Erie.[7] This is a quite large price difference from one place to another for a standardized procedure. In other words, it is supposed to be the exact same (homogeneous) service, but the price is over 68 percent more in Manhattan. What if a service is transportable? In the same time period, the mortgage rate was 5.85 percent in Manhattan and 6.09 percent in Erie.[8] To put this into perspective, on a 30-year

[7] Doctor is defined by ACCRA as American Medical Association procedure 99213 (general practitioner's routine examination of established patient).
[8] Mortgage rate is defined by ACCRA as the effective rate, including points and origination fee, for a 30-year conventional fixed rate mortgage.

repayment for a $250,000 principal, the monthly payment would be $1,475 in Manhattan and $1,513 in Erie, only a 2.6 percent difference.

There is clearly a difference between the price variations for these two services. The price of a doctor visit in Manhattan was 68% higher in the second quarter of 2005 and the monthly mortgage payment was only 2.6% higher in Manhattan. Again, part of the reason is likely due to the fact that mortgage rates can be transported easily from place to place. For example, if an individual lives in Erie and finds an attractive mortgage rate at a financial institution in Manhattan, he/she could use the Internet to purchase it through the Manhattan institution. The larger price difference for a doctor visit could also be partially due to the fact that the doctors' services are not identical; some doctors could likely be better trained than others, just as some individuals excel in any field.

It could also be due to the doctors themselves taking advantage of a known cost of living difference. This is also another type of arbitrage. It is not as clear as the buying and selling of products, but when the price for services is higher in one area, individuals providing that service will tend to sell it there. This will increase the supply of the services in areas where the price is higher and decrease the supply (since there are fewer service providers) in areas where the price is lower. In the long run this should cause the price of services to converge to a single price. But because of the fierce competition, innovation and other influences of today's economy, this is unlikely to happen.

V. Data Analysis

It is apparent that different goods and services will have different degrees of variation of prices across the country. What are the factors that can influence the different prices that are paid in different areas? In 1980, Cebula developed a model that tried to determine the variables that influenced the cost of living differences. His model included population density, total population, per capita income, per capita property taxes and right-to work legislation. The model indicated that total population and per capita property taxes were highly statistically significant. Furthermore, population density, per capita income and right-to-work legislation were also statistically significant.

In 1983, Ostrosky added to Cebula's work. Ostrosky determined that the "Fuel-cost (utility-bill) variable has a positive coefficient that is statistically significant at nearly the .01 level". This means that he was 99 percent sure that the coefficient of his utility-bill variable was not zero and was located within the confidence interval.[9] In economics, variables that are significant at the .05 level or better (.01) are generally accepted. In simplest terms, his model was likely better off with the utility-bill variable than without it. He was also concerned that there was not a climate variable included in Cebula's original model. Ostrosky also stated that using a dummy variable for right-to-work legislation was flawed and that a better measure would be the percentage of the civilian labor force that was unionized. He found this union variable to be statistically significant.

It has been determined that some products and services have a large difference in prices through space and some have small difference in prices. But just looking at the differences in prices is not enough. Total home price averaged almost $280,000 in the second quarter of 2005 for all of the metropolitan areas that participated in the ACCRA study. Milk, on the other hand, had an average price of $1.99 during the same quarter. Because the total home price is so large relative to that of milk, one would expect to see larger variations in the price of homes relative to milk.

For initial analysis of the many different products, Table 1 lists the maximum, minimum, mean and median of each product in the ACCRA database. These summary statistics are an excellent starting point for analysis since they help gain a basic understanding of each data series. The mean price of a T-bone steak was $8.79. The minimum was $6.12 and the maximum was $13.32. Since the mean was $2.67 away from the minimum and $4.53 away from the maximum, it is known that more of the observations tend to be near the minimum rather than the maximum. In this instance, the median (middle observation) is the same as the mean, $8.79.

[9] A confidence interval is defined as the coefficient of the variable being tested plus or minus one standard error.

Table 1. Summary Statistics for ACCRA items

	Minimum	Maximum	Mean	Median		Minimum	Maximum	Mean	Median
TBONE STEAK	6.12	13.32	8.79	8.79	ALL ELECTRIC	70.12	246.47	36.30	128.55
GROUND BEEF	1.34	3.73	2.48	2.46	PARTIAL ELECTRIC	35.38	132.11	51.82	66.61
SAUSAGE	2.31	6.39	3.62	3.40	OTHER ENERGY	31.77	219.07	54.42	74.91
FRIED CHICKEN	0.64	2.73	1.08	1.04	TOTAL ENERGY	70.12	294.47	142.54	137.73
TUNA	0.50	1.47	0.72	0.67	PHONE	16.49	38.90	25.53	25.07
HALF GALLON MILK	1.31	2.93	1.99	1.98	TIRE BALANCE	4.67	15.00	8.76	8.70
DOZEN EGGS	0.51	2.77	1.01	0.91	GASOLINE	1.98	3.26	2.25	2.22
MARGARINE	0.50	1.81	0.87	0.79	OPTOMETRIST	45.00	135.33	73.60	70.00
PARMESAN	2.32	6.07	3.45	3.19	DOCTOR	0.00	112.00	73.54	72.50
POTATOES	1.49	9.15	3.07	2.86	DENTIST	43.20	121.00	67.03	65.40
BANANAS	0.32	1.06	0.51	0.49	IBUPROFEN	4.15	7.74	5.62	5.57
LETTUCE	0.80	2.43	1.31	1.29	LIPITOR	60.78	133.37	115.83	115.41
BREAD	0.59	2.38	1.10	1.06	HAMBURGER SANDWICH	1.50	3.45	2.46	2.40
ORANGE JUICE	1.97	4.87	2.72	2.61	PIZZA	6.99	15.00	10.20	9.99
COFFEE	1.99	5.21	3.13	3.05	TWO PIECE CHICKEN	1.75	4.35	2.78	2.78
SUGAR	1.07	2.57	1.58	1.53	HAIR CUT	6.67	19.60	11.43	11.20
CEREAL	1.68	5.45	2.91	2.84	BEAUTY SALON	15.00	55.00	28.03	26.99
SWEET PEAS	0.50	1.49	0.84	0.81	TOOTHPASTE	1.72	3.91	2.35	2.29
PEACHES	1.29	4.13	1.72	1.67	SHAMPOO	0.82	3.97	1.10	1.05
KLEENEX	0.97	2.33	1.39	1.36	DRY CLEANING	5.30	13.00	8.69	8.65
CASCADE	2.86	5.74	3.82	3.70	MEN'S SHIRT	15.99	54.40	26.04	25.21
CRISCO	2.68	6.16	3.48	3.41	BOY'S JEANS	11.39	31.60	18.78	18.65
FROZEN MEAL	1.19	4.49	2.51	2.45	WOMEN'S SLACKS	17.10	49.50	27.53	26.78
FROZEN CORN	0.70	3.15	1.19	1.14	WASHER REPAIR	21.90	90.00	50.65	49.86
POTATO CHIPS	1.50	4.74	2.40	2.37	NEWSPAPER	6.00	35.15	13.96	13.50
COKE	0.92	2.22	1.24	1.23	MOVIE	4.00	10.33	7.59	7.50
APARTMENT RENT	450.00	3,411.00	721.64	675.00	BOWLING	2.00	7.29	3.36	3.25
HOME PRICE	185,090	985,750	279,773	246,526	TENNIS BALLS	1.71	4.24	2.26	2.05
MORTGAGE RATE (%)	5.53	6.23	5.91	5.93	VETERINARIAN SERVICES	16.50	59.00	34.30	33.50
HOME P + I	829.40	4,361.16	1,245.61	1,089.43	BEER	5.95	10.16	7.51	7.47
					WINE	4.10	11.29	6.42	6.33

A better measure of the variation of prices across space is the standard deviation. To understand it, consider the price of one gallon of gasoline in four metropolitan areas in 2005. The prices of gasoline in these areas are as follows: Erie, PA MSA, $2.245; Manhattan, NY MSA, $2.496; Orlando, FL MSA $2.203; and Palm Springs, CA MSA, $2.643.[10] The average price of gasoline for these areas was $2.397. In order to get a measure of how far the observations disperse from the mean, the difference of each observation from the mean was calculated. These numbers are then squared because if they were not, the positive and negative numbers would cancel each other out. This was accounted for in the final step when the square root was taken. Each observations' squared difference from the mean was added together (0.131) and divided by the total number of observations. The result was a measure of the average squared differences from the mean (0.033). In the final step, the square root of the averaged squared differences from the mean was calculated, which results in the standard deviation (0.181). The formula for standard deviation is as follows:

$$\sigma = \sqrt{\frac{1}{N}\sum_{i=1}^{N}(x_i - \mu)^2}$$

σ = standard deviation of the population
N = number of observations
X_i = the individual observation of x, where i = 0,1,2…N
μ = average of all observations of population.

