8-2012

Market Analysis of Fresh Berries in the United States

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A thesis submitted in partial fulfillment
of the requirements for the degree of
Master of Science in Agricultural Economics

BY

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Bachelor in Public Administration and Rural Development, 2009

August 2012
University of Arkansas

ABSTRACT

This thesis contains a market analysis of fresh berries in United States. Specifically, it addresses strawberry, blueberry, blackberry and raspberry markets during 2008-2011. A double log model and the Almost Ideal Demand model are used to gain insight into the demand side of the market. An equilibrium displacement model is used to develop suggestions for producers and decision makers. The results demonstrate that retail demand for berry crops is elastic and that the different berries are substitutes for one another. The equilibrium displacement model is used to predict producer surplus changes to industry wide efforts aimed at both production efficiencies and promotion of berries to consumers. There are positive spillovers from one berry market to another in the case of promotion.

Keywords: Almost Ideal Demand system, Equilibrium displacement model, demand elasticities, berry crops

This thesis is approved for recommendation

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ACKNOWLEDGMENTS

Special thanks to Dr. Michael R. Thomsen for his valuable time and patience to guide me successfully through my thesis research.

I would like to thank you to Dr. Bruce L. Ahrendsen for his suggestions and comments to complete my thesis. Also, thank you for his help and guidance through my studies as Atlantis student at University of Arkansas.

I would like to thank you to Dr. Hupkova for her valuable input and friendly support to complete my research.

I give my sincerest gratitude to the entire staff at the Department of Agriculture Economics and Agribusiness at University of Arkansas for the pleasant experience and fellowship.

A special recognition goes to my family and friends for support and assistance in my educational career.

It would have not been possible to complete the research without the support and assistance of people mention above.

The contents of this thesis were partially developed and supported under the Fund for the Improvement of Postsecondary Education (EU-US Atlantis Program grant P116J080034, U.S. Department of Education) and the EU-US Cooperation Programme in Higher Education and Vocational Training (Transatlantic Degree Consortia Projects, nr. 2008-1745/001 – 001 CPT-USTRAN). However, the contents of the thesis do not necessarily represent the policy of the supporting agencies, and you should not assume endorsement by the supporting agencies.

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1.1 Berry market

Americans are consuming more fresh fruits and vegetables, but consumption is still below recommended levels. The increase in consumption has been due to greater variety on the market, year-round availability for fresh products, and increasing consumer incomes. Berry crops have taken part in this growth. As consumers become more health conscious, they are eating more berries because they contain high levels of antioxidants (Lucier et al., 2006; Monson, 2009). The benefits of consuming berries have been widely diffused by generic promotion programs supported by grower assessments in each industry (Cook, 2011). Over the last 20 years, the number of berry farmers rose 3 percent to 18,234, while harvested berry area increased 26 percent (Lucier et al., 2006). Berries are considered to be high-value agriculture products. This means that producers of berries are capable to earn higher return with using less land. Also, the demand for berries has constantly risen in recent years. Particularly, from 1990 to 2004, U.S. per capita consumption of total berries rose by 55 percent (Monson, 2009). Figure 1.1 illustrates per capita availability (fresh weight equivalent) of blackberries, blueberries, and raspberries for 1970-2009. Figure 1.2 describes per capita availability (fresh weight equivalent) of strawberries for the same period of time. The blackberry data only includes processed (frozen) availability which might be a reason for their relatively flat curve in the graph. Fresh data for some others berries were missing in some years, particularly at the beginning of 1970.Blueberries fresh data were gathered since 1980. Fresh raspberry data started to be gathered since 1991.

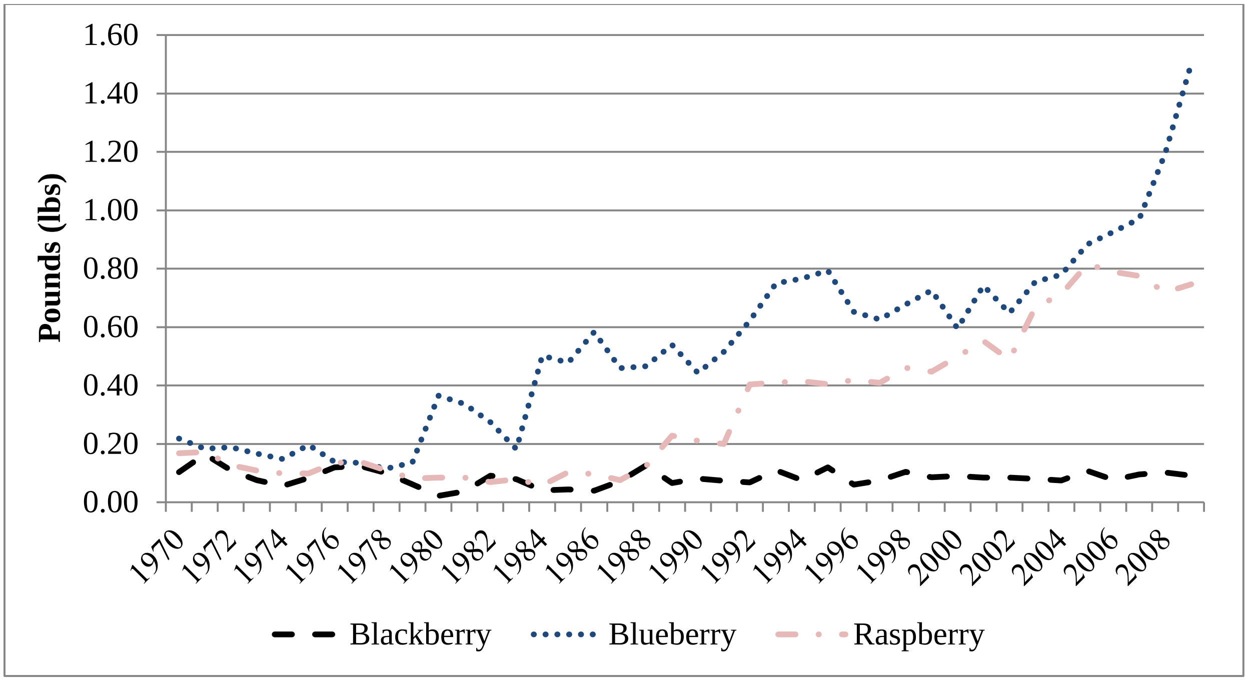

Figure 1.1 Per capita availability (fresh weight equivalent) of blackberries, blueberries, and raspberries, 1970-2009

Source: USDA Economic Research Service

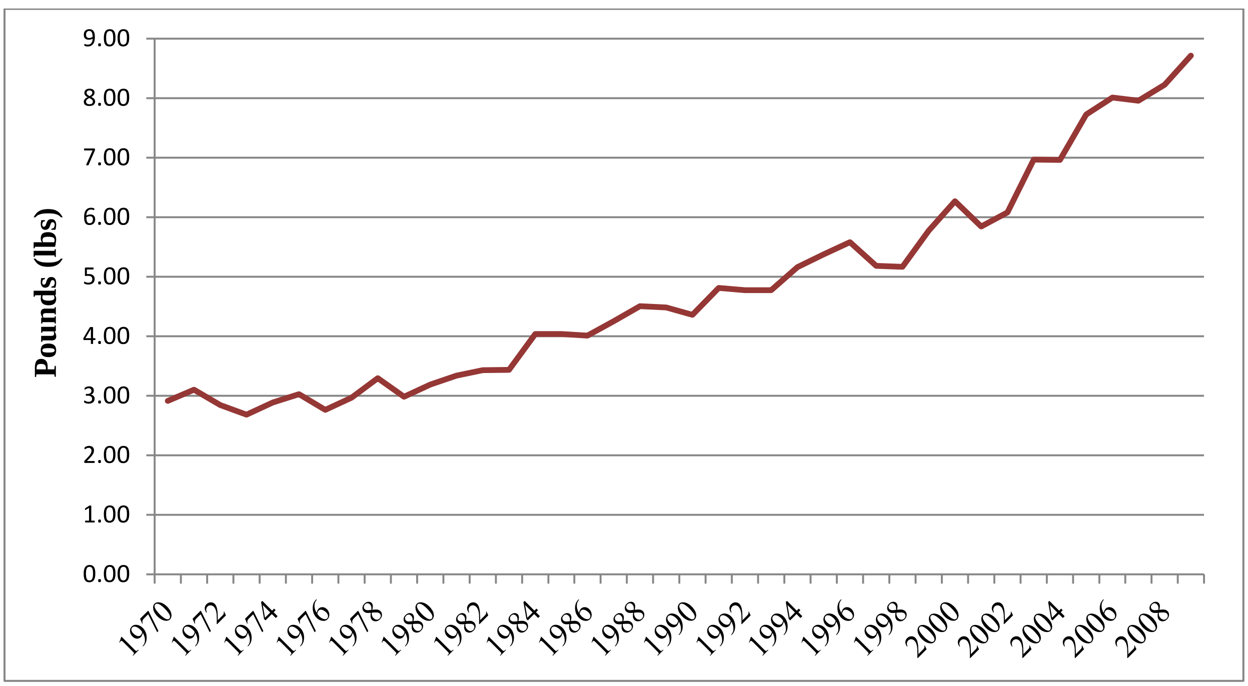

Figure 1.2 Per capita availability (fresh weight equivalent) of strawberries, 1970-2009

Source: USDA Economic Research Service

Nevertheless**,** cardiovascular diseases, cancer, and obesity, currently kill more people every year than any other cause of death. Fruit and vegetables are an important component of healthy diet and, if consumed daily in sufficient amount, could help to prevent major diseases (FAO and WHO, 2004). Hence, the national debate on diet and health is frequently concentrated on the nutritional role of fruits and vegetables. The benefits of eating fruits and vegetables may offer opportunities to the sector (Lucier et al., 2006).

1.1.1 Strawberries

Strawberries have one of the highest rates of consumption growth of all fruit and vegetables. Strawberries are the fifth highest consumed fresh fruit in the United States, behind bananas, apples, oranges and grapes (Boriss et al., 2006). Strawberries are cultivated mostly in California with production locations varying from south to north. This fact extends the season of the fruit through most of the year. In the low season in California, the second producer of strawberries is Florida. U.S. strawberries are mainly marketed domestically and in Canada. In 2010, imports covered only 8% of strawberry supply. This is due to high perishability of the fruit and favorable conditions for growing strawberries in the U.S., Mexico is the main import source (Cook, 2011).

1.1.2 Blueberries

The U.S. blueberry industry does a great deal to make consumers aware of health benefits of the crop. Due this fact, demand has continued to grow. Michigan and Maine are the leading states in blueberry production. Other important producing states are Georgia, Washington, Oregon, North Carolina, New Jersey and California (Perez et al., 2011)**.**

Blueberries are much less fragile than raspberries and strawberries. This advantage allows for long distance international shipping and trade. Canada exports the majority of blueberries to the

U.S. market. Chile and Argentina provide blueberries to the U.S. market when domestic berries are out of season. One-third of domestic and import shipments are covered by four shippers in the U.S. market. However, given strong demand, the global supply response continues (Cook, 2011).

1.1.3 Blackberries

Blackberries are a relatively recent addition to supermarket fresh produce departments, although local blackberry fruits have long been available in-season via farmers markets. Shipping markets for blackberries practically did not exist until more research was done and found positive attributes of the fruit. In the late 1990s, two types of blackberries (Chestner Thornless and Navaho) were found to have a good fruit firmness and excellent shelf-life. These and other characteristics contributed to create blackberries market (Clark, 2005). The blackberry crop is mostly cultivated in Oregon State. The next largest producer is California, followed by Texas and Arkansas. Out of the season, blackberries are imported from Mexico, Chile and Guatemala (Strik et al., 2006).

1.1.4 Raspberries

The United States is considered the third largest producer of raspberries in the world after Russia and Serbia. The largest areas for cultivating raspberries in the U.S. are in Washington, California and Oregon State. In North America, production of raspberries comes mainly from two species: red raspberry and black raspberry. Red raspberry is more marketable in the U.S. because in general it is less disposed to diseases, provides higher yields and is more cold tolerant. Farmers in the U.S cultivate two types of red raspberries. One type is the summer bearing variety (early to mid-summer) and the other type is overbearing (early summer and fall). Out of season raspberries are imported from Mexico and Chile (Pollack and Perez, 2006).

1.3 Problem Statement

In recent years, consumption of the fresh berries increased and the trend is predicted to continue. Recognition of the health characteristics of berries has helped this market to grow. At present, fresh berries are available in retail stores all year long due to different times of growing among of the states and imports from international sources during the domestic off seasons (Lin et al., 2003).

A consideration of own price elasticity, price elasticity of related goods and per capita income are useful for understanding the demand for a commodity. These measures also assist producers and decision makers. There is very little information about demand elasticities for fresh fruits in contrast to demand for other food commodities. In the past, George and King, 1971, computed demand elasticities for a large number of agriculture commodities (49 items), however, there were only three fresh fruit items included. Later, Price and Mittelhammer, 1979, You et al., 1996, and Henneberry et al., 1999, estimated demand elasticities for more than 10 fresh fruits. The only berry crop included in their studies was strawberry because of its high consumption popularity.

At present there is little knowledge about demand conditions in the U.S. berry markets. In this thesis, I examine two different demand models. One is a double logarithmic model and the other is the linear-approximate almost ideal demand system (LA/AIDS). To understand relationships between the different berry crops, I also estimate farm-to-retail price transmission elasticities and incorporate them into an equilibrium displacement model (EDM). The goal is to provide a framework that can be used to understand the impacts of a demand or supply shock to any one of the four berry markets examined in the study.

1.4 Research Objectives

This study has two main objectives. The first aim is to estimate demand elasticities for fresh berries (strawberries, blueberries, blackberries, raspberries). This will provide a better understanding of consumer behavior in response to price changes during a certain time period. Awareness of price and expenditure elasticities for berries is very beneficial to all actors in the fruit market.

The second objective of the study is to characterize berry markets within an equilibrium displacement model (EDM). The EDM will create a framework to understand how a demand or supply shock will influence prices at both the farm and retail stages of the markets. Demand elasticities are necessary to implement the EDM model but they will also be necessary to clarify linkages between retail and farm market level. Price transmission elasticities will be estimated and used in the model. The results from the EDM framework will assist market participants in developing a better understanding of berry market behavior.

Accomplishing the two objectives presented above will provide a clearer idea of markets for berries in the Unites States. In addition, the thesis will fill the gap in the present lack of up-to-date demand elasticities for berry crops at the retail level. Moreover, the study will provide more facts and knowledge about the developing markets for fresh berries, which should be useful to both farmers and consumers.

1.4 Thesis outline

The study consists of six chapters. Chapter 2 provides a literature review for demand models. Definition and characteristics of the demand models used in the thesis are also provided along with a general overview of price transmission elasticities and EDM. Chapter 3 contains data and illustrations showing important features of markets for berries. Sources of data for the research are discussed. Also, a list of the 52 U.S. markets analyzed in the study is presented. The following chapter will discuss the methodology. Empirical models are estimated and described. In chapter 5, results from empirical models are analyzed. The last chapter, chapter 6, will summarize findings of the study and discuss an application with some recommendations and suggestions for further studies.

Chapter 2: Literature review

2.1 Previous studies of demand for fresh fruits

Demand analysis has improved over the past years. Economists have estimated demand for other commodities, especially meat (Gardner, 1975; Kinnucan et al., 1996; Wohlgenant, 1989). However, few studies have examined perishable fruit, and none have specifically examined markets for berries.

George and King, 1971, and Brandow, 1961, were the first pioneers to estimate demand elasticities for fresh fruits. George and King, 1971, created a large sample of 49 agriculture commodities however their analysis included only three fresh fruits. These early studies created a framework for demand elasticities and many researchers have developed studies based on these early works.

