International Food and Agribusiness Management Review
Volume 19 Issue 3, 2016

A Segmented Hedonic Analysis of the Nutritional Composition of Fruit Beverages

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Abstract

Given the increased importance consumers and manufacturers have placed on the functional nutrients found in fruit beverages, as well as the changing federal guidelines on fruit beverage consumption, this study sought to determine whether specific nutrients garner price premiums in fruit beverages sold in the US. Using the National Household Food Acquisition and Purchase Survey, hedonic price models for fruit juice and fruit drinks are estimated to determine whether specific nutrients, product characteristics, packaging type and acquisition characteristics are associated with price premiums. Based on the results from the hedonic price models, three generalizations are made about the price premiums for nutrients and sugar in fruit beverages: (1) all nutrients garner premium prices in fruit juice, (2) sugar and select nutrients garner price premiums in non-diet fruit drinks and (3) all nutrients and sugar are associated with negative price premiums in diet fruit drinks. Findings further suggest that product attributes such as brand, flavor, organic labels, diet labels and package type, and acquisition characteristics such as store type, region, season and payment type are associated with price premiums in fruit beverages.

Keywords: fruit beverages, juice, nutrients, hedonic price analysis, price premium

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Introduction

With the average American consuming nearly 40 liters of fruit beverages every year, the United States is one of the world's largest fruit beverage consumers (Euromonitor 2015; Singh et al. 2015). Fruit beverages can be grouped into two categories: fruit juice and fruit drinks. Fruit juice is defined as pure, 100% juice with no added ingredients, while fruit drinks are fruit beverages containing ingredients other than fruit juice, such as sugar, and often have minimal nutritional value (Mintel Report 2015). On average, fruit drinks contain only 10% fruit juice (Harris et al. 2011).

Currently, a significant shift in fruit beverage consumption is occurring in the US, due largely to concerns over its sugar content. Wang et al. (2008) explain that fruit beverages' sugar content is similar to that of soft drinks and other sugar-sweetened beverages. Studies have further found evidence that fruit beverage consumption is associated with an increased risk for obesity, heart disease and diabetes (Dennison et al. 1997; Wojcicki and Heyman 2012; Imamura et al. 2015; Eshak et al. 2013). Reflecting these concerns, the Dietary Guidelines for Americans have been revised and now recommend abstaining from fruit drink consumption and limiting fruit juice consumption (USDA 2015). As a result, the United States Department of Agriculture has cut back on fruit beverage provisions in food assistance programs such as Women, Infants, and Children (WIC), and has begun regulating fruit beverage sales in schools. Consumers' reactions to these concerns and changing federal guidelines/programs are reflected in the sales declines for fruit juice and non-diet fruit drinks from 2010 to 2015 (Mintel Report 2015; Okrent and MacEwan 2014).

Despite its high sugar content, many nutritionists view fruit beverages as an important source of vitamins and minerals and as a cost-effective way for consumers to meet their daily fruit intake recommendations (O'Neil et al. 2012; Clemens et al. 2015). Among its consumers, fruit beverages are increasingly purchased for their functional attributes i.e. the nutrients they contain (Mintel Report 2014). According to Mintel, over 40% of Americans depend on fruit juice as a source of added nutrients in their diets (2015). Manufacturers have responded to the demand for functional fruit beverages by emphasizing the naturally occurring nutrients in their products and introducing fruit beverages fortified with vitamins and minerals (Siro et al 2008; Bishai and Nalubola 2002).

Given the increased importance consumers and manufacturers have placed on the functional nutrients found in fruit beverages, as well as the changing federal guidelines on fruit beverage consumption, this study seeks to determine whether specific nutrients garner price premiums in fruit beverages sold in the US. Specifically, this study seeks to answer the following questions: (1) which nutrients found in fruit beverages garner price premiums, (2) do the specific nutrients that garner price premiums vary by fruit beverage type and (3) what other attributes of fruit beverages garner a price premium. This study adds to the literature in that it is the first to consider whether specific nutrients garner price premiums in fruit beverages sold in the US. Further, this study is the first to estimate separate hedonic models for fruit juice and fruit drinks, thus allowing price premiums for nutrients to differ between the two fruit beverage types.