The standard deviation is a statistic that allows measurement of how different the observations of the data set are from the mean. In a normal distribution, approximately 68% of the observations will fall within one standard deviation of the mean, 95% of observations will fall within two standard deviations and 99.7% of observations will fall within three standard deviations.[11] This is important because for large data sets (such as the approximately 300 areas in the ACCRA database) any observation falling outside of three standard deviations can likely be characterized as an outlier.

Table 2 lists the means and the standard deviations of all of the products in the ACCRA sample, sorted from highest to lowest standard deviation. Notice that the products and services with larger means tend to have larger standard deviations. This would be expected since the standard deviation is a measure of how far the observations are away from the mean in dollar terms. In a normal distribution, larger means are associated with larger standard deviations. But also note that some products with smaller means have larger standard deviations, which leads to the next issue. Some examples are Lipitor, pizza, eggs and gasoline.

[10] Prices are actual data from the MSAs listed for the ACCRA cost-of-living index in the second quarter of 2005.
[10] These (68, 95, 99.7) are approximations.

Table 2. Means and Standard Deviations of ACCRA items

Product/Service	Mean	Standard Deviation	Product/Service	Mean	Standard Deviation
HOME PRICE	279,773.46	110,767.07	BEER	7.51	0.58
HOME P + I	1,245.61	491.86	IBUPROFEN	5.62	0.54
APARTMENT RENT	721.64	299.09	CASCADE	3.82	0.54
TOTAL ENERGY	142.54	28.56	FROZEN MEAL	2.51	0.53
OTHER ENERGY	54.42	24.63	CEREAL	2.91	0.53
ALL ELECTRIC	36.30	23.75	COFFEE	3.13	0.52
PARTIAL ELECTRIC	51.82	20.99	ORANGE JUICE	2.72	0.47
OPTOMETRIST	73.60	15.68	TENNIS BALLS	2.26	0.47
DENTIST	67.03	13.73	GROUND BEEF	2.48	0.46
DOCTOR	73.54	13.21	POTATO CHIPS	2.40	0.44
WASHER REPAIR	50.65	10.52	CRISCO	3.48	0.42
BEAUTY SALON	28.03	6.94	DOZEN EGGS	1.01	0.38
LIPITOR	115.83	6.81	TOOTHPASTE	2.35	0.37
VETERINARIAN SERVICES	34.30	6.34	TWO PIECE CHICKEN	2.78	0.37
WOMEN'S SLACKS	27.53	6.07	PEACHES	1.72	0.31
MEN'S SHIRT	26.04	5.47	FROZEN CORN	1.19	0.30
PHONE	25.53	4.47	BREAD	1.10	0.28
NEWSPAPER	13.96	3.99	LETTUCE	1.31	0.28
BOY'S JEANS	18.78	3.41	SHAMPOO	1.10	0.28
HAIR CUT	11.43	2.16	HALF GALLON MILK	1.99	0.27
TIRE BALANCE	8.76	1.55	FRIED CHICKEN	1.08	0.27
DRY CLEANING	8.69	1.45	MARGARINE	0.87	0.26
T-BONE STEAK	8.79	1.18	HAMBURGER SANDWICH	2.46	0.25
WINE	6.42	1.12	SUGAR	1.58	0.22
PIZZA	10.20	1.00	KLEENEX	1.39	0.21
POTATOES	3.07	0.89	COKE	1.24	0.18
MOVIE	7.59	0.87	SWEET PEAS	0.84	0.17
SAUSAGE	3.62	0.86	TUNA	0.72	0.16
BOWLING	3.36	0.71	GASOLINE	2.25	0.14
PARMESAN	3.45	0.67	MORTGAGE RATE (%)	5.91	0.14
			BANANAS	0.51	0.11

While the standard deviation is a useful measure of the dispersion of prices through space it is not the best one. Another statistic called the relative standard deviation or coefficient of variation (COV) is even more useful. This statistic is the ratio of the standard deviation to the mean. Since some goods and services are more/less expensive than others, this statistic will allow us to standardize the dispersion measure so that the variation in prices can be compared between goods and services with very different prices. The formula is as follows:

$$COV = \frac{\sigma}{\mu}$$

σ = standard deviation of the population
μ = average of all observations of population.

The average price of some goods is much greater than that of others, so the standard deviation can be expected to be larger. For example, in the second quarter 2005 ACCRA index, the average price

of a visit to the optometrist was $73.60 and the standard deviation was $15.68. This service had the eighth highest standard deviation. In the same time period the average price of women's slack was $27.53 and the standard deviation was $6.07. This was the fifteenth highest standard deviation for all products and services in the period.

It can be seen in Table 3 that the ranks of the two goods mentioned previously (optometrist and women's slacks) are reversed when the COVs are calculated. The optometrist visit (which ranked eighth for standard deviation) ranks thirteenth for COV. The women's slacks (which ranked fifteenth for standard deviation) rank seventh for COV. The COV statistic is a superior measure of dispersion because it adjusts the dispersion measure (standard deviation) relative to the mean. Because the total purchase price of a home was so large, it had the highest standard deviation of all of the products. But adjusting the standard deviations of all the products by their respective means, the COV of total purchase price of a home ranks twentieth. These COVs will be used for the remainder of the study for a more accurate picture of how much variation of prices exist from place to place. Table 3 presents the COVs for all items in descending order.

Table 3. Coefficient of Variations

Product/Service	COV	COV Rank	Standard Deviation Rank	Product/Service	COV	COV Rank	Standard Deviation Rank
PARTIAL ELECTRIC	0.159	1	7	COFFEE	0.100	31	36
MARGARINE	0.141	2	52	WINE	0.099	32	24
DOZEN EGGS	0.138	3	42	FRIED CHICKEN	0.098	33	51
SAUSAGE	0.135	4	28	BOWLING	0.097	34	29
BEAUTY SALON	0.126	5	12	TOTAL ENERGY	0.097	35	4
GROUND BEEF	0.124	6	39	POTATOES	0.097	36	26
WOMEN'S SLACKS	0.123	7	15	CEREAL	0.096	37	35
DOCTOR	0.118	8	10	ORANGE JUICE	0.096	38	37
FROZEN MEAL	0.117	9	34	ALL ELECTRIC	0.096	39	6
CEREAL	0.117	10	47	TOOTHPASTE	0.096	40	43
WASHER REPAIR	0.117	11	11	FROZEN CORN	0.095	41	46
SWEET PEAS	0.116	12	57	CASCADE	0.094	42	33
OPTOMETRIST	0.116	13	8	POTATO CHIPS	0.092	43	40
PHONE	0.115	14	17	HALF GALLON MILK	0.092	44	50
LETTUCE	0.114	15	48	KLEENEX	0.090	45	55
NEWSPAPER	0.114	16	18	TBONE STEAK	0.088	46	23
DENTIST	0.113	17	9	APARTMENT RENT	0.088	47	3
HOME P + I	0.113	18	2	SUGAR	0.085	48	54
OTHER ENERGY	0.112	19	5	TWO PIECE CHICKEN	0.085	49	44
HOME PRICE	0.112	20	1	MOVIE	0.084	50	27
DRY CLEANING	0.112	21	22	COKE	0.080	51	56
HAIR CUT	0.110	22	20	PEACHES	0.075	52	45
TENNIS BALLS	0.110	23	38	HAMBURGER SANDWICH	0.073	53	53
PARMESAN	0.110	24	30	IBUPROFEN	0.070	54	32
BOY'S JEANS	0.108	25	19	SHAMPOO	0.070	55	49
VETERINARIAN SERVICES	0.107	26	14	CRISCO	0.069	56	41
TUNA	0.106	27	58	PIZZA	0.067	57	25
BANANAS	0.103	28	61	BEER	0.057	58	31
TIRE BALANCE	0.103	29	21	LIPITOR	0.051	59	13
MEN'S SHIRT	0.101	30	16	GASOLINE	0.044	60	59
				MORTGAGE RATE (%)	0.023	61	60

VI. Determinants of COV

It is apparent that some products' prices will vary more through space than others'. There are several possible factors that could cause this variation. The main one discussed above was transportation costs associated with each product. The theory behind this is that a product that is more costly to transport will experience a larger variation in prices across space, all else being held equal. Our hypothesis is that the price variation (COV) is an inverse function of how transportable a product is, expressed as follows: COV = f (transportability).

A. Product Standardization

Another possible reason for some products' greater price variation may have been caused by measurement error for some of the data. Although ACCRA makes every attempt to have identical products priced across space, there will likely be some issues with how standard the products were. It is likely that some products will be more or less "standard" than others. These variations in products will likely cause prices to vary across space. For example, one product to be priced was dishwashing powder. The ACCRA definition of this product was "75-ounce Cascade dishwashing powder." This item has little room for misinterpreting the product to be priced, which could be one form of measurement error. During the same sample another product to be priced was Coffee. The ACCRA definition was an "11.5-ounce can, Maxwell House, Hills Brothers, or Folgers." While coffee was very similar across brands in the second quarter of 2005, there were likely some differences in the products as produced by the three companies, so the product was not perfectly standardized. Price data may have been gathered for Maxwell House coffee in one area and Folgers in another, and this may have led to some degree of price variation just due to differences in brands. That was a form of measurement error for purposes of this study.