You et al., 1996, estimated demand for 11fresh fruits, including strawberries and 10 fresh vegetables in the United States at the retail level with annual data (1960-1993). Price and expenditure elasticities were computed using a composite demand model system with time series data. The study was done in two steps. First, cumulative demand system consisting of 11 food groups and including a non-food sector was computed. Second, demand system was estimated for individual fresh fruits and vegetables. The output found significant response to changes in their own price but insignificantly to changes in total expenditure. The demand for most of fresh fruits was found to rise when per capita total expenditure increased. The demand for perishable fruit as a group has had an increasing trend since 1973 but not for fruit as an individual. The research compares responsiveness between fresh fruits and all other commodities. In conclusion, You et al., 1996, state that if the fresh produce industry wants to increase its market share, then it needs to reduce retail prices.

Price and Mittelhammer, 1979, estimated price and income demand elasticities at the farm level for 14 fresh fruits. The research used time series data (1943-1973). The results demonstrated demands for apples, oranges and grapefruits were all inelastic. These fruits were available all year long and have minimal competition during the winter time. In contrast, seasonal fruits had elastic results. In addition, all the cross price elasticities showed that fruits were substitutes in demand. By volume, minor fruits had higher elasticities than major fruits.

Henneberry et al., 1999, used the LA/AIDS model to measure the impacts of prices, expenditures and consumer food safety concerns on the consumption of 14 major fresh produce categories with annual data from 1970 until 1992. Marshallian and Hicksian demand elasticities were calculated. In addition, the study conducted tests for separability and the results demonstrate the fresh fruit could be used as an individual group. Furthermore, switching by consumers to the other fresh products due to safety concerns was estimated. The elasticities demonstrated that consumption in some fresh products have more impact from their own price and expenditure elasticities than from the cross elasticities. The risk information variable in their study is negative information from newspapers, TV and radio broadcasts, journals and magazines. The negative information consists of health hazard for the chemical remains in and on the fresh fruit. The affect of risk information on consumption was very small and statistically insignificant for the majority of products. The average loss for fresh vegetables is 0.07% in the consumption and for fresh fruits is 0.05% in the consumption. The results conclude that price and quantity are the main drivers for the consumer instead of changes in risk information.

The latest study (Tshikala and Fonsah, 2012) analyzed demand for imported fresh and frozen melons using quarterly data from 1989 to 2010. The study used static and dynamic LA/AIDS models to estimate Marshallian and Hicksian elasticities. The research is similar to my study due to the seasonality of melons. The elasticities demonstrated that consumers were more price sensitive in the long run. Moreover, expenditure elasticities were elastic. Almost all the commodities were substitutes except fresh and frozen melons.

The Table 2.1 provides some of the historical demand elasticities of fresh fruits. Only, strawberries are matching with the commodities being examined in this thesis, however I am assuming some similarities among other perishable fruits. other perishable fruits.

Table 2.1 : Select demand elasticities for fresh fruits

Author	Date	Commodity	Elasticity	Output
Price and Mittelhammer	1979	*Strawberry*	own price	-1.957
			income	0.441
You et. al.	1996	Apple	cross price	0.445
		Banana	cross price	-0.502
		Cherry	cross price	-0.067
		Grape	cross price	0.025
		Peach	cross price	0.140
		Strawberry	own price	-0.275
			expenditure	-0.474
Henneberry et. al.	1999	Apple	cross price	-0.229
		Banana	cross price	-0.456
		Grape	cross price	0.289
		Melon	cross price	0.106
		Peach	cross price	0.161
		Strawberry	own price	0.438
			expenditure	-0.449
Tshikala and Fonsah	2012	Fresh cantaloupe	own price	-0.770
		Fresh watermelon	own price	-0.125

Source: USDA/ERS (2011), Tshikala and Fonsah (2012)

2.1.1 The supply side of the berry market

Supply elasticities measure the responsiveness of the farm market to adjust production to changing economic conditions and they estimate the impact of government programs, exchange rate, commodity, trade policy, etc. This is very important for public decision makers. Supply elasticities measure the supply response to changes in product price. Estimation of agricultural supply elasticities is a complex process because there are many exogenous variables, such as weather, innovation, and technology, which are hard to control and analyze (Ball et al., 2003).

Onyango and Bhuyan, 2001, conducted a study of supply responses to changes in prices of fruit and vegetables in New Jersey. The methodology used in the study was a Nerlovian supply model using data from 1980-1997. Fruit: apples, blueberries, peaches, strawberries, cranberries, and vegetables: asparagus, cabbage, cucumber, eggplant, escarole, head lettuce, bell peppers, snap beans, spinach, sweet corn and tomatoes, were analyzed. The objective of the study was to provide information for decision making by producers and other actors in the production chain and, to provide basic data about the fruit and vegetable sector. Results demonstrated that some fruits and vegetables were mostly price inelastic. In particular, blueberry output from the empirical estimation showed inelastic responses. Other fruits were substitutes for blueberries. Blueberry production did not change as much as its priced changed, probably due to the fact of more responsiveness to the weather conditions than other fruits. In the strawberry case, supply elasticities were inelastic in the short run but elastic in long run. They positively respond to the price changes and the other fruits did not have an impact in their production. In general, producers have inability to respond to the prices due to existing vertical relationships. Generally, fruit and vegetable producers exploit most of the available information, such as supply-demand market situations, and changes in government policies in forming expectations about future prices.

Yang, 2010, investigated boom and bust cycles of blueberries in British Columbia, Canada. The methodology of the study has three parts. One was to create a financial analysis to investigate productivity of blueberry investment in the province. A second was to estimate supply price elasticities for blueberry using a Nerlovian model. The third was to simulate boom-and-bust cycles using the cobweb model derived from supply elasticities. Supply elasticities were computed by using a double log specification. Data used in the study were annual data on blueberry prices (real terms) and the planted acreage for the period 1988-2009. The Nerlovian model used in the study was designed to capture a farmer's reaction to changes in price expectations. This model was considered the best at elaborating on the boom-and-bust cycle of blueberries. Some adjustments were done to better suit the model to the British Columbia blueberry market. For the Nerlove model, it was necessary to gather price, quantity and acreage data. Planted acreage increased rapidly after 2003. Consequently, to capture this trend, dummy variables were included in the supply model. The results demonstrated that in the short run, supply elasticities were inelastic. In contrast, the long run showed elastic supply. The output confirmed that farmers are price takers and thus constructive economic incentives will inspire them to invest more, plant more acreage or farm more intensively.

2.1.2 Price transmission and EDM studies

To analyze relationships among different vertical levels of the marketing system it is necessary to compute price transmission elasticities. There are a few studies which developed a framework for estimation price transmission and EDM framework

First, George and King, 1971, developed a matrix which measured income-consumption relationship, demand interrelationship at the retail level, and the nature of price spreads between retail and farm levels. The study used time series and cross-sectional data from the period 1955-1965 from the USDA household food consumption surveys. The relationship was created for 49 commodities at the retail level. The individual fruits were clustered into the 15 groups and all elasticities (own and cross) within a group were computed directly. They investigated farm-retail price spread, estimated price transmission elasticities for 32 commodities. Farm level elasticities are the product of elasticities at the retail level and elasticities of price transmissions. The majority of the elasticities at the farm level were less elastic than the elasticities at the retail level, and then elasticities for price transmissions were, in most cases, less than one. The output demonstrated price transmission elasticities were lower than one for 24 of the commodities. The major result introduced that higher income groups tended to buy better quality food, if the quality is captured in price. Throughout the ten years (1955-1965) income elasticities did not significantly change. Results also demonstrated regional variations in income elasticities.

Second, Gardner, 1975, investigated effects of shifting demand and supply curves according on market equilibrium theory of price mark up. He developed equations representing each side of the market and the elasticities demonstrate influence at the different levels. Factors that raise the demand for food will decrease the retail-farm price ratio and marketing margin if activities for marketing are more elastic in supply than farm items and vice versa. Farm level demand is always less elastic than retail level demand in his study.

Third, Wohlgenant, 1989, created a conceptual and empirical framework on retail to farm demand linkages. The focus is on fluctuations in retail demand, farm product supplies, and cost of food marketing on prices at retail and farm level. The framework is developed for eight food commodities, including fresh fruit and processed fruits as separate groups. The framework was built with time series data using a double log-ordinary least squares model. The majority of cross-price elasticities were negative, which means there are substitutions among farm products. In contrast, all income elasticities are positive. Furthermore, except for one commodity, fresh fruits, the outputs are consistent with an aggregate technology for food processing.

Chapter 3: Data source

3.1 Data sources

The time period covered by this study is from 1st March 2008 through 19th February 2011. Retail level data used in the research were purchased from Nielsen Company. The data provided information on volume of berries being sold through the supermarket format as well as corresponding prices for four berry crops. The data are weekly and are reported for 52 U.S. markets (see Table 3.1). Volumes are reported in pounds per market per week. Prices were reported by retail package size and vendor and so were converted to dollars per pound using the weight of the retail package being sold.

Table 3.1 List of 52 berry markets in the U. S.

Albany	Des Moines	Miami	Raleigh Durham
Atlanta	Detroit	Milwaukee	Richmond Norfolk
Baltimore	Grand Rapids	Minneapolis	Sacramento
Birmingham	Hartford New Haven	Nashville	Salt Lake City Boise
Boston	Houston	New Orleans Mobile	San Antonio
Buffalo Rochester	Indianapolis	New York	San Diego
Charlotte	Jacksonville	Oklahoma City Tulsa	San Francisco
Chicago	Kansas City	Omaha	Seattle
Cincinnati	Las Vegas	Orlando	St. Louis
Cleveland	Little Rock	Philadelphia	Syracuse
Columbus	Los Angeles	Phoenix	Tampa
Dallas	Louisville	Pittsburgh	Washington D.C.
Denver	Memphis	Portland	West Texas

Shipping point price data were obtained from the USDA Agriculture Marketing Service (AMS) Historical Market News Data. These are used as indicators of farm-level prices although they reflect prices at border crossings in the case of imported berries. These prices are reported in dollars per flat. Flats are quoted for different sizes of packaging and there is no corresponding volume information at the different shipping point markets by flats with given package sizes. Consequently, I choose the most frequent package size for each berry crop as an indicator of shipping point prices. The most common package size for blackberries, blueberries and raspberries is flats of 12 6-oz cups with lids. The most common package size for strawberries is flats of 8 1-lb containers with lids. The data contain weekly high and low prices. The price used in my analysis is the simple average of high and low prices. There are different shipping points for individual berries. In general main shipping points for strawberries are in California, for instance, Santa Maria and Salinas/Watsonville. For blueberries the major shipping points are in Oregon, Michigan and Washington. California is the main domestic source reporting blackberry shipping point prices. Imported berries are quoted for South Florida and Mexican borders. Important shipping point prices for raspberries are from Oxnard district and Salinas/Watsonville in California.

Volume movement data were received from USDA-AMS. These data contain the origin of the berries and their volumes in 10,000 pound increments. Major shipping points varied among products. Strawberry and raspberry volumes are coming to the market through central California (Salinas-Watsonville and Santa Maria) following by Southern California (Oxnard and San Diego). Blackberries are penetrating the domestic market through Mexico boarders with Texas. Blueberries are all over the U.S. (New Jersey, New York City, Miami Florida, and Canada boarders with Washington State).

3.1.1 Trend of berries in the market

Strawberry volume and expenditures are large compared to blueberries, blackberries or raspberries (Figures 3.1 and 3.2). They are the most consumed berry by volume followed by blueberries. Blueberries have become more popular given publicity of positive health benefits. This is due to very strong promotion of the fruit which has largely resulted in increasing volume every year since 2006 (Yang, 2010). Blackberries and raspberries have substantially lower volume levels, however, their demand is increasing too (Figure 3.1). Figure 3.2 illustrates how much money the U.S. population spent for berries during 2006-2010. All of the expenditure and prices are in nominal dollars. Strawberries are leading with the highest expenditure followed by blueberries, raspberries and blackberries. U.S. citizens spent more money for berries (in total and by each berry type) in 2010 than they did in 2006.