Background

US Fruit Beverage Industry

The US is one of the largest consumers of fruit beverages, with 8.4 and 4.2 billion liters of fruit juice and fruit drinks purchased in 2014 (Euromonitor 2015; Singh et al. 2015). According to Mintel, approximately 75% (49%) of US consumers reported drinking fruit juice (drinks) in 2015. Orange (mixed fruit) is the most popular flavor of fruit juice (fruit drink), with a 60% (29%) market share (Euromonitor 2015). Other leading fruit juice (drink) varieties in order of market share include apple, mixed fruit, tomato, grape, cranberry, grapefruit, prune and lemon (citrus, berry, lemonade, grape and apple) (Euromonitor 2015).

The fruit beverage industry in the US is relatively concentrated, with ten major companies accounting for 70% of fruit beverage sales. These companies and their respective market shares are as follows: Coca-Cola Co. (18.2%), PepsiCo Inc (13.4%), Campbell Soup (7.7%), Kraft Foods Group Inc. (6.6%) Ocean Spray Cranberries Inc. (6.5%), Dr. Pepper Snapple Group (5.3%), National Grape Cooperative Association Inc. (3.7%), Citrus World (3.3%), Beverage Holdings (2.4%) and Nestle (2.2%) (Euromonitor 2015).

Nutritional Composition of Fruit Beverages

In the US, sugar-sweetened beverages are the single greatest source of added sugars in the American diet, with fruit drinks alone accounting for 10% of the added sugar consumed every year (Krebs-Smith 2001; US 2015). On average, an eight-ounce fruit drink serving contains thirty-two grams of sugar or approximately 100% of one's recommended daily sugar intake (Harris et al. 2011). A 2014 report by Yale's Rudd Center for Food Policy and Obesity further explains that the average fruit drink sold in the US contains only 10% fruit juice, with the remaining 90% of the drink comprised of water and sugar (Harris et al. 2011). Correspondingly, fruit drinks are described as providing empty calories, in that they are high in energy from added sugars, but low in nutrients such as vitamins, minerals, and fiber (Reedy and Krebs-Smith 2010).

Unlike fruit drinks, fruit juice has historically been viewed as an important source of nutrients in the American diet. A detailed summary of the nutritional composition of seven common varieties of fruit juice is provided in Table A1 in Appendix A. In general, fruit juice is a significant source of Vitamin C, Potassium, Magnesium, Iron and Phosphorus (O'Neil and Nicklas 2008). However, despite being a natural source of vitamins and minerals, all fruit juice varieties have high sugar contents, ranging from 49% of the recommended daily sugar intake for an 8oz serving of grapefruit juice to 119% for grape juice (O'Neil and Nicklas 2008; FDA 2013b).

Federal Programs, Policies and Guidelines Concerning Fruit Beverages

Over the past decade, federal programs, policies, and guidelines have been altered or enacted in response to concerns over the high sugar content of fruit beverages in the US. Issued every five years, the Dietary Guidelines for Americans (DGA) provide consumers with guidance on maintaining a healthy diet and serve to inform food, health and nutrition policy (USDA 2015). The DGA recommendations on fruit beverage consumption have evolved considerably over the

past decade. In 2005, the DGA recommended choosing fruit beverages with little-added sugar (US 2005). By 2010, the DGA specifically stated to abstain from consuming fruit drinks and suggested limiting children's intake of fruit juice, especially if children are overweight or obese (US 2010). In the 2015 DGA, specific limits were placed on added sugar consumption, with no more than 10% of one's calories to be derived from added sugar (US 2015).

In 2007, the USDA's nutrition program for Women, Infants, and Children (WIC) was revised in response to the 2005 DGA's recommendation to choose beverages with little-added sugar (Cole et al. 2011). Established in 1966, the goal of WIC is to provide supplemental foods containing nutrients known to be lacking in the diets of at-risk women and children (Oliveira et al. 2002). Since its inception, fruit juice has been among the items provided by WIC due to its vitamin content. To be deemed WIC eligible, a product must contain only 100% unsweetened, pasteurized juice and contain a minimum of 20 mg of Vitamin C per 100ml of juice (USDA 2016b). In compliance with the 2005 DGA, revisions made to WIC in 2007 include the removal of fruit juice from all infant packages and a nearly 50% reduction in the maximum fruit juice prescription for women and children (Cole et al. 2011).

The USDA has also taken steps to regulate beverages sold in US schools. In July of 2014, the USDA implemented the Smart Snacks in School Standards which defined nutritional standards that all foods and beverage items sold in schools must satisfy (USDA 2013a). The standards effectively banned the sales of SSBs in schools, including fruit drinks. Among fruit beverages, only 100% fruit juice or 100% fruit juice diluted with water and with no added sugar can be sold in schools. The standards also limit the portion size of fruit juice that can be sold to 8oz and 12oz in elementary and middle/high schools respectively (USDA 2013a).