To account for this lack of perfect standardization among products, a standardization index was created to account for some of this measurement error. This index will necessarily be somewhat subjective, but the alternative would be to ignore that this measurement (or standardization) error exists. We believe it is better to try to quantify the qualitative differences in products than to ignore them entirely.

Each product was evaluated based on several criteria to see how much it could possibly be different from place to place. In this index, a value of one was assigned to products that were identical from place to place. A zero represents a product that was likely different in each area across space. For this index, a zero value was assigned to the price of a home. This was done because a home is inevitably going to have characteristic differences from place to place. It was the product in the ACCRA index most likely to have differences across space, so it was used as the benchmark. The rest of the products were then assigned values between 0.0 and 1.0 based on several criteria. The following criteria were used to evaluate each of the products in the ACCRA index:

1. How many different suppliers for each product were specified in the ACCRA definition? 0, 1, 2 …n. For example:
    a. Coffee – Maxwell House, Hills Brothers, Folgers (3)
    b. Toothpaste – Crest or Colgate (2)
    c. Facial Tissues – Kleenex brand (1)
2. How similar are the physical characteristics of each product? Identical, minor variation, major variation. For example:
    a. Ground beef – price per pound - Identical
    b. Sweet peas – 15 to 17 ounce can – minor variation
    c. Newspaper – major variation
3. What variation in service level would be associated with each product? Identical, minor variation, major variation. For example:
    a. None are clearly identical. Services by their very nature are characterized by variation. This variation is what allows different service providers to compete with each other. Is the experience of dining at many different restaurants the same? Is the experience the same each and every time the same restaurant is visited?
    b. Mortgage rate – minor variation. Mortgage rates are identical across space as long as the way they are reported is the same. The differences for the purposes of this study reside in the services of the financier offering the mortgage rate. How many different ways does the financier allow one to pay the mortgage? What complementary services does the financier offer? Will the financier work with individuals during times of hardships?
    c. Beauty salon – major variation. Beauty salons are used as an example here because they are likely to have major variations from one area to another. Some beauty salons might hire individuals right out of school while others might require ten years of experience. Do beauty salons offer all of the same services? How friendly and comforting are the employees? Are the beauty salons in Hollywood and New York City likely to provide the same service as those in smaller rural towns with populations of 50,000?
4. Values assigned to each product, as well as more details, are presented in Appendix I.

After each of the ACCRA items was assigned a value, a hypothesis test was performed to test the significance of the standardization index. Theory suggests that products whose characteristics vary more from place to place should have greater variation in price, ceteris paribus. Alternately, products that have more similar characteristics across space should have smaller variation in price. In the following

equation, products that were more standard should tend to have lower COVs than products that were less standard across space. According to the index, products whose standardization index value was close to one should have lower COVs and vice versa. The regression equation and hypothesis test were designed as follows:

$$COV_i = B_0 - B_1 STANDARD_i + e_i$$

Where, COV_i = Coefficient of Variation for product i,

$STANDARD_i$ = Standardization Factor (Value between 0.0 and 1.0) for product i

e_i = error term for each product i,

The hypothesis test was as follows:

For coefficient B_1, H_0: $B_1 > 0$

H_A: $B_1 \leq 0$.

The results were:

(1) $\mathbf{COV_i = 0.1236 - 0.0338 STANDARD_i + e_i}$

(t-stat) (14.46) (-3.02)

$R^2 = 0.134$ n = 61 F-statistic = 9.14

In the above estimation, the hypothesis test is stating that we are trying to disprove the null hypothesis (H_0). If we are able to disprove the null hypothesis, then the alternative (H_A) will be the one that is accepted. When something is "proven", it carries much more weight than something that has been disproved. So the hypothesis test is essentially listing two possible scenarios for the B_1 coefficient above. The first (null hypothesis) is what we are trying to "disprove". If we are able to disprove it, then the other (alternative) hypothesis will be accepted.

The regression of the COV on the standardization index returned results that indicated that the standardization index was statistically significant at the .01 significance level and the null hypothesis may be rejected. It has been determined statistically that the standardization index factor (used to account for measurement errors) was significant and that it does play a role in the price variation of some products across space.

The original hypothesis will be modified to include the standardization variable. Again, although this is a subjective measure, we believe it is a necessary variable to account for the lack of

standardization of different products across space. The resulting hypothesis is that spatial price variation (measured by COV) is a function of how standard the product is across space and how transportable the product is. To account for the subjectivity of this variable, robustness tests were performed on two other interpretations of how standard the products tended to be. The first was a loose interpretation where items that could possibly be less standard across space were assigned values less than the values that we used for our analysis. The results were consistent with the original variable. Another test was a tighter interpretation of the ACCRA items with values closer to 1.0. This test was also consistent with the original test.

The loose interpretation assumed that there was less standardization of products across space. The tight interpretation assumed that there was more standardization of products across space. The original mean of the standardization variable was 0.72. The loose interpretation caused the mean to decrease to 0.69 and the tight interpretation caused the mean to increase to 0.82.

The results for the loose standardization variable will be denoted "Lstandard" and the tight standardization variable will be denoted "Tstandard." The results were as follows:

(2) $\mathbf{COV_i = 0.1234 - 0.0351Lstandard_i + e_i}$

(t-stat) (15.42) (-3.23)

$R^2 = 0.150$ n = 61 F-statistic = 10.43

(3) $\mathbf{COV_i = 0.1311 - 0.0390Tstandard_i + e_i}$

(t-stat) (11.82) (-2.97)

$R^2 = 0.130$ n = 61 F-statistic = 8.83

It can be seen that the standardization variable has the expected sign and is statistically significant at the .01 level in all situations. Furthermore, the remaining results from regressing the COVs on the standardization variables show little change. The R^2, f-statistic and t-statistic all only had a minor amount of variation. This indicates that the variable is likely significant even though it is a "subjective" measure.

B. Transportability

The key factor hypothesized to have caused some products' prices to vary more across space is the transportability of these products. To test if a product's price variation across space was associated with its transportability, a dummy variable was assigned to each of the ACCRA items. The dummy variable, TRANSPORT, was equal to one if the product was transportable and zero if it was not. According to the theory mentioned above, items that were transportable should have smaller price variations across space than those items that could not be transported. The test was as follows:

$$COV_i = B_0 - B_1 TRANSPORT_i + e$$

Where, COV_i = Coefficient of Variation for product i,

$TRANSPORT_i$ = Dummy variable, one if transportable and zero if it cannot be transported

e_i = error term for each product i,

The hypothesis test was as follows:

For coefficient B_1, H_0: $B_1 > 0$

H_A: $B1 \leq 0$.

The results were:

(4) $\mathbf{COV_i = 0.1054 - 0.0096 TRANSPORT_i + e_i}$

(t-stat) (21.17) (-1.55)

$R^2 = 0.039$ n = 61 F-statistic = 2.41

After regressing the COV for the ACCRA items against the transportable variable, the null hypothesis may not be rejected at any significance level. This does not allow us to confirm our original hypothesis that products that are transportable will experience smaller variations in price across space. It should be noted that other tests on the transportable dummy variable were performed. Initially, four products took on a value of one and were then changed to zero. These products were hamburger sandwich, pizza, fried chicken and newspaper.

These products were changed because of the connection of arbitrage activity and the transportability variable. For example, the ACCRA definition of hamburger sandwich was "1/4-pound patty with cheese, pickle, onion, mustard, and catsup. McDonald's Quarter-Pounder with cheese, where

available". If the price of this sandwich was $10 in one city on the east coast and $3 in another city on the west coast, it is unlikely that someone would buy a sandwich from the west coast city and ship it to the east coast for a $7 profit. It is possible, but very unlikely. For one, if you bought a McDonald's 1/4-pounder and then shipped it cross-county, it probably would not taste nearly as good. When ACCRA defined hamburger, pizza and fried chicken they intended them to be priced as fast food.

One could also make the case that they are transportable because they technically can be shipped. In this context it would be equivalent to saying that a doctor's visit could be transportable because the doctor "can" make cross-country house calls. The line had to be drawn somewhere and the transportation variable is listed in Appendix II. Quite interesting though, the transportable variable was statistically significant when these previously mentioned four variables took on a value of one instead of zero. The results were:

(5) $\mathbf{COV_i = 0.1101 - 0.0154TRANSPORT_i + e_i}$

(t-stat) (20.54) (-2.41)

$R^2 = 0.089$ n = 61 F-statistic = 5.80

The result of regressing COVs on the transportability dummy variable indicates that it is statistically significant at the .05 level and close to significant at the .01 level. These results suggest that the transportability dummy variable is not very robust. Just changing four products' value from one to zero made the entire equation not statistically significant at any level. This raises concern about how well the transportability variable is characterizing what we want it to. It was quite sensitive to a minor variation in values so robustness tests were then performed on the transportability variable similar those performed on the standardization variable.