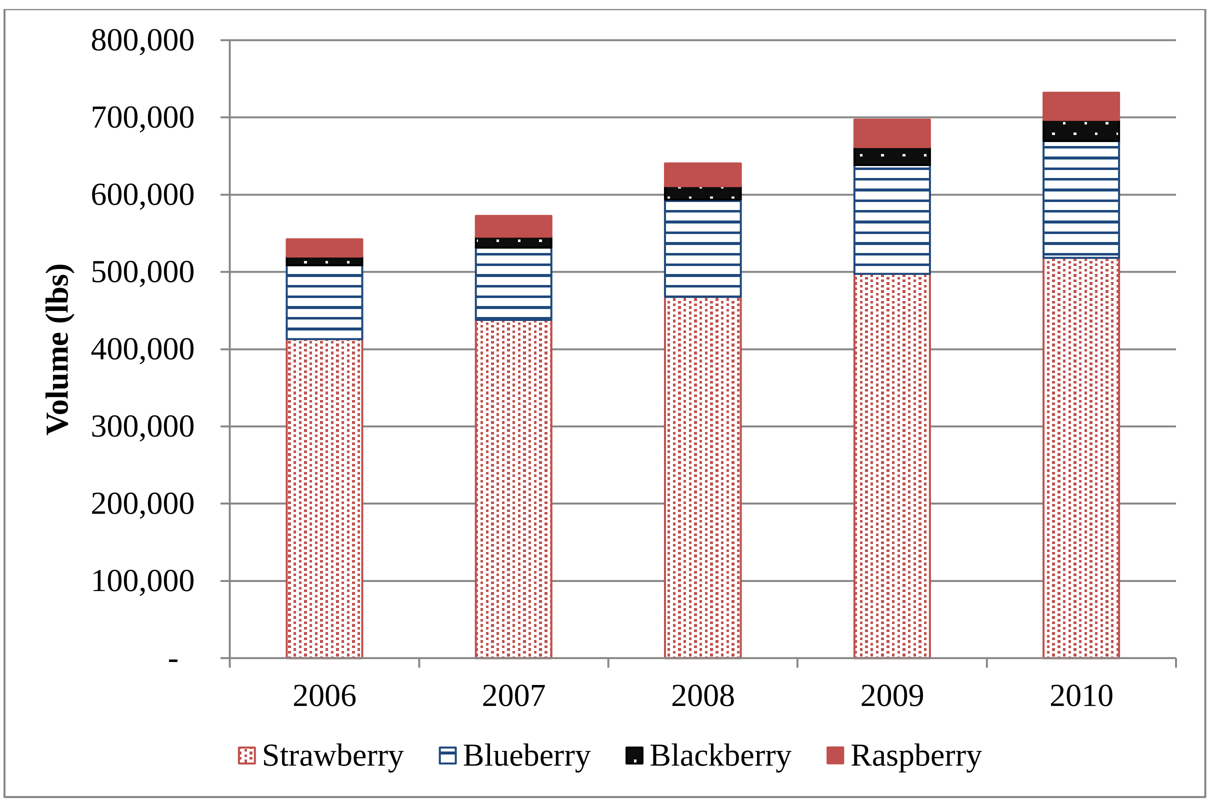

Figure 3.1 Total volume of berries in the U.S., 2006-2010

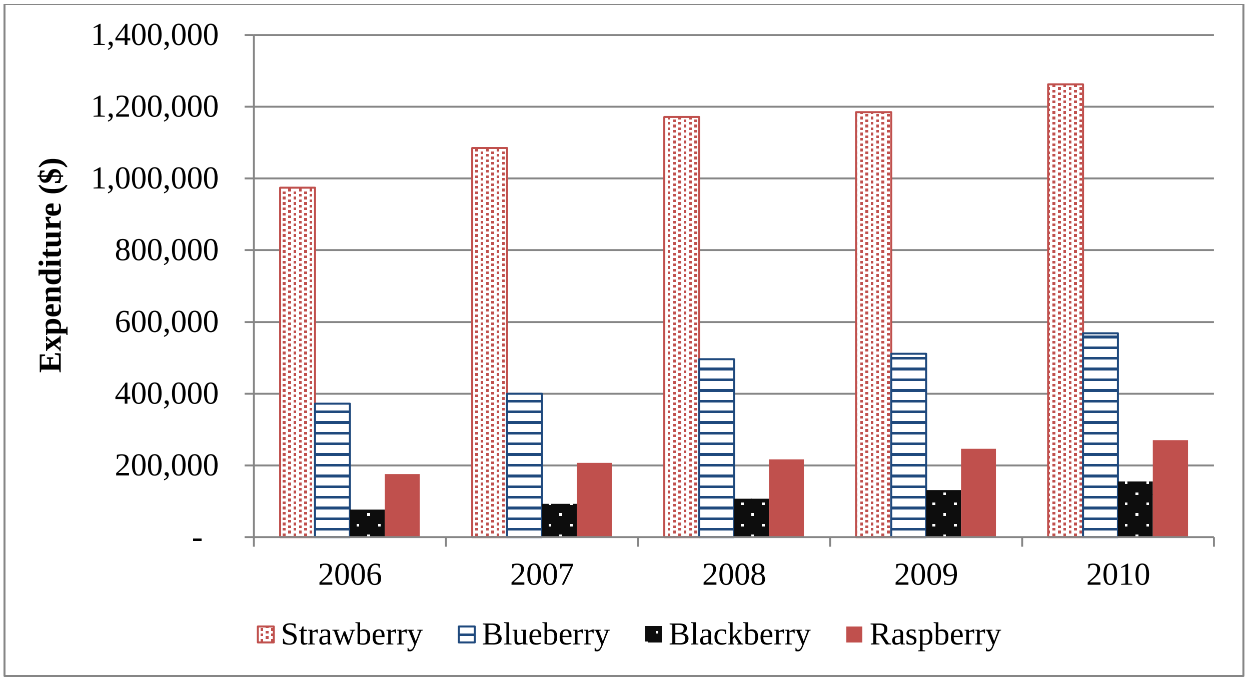

Figure 3.2 Total expenditure of berries in the U.S., 2006-2010

An examination of weekly volumes of berries in the U.S. during 2008-2011 demonstrates their trends and seasonal patterns in recent years (Figure 3.3). Strawberries and blueberries have high volume comparing to blackberries and raspberries. Therefore, it was necessary to separate these fruits into two different graphs for better illustration (See Figures 3.4 and 3.5). Strawberries have been consumed more often in late winter and earlier summer compared to the other berries. Blueberries trend start in the beginning of summer and last until the end of summer/ beginning of fall (Figure 3.4). Figure 3.5 describes the weekly volume of blackberries and raspberries. We can observe that blackberry consumption in 2008 was weak but increased in 2009. Their season is a bit earlier than raspberries and starts at the beginning of spring and lasts until the beginning of summer. The trend of consuming raspberries is at the beginning of summer and last until mid of fall.

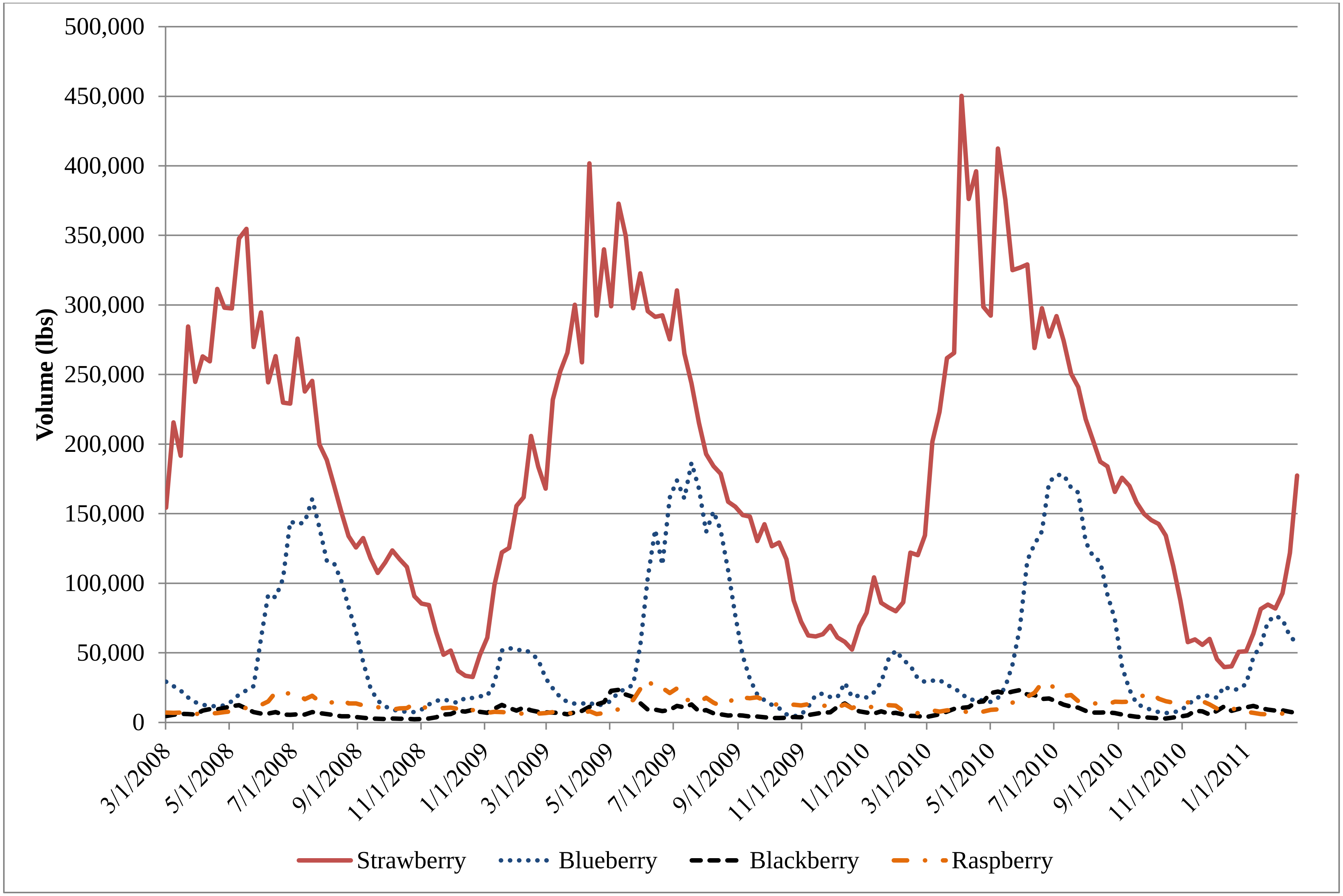

Figure 3.3 Weekly volumes of berries in the U.S., 2008-2011

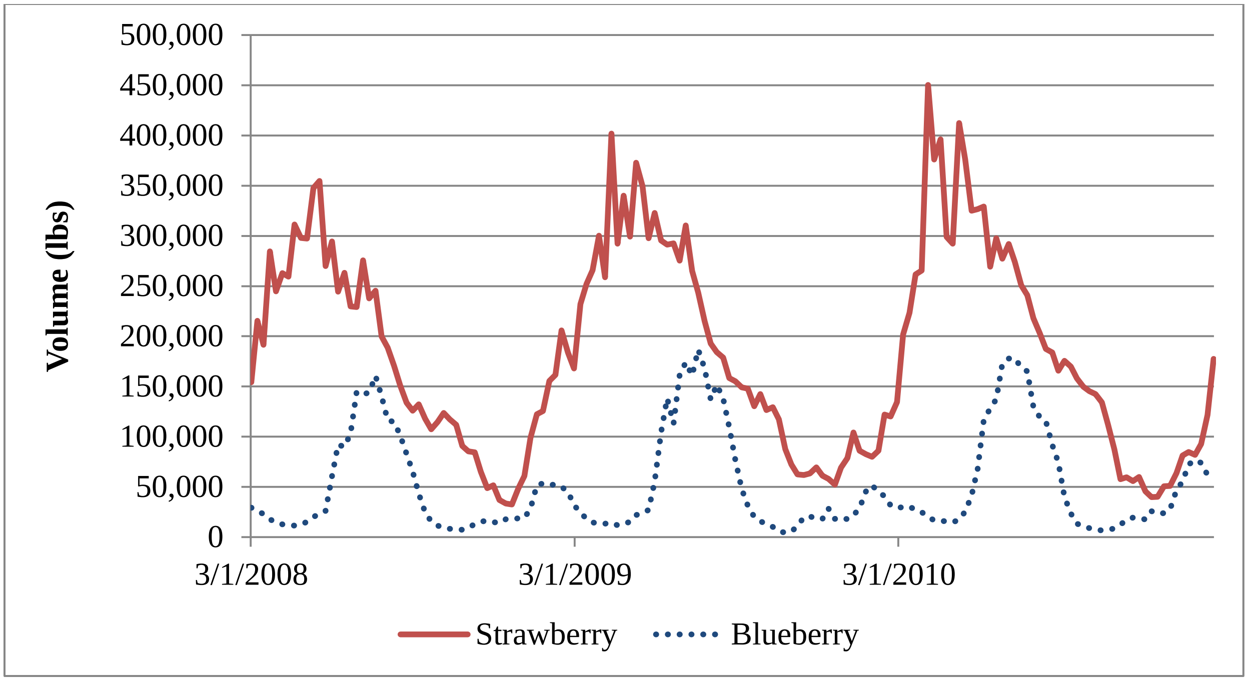

Figure 3.4 Weekly volume of strawberries and blueberries in the U.S., 2008-2011

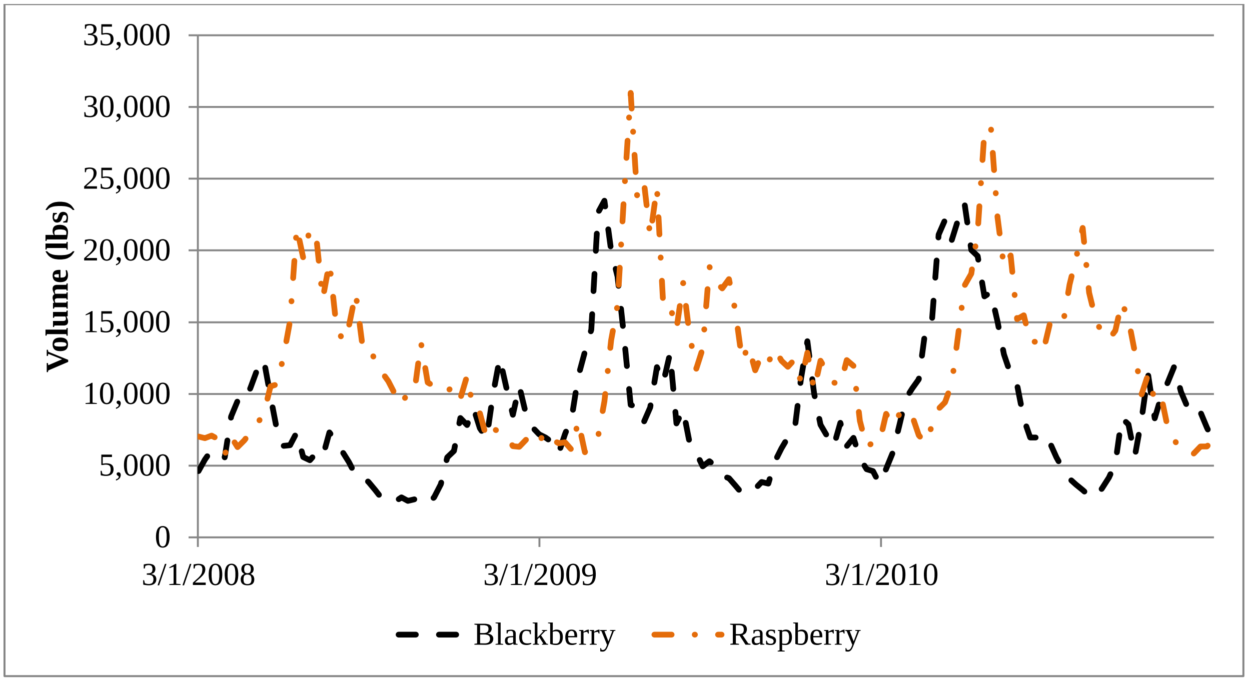

Figure 3.5 Weekly volumes of blackberries and raspberries in the U. S., 2008-2011

The next four figures, 3.6, 3.7, 3.8, and 3.9 captured volume and price of individual types of berries. The price of the strawberries is the lowest among the berry crops where the average weekly price is 3 dollars per pound with the highest volume level of about 450 thousand pounds.

The price is the highest when the volume of strawberries is the lowest and vice versa (Figure 3.6). Moreover, the gap between the highest volume and price is small compared to the gap between the lowest volume and highest price. Volume and price appear as mirror images. The average weekly price of blueberries is quite high at 6 dollars per pound; however, the price fluctuates a lot and could drop to between 2 to 3 dollars per pound from a high of 11 or more dollars per pound (Figure 3.7). The highest volume is about 186 thousand pounds. The gap between the highest volume and the lowest price is much larger than that shown in the example of strawberries. Blackberries are relatively new to the market. Volume is continuously increasing but the price remains quite high. The average weekly price is 6.78 dollars per pound (Figure 3.8). The highest volume is about 22 thousand pounds, which compared to other types of berries is the lowest. Raspberries average price is 8.33 dollars per pound and, compared to the other berries, they are the most expensive berry (Figure 3.8). Nevertheless, their volume is a bit higher (30 thousand pounds) than blackberries which could be because raspberries are a little bit more established in the market.