Changing Consumer Demand for Fruit Beverages

Consumers have reacted to the concerns over the sugar content in fruit beverages, as well as the changing federal guidelines and programs, by altering their fruit beverage consumption (Okrent and MacEwan 2014). Fruit juice expenditures in the US declined by 5% from 2010 to 2015, with approximately 34% of consumers who stopped drinking fruit juice doing so because of its high sugar content (Mintel Report 2015; Mintel Report 2014). During the same time period, fruit drink expenditures increased by 6%, driven primarily by the development of products containing fewer calories and less sugar (Mintel Report 2015; Taylor 2014; Okrent and MacEwan 2014).

Among consumers, fruit beverages are increasingly viewed as functional foods (Mintel Report 2014). The Functional Food Center defines functional foods as "natural or processed foods that contain known or unknown biologically-active compounds; which, in defined, effective non-toxic amounts, provide a clinically proven and documented health benefit for the prevention, management, or treatment of chronic disease" (Martirosyan and Singh 2015). According to Mintel, 40% (24%) of US consumers who purchase fruit juice (fruit drinks) look for vitamin or mineral enhanced formulas (Mintel Report 2014). Leading functional ingredients consumers seek in fruit beverages include Vitamin C, Vitamin D and Calcium (Euromonitor 2016). In addition to added nutrients, approximately 43% of fruit juice and fruit drink consumers are interested in no sugar added or low sugar varieties. (Mintel Report 2014).

In response to consumer demand for functional fruit beverages, manufacturers are emphasizing the naturally occurring nutrients in its products and introducing new fruit beverages fortified with vitamins and minerals (Siro et al. 2008; Bishai and Nalubola 2002). Key nutrients manufacturers are fortifying their fruit juice (drink) products with include Calcium, Vitamin D and Vitamin C (Vitamin C and Vitamin E) (Euromonitor 2016). In addition to functional attributes, a main area of focus for fruit beverage manufacturers is sugar reduction in its products (Mintel Report 2015). Manufacturers are conveying the nutritional benefits of their fruit beverages to consumers through the use of front-of-package labels. Detailed in Table 1, common front-of-package nutrition labels on fruit beverages include: good source of vitamins/antioxidants; percent (%) of daily values of vitamins/minerals; natural source of antioxidants; and no added/reduced/less sugar.

Table 1. Top fruit beverage front-of-package nutritional labels

	100% Fruit Juice	**Fruit Drinks**
Vitamin C	% Daily Value Vitamin C ● An Excellent Source of Vitamin C ● With Vitamin C	With Vitamin C ● % Vitamin C Per Serving ● Excellent/Good Source of Vitamin C
Vitamin D	An Excellent Source of Vitamin D ● Plus Calcium & Vitamin D	Plus Vitamin D
Vitamin E	% Daily Value of Vitamin E	Great Source of Vitamin E
Antioxidants	Antioxidant Advantage ● Packed with Antioxidants A & C ● Essential Antioxidants ● Natural Source of Antioxidants	Antioxidants Vitamin C & E ● 100% Daily Value of the Antioxidant Vitamin C
Multiple Vitamins	With Vitamins A,B,C,D,E ● Packed with Vitamins ● Excellent Source of Vitamins	Good Source of Vitamins A, C, E
Calcium	% Daily Value of Calcium ● An Excellent/Good Source of Calcium ● Plus Calcium & Vitamin D	None
Sugar	1/2 the Sugar ● No Sugar Added ● Less Sugar ● No High Fructose Corn Syrup	% Less Sugar ● Reduced Sugar ● No High Fructose Corn Syrup
Fiber	High Fiber ● Good Source of Fiber ● With Fiber	None

Uniqueness of this Study

Given the increased importance consumers and manufacturers place on the functional nutrients found in fruit beverages, as well as changing federal guidelines on fruit beverage consumption, this study seeks to determine whether key nutrients garner price premiums in fruit beverages. Several past studies have considered price premiums for nutrients in foods other than fruit beverages. Looking at breakfast cereal, Morgan et al. (1979) and Stanley et al. (1991) collectively find that protein, minerals, vitamins and sugar garner a premium price, while fiber and calories are associated with a price discount. Similarly, Angulo et al. (2006) and Harris (1997) conclude that meat with greater fat, protein and fiber content commands a premium price. Gulseven and Wohlgenant (2014) further find a price premium for lactose and cholesterol free milk.