Again a loose interpretation was performed on the transportable variable. Products that were not likely to be arbitraged (transported) were given a value of zero. Some changes that occurred were coke changing from one to zero because there were likely local bottling plants, bread changing from one to zero because most of the bread would have been purchased from local bakeries, and milk changing from one to zero because there were likely local milk producing plants. A tight interpretation was also performed on the transportable variable. For this interpretation, anything that could have been transported was given a value of one. The original transportation variable that was used in equation 4

had a mean of 0.64. The loose interpretation had a mean of 0.56 and the tight interpretation had a value of 0.77. The transportation variable in equation 5 had a mean of 0.71. The loose interpretation will be denoted "Ltransport" and the tight interpretation will be denoted "Ttransport." The results were as follows:

(6) $\mathbf{COV_i = 0.1017 - 0.0044Ltransport_i + e_i}$

(t-stat) (22.27) (-0.71)

$R^2 = 0.009$ n = 61 F-statistic = 0.52

(7) $\mathbf{COV_i = 0.1080 - 0.0111Ttransport_i + e_i}$

(t-stat) (16.66) (-1.52)

$R^2 = 0.038$ n = 61 F-statistic = 2.33

The only time the transportability dummy variable was statistically significant was in equation 5. This is when the original transportability variable had pizza, hamburger sandwich, fried chicken and newspaper changed from zero to one. Despite the insignificance of the transportability variable in equation 4, we feel that it helps capture the transportability (capable of arbitrage) that we are looking for so it will be used together with the standardization variable.

When the COVs were regressed on the two variables STANDARD and TRANSPORT together, the results were as follows:

(8) $\mathbf{COV_i = 0.1243 - 0.0374STANDARD_i + 0.0029TRANSPORT_i + e_i}$

(t-stat) (14.13) (-2.55) (0.376)

$R^2 = 0.136$ adj. $R^2 = 0.106$ n = 61 F-statistic = 4.57

One problem with these variables was that they are correlated; their correlation coefficient (r) was 0.64. Due to the high correlation of the two variables, STANDARD and TRANSPORT, the effect that each has on the COVs cannot be disentangled. This high correlation between the two variables means that they tend to move together. The products that had a value of one for their transportability dummy variable also tended to have higher standardization index values. The opposite tended to be true for products that took on a value of zero for their transportability index. This can be seen in Table 4 below. Table 4 was first sorted by the transportability variable and then by the standardization factor.

Table 4. Standardization Factor and Transportability

Product	COV	Transportable	Standardization Factor	Product	COV	Transportable	Standardization Factor
HALF GALLON MILK	0.092	1	1.0	PEACHES	0.075	1	0.7
PARMESAN	0.110	1	1.0	FROZEN MEAL	0.117	1	0.7
KLEENEX	0.090	1	1.0	MORTGAGE RATE (%)	0.023	1	0.7
CASCADE	0.094	1	1.0	MEN'S SHIRT	0.101	1	0.7
CRISCO	0.069	1	1.0	WINE	0.099	1	0.7
COKE	0.080	1	1.0	POTATO CHIPS	0.092	1	0.6
IBUPROFEN	0.070	1	1.0	BOY'S JEANS	0.108	1	0.6
LIPITOR	0.051	1	1.0	PHONE	0.115	1	0.5
SHAMPOO	0.070	1	1.0	WOMEN'S SLACKS	0.123	1	0.4
BEER	0.057	1	1.0	HAMBURGER SANDWICH	0.073	0	1.0
TBONE STEAK	0.088	1	0.9	ALL ELECTRIC	0.096	0	0.9
GROUND BEEF	0.124	1	0.9	PIZZA	0.067	0	0.9
SAUSAGE	0.135	1	0.9	TWO PIECE CHICKEN	0.085	0	0.8
FRIED CHICKEN	0.098	1	0.9	PARTIAL ELECTRIC	0.159	0	0.7
TUNA	0.106	1	0.9	DRY CLEANING	0.112	0	0.7
DOZEN EGGS	0.138	1	0.9	BOWLING	0.097	0	0.7
MARGARINE	0.141	1	0.9	TIRE BALANCE	0.103	0	0.6
BANANAS	0.103	1	0.9	MOVIE	0.084	0	0.6
LETTUCE	0.114	1	0.9	TOTAL ENERGY	0.097	0	0.5
ORANGE JUICE	0.096	1	0.9	WASHER REPAIR	0.117	0	0.5
SUGAR	0.085	1	0.9	HOME P + I	0.113	0	0.4
CEREAL	0.096	1	0.9	OTHER ENERGY	0.112	0	0.4
FROZEN CORN	0.095	1	0.9	HAIR CUT	0.110	0	0.4
GASOLINE	0.044	1	0.9	NEWSPAPER	0.114	0	0.4
TENNIS BALLS	0.110	1	0.9	APARTMENT RENT	0.088	0	0.3
POTATOES	0.097	1	0.8	OPTOMETRIST	0.116	0	0.3
TOOTHPASTE	0.096	1	0.8	DOCTOR	0.118	0	0.3
BREAD	0.117	1	0.7	DENTIST	0.113	0	0.3
COFFEE	0.100	1	0.7	BEAUTY SALON	0.126	0	0.2
SWEET PEAS	0.116	1	0.7	VETERINARIAN SERVICES	0.107	0	0.2
				HOME PRICE	0.112	0	0.0

This correlation prevents regression analysis from measuring the effect of each variable independent of the other. For example, take the ACCRA item of a doctor visit. It had a zero value for its transportability dummy variable and a standardization index of 0.3. The regression resulted in a predicted COV for doctor visit of 0.113. The two variables failed to explain only 0.005 in COV for a doctor visit. Although for this particular ACCRA item the regression equation (8) accounts for most of the COV, the transportability variable was statistically insignificant and it was unclear as to which variable was explaining the COV. Examine the ACCRA item, half-gallon of milk. It had value of one for the transportability dummy variable and a standardization index value of 1.0. The predicted COV for milk was 0.089 and the regression failed to explain 0.001 of the COV. Although this equation explained a good portion of COV for most of the ACCRA items, the two variables used were statistically insignificant due to correlation. Further research uncovered another transportability variable that may better measure the differences in characteristics of the products. These differences might better explain why some products are easier to transport than others are.

C. NMFC Ratings

The National Motor Freight Traffic Association (NMFTA) is a nonprofit membership organization consisting of 1,100 motor carriers in the United States, Mexico and Canada. The NMFTA is regulated by the U.S. Department of Transportation's Surface Transportation Board as well as other state and federal agencies. The NMFTA publishes annually the National Motor Freight Classification (NMFC) manual. Each commodity is evaluated based on its density, stowability, handling and liability. The commodities are then grouped into eighteen classes ranking between 50 (most transportable) and 500 (least transportable.) This classification allows for a comparison of goods relative to others and a set standard so that price negotiations may begin at a consistent place.

The NMFTA says that "NMFC is collectively developed and maintained by the National Classification Committee (NCC), an autonomous standing committee of NMFTA. The NCC consists of up to 100 members elected or appointed from the 50 states, the District of Columbia, Canada and Mexico. These classifications of commodities allow individual carriers to determine transportation costs. Other factors of individual carrier's transportation costs include distance and value of the commodity to be transported."[12]

For the second quarter of 2005 ACCRA index, 61 products were priced in each area. Of these 61 products, 43 were capable of being transported. The original transportability measure discussed was a dummy variable that took on a value of either zero or one. This measure turned out to be statistically insignificant and failed to allow for comparison between the many items in the ACCRA index. The NMFC index allows for comparison of how transportable different products are. A classification value of 500 indicates that the item is the hardest of all goods to transport. An item that takes on a value of 50 indicates that it is the easiest of all goods to transport. Because of the correlation between the standardization factor and the transportability dummy variable, and the lack of comparison capable when using the dummy variable, we expect that the NMFC index will be a better measure of how transportable a product is.

Theory suggests that products harder to transport will experience a larger price variation across space. Items classified as 500 in the NMFC index should experience a larger spatial price variation than

[12] National Motor Freight Traffic Association (NFMTA) is located in Alexandria, VA. Available at http://www.nmfta.org.

those items classified as 50. The variable that NMFC publishes is listed as “Class”. For this analysis it will be called NMFC. These data were obtained for the year 2005 and came directly from NMFTA. Classifications, and were available for 35 of the 43 transportable products as determined by our transportability dummy variable. They are listed in Appendix III. The hypothesis test for this variable (NMFC) was as follows:

$$COV_i = B_0 + B_1 (NMFC)_i + e_i$$

Where, COV_i = Coefficient of variation for product i,

$NMFC_i$ = Class ranking for product i

e_i = error term for each product i,

The hypothesis test was as follows:

For coefficient B_1, H_0: $B_1 \leq 0$

H_A: B1 > 0.