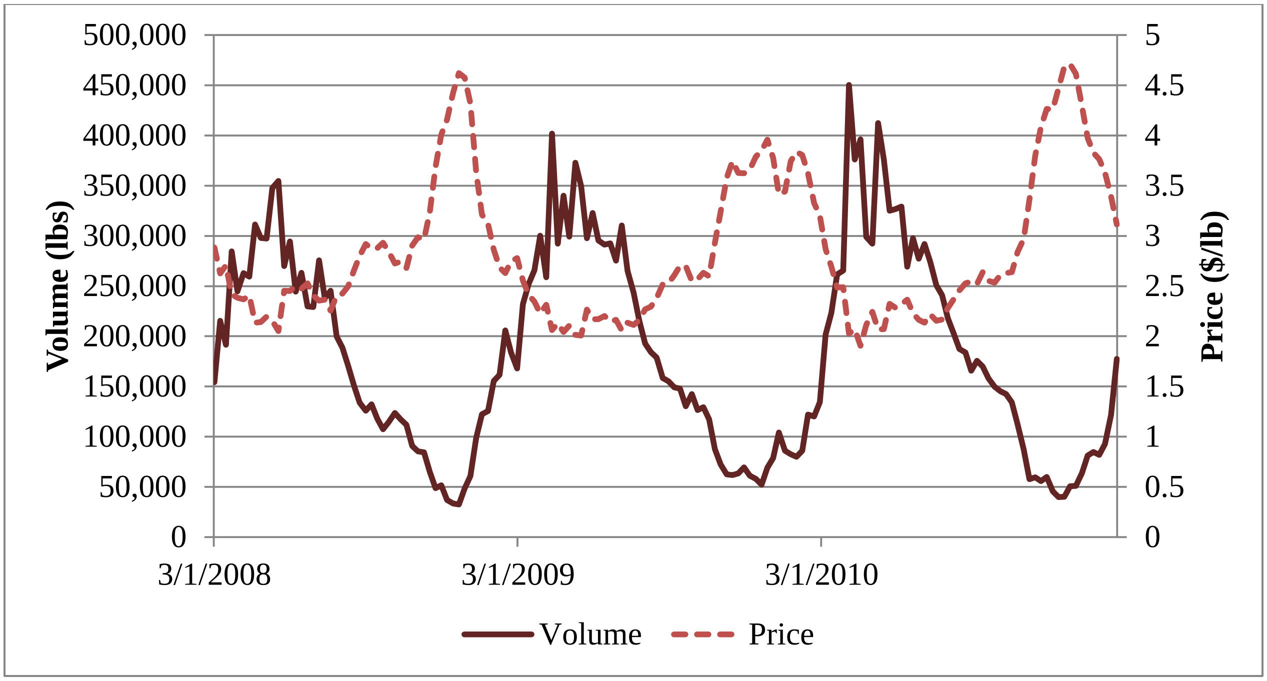

Figure 3.6 Weekly volume and price of strawberries in the U. S., 2008-2011

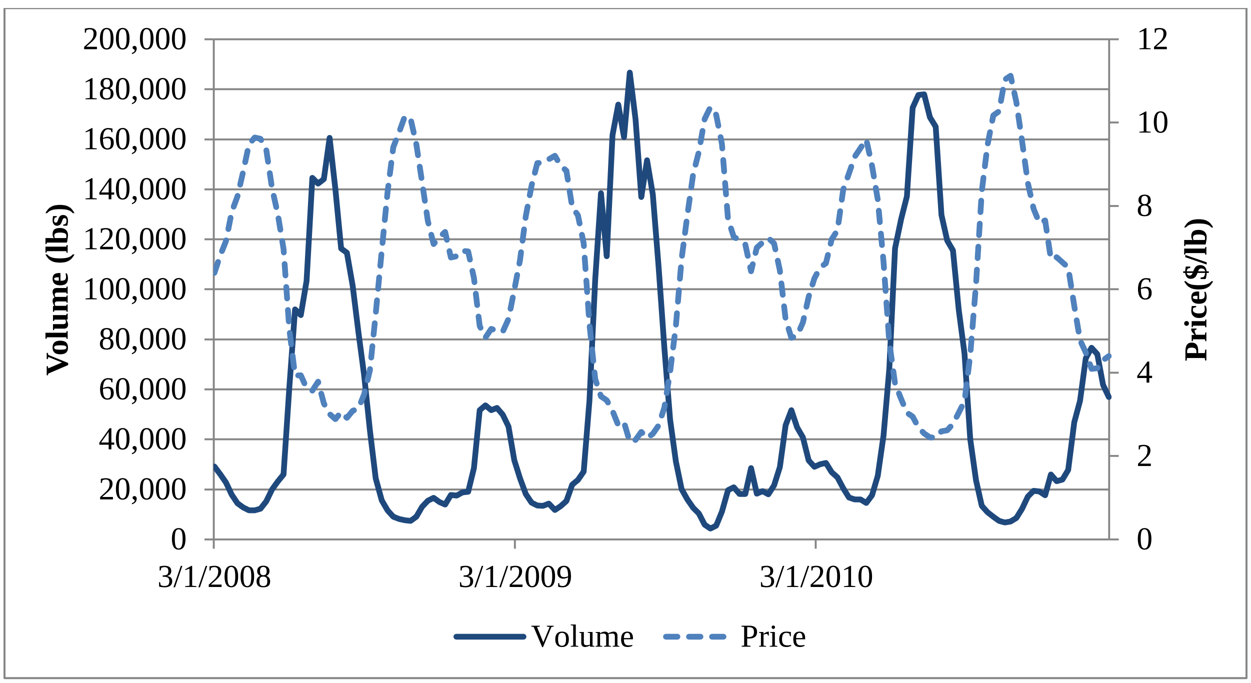

Figure 3.7 Weekly volume and price of blueberries in U.S., 2008-2011

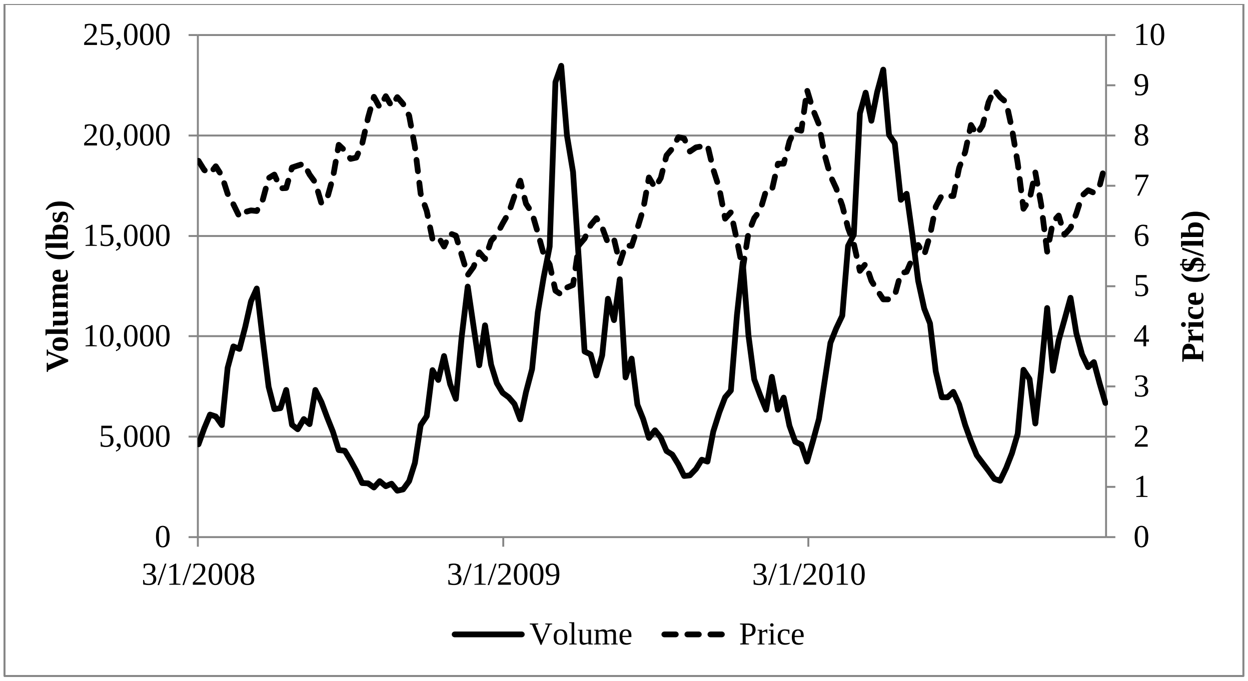

Figure 3.8 Weekly volume and price of blackberries in the U. S., 2008-2011

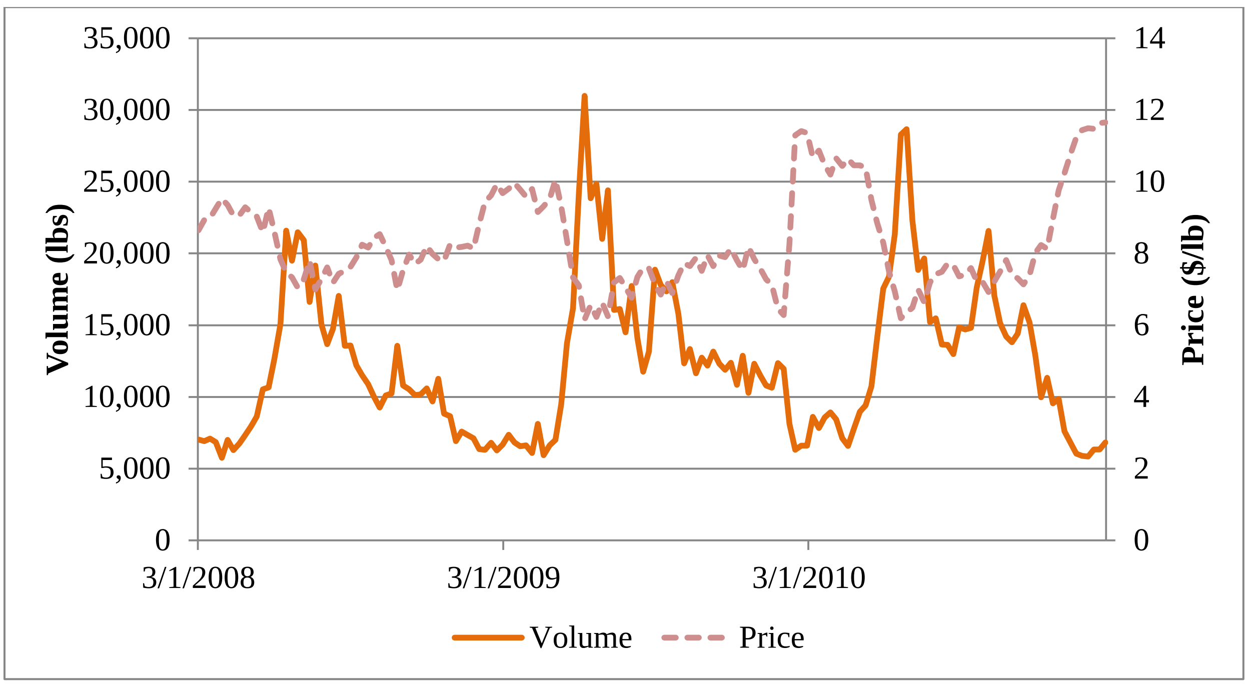

Figure 3.9 Weekly volume and price of raspberries in the U. S., 2008-2011

To better understand retail prices over space, I choose three cities representing different sizes and location. As presented in Figures 3.10; 3.11; 3.12; 3.13 I compared weekly prices of individual berries. Price of strawberries (Figure 3.10) varies across individual cities. People in

New York paid more for strawberries than people in Little Rock. This gap was quite large in 2008-2009. Later, in 2010, people from San Francisco paid a little bit more than people from New York. In 2011 the prices in Little Rock raise to almost the same level as in other two cities, although Little Rock still had the cheapest strawberries. Prices in all three cities are highly correlated which means if the price in one city will increase the price in the other cities also increase (Table 3.2). The highest relationship is between Little Rock and New York. Figure 3.11 describes price of blueberries in Little Rock, New York and San Francisco during 2008-2011. In 2008, 2009, and 2010 people from San Francisco paid the highest price for blueberries. People from Little Rock paid the lowest price, however the price rapidly increased at the end of 2010. The price of blueberries fluctuated the most compared to the other berries in my study. Prices of blueberries are positively correlated across cities but are less strongly correlated than strawberry prices. The strongest correlation is between San Francisco and New York. Blackberries prices are illustrated in Figure 3.12. The most expensive blackberries are in San Francisco. The differences in how much people in individual cities paid is not as significant as it was for strawberries and blueberries. The correlation of Little Rock prices with New York and San Francisco prices is very low and there is almost no correlation at all. Raspberries prices are high in New York and San Francisco. They are positively but weakly correlated. People from Little Rock paid the lowest price for raspberries.

Table 3.2 Price correlation table across three cities by type of berry

	Little Rock and New York	**Little Rock and San Francisco**	**New York and San Francisco**
Strawberry	0.8737	0.8322	0.8461
Blueberry	0.7546	0.7285	0.8518
Blackberry	0.2755	0.2366	0.6197
Raspberry	0.3359	0.4794	0.6441