Two past studies have analyzed whether nutrients garner price premiums in fruit beverages. Weemaes and Riethmuller (2001) considered the price premium associated with quality attributes, including nutrients, in Australian fruit beverages. Findings include that sugar is associated with a negative price premium and fruit beverages labeled with the Australian Heart Foundation seal garner a price premium. In 2014, Szathvary and Trestini analyzed the effects of nutrition and health claims on the prices of fruit beverages in Northeast Italy. Results suggest that fruit beverages containing a nutrition and/or health claim are associated with a price premium.

This study adds to the literature in that it is the first to consider whether specific nutrients garner price premiums in fruit beverages sold in the US. Building off of Weemaes and Riethmuller (2001) and Szathvary and Trestini's (2014) analysis of select nutrition claims, this analysis seeks to determine the price premiums associated with all key nutrients found in fruit beverages, including Vitamin C, Vitamin D, Antioxidants, Calcium, and sugar. This study is also the first to perform a segmented hedonic analysis of fruit beverages, with separate models estimated for fruit juice and fruit drinks.

Hedonic Pricing Model

Hedonic Price Theory

In their formative works, Lancaster (1966) and Rosen (1974) questioned the traditional notion that consumers obtain utility from goods themselves. Instead, they explain that goods are made up of a set of attributes, and it is these attributes that provide utility to the consumer. This concept serves as the basis for hedonic price theory. Under this theory, the observed prices and quantity of attributes for a specific good define a set of hedonic prices (Rosen 1974). There are three key assumptions made by hedonic theory: (1) consumers are aware of all available versions of a product, (2) there is significant variation within a product segment and (3) it is costless to switch between products (Costanigro et al. 2011).

Hedonic Price Model

Following Rosen (1974), the hedonic price function for a good is defined as follows:

(1) $p(z) = p_i(z_1, \dots, z_k)$

(2) $z_i = (z_1, \dots, z_k)$

where z is the product and z_i is a row vector of the attributes for the i_{th} product. Given this price function, consumers choose a bundle of attributes to maximize the following utility function (3) subject to their budget constraint (4):

(3) $U = U(x, z_1, \dots, z_k)$

(4) $y = x + p(z)$

where y is income and x represents all other goods and has a unit price. Maximization of the utility function subject to the budget constraint results in the following first order condition:

$$(5)\ \ p_{z_k} = \frac{U_{z_k}}{U_x}.$$

This first order condition yields the implicit price for a specific attribute, p_{z_k}, and implies that consumers are indifferent between paying the implicit price for an additional unit of an attribute and using the money to purchase all other goods x (Costanigro et al. 2011).

Analogously, producers choose a bundle of attributes and the number of goods to produce containing a particular attribute, $M(z)$, to maximize the following profit function:

$$(6)\ \ \pi = Mp(z) - C(M, z; \beta),$$

where $C(M, z; \beta)$ is the producer's cost function and β is a parameter representing the producer's factor prices and production technologies. Maximization of this profit function results in the following first order condition:

$$(7)\ \ p_{z_k} = \frac{C_{z_k}}{M}.$$

This first order condition implies that the marginal cost of adding an additional unit of an attribute to a product equals the implicit price of the attribute (Costanigro et al. 2011). Thus, at equilibrium, the market clearing implicit price for a particular attribute represents both producers' costs of providing the attribute and consumers' willingness-to-pay for the attribute.

There are several common issues associated with hedonic models, the most important of which of which is model misspecification. Economic theory provides no guidance on choosing the appropriate functional form for the hedonic price function (Chau and Chin 2003; Halvorsen and Pollakowski 1981). Following Yim et al. (2014) and Teuber and Hermann (2012), the Box-Cox Test was used to determine the appropriate functional form for the hedonic price functions in this study (Box and Cox 1964). Three functional forms were considered: linear, log-linear and inverse square root. Results from the Box-Cox Test suggest that the log-linear functional form outperforms the other specifications and was thus used in this study. Other common issues present in hedonic analyses include heteroscedasticity and multicollinearity (Constanigro et al. 2011). In this analysis, the Breusch-Pagan-Godfrey test and variance inflation factors are used to detect the presence of heteroscedasticity and multicollinearity respectively.