(9) COV_i = 0.068945 + 0.000355 $NMFC_i$ + e_i

(t-stat) (3.44) (1.45)

R^2 = 0.060 n = 36 F-stat = 2.11

After regressing the COV(s) on the NMFC variable the null hypothesis could not be rejected for the NMFC variable at any significance level. The hypothesized positive relation to COV characterized this NMFC variable. Although this measure was not significant at a high level, the regression in equation 9 suggests that there could be a relationship between the NMFC classification and COV. Nevertheless, the results for the NMFC variable are far better than for the transportability dummy variable originally used. First, the NMFC variable and the Standardization variable have a correlation coefficient (r) of 0.029. This means that the two variables only tend to mirror each other roughly three percent of the time. Also, the NMFC variable will allow for comparison of the transportability of the many ACCRA items. For example, the NMFC class rating was 100 for T-bone steak and ground beef in 2005. At the same time it was 65 for canned tuna. This classification makes sense due to the durability of canned tuna relative to that of the beef products. It is essentially saying that T-bone steak and ground beef are harder (and likely more expensive) to ship relative to canned tuna.

One major problem with the NMFC class variable is the limited amount of rankings available for ACCRA products. The ACCRA products' NMFC rankings range from 55 to 100. The entire NMFC rankings range from 50 to 500. Also, most of the products that have NMFC rankings were grocery items. Only 11 of the 35 products tested were not grocery items. It is possible that if a larger sample of products were tested along with their NMFC ranking, the NMFC ranking may be significant at a higher level. It has given some indication of significance because it was nearly significant at the .10 level and has the correct sign. Because of the possibility of the NMFC ranking being significant and the low correlation with the standardization variable, we decided to modify our original equation to include it.

The new and final equation says that the COV is function of the NMFC class ranking and the standardization variable, expressed in an equation as follows: COV = f [(+) NMFC, (-) STANDARD]. A hypothesis test was performed for STANDARD and NMFC together as follows:

$$COV_i = B_0 + B_1 NMFC_i - B_2 STANDARD_i + e_i$$

Where, COV_i = Coefficient of Variation for product i,

$NMFC_i$ = NMFC classification for product i

$STANDARD_i$ = Standardization factor for product i

e_i = error term for each product i,

The hypothesis test was as follows:

For coefficient B_1, H_0: $B_1 \leq 0$ For coefficient B_2, H_0: $B_2 \geq 0$

H_A: B1 > 0. H_A: $B_2 < 0$.

The regression results were:

(10) $COV_i = 0.12396 + 0.00037NMFC_i - 0.06572STANDARD_i + e_i$

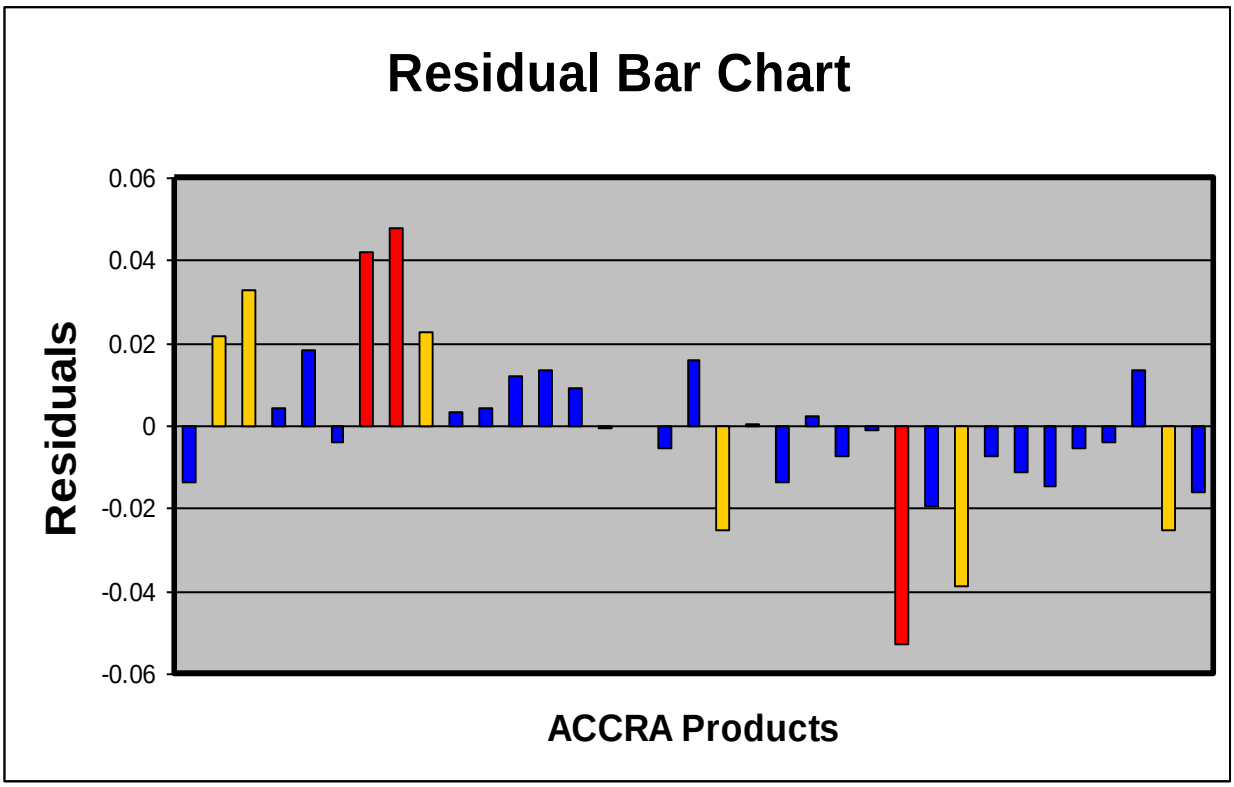
(t-stat) (4.33) (1.64) (-2.53)

$R^2 = 0.217$ adj. $R^2 = 0.168$ F-stat = 4.42 n = 35

After regressing COV(s) on the NMFC class and standardization variables the null hypothesis may be rejected for the standardization variable at the .05 significance level and nearly at the .01 level. The null hypothesis may not be rejected for the NMFC class variable, but it is nearly significant at the .10 significance level and has the correct sign. Overall, despite the low significance of the NMFC variable, the equation explains most of the COVs quite well. The residuals are shown in Graph 1 below. They

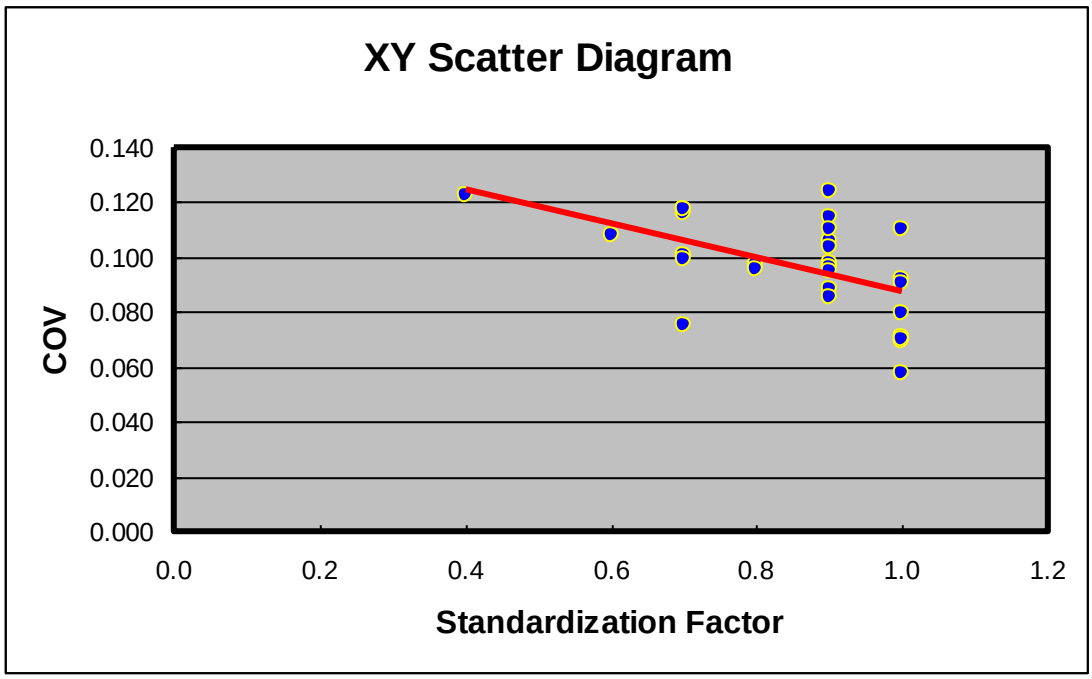
average to near zero and are not sorted in any way. On the x-axis, each bar represents the residual of an ACCRA product which was unexplained by equation 10 above.