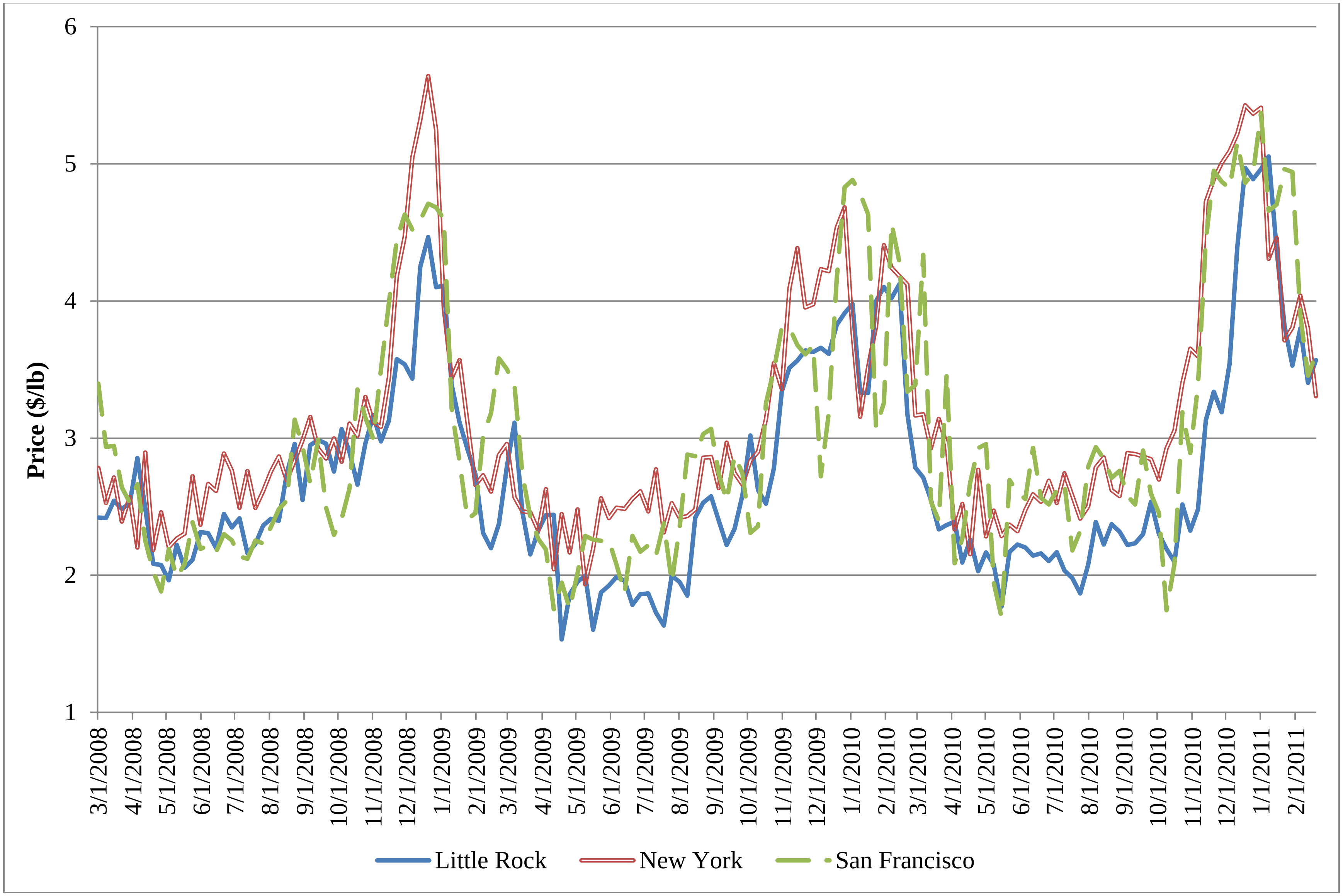

Figure 3.10 Price of strawberries in LR, NY, and SF, 2008-2011

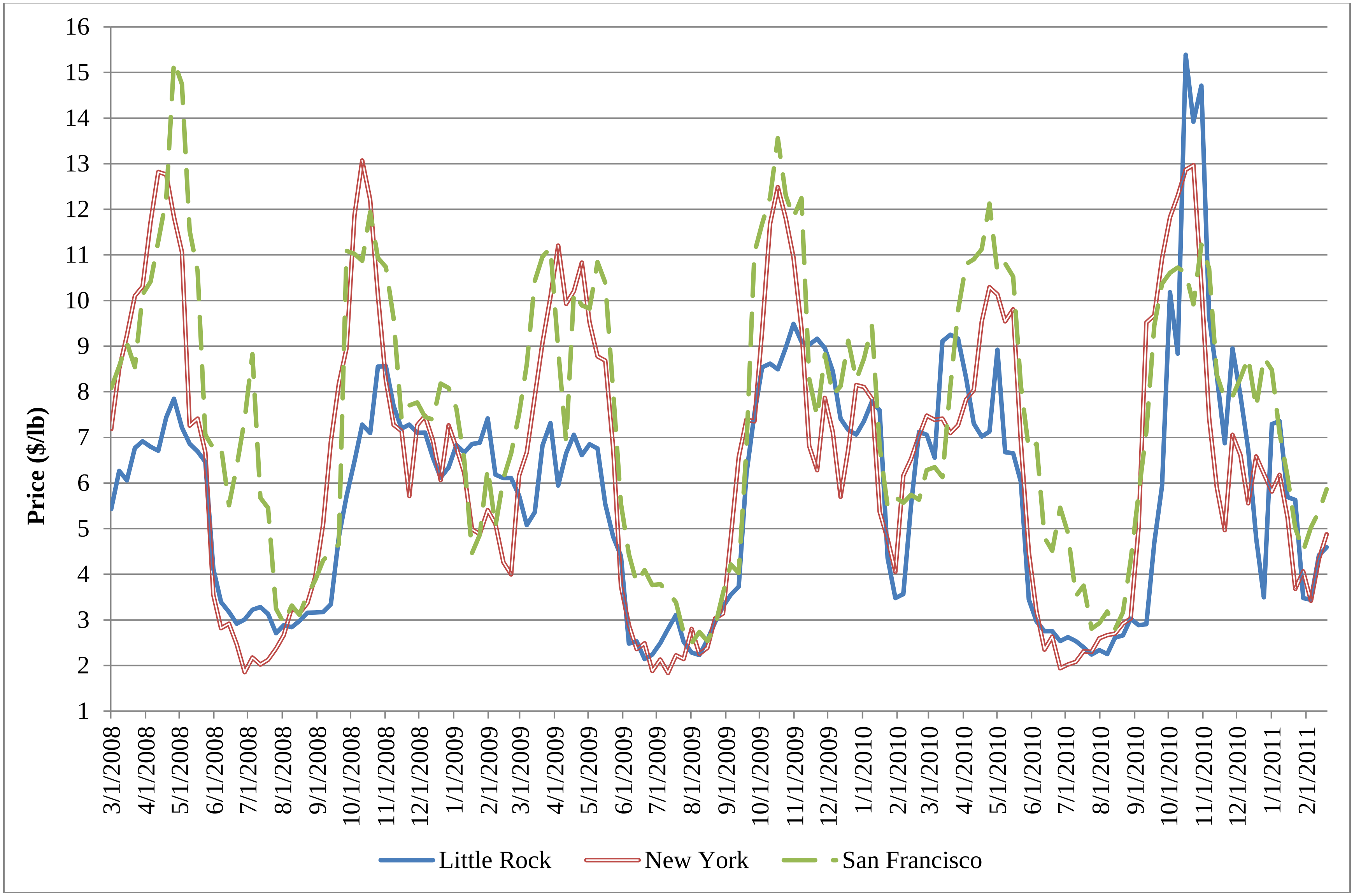

Figure 3.11 Price of blueberries in LR, NY, and SF, 2008-2011

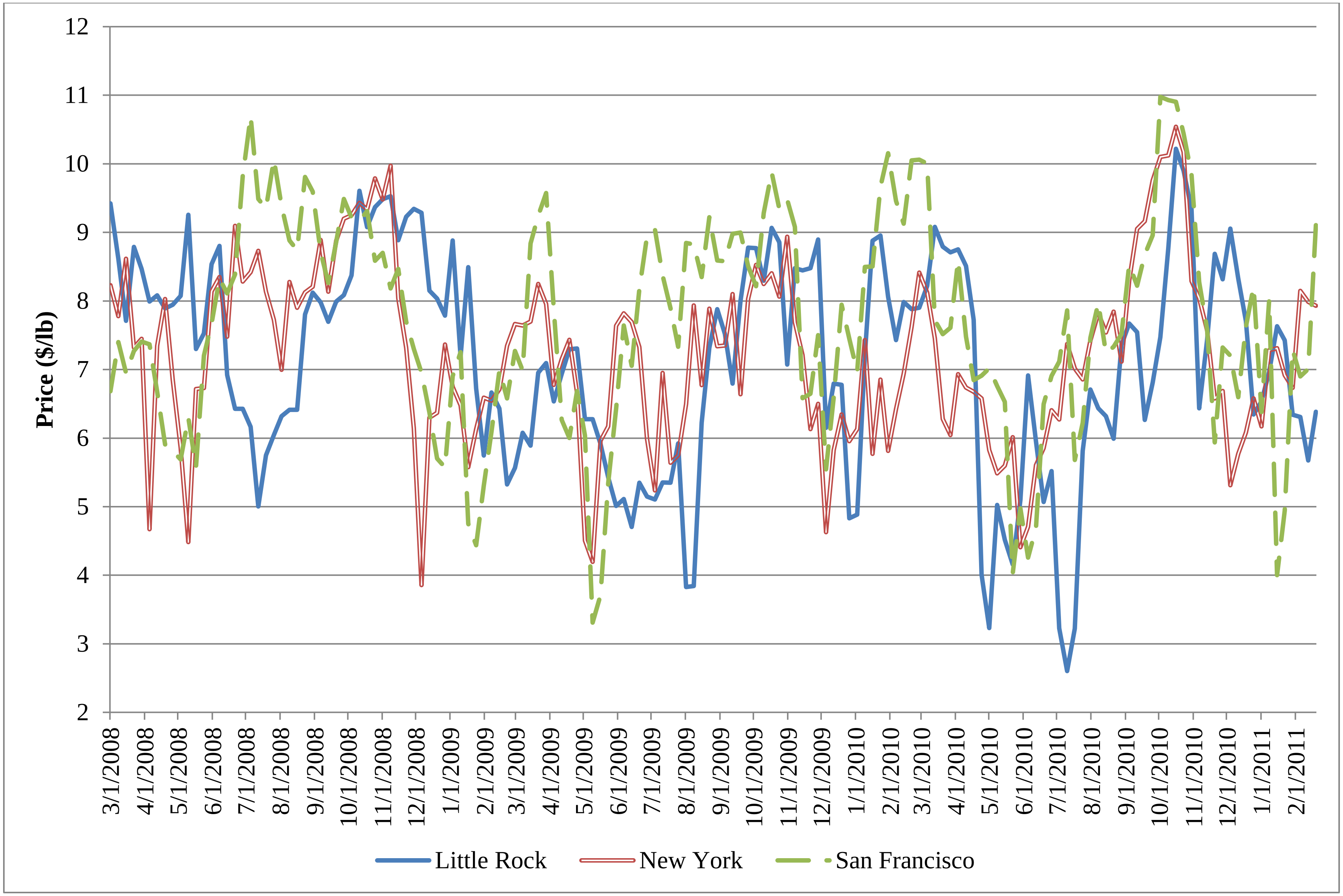

Figure 3.12 Price of blackberries in LR, NY, and SF, 2008-2011

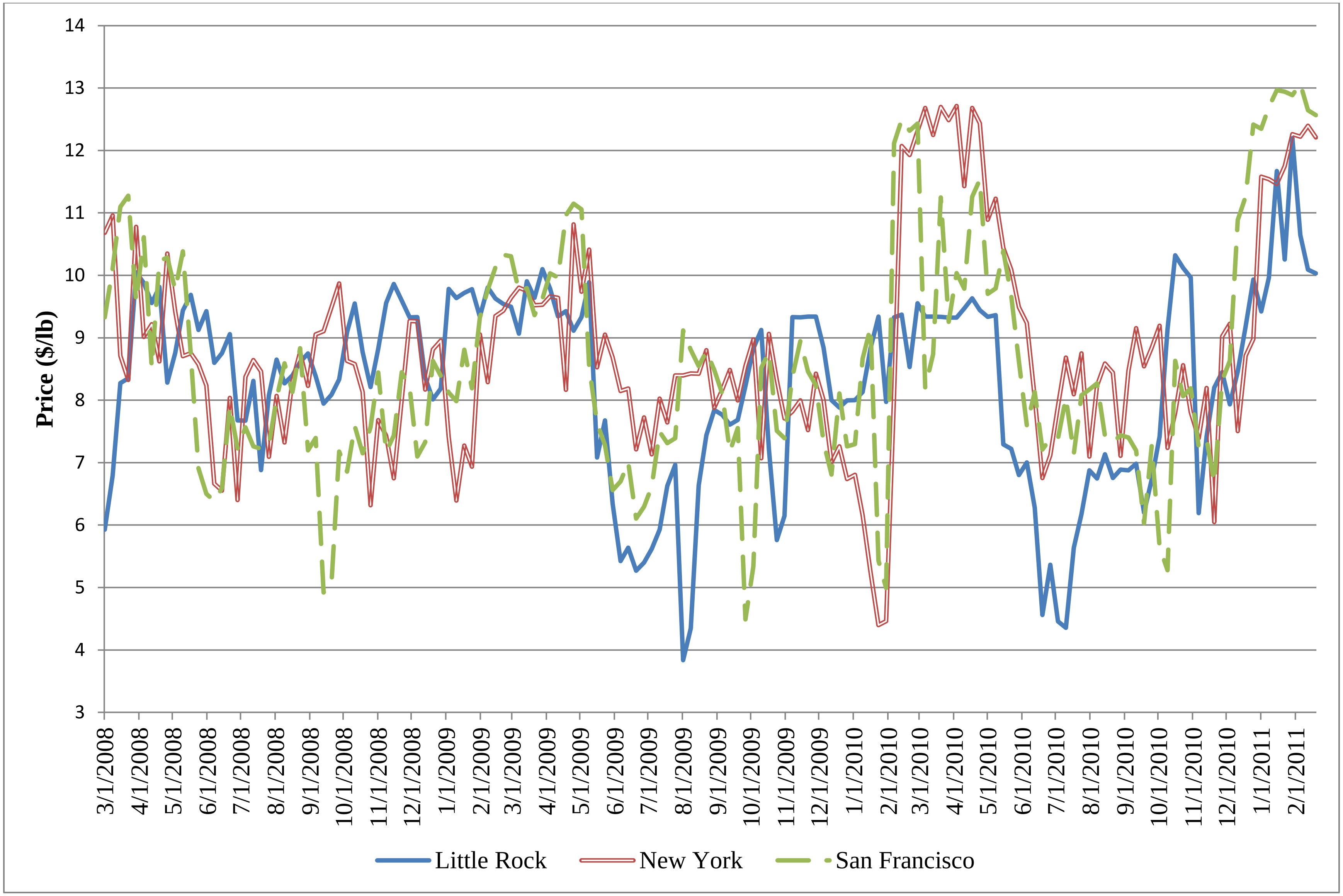

Figure 3.13 Price of raspberries in LR, NY, and SF, 2008-2011

3.1.2 Seasonality of the fresh berries

In recent years, strawberries, blueberries, blackberries and raspberries could be found in the market all year around. However, fresh berries are highly seasonal fruits and their price and quantity fluctuate through the season. The following four graphs illustrate total volume and average price for three years during 2008-2011 (Figures 3.14; 3.15; 3.16; 3.17). The peak season for strawberries in the U.S. is from April to July when consumption is on the highest point and prices are at their lowest points (Figure 3.14). They have the longest running season compared to blueberries, blackberries and raspberries. Blueberries (Figure 3.15) are at seasonal high prices when consumption is at seasonal lows and vice versa. Blueberry prices fluctuated the most over the season. The blueberry season starts around July and lasts to late August and beginning of September. At the end of the year (November, December) there is almost not supply of blueberries. The next Figure 3.16 demonstrates blackberry seasonality in a year. Its season starts in May and lasts till late summer. In this graph the mirror image pattern is less pronounced due to constantly higher price of blackberries. Even if the demand is high the prices are more or less at the same level. The same conclusion can be draws from Figure 3.17 where raspberry volume and price in a year is captured. Their prices are constantly high too and only at the peak season do prices show a seasonal decline. The raspberry season starts around June and runs till August.

Figure 3.14 Average volume and price of strawberries in the U. S. by week for 2008-2011

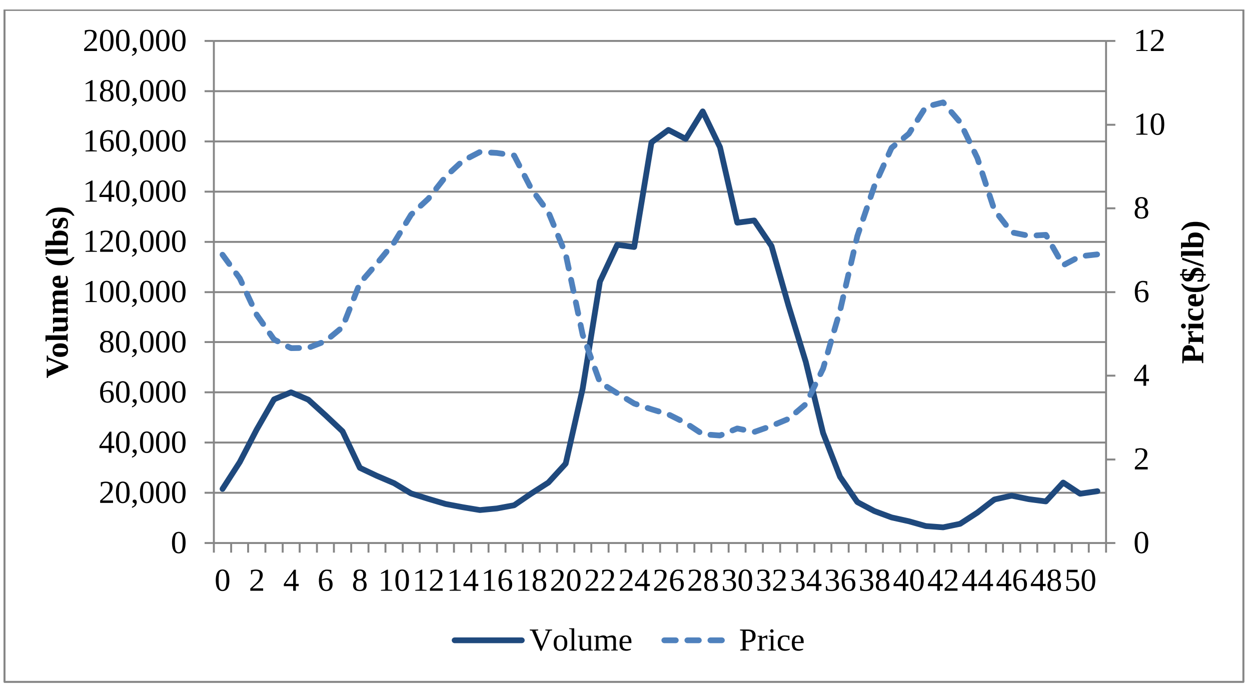

Figure 3.15 Average volume and price of blueberries in the U. S. by week for 2008-2011

Figure 3.16 average volume and price of blackberries in the U. S. by week for 2008-2011

Figure 3.17 Average volume and price of raspberries in the U. S. by week for 2008-2011

The other way to demonstrate seasonality could be expenditure of consumers for berry crops. I used the same three cities as before (Little Rock, New York and San Francisco). This time, population of the cities matters a lot. New York is the highest populated city followed by San Francisco and Little Rock. That is the reason that we compare only individual berries and not cities (Figures 3.18; 3.19; 3.20). The most popular berry in Little Rock is strawberries following by blueberries (Figure 3.18). Expenditure for blackberries and raspberries are very similar. People in Little Rock buy strawberries in May and blueberries are popular all summer which correspond to their season. Population in New York spends most of the money for strawberries and blueberries (Figure 3.19). Mostly they buy the berries in their season. San Francisco population spends money not only for strawberries and blueberries, but raspberries and blackberries have their place in consumption too. Blackberries are sold around April, which is quite early compared to their volume season. Blueberries are popular at the beginning of the year and during the summer. Strawberries start to be sold around March. Raspberries are mostly sold at the beginning of summer which correspond with their season and then later in fall.