Application of Hedonic Price Model to Fruit Beverages

In this analysis, we estimate hedonic models for 100% fruit juice and fruit drinks. The following hedonic price functions are estimated:

$$(8)\ \ \ln(JuicePrice) = \beta_0 + \sum_{j=1}^{4} \alpha_j Nutr + \sum_{k=1}^{14} \beta_k Prod + \sum_{l=1}^{3} \gamma_l Pack + \sum_{m=1}^{15} \delta_m Acq + \varepsilon$$

$$(9)\ \ln(DrinkPrice) = \beta_0 + \sum_{j=1}^{8} \alpha_j Nutr + \sum_{k=1}^{15} \beta_k Prod + \sum_{l=1}^{3} \gamma_l Pack + \sum_{m=1}^{14} \delta_m Acq + \varepsilon$$

where *JuicePrice and DrinkPrice* are the price per ounce for fruit juice and fruit, drink purchases respectively. Attributes of fruit beverages included in the hedonic price function are classified into four categories: (1) nutrients (*nutr*), (2) product attributes (*prod*), (3) packaging (*pack*) and (4) acquisition attributes (*acq*). The variables included in these categories are detailed in Table 2.

The first category of attributes, nutrients, is comprised of the key nutrients found in fruit beverages that are sought by consumers and advertised by manufacturers. These include antioxidants, Vitamin C, Vitamin D, Calcium and sugar[1]. Calcium and Vitamin D are combined into a single variable as fruit beverage manufacturers tend to fortify fruit beverage products with Vitamin D in conjunction with Calcium (Biancuzzo et al. 2010; De Lourdes et al. 2012; Table 1). With the exception of sugar, a price premium is expected for each of these nutrients due to the health benefits they provide consumers, as well as the added costs manufacturers, incur when fortifying fruit beverages. Conversely, we hypothesize that sugar will garner a negative price premium as consumers and manufacturers seek to limit its content in fruit beverages. Interaction terms between the nutrients and a diet (zero or low-calorie) fruit drink dummy variable, are also included in the nutrients category. These interaction terms are included to distinguish between the price premium for nutrients in diet and non-diet fruit drinks.

The second category, product attributes, consists of five variables representative of the products' characteristics: flavor, brand name, private label, diet and organic. In their studies on fruit beverages, Szathvary and Trestini (2014) and Weemaes and Riethmuller (2001) found that price premiums for fruit beverages varied by flavor. In this study, we include the following top-selling fruit beverage flavors: orange, other citrus, berry, apple, lemonade[2], mixed fruit, vegetable[3], grape and other flavors (Euromonitor 2015); orange is the reference flavor. In addition to flavor, dummy variables for brands with a market share greater than 5% in the fruit juice and drink markets are included in the model. Depending on the brands's reputation, prior hedonic analyses have found that brand names garner both positive and negative price premiums (Morgan et al. 1979; Szathvary and Trestini 2014). A dummy variable is also included for private label products, with the expectation that these products are associated with negative price premiums (Sethuraman & Cole 1999). Two additional product attributes are included in the analysis: organic and diet[4]. Past studies have found that organic beverages garner significant price premiums (Szathvary and Trestini 2014; Gulseven and Wohlgenant 2014). Diet fruit beverages are also expected to garner a price premium given their value-added attribute of having fewer calories.

[1] For brevity, sugar is included in the nutrients variable category despite it classification as a carbohydrate.
[2] A lemonade dummy variable is not included in the fruit juice price functions as no lemonade is 100% juice.
[3] A vegetable dummy variable is included only in the juice price functions as all vegetable beverages are 100% juice
[4] Note that only fruit drinks can be classified as "diet"