Graph 1. Residuals of Equation 10

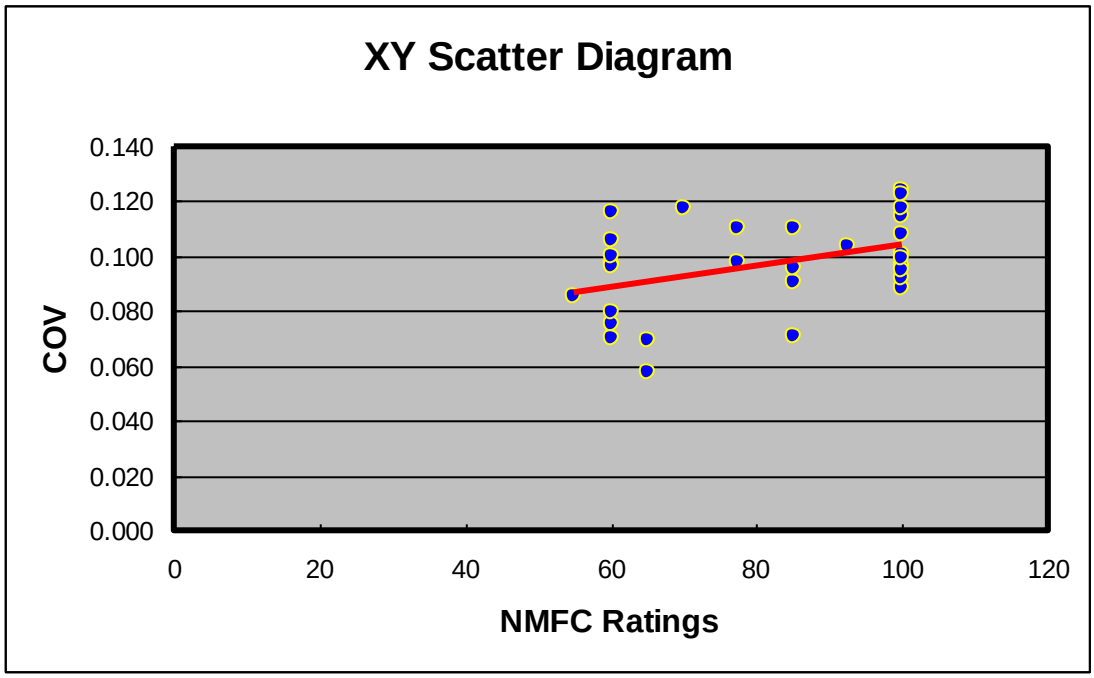


Graphs 2 and 3 below are XY scatter diagrams. The first has COV on the Y-axis and standardization factor on the X-axis. The second has COV on the Y-axis and NMFC Ratings on the X-axis. These graphs were prepared to display the linear relationship between the measure of price variation across space (COV) and the variables used in our equation to explain the variation. It is apparent that there is at least some relationship between the price variation and our variables.

Graph 2. Linear trend line on XY scatter of COV and Standardization variables



Graph 3. Linear trend line on XY scatter of COV and NMFC variables



Items with the worst results were: gasoline (0.053 unexplained COV), margarine (0.048), eggs (0.042), Lipitor (0.039) and sausage (0.033). All of the other products had unexplained COVs of less than 0.03. Some of the items with the least amount of unexplained COV were: coffee (0.0005 unexplained COV), sugar (0.0002), Kleenex (0.0006) and coke (0.0009).

The regression results may look mediocre, but when they are compared against the original summary statistics of the COVs, the equation appears to work rather well. The range of COV is 0.023 to 0.159, with a mean of 0.099. The standard deviation of the COV for this sample is 0.023. Assuming a normal distribution, approximately 95% of the products' COVs should be between 0.053 and 0.145. The range of the predicted COVs is from 0.081 to 0.126 with a mean of 0.097. The standard deviation of the predicted COVs is 0.011. When the predicted range and standard deviation is compared with the 0.015 mean absolute error (MAE), it looks to fit the data quite well.

The products with the very high absolute errors were listed above as gasoline, margarine, eggs, Lipitor and sausage. When the COV of each of these products was examined, they were found to have spatial price variations at the very low end or very high end of the COV's range. Gasoline and Lipitor were actually more than two standard deviations from the mean. Margarine, eggs and sausage were near the upper boundary of two standard deviations from the mean. There is something causing these products' prices to be less explainable by our model than the other products. In fact, when these five products (with polar COVs) were dropped from the model, both variables became significant. The NMFC variable was then significant at the 5 percent level and the STANDARD variable was significant at the 1 percent level. The r-squared was 0.389 and the adjusted r-squared was 0.344. The f-statistic was 8.62.

In general, the equation appeared to fit the data somewhat well although the NMFC was not quite significant at the 5 percent level. The NMFC variable was characterized by the correct sign and showed signs of significance when a few of the items with polar COVs were dropped from the model.

VII. Conclusion

The ACCRA database was analyzed with great detail and most concerns about the database were addressed. The study has shown that some products are characterized by greater variation in price than others. The products in this study range in COV from 0.159 to 0.044 and even down to 0.023 for mortgage rates (which is the only product listed as a percentage).

The standardization index created showed great promise in accounting for a significant portion of the products' COV. Regressing the COVs on the standardization yielded an R^2 of 0.134. This loosely means that it explained roughly 13% of the variation of the COVs, better than the mean. Although this variable was subjective in nature, it seems to capture some information about COVs..

The transportability of each of the products was addressed and two different variables were used to try to explain the different COVs. The first variable was a dummy variable that took on a value of one if the item was transportable and zero if it was not. After the first regression, the variable was found to be statistically significant. After further review and discussion with others[13] some of the dummy variables were changed because although the items "could" be transported, they likely were not. An example would be a McDonald's sandwich. When these changes were made, the variable became insignificant. The second transportability variable examined was a classification rating obtained from the National Motor Freight Classification (NMFC) manual. This variable was also found to be insignificant at the .05 significance level. This NMFC variable was characterized by the hypothesized positive relationship and was nearly significant at the .10 significance level.

After examining both of these variables, the decision was made to use the NMFC variable because of its low correlation with the standardization factor (and the dummy variable's high correlation) and its ability to compare the relative transportability between two products. The final regression equation included 35 observations, had an R^2 statistic of 0.217 and a F-statistic of 4.42. The entire results can be found in regression equation 10.

[13] Dr. James Kurre and Ben Schlosser. Mr. Schlosser worked on a sister project during the same time. This project examined the ACCRA database over time. It is titled, "Analysis of Spatial Variation in Prices through Time in the United States ."

VIII. Further Research

A. Government Regulation

Another factor that may influence some products' price variation across space may be the level of government involvement or regulation. For example, in some areas the price of milk is controlled so that it is not allowed to fall below a particular level. Also, there may have been government controls on imports. Some products may have had a tariff associated with them and others may have not had one.

Price ceilings and price floors are tools that governments use to control the prices of some products. Price ceilings are restrictions on how high the price of product may be. Price floors are restrictions on how low the price of a product may be. These regulations may cause some products' prices to vary more than others' across space because these controls are often imposed at the state level. This means that each product in the ACCRA index would need to be examined at the state level. The issue of price ceilings and price floors is outside the scope of this study and could be an area of further research.

Because this study covers a large geographic area, many different governments are involved. It is quite possible that some governments place very strict regulations on the production and distribution of foods (or grocery items for this study). Any product that has different regulations from one area to another may likely see a variation in price because of the increased costs associated with regulation. This issue could be studied along with the price ceilings and floors mentioned above. Because they are both dealing with issues of government involvement, it makes sense to study them together.

Almost all taxes are excluded from the explicit prices collected for the ACCRA database. If the taxes are likely to come out of the businesses' pocket, the tax would likely be passed through in the price of the product. So even though consumers may believe that they are not paying taxes, there are taxes already included in the face value of the product. This may cause price variation across space if the tax rates for the many ACCRA products were different from place to place.

B. Location of Supply

An issue that may have had a significant impact on some products' price variation may have been the location of supply. If a good was produced near every sample area, than it would have a short average distance to be transported. On the other hand, if another good was only produced in one area and needs to be transported everywhere throughout the country, it would have a greater average distance to be transported. This means that one of the goods should experience smaller amounts of transportation costs relative to the other good.

Look at the national supply of lettuce. Assume that all of the lettuce supply comes from warmer, wet climates of the south, particularly Florida. If the entire nation demands lettuce and the only place it is produced is Florida then it will cost more to ship it to the state of Washington than other areas closer to Florida. On the other hand, assume that there is a milk factory in every city larger than 50,000. The transportation costs will be very small for the milk producers. This transportation distance factor would likely cause the price variation of lettuce to be larger than the price variation for milk.

This concept, although intuitive, is very difficult to measure. It would require an in-depth analysis of the market structure of supply for each of the ACCRA items. This would include finding the number of domestic producers, how far they transport, amount of imports and where they are imported, and the creation of a concentration of supply index for the entire U.S.

C. Location of Supply (Import/Export)

Probably the most essential products purchased are agricultural products. The U.S. is incapable of producing all of the agricultural products needed (demanded) by U.S. consumers. This is due to climate differences, comparative advantage and other factors. To account for this there is a reliance on imports from other countries. These imports may have been subject to import quotas, tariffs and other forms of trade barriers. If some products were subject to heavier trade barriers it makes sense that these products' prices should vary more across space. Also, some countries that export to the U.S. had a special relationship with the U.S., known as Normal Trade Relations (NTR). These countries usually experience less or no trade barriers on products that otherwise would be subject to them. If some products were being imported with trade restrictions and some without, it would likely cause the price to vary more across space.