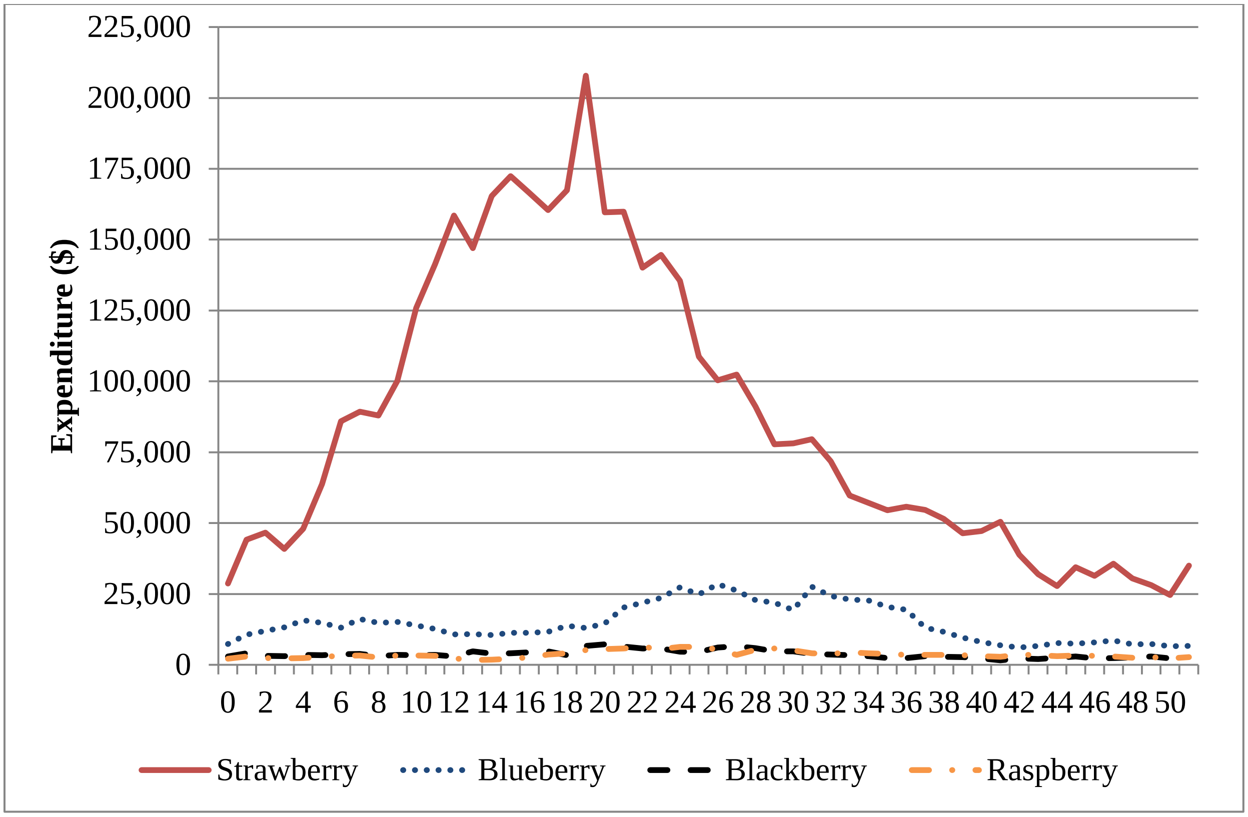

Figure 3.18 Average weekly expenditure of fresh berries in Little Rock, for 2008-2011

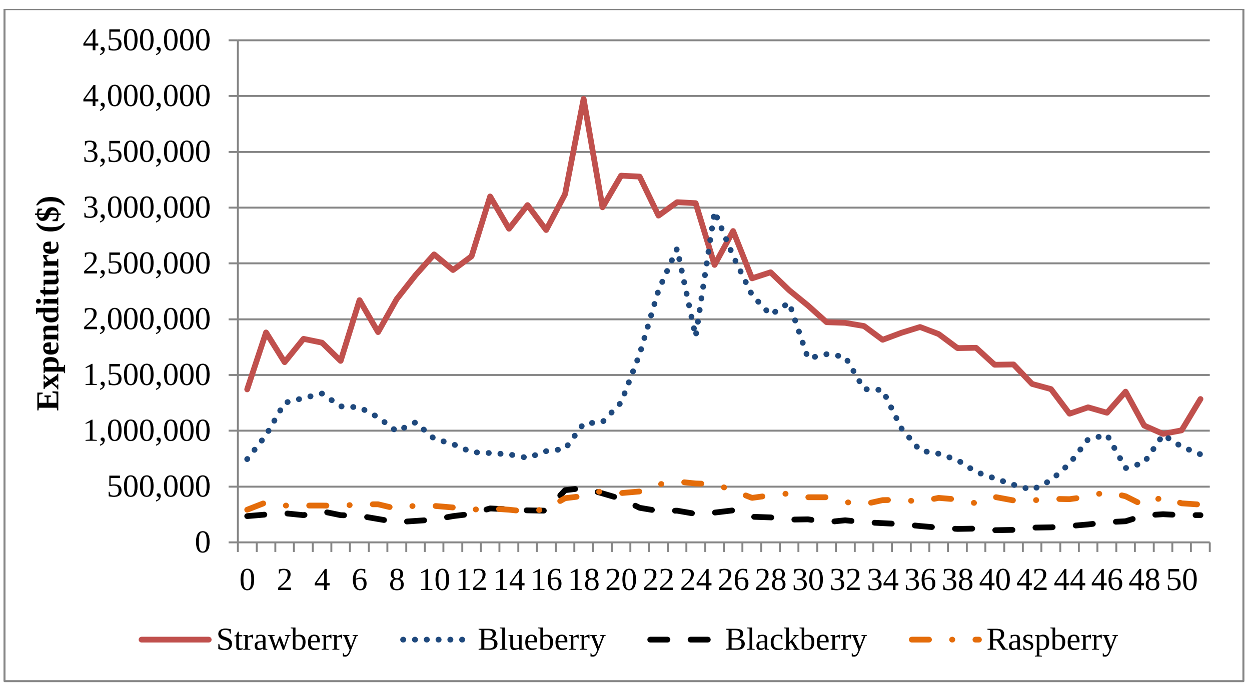

Figure 3.19 Average weekly expenditure of fresh berries in New York, for 2008-2011

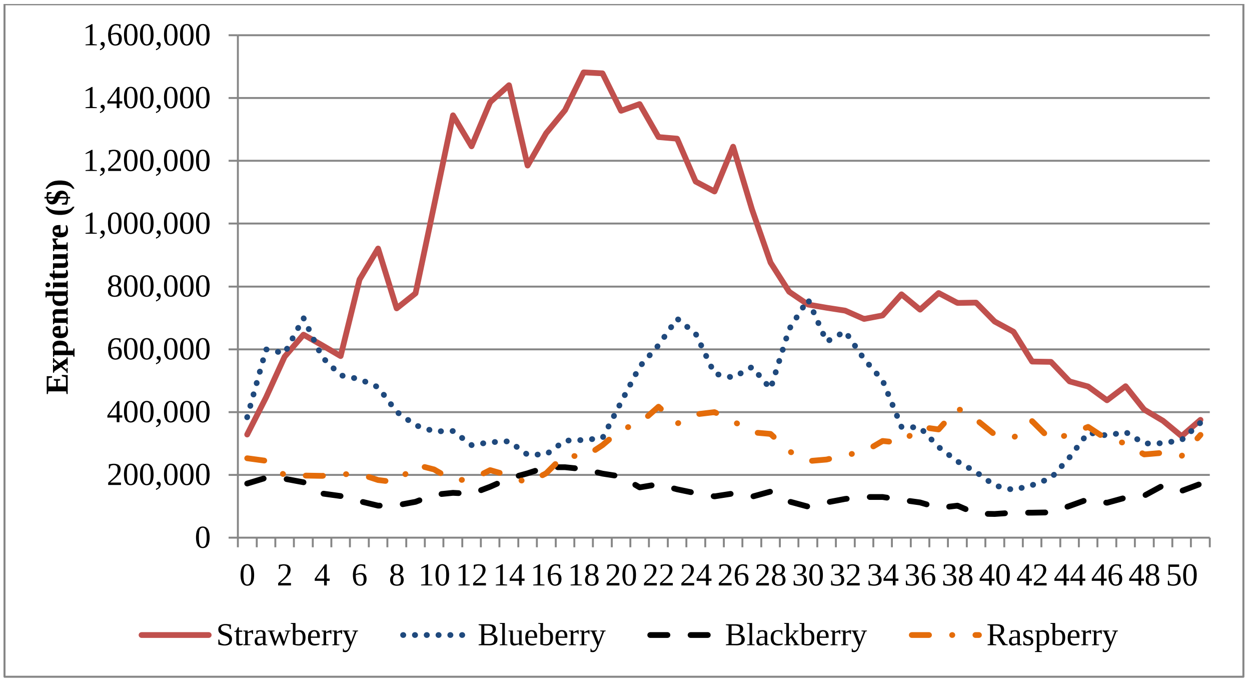

Figure 3.20 Average weekly expenditure of fresh berries in San Francisco, for 2008-2011

Chapter 4: Methodology

4.1 Considerations in modeling the U.S. berry markets

4.1.1 Choice of demand function

Two modeling approaches to demand estimation are used. The first is the double-logarithmic model. This is a popular single-equation model in studies of demand for commodities. The double-log model is easy to estimate and the coefficients can be directly interpreted as elasticities. The price and expenditure elasticities are constant over all data points. However, the model does not satisfy the general constraints from consumer theory (Alston et al., 2002; Paudel et al., 2010). Moreover, flexibility of demand elasticities as price and quantity vary is a strong assumption that may not be suitable for many research problems. In addition the double log model cannot guarantee that the parameters have the “right” signs (Hosken et al., 2002).

Mathematically, double log model can be illustrated as follow:

(3.1) $$\ln Q_i = \alpha_i + \sum_{j=1}^{n} \gamma_{ij} \ln P_j + \beta_i \ln X + \varepsilon_i$$

Where, α_i,β_i, γ_{ij} are the parameters (i, j= 1,…n), n is the number of products in the system, Q_i is the quantity of commodity i, X is the total expenditure on all of the commodities, P_j represents price of commodity j and ε_i is an error term for commodity i.

Equation 3.1 is estimated using panel data methods where the cross sectional unit is the geographic market (U.S. City) and the time series unit is the week of observation. These methods are advantageous because they help to control for omitted variables unique to the geographic market or time period. The study used both fixed and random effects specifications. Equations 3.2 and 3.3 provide the fixed and random effects specifications, respectively.

(3.2) $$\mathbf{Y_{it} = \beta_1 X_{it} + \alpha_i + u_{it}}$$

(3.3) $$\mathbf{Y_{it} = \beta_1 X_{it} + \alpha_i + u_{it} + \varepsilon_{it}}$$

Where, α_i, is the unknown intercept for each entity (i = 1,…n), n is the number of products in the system, Y_{it} is the dependent variable of entity i and time t, X_{it} represent an independent variable for entity i, β_1 is the coefficient for independent variable, u_{it} is an error term. The random model has an overall intercept and two error terms: $\varepsilon_{it} + u_{it}$. Where, ε_{it} is for the normal error term to each observation. The u_{it} is an error term which symbolizes the extent to which the intercept of the ith cross-sectional unit and time t differs from the overall intercept.

To choose fixed or random effect I used the Hausman test which measures the correlation between the error and the independent variables. The null hypothesis is that there is no correlation. If the null hypothesis is true then the random effects specification is preferred. Otherwise, the fixed effects specification is more appropriate (Kennedy, 1992).

The major difference between fixed and random effects specifications is the conclusion that can be drawn. A fixed-effects analysis allows one to draw conclusion about the actual subject pool you have measured. By contrast, a random-effects analysis allows you to draw conclusion about the population from which you drew the sample, if the sample size is large enough to allow conclusions to be drawn (Verbeek, 2008).

In estimating the panel data models heteroscedasticity consistent standard errors are used. Heteroskedasticity is likely a problem due to the fact that observations reflect city-level aggregates and the market cities can differ substantially in terms of overall size. Estimates were obtained using the TSCS reg procedure in SAS using Heteroscedasticity-Corrected Covariance Matrices (HCCME) (Kennedy, 1992; SAS institute, 2012).

4.1.2 Almost Ideal Demand Model (AIDS)

A second modeling approach involves estimating a demand system comprising fresh berries. In 1980 Deaton and Muellbauer developed The Almost Ideal Demand System (AIDS). Since then, the AIDS model has been commonly used among researchers of demand studies due to its flexible functional form. The typical AIDS model consists of expenditure share equations, each a function of product prices, total expenditures, and an aggregate price index. The model is consistent with utility maximization subject to a budget constraint, and with further restrictions can allow aggregation across consumers (Green and Alston, 1990; Thompson, 2004). To estimate it in the easiest way it is suggested to use linear approximation almost ideal demand system (LA/AIDS) (Alston et al., 1994).

Alston and Chalfant, 1993 state that the Rotterdam model, another demand system, has very similar structure and data requirements, however, results can differ in some applications. Their study demonstrated that the Rotterdam model is preferred for meat demand studies over the AIDS model. Henneberry et al., 1999 tested appropriateness of the Rotterdam model for a fruit and vegetable demand system. Their test demonstrated that the Rotterdam model is more appropriate for commodities other than fruit and vegetables. Thus, the LA/AIDS is more suitable for this study.

According to Deaton and Muellbauer, 1980, AIDS model is illustrated as follow:

$$\textbf{(3.4)} \qquad w_i = \alpha_i + \sum_{j=1}^{n} \gamma_{ij} \ln P_j + \beta_i \ln \left(\frac{X}{P}\right)$$

Where, α_i,γ_{ij}, β_i are the parameters (i, j= 1,…n), n is the number of products in the system, w_i symbolize the budget share of commodity i, P_j represents the price of commodity j, X is the total expenditure on all the commodities, and P is the value of a price index.

In the linear-approximate AIDS specification I use, P is defined as:

(3.5) $$\mathbf{lnP = \sum_{j=1}^{n} w_j \, lnP_j}$$

To fulfill the demand theory, the following restrictions are required:

Adding up: $\sum \boldsymbol{\alpha_i} \mathbf{= 1}$, $\sum_i \boldsymbol{\gamma_{ij}} \mathbf{= 0}$ and $\sum_i \boldsymbol{\beta_i} \mathbf{= 0}$

Homogeneity: $\sum_i \boldsymbol{\gamma_{ij}} \mathbf{= 0}$

Symmetry: $\boldsymbol{\gamma_{ij} = \gamma_{ji}}$

These restrictions characterize a structure of demand functions which add up to total expenditure ($\sum w_i$= 1), are homogeneous of degree zero in prices and total expenditure taken together, and which satisfy Slutsky symmetry. Under these conditions, gammas define how the budget share of good i changes due to a percentage change in the price of good j holding the real expenditures constant. Changes in real expenditure operate through the β_i coefficients. If $\beta_i < 0$, the good is a necessity, If the $\beta_i > 0$, then the commodity is luxury good. If $\gamma_{ij} > 0$, goods i and j are substitutes, while if $\gamma_{ij} < 0$, they are complementary goods (Nzaku and Houston, 2009). Dummy variables for each of the 52 markets and for each weekly time period were used to augment the specification in equation 3.5.

Both Marshallian and Hicksian elasticities can be obtained from estimates of the AIDS model. According to consumer theory, a Hicksian demand function is obtained by minimizing consumer's expenditures. The consumer's demand function demonstrates the relationship between the price of a good (P1) and the quantity purchased on the assumption that other prices (P2), and a base level of utility are held constant. On the other hand, the Marshallian demand function is obtained by maximizing the consumer's utility. The Marshallian demand function shows the relationship between the price of good (P1), and quantity purchased (Q1) under the restriction that other price (P2) and consumer's budget (income) is held constant (USDA ERS, 2009). From the AIDS estimates Marshallian price elasticities can be obtained as:

(3.6) $$\epsilon_{ij}^{M} = -\delta_{ij} + \frac{\gamma_{ij}}{w_i}$$

Hicksian elasticity can be calculated from the Marshallian elasticities using the Slutsky equation as:

(3.7) $$\epsilon_{ij}^{H} = \epsilon_{ij}^{M} + w_j * E_i$$

In equations 3.6 and 3.7, ϵ_{ij}^{M} and ϵ_{ij}^{H} are Marshallian and Hicksian elasticities (i, j,…n), δ_{ij} is the Kronceker delta (δ_{ij} =1 for i = j; δ_{ij} = 0 for i ≠ j), w_i and w_j are the budget shares of the i and j commodities. Expenditure elasticities are computed as:

(3.8) $$\epsilon_{ix} = 1 + \beta_i w_i$$

Where, ϵ_{ix} represents expenditure elasticity (i,x…n) (Tshikala and Fonsah, 2012; Green and Alston, 1990; Kinnucan et al., 1996).

A priori, I expect the own price elasticities to be negative and cross-price elasticities positive for both types of elasticities. Elasticities of expenditure from Marshallian calculations are expected to be positive (Kinnucan et al., 1996).

4.1.3 Price transmission

The equilibrium price is where demand and supply schedules of buyers and sellers meet. However, there is a difference between producer prices at the farm level and consumer prices at the retail level. The difference between what producers received and what consumers pay is the marketing margin (Tomek and Robinson, 1990).

Particularly, the price of many agriculture products depends on the season. The price of fresh fruits and vegetables are highly seasonal. During the season fruits and vegetables are grown locally which means there is a direct channel between farmers and consumers. On the other hand, off season involves transportation, storage expenditures, etc. (George and King, 1971).

Market margins are basically payments spreads among intermediaries. Usually, these charges contain the expenditures for raw materials, processing, storage, shipping, wholesaling and retailing (George and King, 1971). There are various stages of price transmission. Horizontal price linkage means the links between prices at different locations and vertical price linkage is concentrated networks between farm, wholesale and retail prices. Vertical relationship becomes more important as commodity markets have developed more at each level and integrated across levels (Karantininis et al., 2011; Vavra and Goodwin, 2005). Price transmission elasticities are essential input for my equilibrium displacement model that is to be described below. Consequently, it was necessary to compute them.

The price transmission model was based on George and King's 1971 study. First, it was required to estimate market margin as follow:

(3.9) $$M_j = \omega_j + \varphi_j P_{jr}$$

Where, M_j is market margin of commodity j, ω_j ,φ_j are parameters and P_{jr} and P_{jf} denote the retail and farm level prices of commodity j.

Therefore,

(3.10) $$P_{jf} = -\omega_j + (1 - \varphi_j)\, P_{jr}$$

(3.11) $$\tau_j = \frac{1}{(1-\varphi_{j})} * \frac{P_{jf}}{P_{jr}}$$

Where, τ_j is the price transmission elasticity of j commodity.

4.1.4 Equilibrium Displacement Model (EDM)

Equilibrium displacement models are commonly used in assessments of research and promotion efforts. The models can represent multiple markets, which are characterized by supply and demand relationships. There are exogenous factors. For example, new technologies or promotion of products can disturb supply or demand from initial equilibrium to the new equilibrium. Endogenous relationships, price and quantity changes, influence the new equilibrium that results. Exogenous and endogenous changes can be estimated and welfare implications derived (Zhao et al., 2003).

In the competitive agriculture industry, market equilibrium processes place constraints on pricing policies of food marketing firms. The equilibrium displacement model (EDM) demonstrates the demand and supply sides of each market. Demand and supply are characterized in terms of elasticities with the farm and retail level being linked by elasticities of price transmission. The EDM demonstrates how these movements of demand and supply will influence the retail-farm price ratio and the farmer's share of retail food expenditures. Most of the commodities in the Gardner model were less elastic at the farm level than retail level (Gardner, 1975).

Kinnucan et al., 1996, estimated the economic influences of increased U.S. beef advertising with responsive to supply, cross-commodity substitution and advertising spillover. The estimation used time series data and a Rotterdam model to provide demand elasticities for an equilibrium-displacement model. Marshallian and Hicksian price elasticities were computed and they demonstrated that beef advertising caused large reductions in the poultry sector. The reduction is big enough to come to the conclusion that meat producer as a group may be worse off with advertising.

I followed the general approach of the Kinnucan et al., 1996, study by developing a partial EDM model for berries. The EDM contains four sets of equations: retail demand, farm supply, retail-farm price transmission and market equilibrium. Marshallian elasticities from the AIDS were used in the EDM.

(3.12) Retail demand

$$\mathbf{dln\ Q_i^D = \sum_{j=1}^{n} \epsilon_{ij}\ dlnP_j + \epsilon_{ix}\ dlnX + K_i^D}$$

(3.13) Farm supply

$$\mathbf{dln\ Q_i^S = \theta_i\ dln\ W_i\ + K_i^S}$$

(3.14) Retail-farm price transmission

$$\mathbf{dln\ W_i\ = \tau_i\ dln\ P_i}$$

(3.15) Market equilibrium

$$\mathbf{dln\ Q_i^D = dln\ Q_i^S}$$

Where, ϵ_{ij} represent retail price elasticities of demand, ϵ_{ix} is retail expenditure elasticities of demand, θ_i is a farm price elasticity of supply and $\tau_i$characterize farm to retail price elasticity. K_i^D and K_i^S are exogenous variables of demand and supply. Exogenous variables to supply or demand are expressed as percentage change of quantity

In the market analysis there are two ways how to increase consumption of berries. The industry can invest money to the research for new technology or techniques on how to cultivate berry crops. In contrast, the industry can invest money to support the promotion of the product. I decided to compare producer surplus outcomes from a technological improvement that would result in a cost saving that is equivalent to 5% of producer prices with a promotional effort that increases consumer willingness to pay by an amount equivalent to 5 % of retail prices. This is an arbitrary choice in terms of the effectiveness of research or promotion efforts but does allow me to draw conclusions about what is more profitable for the berry industries being examined and which type of activity would make berry producers better off. I estimated producer surplus (PS) equation (3.16) according Richards and Patterson, 1999, and equation (3.17) was estimated according Shiptsova et al., 2002, as follows:

(3.16)

$$\mathbf{\Delta PS_i^D = S_i^f P_i Q_i \tau dlnP_i\ (1+0.5dlnQ_i)}$$

(3.17)

$$\Delta \mathbf{PS_i^S} = \boldsymbol{S_i^f P_i Q_i (\tau dlnP_i + 0.05)\ (1 + 0.5 dlnQ_i)}$$

Where, ΔPS_i^D is the change in producer surplus for commodity i in effect on demand, ΔPS_i^S is the change in producer surplus for commodity i in effect on supply, S_i^f is farm share of commodity i. The results are coming from price transmissions estimates. P_i represents average price of commodity i, Q_i is an average volume of i commodity, $\tau dlnP_i$, demonstrates coefficient in farm price of commodity i from the EDM model and $dlnQ_i$ is a coefficient in quantity of commodity i from the supply side.

Chapter 5: Results

5.1 Double logarithmic demand

Results of the double log model with fixed effects are illustrated in Table 5.1. One can observe that for all four berries, the own price elasticity is highly elastic (less than -1). The most elastic berry is blackberry with an own-price elasticity of -1.85, which means that if the price of blackberries increased by 1%, the quantity of blackberries will go down by 1.85%. They are the most sensitive berry to the price changes. The own price elasticity for raspberries is -1.66. If the price of raspberries increased by 1%, the quantity of raspberries will decline by 1.66%. Blueberries estimate is -1.45. If the price of blueberries increased by 1%, the quantity of blueberries will decreased by 1.45%. Strawberries are less elastic than the previous three berries and have an own-price elasticity of -1.27, which represent increased price of strawberries by 1%, the quantity of strawberries will drop down by 1.31%.

Moreover, Table 5.1 presents t values which show that the own-price elasticity estimates are statistically significant. The t value is compared to the critical values in the t-table to test the hypothesis that the parameter is equal to zero or not. All, results presented using a two-sided test, were significant most at the 1% level and some at the 5% significant level.

The next observations in Table 5.1 are cross price elasticities. Almost all of them are positive which indicates that most berry crops are substitutes. For instance, increasing price of strawberries will increase the demand for blueberries, blackberries and raspberries. The only complementary relationship is between blackberries and raspberries. The point estimate suggests that increasing the price of raspberries will decrease quantity of blackberries. However, t ratio is smallest which means that this is the least statistically significant different from zero.

Expenditure elasticities of demand refer to how much the demand for a good is affected in consumer expenditure. All of the double log expenditure elasticities are positive. Each type of berry can be considered as a normal good. As expenditure increases, the quantity demanded for each type of berry increases.

Table 5.1 Double log two-way fixed effects estimates of fresh berries in the U.S.

Demand for	**Price of**				Expenditure
	Strawberry	Blueberry	Blackberry	Raspberry	
Strawberry	**-1.2662****	0.1627**	0.073425**	0.114821**	1.059192**
	(-130.32)	(25.08)	(11.22)	(16.71)	(143.93)
Blueberry	0.32842**	**-1.45493****	0.030715*	0.055621**	0.768192**
	(18.1)	(-120.07)	(2.51)	(4.33)	(55.89)
Blackberry	0.200694**	0.09476**	**-1.84962****	-0.03278*	0.55236**
	(8.88)	(6.28)	(-121.41)	(-2.05)	(32.25)
Raspberry	0.177112**	0.093387**	0.3325*	**-1.6589****	0.561835**
	(8.9)	(7.03)	(2.48)	(-117.83)	(37.26)

Numbers in parentheses are estimated t-ratio
** 1% significance level
* 5% significance level

Due to the panel structure of my data I used the Hausman test to choose between fixed or random effects. The null hypothesis of no correlation between the error and the independent variable was rejected. The results of Hausman test demonstrate that the fixed effect is the more appropriate effect to use. Despite that, the results of the random effects specification are presented in Table 5.2. Elasticities are only slightly higher than the fixed effect elasticities. All of the results are significant at the 1% level expected for the demand elasticity of blackberries with respect to raspberry price, which is insignificant. In general, the random effects model estimates lead to the same conclusions as the fixed effects model.

Table 5.2 Double log two- way random effects estimates of fresh berries in the U.S.

Demand for	**Price of**				Expenditure
	Strawberry	Blueberry	Blackberry	Raspberry	
Strawberry	**-1.30772****	0.164133**	0.07534**	0.118086**	1.049335**
	(-141.8)	(28.62)	(11.65)	(17.47)	(163.31)
Blueberry	0.411841**	**-1.5176****	0.032846**	0.053257**	0.842347**
	(24.21)	(-146.66)	(2.72)	(4.22)	(72.42)
Blackberry	0.252483**	0.114616**	**-1.86856****	-0.01089**	0.649514**
	(11.64)	(8.43)	(-123.66)	(-0.69)	(42.02)
Raspberry	0.20097**	0.083088**	0.041743	**-1.66835****	0.583337**
	(10.27)	(6.58)	(3.12)	(-118.97)	(40.46)

Numbers in parentheses are estimated t- ratio
** 1% significance level

5.2 Results of the Almost Ideal Demand System

A linear approximate AIDS model was estimated with the theoretical restrictions described in chapter 4 imposed on the model. As shown in Table 5.3, restrictions for homogeneity were rejected. The symmetry restrictions were not. Table 5.4 presents estimates, which were used to compute demand elasticities. All of the estimated coefficients are statistically significant at the 1% level.

Table 5.3 Restrictions of LA/AIDS model

Parameter	Estimate	Label
Homogeneity 1	-4305.25** (-18.45)	γss+γsb+γsk+γsr = 0
Homgeneity 2	-3633.52** (-12.18)	γbs+γbb+γbk+γbr = 0
Homogeneity 3	3474.785** (6.81)	γks+γkb+γkk+γkr = 0
Symmetry 1	-74.3852 (-0.24)	γsb=γbs
Symmetry 2	799.5521 (1.82)	γsk=γks
Symmetry 3	637.7911 (1.24)	γbk=γkb

Numbers in parentheses are estimated t-ratio
** 1% significance level

Table 5.4 Estimates of LA/AIDS model with homogeneity and symmetry imposed

Demand for	**Price of**				Expenditure
	Strawberry	Blueberry	Blackberry	Raspberry	
Strawberry	**-0.15225** **(-46.21)**	0.073084 (30.59)	0.031789 (27.82)	0.047378 (26.1)	0.03784 (17.53)
Blueberry		**-0.11106** **(-48.73)**	0.014458 (15.33)	0.023514 (14.97)	-0.01531 (-7.8)
Blackberry			**-0.05392** **(-61.11)**	0.007674 (8.57)	-0.00664 (-8.13)
Raspberry				**-0.07857** **(-47.65)**	-0.01589 (-11.22)

Numbers in parentheses are estimated t-ratio
** All estimates are statistically significant at 1% level

The Marshallian elasticities (Table 5.5) represent high responsiveness to the prices with own price elasticities less than -1. The strawberries are less responsive to the prices with an elasticity of-1.26 than other berries in this study. The most responsive is blackberry with an own-price elasticity of -1.88, followed by raspberry with an own price elasticity of -1.66 and blueberry with an own-price elasticity of -1.49. For all the berries, if the own-price increased by 1%, the elasticities represent the percentage decline in quantity that would be expected to result. Furthermore, cross-price elasticities of demand are positive indicating that the berries are substitute goods. Some of the elasticities have stronger substitution than others. Blackberries are a very week substitute among other berries, but strawberries are a very strong substitution berry crop. If the price of blackberries increases by 1%, strawberries quantity will go up by 0.05%. All of the cross-price elasticities are statistically significant at the 1% level. In addition, the expenditure elasticities are all positive. Positive expenditure elasticities represent normal goods. The expenditure elasticity for strawberry is 1.023 while blueberries, blackberries and raspberries are 0.997, 1.000, and 0.998. These results demonstrate that consumers would increase consumption of each berry in nearly equal proportion to increases in expenditure on berries as a group.

Table 5.5 Marshallian elasticties of U.S. demand for fresh berries

Demand for	**Price of**				Expenditure
	Strawberry	Blueberry	Blackberry	Raspberry	
Strawberry	**-1.25610**	0.12293	0.05347	0.07970	1.02250
Blueberry	0.32354	**-1.49164**	0.06401	0.10410	0.99654
Blackberry	0.52144	0.23716	**-1.88447**	0.12587	0.99959
Raspberry	0.39930	0.19818	0.06467	**-1.66215**	0.99811

Hicksian elasticites are presented in Table 5.6. Own-price elasticities are lower than Marshallian elasticties but this is expected because Hicksian elasticities represent substitution effects after compensating consumers for the income effect of the price change. The Hicksian elasticities show that the different berries remain substitutes in demand even after holding income constant.

Table 5.6 Hicksian elasticities of U. S. demand for fresh berries

	Price of			
Demand for	Strawberry	Blueberry	Blackberry	Raspberry
Strawberry	**-0.66498**	0.92289	0.52041	0.65419
Blueberry	0.89965	**-0.71199**	0.51910	0.66400
Blackberry	1.09931	1.01920	**-1.42799**	0.68749
Raspberry	0.97632	0.97906	0.52047	**-1.10136**

The outputs of simple double log model and theoretically consistent AIDS model demonstrate robustness of the estimated elasticities. The estimates are quite similar. Basically, from both of the models one can draw the same conclusions on demand relationships.

There has not been research for fresh berry elasticity of demand. Due this fact I am not able to compare berry elasticities of demand with historical data. Only with one exception and that is strawberry. Blueberry, blackberry and raspberry are compared with other fresh fruits because I am assuming some kind of similarity among them. As it was mentioned in Chapter 2 (Table 2.1), the own price elasticity of demand for strawberry from 1979 is highly elastic and that is consistent with my results.

5.3 Equilibrium displacement model (EDM)

The next method used in this research is partial equilibrium model. To implement this approach it is essential to have parameters of retail demand. I use the Marshalian elasticities from the AIDS model for this purpose. Supply elasticities were obtained from the literature (see Table 5.7 footnotes for references) and retail-farm transmission elasticities are estimated as these are also required to implement the equilibrium model.

Table 5.7 Coefficient for fresh berries in the U. S.