For example, assume a three-way trade triangle between the U.S., China, and Europe. China and Europe are the producers of widgets which are exported to the U.S. The U.S. imports from China on the west coast and imports from Europe on the east coast. Because of the U.S. movement toward free(r) trade (and Chinese reluctance), they impose a tariff on widgets from China, but not from Europe. Because Chinese widgets are taxed they are more expensive on the west coast but less expensive on the east coast, leading to greater price variability.

Because of the complexity of imports in the U.S. it is also outside of the reach of this study and could be another topic for further research. The main reasons are that many different things would need to be analyzed. First, the different tariff rates for each of products would need to be found. Second, the trade status that applies to each country that imports to the U.S. would need to be found. Next, the amount of imports for each product from each country would need to be found. Finally, the amount of imports to each U.S. Custom district of entry for every product would need to be found. This will be discussed in Location of Supply section. All of the previously mentioned reasons make it difficult to study the impact of the U.S. import regime on COVs of the ACCRA items.

D. Market Structure

Another possible explanation for price variation may be attributed to the national and local market structures associated with each of the ACCRA items. Market structure is used to determine the price equilibrium in many situations and should also be mentioned here. The type of market that each of the products are in will likely help determine the price. For this study, most of the products appear to be produced in either monopolistically competitive or perfectly competitive industries. This could be different at the local level and national level. At the national level, the producers of potatoes would likely be perfectly competitive. But in certain regions, there may only be a few competitors, which could lead to higher prices in that area, and so greater price variation for this good.

Some of the ACCRA items are also sold by national corporations, such as McDonald's, KFC, Lipitor, etc. Because of the size and the spending ability of corporations, they are much more knowledgeable in pricing strategies and other techniques to increase profits. One of the more important techniques according to this study is price discrimination. This is the practice of charging different prices

to different buyers. By definition, this will cause price variation. Corporations have the ability to practice geographic price discrimination. For example, a corporation might know that incomes are higher in a specific region, so it charges a premium for their products.

Market structure would be one of the more difficult subjects to study in the spatial price variation arena. First, each good would need to be examined to understand the national market and the pricing power of the companies at this level. This means that 61 products would need to be analyzed and the data would be very hard to find. Second, because we are dealing with products across space, each local market would need to be analyzed for each good. This means 61 products times 283 metro areas. Finally, if all these data were gathered, it would still be quite difficult to understand what it all means.

One possible measure of the national market structure is concentration ratios. At this time the best measure of concentration can be found in the Economic Census, which is published for years ending in 2 and 7. The U.S. Census Bureau defines the Concentration Ratio in the 2002 Economic Census as, "…data on the percentage of value of shipments and value added accounted for by the 4, 8, 20, and 50 largest companies for each manufacturing industry." The higher the concentration index, the more concentrated the market power is for the 4, 8, 20, or 50 largest companies.

Theory is unclear about how the level of concentration will affect the industry. It depends on the type of concentration. Some industries with low concentration may have an enormous amount of pricing power. Alternately, some industries with very high concentration may not have much pricing power at all. This is due to oligopoly structure, collusion, international manufacturers, etc. For the purposes of this study, the concentration indexes will be tested to see if they are statistically significant. The COV was regressed on three different variables of concentration as follows:

$$COV_i = B_0 \pm B_1 C(n)_i + e_i$$

Where, COV_i = Coefficient of Variation for product i,

$C(n)_i$ = 4-, 8-, or 20- company concentration ratio

e_i = error term for each product i,

The hypothesis test was as follows:

For coefficient B_1, H_0: $B_1 = 0$

H_A: $B1 \neq 0$.

The results were:

(11) $\mathbf{COV_i = 0.12061 - 0.00048C4_i + e_i}$

(t-stat) (9.29) (-1.89)

$R^2 = 0.174$ n = 19

(12) $\mathbf{COV_i = 0.13124 - 0.00055C8_i + e_i}$

(t-stat) (7.75) (-2.06)

$R^2 = 0.199$ n = 19

(13) $\mathbf{COV_i = 0.14067 - 0.00062C20_i + e_i}$

(t-stat) (5.67) (-1.91)

$R^2 = 0.176$ n = 19

The concentration ratios for 4, 8, and 20 companies were statistically significant at the .10 significance level. The eight-company concentration ratio was nearly significant at the .05 confidence level. One apparent problem with these regressions was the number of observations was lower than the previous regressions. This was because concentration indexes were only reported for manufacturing industries. There were a few other problems with the concentration indexes reported in the Economic Census.

First, these indexes only account for the concentration of market power in the 4-, 8-, or 20- largest companies. Every other company in the industry had no influence on the concentration index reported. Second, the concentration ratios were only reported at the national level. This means that the influence of international companies had no part in the indexes. Also, the index does not account for regional or local concentration. For example, a local newspaper company might have a near monopoly within a 50 mile radius. But if the national concentration ratio were to be reported for the newspaper industry it would likely be very low. This is because very few newspaper companies provide at the national level (with some exceptions, such as *USA Today, NY Times, Wall Street Journal*, etc.). Because there were currently no indexes of local market concentration, this issue will not be examined in this study.

The results do show some signs of statistical relevance. First, all three have negative coefficients. Second, they are all nearly significant at the .05 confidence level. The results indicate that the more concentrated the industry, the lower the price variation of that industry's product across space.

This is counter-intuitive because an industry that has 100 percent concentration may likely include a monopolist who could use geographic price discrimination. On the other end of the spectrum, a 0 percent concentration indicates a perfectly competitive industry with identical prices across space.

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Appendix I – Standardization Index

Index	Grocery
0.9	T-Bone Steak – Price per pound. A T-bone steak is likely to be a T-Bone steak wherever one travels.
0.9	Ground Beef or hamburger – Price per pound, lowest price, min 80% lean. Ground beef hamburger is likely to be the same as one moves across space.
0.8	Sausage – Price per pound; Jimmy Dean or Owen's brand 100% pork. Clear description with only two possible brands.
0.9	Frying Chicken – Price per pound, whole fryer. Clear description, but lack of supplier standardization.
0.9	Chunk Light Tuna – 6.0 oz can, Starkist of Chicken of the Sea. Clear description with only two possible brands.
1.0	Whole Milk – Half-Gallon carton. Clear description, but lack of supplier standardization.
0.9	Eggs – One Dozen, Grade A, Large. Clear description, but lack of supplier standardization.
0.9	Margarine – One Pound, cubes, Blue Bonnet or Parkay. Clear description with only two possible suppliers.
1.0	Parmesan Cheese, Grate – 8 oz. Canister, Kraft Brand. Clear description with only one possible supplier.
0.8	Potatoes – 10 lb. white or red. Clear description with two alternatives, but lack of supplier standardization.
0.9	Bananas – Price per pound. Clear description, but lack of supplier description.
0.9	Iceberg Lettuce – Head, approximately 1.25 pounds. Clear description, but lack of supplier standardization.
0.7	Bread, White – 24 oz. loaf, lowest price, or prorated 24-oz. equivalent, lowest price. Somewhat vague description with option to prorate, which could lead to confusion. Also, there is no mention of supplier, just lowest price.
0.9	Fresh Orange Juice – 64 oz. (1.89 liters) Tropicana or Florida Natural Brand. Clear description with only two suppliers.
0.7	Coffee, Vacuum-Packed – 11.5 oz. can, Maxwell House, Hills Brothers, or Folgers. Clear description with only two suppliers.
0.9	Sugar – 4 pound sack, Cane or Beet, lowest price. Clear description with two alternatives, but lack of supplier standardization.
0.9	Corn Flakes – 18 oz., Kellog's or Post Toasties. Only two possible suppliers.
0.7	Sweat Peas – 15-17 oz. can, Del Monte or Green Giant. Some variation in size with only two possible suppliers.
0.7	Peaches – 29 oz. can, Hunt's, Del Monte, or Libby's or Lady Alberta, halves or slices. Three choices of suppliers with clear description.
1.0	Facial Tissues – 160-count box, Kleenex brand. Only one possible choice and clear description.
1.0	Dishwashing Powder – 75 oz. Cascade dishwashing powder. Only one possible choice with a clear description.
1.0	Shortening – 3 pound can, all-vegetable, Crisco brand. Clear description with only one possible supplier.
0.7	Frozen meal – 8 to 10 oz. frozen chicken entrée, Healthy Choice or Lean Cuisine brand. Some variation in size with three possible choices.
0.9	Frozen Corn – 16 oz., Whole Kernel, lowest price. Clear description, but lack of supplier standardization.
0.6	Potato Chips – 12 oz. plain regular Potato chips. Clear description, but a complete lack of supplier standardization.
1.0	Soft Drink – 2 liter Coca Cola, excluding any deposit. Clear description with only one possible supplier.

Index Housing

0.3 Apartment, Monthly Rent – Two-Bedroom, unfurnished, excluding all utilities except water, 1-1/2 baths, approximately 950 sq.ft.

Clear description but many variations possible in between.

0.0 Total Purchase Price – 2,400 sq.ft. living area new house, 8,000 sq.ft. lot, urban area with all utilities.

Although special emphasis is put on making sure that the pricing of homes is standard, variations in regional, opinion and other factors will cause the home price to vary more often than other products.

0.7 Mortgage rate – Effective rate, including points and origination fee, for 30-year conventional fixed rate mortgage.

Clear description, but lack of lender information leaves room for variation.

0.4 Monthly Payment – Principal and Interest, using mortgage rate reported for the MSA and assuming 25% down payment.

This is a combination of the previous two products/services.

Index Utilities

0.5 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 reported for each MSA.

0.9 Electricity

0.4 Other Home Energy – Average monthly cost at current rates for natural gas, fuel oil, coal, wood and any other forms of energy except electricity.

Many different products, of which, most would be in industries of natural monopolies or tight oligopolies, leading to larger variations in price.

0.5 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.

Clear description, but lack of supplier specifications. Different telephone service providers may vary in types of features and customer service offered.

Index Transportation

0.6 Auto Maitenance – Average price to computer- or spin balance- one front wheel. Clear description, but lack of supplier standardization.

Service standards may vary across space.

0.9 Gasoline – One Gallon regular unleaded, national brand, including all taxes; cash price at self-service pump if available.

Clear description with heavy competition in industry creating similar prices. Gasoline is the same wherever one travels.

Index HealthCare

0.3 Office Visit, Optometrist – Full vision eye exam for established adult patient.

Standard procedure with some variation in skill involved. Likely to have larger price variations. Service level may vary across space.

0.3 Office Visit, Doctor – American Medical Association procedure 99213 (general practitioner's routine examination of established patient).

Standard procedure with variation in skill involved. Service level may vary across space.

0.3 Office Visit, Dentist – American Dental Association procedure 1110 (adult teeth cleaning) and 0120 (periodic oral examination).

Standard procedure with two possible services with variation in skill involved. Service level may vary across space.

1.0 Ibuprofen – 200 mg. 50 tablets, Advil Tablets.

Clear description with only one possible choice.

1.0 Atorvastatin Calcium – 20 mg. 30 tablets, Lipitor brand.

Clear description with only one possible choice.

Index Miscellaneous

1.0 Hamburger Sandwich – ¼ pound patty with cheese, pickle, onion, mustard, and catsup. McDonald's Quarter-Pounder with Cheese, where available.
Clear description with only one possible choice.

0.9 Pizza – 11"-12" thin crust cheese pizza. Pizza Hut or Pizza Inn, where available.
Clear description with small variation in size and only two choices.

0.8 Fried Chicken – Thigh and Drumstick, with or without extras, whichever is less expensive. Kentucky Fried Chicken or Church's, where available.
Clear description with only two choices.

0.4 Haircut – Man's barbershop haircut, no styling.
Clear description with various level of skill involved.

0.2 Beauty Salon – Women's shampoo, trim, and blow dry.
Clear description with various level of skill involved.

0.8 Toothpaste – 6 oz.-7 oz. tube, Crest or Colgate. Small variation in size with only two choices. Standardization rating of **0.2.**

1.0 Shampoo – 15 oz. Bottle, Alberto VO-5.
Clear description with only one possible choice.

0.7 Dry Cleaning – Man's two-piece suit.
Clear description with standard process.

0.7 Man's Dress Shirt – Cotton/Polyester, pinpoint weave, long sleeves.
Clear description, but lack of supplier standardization.

0.6 Boy's Jeans – Blue Denim jeans, regular, relaxed or loose fit, sizes 8-20.
Clear description, but lacks supplier specifications in a highly competitive industry.

0.4 Women's Slacks – 100% cotton, twill khakis, misses 4-14.
Standard product with lack of producer information.

0.5 Major Appliance Repair – Home service call, clothes washing machine; minimum labor charge, excluding parts.
Standard service provided with some variation.

0.4 Newspaper Subscription – Daily and Sunday home delivery, large-city newspaper.
Clear description, but there is variation in the quality of newspapers.

0.6 Movie – First-run, indoor, evening, no discount.
Clear description with nearly identical products.

0.7 Bowling – Price per line (game), Saturday evening, non-league event.
Clear description with some variation in complementary services provided at venue.

0.9 Tennis Balls – Can of three extra duty, yellow, Wilson or Penn Brand.
Clear description with only two choices.

0.2 Veterinary Services – Annual exam, four-year old dog.
Clear description with some variation in skill involved. Service level may vary across space.

1.0 Beer – Heineken's 6-pack, 12-oz. containers, excluding any deposit.
Clear description with only one choice.

0.7 Wine – Livingston Cellars or Gallo chablis or chenin blanc, 1.5-liter bottle.
Clear description with three choices.

Appendix II – Transportability Variable

ACCRA Item	Transportable (Second)	Robust (Loose Dummy1)	Robust (Tight Dummy2)
TBONE STEAK	1	1	1
GROUND BEEF	1	1	1
SAUSAGE	1	1	1
FRIED CHICKEN	1	1	1
TUNA	1	1	1
HALF GALLON MILK	1	0	1
DOZEN EGGS	1	1	1
MARGARINE	1	1	1
PARMESAN	1	1	1
POTATOES	1	1	1
BANANAS	1	1	1
LETTUCE	1	1	1
BREAD	1	0	1
ORANGE JUICE	1	1	1
COFFEE	1	1	1
SUGAR	1	1	1
CEREAL	1	1	1
SWEET PEAS	1	1	1
PEACHES	1	1	1
KLEENEX	1	1	1
CASCADE	1	1	1
CRISCO	1	1	1
FROZEN MEAL	1	1	1
FROZEN CORN	1	1	1
POTATO CHIPS	1	1	1
COKE	1	0	1
APARTMENT RENT	0	0	0
HOME PRICE	0	0	0
MORTGAGE RATE (%)	1	0	1
HOME P + I	0	0	0
ALL ELECTRIC	0	0	1
PARTIAL ELECTRIC	0	0	1
OTHER ENERGY	0	0	1
TOTAL ENERGY	0	0	1
PHONE	1	0	1
TIRE BALANCE	0	0	0
GASOLINE	1	1	1
OPTOMETRIST	0	0	0
DOCTOR	0	0	0
DENTIST	0	0	0
IBUPROFEN	1	1	1
LIPITOR	1	1	1
HAMBURGER SANDWICH	0	0	1
PIZZA	0	0	1
TWO PIECE CHICKEN	0	0	1
HAIR CUT	0	0	0
BEAUTY SALON	0	0	0
TOOTHPASTE	1	1	1
SHAMPOO	1	1	1
DRY CLEANING	0	0	0
MEN'S SHIRT	1	1	1
BOY'S JEANS	1	1	1
WOMEN'S SLACKS	1	1	1
WASHER REPAIR	0	0	0
NEWSPAPER	0	0	1
MOVIE	0	0	0
BOWLING	0	0	0
TENNIS BALLS	1	1	1
VETERINARIAN SERVICES	0	0	0
BEER	1	1	1
WINE	1	1	1

Number	61	61	61
Minimum	0	0	0
Maximum	1	1	1
Median	1	1	1
Mean	0.639	0.557	0.770
Standard Deviation	0.480	0.497	0.421

Appendix III – NMFC Ratings

ACCRA Item	NMFC Ratings	ACCRA Item	NMFC Ratings
TBONE STEAK	100	VETERINARIAN SERVICES	-
GROUND BEEF	100	PARTIAL ELECTRIC	-
SAUSAGE	100	OTHER ENERGY	-
FRIED CHICKEN	77.5	TOTAL ENERGY	-
TUNA	60	PHONE	-
HALF GALLON MILK	100	TIRE BALANCE	-
DOZEN EGGS	85	GASOLINE	85
MARGARINE	77.5	OPTOMETRIST	-
PARMESAN	77.5	DOCTOR	-
POTATOES	60	DENTIST	-
BANANAS	92.5	IBUPROFEN	85
LETTUCE	100	LIPITOR	85
BREAD	70	HAMBURGER SANDWICH	-
ORANGE JUICE	60	PIZZA	-
COFFEE	60	TWO PIECE CHICKEN	-
SUGAR	55	HAIR CUT	-
CEREAL	100	BEAUTY SALON	-
SWEET PEAS	60	TOOTHPASTE	85
PEACHES	60	SHAMPOO	60
KLEENEX	85	DRY CLEANING	-
CASCADE	-	MEN'S SHIRT	100
CRISCO	65	BOY'S JEANS	77.5
FROZEN MEAL	100	WOMEN'S SLACKS	77.5
FROZEN CORN	100	WASHER REPAIR	-
POTATO CHIPS	-	NEWSPAPER	-
COKE	60	MOVIE	-
APARTMENT RENT	-	BOWLING	-
HOME PRICE	-	TENNIS BALLS	85
MORTGAGE RATE (%)	-	VETERINARIAN SERVICES	-
HOME P + I	-	BEER	65
		WINE	100