	Strawberry	Blueberry	Blackberry	Raspberry
Demand elasticity w.r.t strawberry price	-1.2561	0.12293	0.05347	0.0797
Demand elasticity w.r.t blueberry price	0.32354	-1.49164	0.06401	0.1041
Demand elasticity w.r.t blackberry price	0.5214	0.2372	-1.8845	0.1259
Demand elasticity w.r.t raspberry price	0.3993	0.1982	0.0647	-1.6622
Demand elasticity w.r.t expenditure	1.0225	0.9965	0.9996	0.9981
Farm-level supply elasticity *	0.30	0.22	0.20	0.21
Price transmission elasticity	0.9768	0.3921	0.4725	0.5856

*Values of supply elasticities are according to Yang (2008)

Table 5.8 demonstrates average price of strawberries, blueberries, blackberries, and raspberries at the retail level (Ps, Pb, Pk, Pr) and price of the same berries at the farm level (Psf, Pbf, Pkf, Prf). The retail prices are higher which is consistent with the theory about marketing margins. The biggest gap between retail and farm price is for raspberries followed by blackberries, blueberries and strawberries. In addition, Table 5.8 shows fluctuation in prices at both levels which represents minimum and maximum coefficients. Table 5.9 represents estimates of the farm to retail model of fresh berries in the U.S. All of the estimates are significant at 1% level and were used to calculate price transmission elasticities. The price transmission elasticities for all berries were less than 1 (strawberries 0.99, blueberries 0.39, blackberries 0.47 and raspberries 0.59). The results of price transmission corresponded the theory (George and King, 1971), because elasticities at the farm level are usually lower than elasticities at the retail level. The results from price transmission were added to the list of the parameters which were needed for computing EDM model.

Table 5.8 Price summary statistics for fresh berries in the U.S.

Variable	Mean	Std Dev	Minimum	Maximum
Ps	2.91953	0.87791	1.12253	5.83991
Psf	1.64610	0.65857	0.68750	4.27500
Pb	6.51837	2.72144	1.03048	18.15842
Pbf	4.24364	1.11738	2.22222	8.22222
Pk	6.74359	1.68416	1.61987	14.52130
Pkf	2.95520	0.91809	1.22222	7.11111
Pr	8.64206	2.10259	2.84679	15.52358
Prf	4.67855	1.39928	2.22222	7.43333

Table 5.9 Price transmission output for fresh berries in the U.S.

Variable	R-squared	Estimates	t-ratio
Intercept	0.4989	0.06632	6.58
Ps		0.55073	163.3
Intercept	0.3412	2.65484	144.16
Pb		0.25524	93.27
Intercept	0.1515	1.55638	51.73
Pk		0.20706	47.99
Intercept	0.2206	1.94863	43.34
Pr		0.31704	62.45

**All coefficients are significant at 1% level

EDM outputs are presented in Tables 5.10 and 5.11. I computed producer surplus in two scenarios: the value to producers of a 5% reduction in costs per pound for each type of berry (Table 5.10) and a 5% increase in consumer willingness to pay per pound for each type of berry (Table 5.11). The results are reported in dollars per market per week.

Producer surplus results for cost reductions show that the strawberry market has the most influence in the berry market. If costs are reduced in strawberry production it will have negative externality for other berry growers. Blueberries show a slightly greater change in producer surplus than strawberry, however, they do not have that strong impact on other growers. A reduction in the costs of producing blackberries and raspberries has less of an effect to the other berries.

On the other hand, a 5% increase in consumer willingness to pay per pound is assumed. The demand curve is moved to the new equilibrium, where price and quantity increase. If strawberry growers invest money for promotion and promotions are effective, it will assist other growers as well. Particularly, blackberry and raspberry will benefit a lot. Effective blueberry promotions will also support strawberry growers. Blackberry and raspberry promotions do not influence other producers as much.

Table 5.10 Producer surplus (PS) resulting from a 5% reduction in costs per pound

	ΔPS ($ per market per week)			
	Strawberry cost reduction	Blueberry cost reduction	Blackberry cost reduction	Raspberry cost reduction
Strawberry	12,197	-64	-3	-12
Blueberry	-273	12,459	-1	-7
Blackberry	-432	-52	1,267	-9
Raspberry	-454	-58	-2	2,777

Table 5.11 Producer surplus (PS) resulting from a 5% increase in consumer willingness to pay per pound

	ΔPS ($ per market per week)			
	Strawberry demand increase	Blueberry demand increase	Blackberry demand increase	Raspberry demand increase
Strawberry	12,509	1,115	51	165
Blueberry	1,197	4,889	26	89
Blackberry	1,855	898	596	117
Raspberry	1,946	999	38	1,622

From the producer surplus results I can conclude that for strawberry growers it does not really matter if the concentration is on reduction of costs or increase in consumer willingness to pay. Although, the berry sector is better off when strawberry growers focus on promotion. Surprisingly, the results demonstrate that blueberry producers will be better off if they concentrate more at reducing costs as opposed to demand promotion. Blackberry and raspberry benefit more from reduction in costs too. However, the 5% shock is just an assumption and other results can be obtained with different scenarios.

Chapter 6: Conclusion and Recommendations

6.1 Summary

The objective of the study was to estimate demand elasticities for four berry crops in the United States, which include strawberries, blueberries, blackberries and raspberries. In addition, the berry market was modeled within an EDM framework to examine how shocks on demand or supply influence prices at both the farm and retail stages of the market. The recognition of health benefits of berries are increasingly acknowledged and has lead to increasing demand for the crops. Moreover, the prediction has an upward slope, which means that berry consumption will rise. The berry market is growing and there has not been a literature to observe their market relationship.

The thesis was based on panel data where 52 U.S. markets were observed weekly during 2008-2011. The data were purchased from Nielson Company. Also, additional data were needed for establishing an equilibrium model. The shipping points and movement data were obtained from USDA/ AMS.

In order to examine the demand system for the berry market I, estimated two main models. A single equation, double-log, model was estimated. A Hausman test was used and demonstrated that the fixed effect model better fit the data. The results of the double log model showed that demand for all four berries was own-price elastic. The most elastic berry is blackberry (-1.85) following by raspberry (-1.66), blueberry (-1.45) and strawberry (-1.27). The cross price elasticities demonstrated substitution relationships among the different berries. Expenditure elasticities showed each type of berry to be a normal good.

The Linear-Approximated Almost Ideal Demand System model (LA/AIDS) was also estimated. The results are similar to the double-log model and confirm robustness of the findings on demand. Marshallian and Hicksian elasticties were computed and the Marshallian elasticities were used in the equilibrium model. The own price elasticties from the AIDS models were also elastic. Blackberries are the most elastic (-1.88) followed by raspberries (-1.66), blueberries (-1.49) and strawberries (-1.26). Their cross-price elasticities showed that the different berries were substitute goods. Strawberries had the strongest substitution with other berries.

The equilibrium displacement model (EDM) was applied. Producer surplus estimates demonstrate that the berry group as a whole is better off when strawberries focus on consumer promotion. Individually, the rest of the berries are better off by concentration on cost reductions. Surprisingly, blueberries are known for their high consumer promotion but the results demonstrate that producers could benefit more by industry efforts aimed at cost reduction. The main conclusion of the thesis is that berries are very highly responsive fruit to prices. They are substitutes, however, so on the demand side there can be a collaboration among promotion efforts.

The literature for berry crops is lacking and this research contributes to expand knowledge of the demand market for strawberries, blueberries, blackberries and raspberries in the Unites States. Although there are limits to estimating a more accurate supply or demand functions for berry crops, this thesis fully analyzed the relationships among the crops. There is a lack of supply data required to calculate a price transmission model in this thesis. The knowledge about fresh berries should be extended with more market research on both sides of the market.

This study can be beneficial for producers and policy makers and will assist them with marketing decisions. Since the thesis is the first one to calculate demand elasticities for berries, it can be useful for grower groups as well. Furthermore, the same methodology can be applied to the other commodities and countries.

References

Alston, J. M., & Chalfant, J. A. (1993). The silence of the lambdas: A test of the Almost Ideal and Rotterdam models. *American Journal of Agricultural Economics, 75*(2): 304-313.

Alston, J. M., Chalfant, J. A., & Piggott, N. E. (2002). Estimating and testing the compensated double-log demand model. *Applied Economics, 34*(9): 1177-1186.

Alston, J. M., Foster, K. A., & Green, R. D. (1994). Estimating elasticities with the linear approximate almost ideal demand system: Some Monte Carlo results. *Review of Economics and Statistics, 76*(2): 351-356.

Ball, V. E., Moss, C. B., Erickson, K. W. & Nehring, R. F. (2003). *Modeling supply response in a multiproduct framework revisited: The nexus of empirics and economics.* Retrieved 6/19/2012, 2012, from http://ageconsearch.umn.edu/handle/21981

Boriss, H., Brunke, H., & Kreith, M. (2006). Agriculture Marketing Resource (AGMRC) Commodity profile: Strawberries. Agricultural Issues Center, University of California

Brandow, G. E. (1961). *Interrelations among demands for farm products and implications for control market supply.* Pennsylvania Agric. Exp. Sta. Bul. No. 680

Clark, J. R. (2005). Changing times for eastern United States blackberries. *HortTechnology July-September 2005.* 15(3): 491-494.

Cook, R. L. (2011). *Fundamental forces affecting the U.S. fresh berry and lettuce/leafy green subsectors.* Retrieved 3/10/2012, 2012, from http://ageconsearch.umn.edu/handle/120009

Deaton, A. S., & Muellbauer, J. (1980). An Almost Ideal Demand System. *American Economic Review, 70*(3): 312-326.

Food and Agriculture Organization (FAO), World Health Organization (WHO). (2004). *Fruit and vegetables promotion* Retrieved 3/13/2012, 2012, from http://www.who.int/dietphysicalactivity/publications/fv/en/index.html

Gardner, B. L. (1975). The farm-retail price spread in a competitive food industry. *American Journal of Agricultural Economics, 57*(3): 399-409.

George, P. S., & King, G. A. (1971). *Consumer demand for food commodities in the United States with projections for 1980.* Retrieved 3/9/2012, 2012, from http://ageconsearch.umn.edu/handle/11936

Green, R. D., & Alston, J. M. (1990). Elasticities in AIDS models. *American Journal of Agricultural Economics, 72*(2): 442-445.

Henneberry, S. R., Piewthongngam, K. & Qiang, H. (1999). *Consumer food safety concers and fresh produce consumption.* Retrieved 4/9/2012, 2012, from http://ageconsearch.umn.edu/handle/30865

Hosken D., O'Brien D., Scheffman D., Vita M. (2002). Demand system estimation and its application to horizontal merger analysis. Draft for forthcoming paper “The Use of Econometrics in Antitrust.”

Karantininis, K., Katrakylidis, K. & Morten Persson, M. (2011). *Price transmission in the Swedish pork chain: asymmetric non linear ARDL.* Retrieved 2/27/2012, 2012, from http://ageconsearch.umn.edu/handle/114772

Kennedy, P. (1992). *A guide to econometrics* (3rd ed.). Cambridge, Massachusetts: The MIT Press.

Kinnucan, H. W., Xiao, H., & Hsia, C. J. (1996). Welfare implications of increased US beef promotion. *Applied Economics, 28*(10): 1235-1243.

Lin, B., Variyam, J. N. & Allshouse, Jane E. Cromartie, John. (2003). *Food and agriculture commodity consumption in the United States: Looking ahead to 2020.* Retrieved 2/29/2012, 2012, from http://ageconsearch.umn.edu/handle/33959/simple-search?query=

Lucier, G., Pollack, S., Ali, M. & Perez, A. (2006). *Fruit and vegetable backgrounder* Retrieved 3/13/2012, 2012, from http://www.ers.usda.gov/Publications/VGS/Apr06/VGS31301/

Monson, J. (2009). *A market analysis for berry crops in Virginia.* Retrieved 3/13/2012, 2012, from http://scholar.lib.vt.edu/theses/available/etd-05132008-114411/

Nzaku, K., and Houston, J. E. (2009). *Analysis of U.S. demand for fresh tropical fruit and vegetable imports.* 2009 [cited 4/9/2012 2012]. Retrieved 4/9/2012, from http://ageconsearch.umn.edu/handle/46850

Onyango, B., & Bhuyan, S. (2001). A supply response analysis of the fruits and vegetables sector in New Jersey.

Paudel, L., Adhikari, M., Houston, J., & Paudel, K. P. (2010). Low carbohydrate information, consumer health preferences and market demand of fruits in the United States. *Applied Economics Letters, 17*(4-6): 411-415.

Perez, A., Baldwin, K., Plattner, K. & Dohlman, E. (2011). Fruit and tree nuts outlook: U.S. citrus production forecast up this season. Washington DC: U. S. Department of Agriculture (USDA/ERS) Retrieved 3/13/2012, from http://www.ers.usda.gov/Publications/FTS/

Pollack, S., & Perez, A. (2006). Fruit and tree nuts outlook: Crops forecast to be bigger for sweet cherries and almonds but smaller for tart cherries and peaches in 2006 than a year ago. Washington DC: U.S. Department of Agriculture (USDA/ERS) Retrieved 3/13/2012, from http://www.ers.usda.gov/publications/fts/2006/07Jul/FTS323.pdf

Price, D. W., & Mittelhammer, R. C. (1979). *A matrix of demand elasticities for fresh fruit.* Retrieved 4/9/2012, 2012, from http://ageconsearch.umn.edu/handle/32427

Richards, T. J., & Patterson, P. M. (1999). *The economic value of public relations expenditures: Food safety and the strawberry case.* Retrieved 3/8/2012, 2012, from http://ageconsearch.umn.edu/handle/30804

Shiptsova, R., M. R. Thomsen, & H. L. Goodwin. (2002). *Producer welfare changes from meat and poultry recalls. Journal of Food Distribution Research* 33 (02).

Statistical Analysis Software (SAS/ETS(R)). *9.2 user's guide* Retrieved 6/22/2012, 2012, from http://support.sas.com/documentation/cdl/en/etsug/60372/HTML/default/viewer.htm#etsug_panel_sect039.htm

Strik, B. C., Clark, J. R., Finn, C. E., & Banados, M. P. (2006). Worldwide production of blackberries. NARBA. Retrieved 2/18/2012, from http://www.raspberryblackberry.com/Webdocs/Worldwide_Production_of_Blackberries_Strik_3-2006_acres.pdf

Thompson, W. (2004). Using elasticities from an Almost Ideal Demand system? Watch out for group expenditure! *American Journal of Agricultural Economics, 86*(4): 1108-1116.

Tomek, W. G., & Robinson, K. L. (1990). *Agricultural product prices* Third edition; Ithaca and London; Cornell University Press.

Tshikala, K. S., & Fonsah, E. G. (2012). *Analysis of U.S. demand for imported melons using a dynamic almost ideal demand system.* Retrieved 4/8/2012, 2012, from http://ageconsearch.umn.edu/handle/119779

U.S. Department of Agriculture (USDA), Agriculture Marketing Service (AMS) *Daily Movement report*. Retrieved 4/10/2012, from http://www.marketnews.usda.gov/portal/fv

U.S. Department of Agriculture (USDA), Agriculture Marketing Service (AMS). *Shipping point high / low highlights data.* Retrieved 4/10/2012, from http://www.marketnews.usda.gov/portal/fv

U.S. Department of Agriculture (USDA), Economic Research Service (ERS) (2009). *Commodity and food elasticities: Glossary* Retrieved 3/29/2012, 2012, from http://www.ers.usda.gov/Data/Elasticities/glossary.htm#demandfunctions

Vavra, P., & Goodwin, B. K. (2005). Analysis of price transmission along the food chain. Working paper, OECD Food,Agriculture and Fisheries

Verbeek, M. (2008). *A guide to modern econometrics* (3rd ed.). Great Britain: John Wiley & Sons, Ltd.

Wohlgenant, M. K. (1989). Demand for farm output in a complete system of demand functions. *American Journal of Agricultural Economics, 71*(2): 241-252.

Yang, J. (2008). Economic analysis of blueberry investment in British Columbia. (Master in Science, The University of British Columbia).

You, Z., Epperson, J. E. & Huang, C. L. (1996). *A composite system demand analysis for fresh fruits and vegetables in the United States.* Retrieved 4/9/2012, 2012, from http://ageconsearch.umn.edu/handle/27894

Zhao, X., Mullen, J., Griffith, G., Piggott, R., Griffiths, W. (2003). The incidence of gains and taxes associated with R&D and promotion in the Australian beef industry. *Agribusiness, 19*(3): 333-344.