Table 2. Definitions and descriptive statistics of variables

Variable	Definition	Unit	Base Variable	Mean (Juice)	Mean (Drinks)
Dependent Variables					
Per Unit Price**	Price per ounce for fruit juice and fruit drinks	$/oz	---	0.07	0.06
Nutrients					
Antioxidants***	Antioxidant content (excluding Vitamin C)	mg/100g	---	0.83	0.16
Calcium and Vitamin D***	Calcium and Vitamin D content	mg/100g	---	31.28	7.4
Vitamin C***	Vitamin C Content	mg/100g	---	30.08	13.08
Total Sugar***	Sugar Content	g/100g	---	10.24	11.63
Product Attributes					
Brand***	Set of ten dummies for top brand names	DV	Other Brands	0.05-0.08	0.05-0.10
Private Label***	Private label product	DV	Non-Private Label	0.21	0.05
Diet	Diet/low-calorie product	DV	Non-Diet	---	0.05
Flavor***	Flavor of fruit beverage: other citrus, berry, lemonade, apple, mixed fruit, vegetable, grape, other flavors	DVs	Orange	0.06, 0.05, ---, 0.17, 0.12, 0.07, 0.06, 0.07	0.02, 0.10, 0.13, 0.02, 0.44, ---, 0.04, 0.14
Organic	Organic product	DV	Non-Organic	0.05	0.06
Packaging					
Package Size*, ***, ***	Set of three package size dummies: oversized (≥ 89oz), standard (59-64oz) and single serve (≤ 24 oz)	DVs	Other Sizes	0.11, 0.13, 0.45	0.13, 0.22, 0.33
Acquisition Attributes					
Low-Access Tract***	Acquisition in low-access census tract at 1/10 mi urban/rural	DV	Non-Low-Access	0.35	0.29
Low-Income Tract***	Acquisition in low-income census tract	DV	Non-Low-Income	0.48	0.59
Region***	Item purchased in the West, South or Midwest	DVs	Northeast	0.26, 0.31, 0.25	0.26, 0.38, 0.19
Season***	Item purchased in fall, winter or spring	DVs	Summer	0.37, 0.04, 0.13	0.33, 0.06, 0.16
Store Type***	Set of four dummies for store type: convenience, club store, discount store and supermarket	DVs	Grocery Store	0.02, 0.04, 0.02, 0.86	0.03, 0.02, 0.05, 0.84
WIC	WIC payment used for acquisition	DV	Non-WIC	0.08	---
Coupon Used	Amount of coupon(s) applied to item purchased	$	---	0.02	0.01
Store Savings**	Amount of store savings applied to item purchased	$	---	0.17	0.14

Note. *Means for fruit juice and fruit drinks differ at the 0.10 level, ** 0.05 level and *** 0.01 level

In the third category of variables, packaging, three variables are included to characterize each fruit beverage's package size: standard, single serve and oversized. In their analysis of soda prices, Fox and Melser (2014) found that the relationship between package size and price is non-linear. In general, single-serving containers of soft drinks cost more per ounce. than standard sized containers (two liters). The authors further find that oversized packages (24 packs) cost less per ounce than standard sized packages. Analogous to the findings of Fox and Mesler (2014), we expect that single-serving fruit beverages will garner a positive price premium and that standard and oversized fruit beverage containers will garner a negative price premium relative to other sizes.

The final category of variables describes the attributes of the acquisition, including where, when and how the fruit beverages were purchased. Store type, region, and census tract characteristics are included to characterize where the fruit beverages were purchased. Szathvary and Trestini (2014) found that fruit beverages sold at supermarkets garner a price premium over other retailer types. Past studies have also found significant heterogeneity in the regional consumption of food products (Morgan et al. 1979; Drescher et al. 2008; Singh et al. 2015). Dummy variables for acquisitions made in low-income and low-access census tracts are also included in the model. Due to a lack of competition from other retailers, food prices tend to be higher in low-access census tracts (Ver Ploeg 2010). Low-income census tracts are also expected to charge higher prices in that they have fewer chain retailers and supermarkets (Ver Ploeg 2009; Powell et al. 2007). Seasonal dummy variables are included in the price functions to account for price variation due to the seasonality of fruit production and demand. We also account for whether WIC was used as payment for fruit juice. Because the size, flavor, and brand that WIC participants can purchase are predetermined, these consumers likely do no not consider price when purchasing fruit juice. Finally, the dollar amount of coupons and store savings applied to fruit beverages are included, with the intuitive hypothesis that coupon usage and store savings are associated with lower prices.

Data

Data Set

The National Household Food Acquisition and Purchase Survey (FoodAPS) data set was used for the analysis in this study (2016a). Funded by the United States Department of Agriculture (USDA) Economic Research Service (ERS) and the Food and Nutrition Service (FNS), FoodAPS is a national survey of 4,826 households. Collected between April 2012 and January 2013, the FoodAPS dataset contains a record of each household's food at home (FAH) and food away from home (FAFH) acquisitions over a one-week period. Entry and exit surveys were administered to households in order to collect demographic and socioeconomic data. The FoodAPS dataset also contains supplemental data on the nutritional composition of all food items purchased, food acquisition characteristics, payment methods and product attributes.

During the one-week acquisition period, 1,852 households in the FoodAPS dataset purchased fruit beverages for at home consumption. These households made a total of 4,166 fruit beverage purchases, of which 42% were fruit juice, and 58% were fruit drink purchases. Fruit beverage items that had a price of zero and were not associated with coupons or store discounts were

removed from the dataset. Each fruit beverage item purchased was then classified as either 100% fruit juice or as a fruit drink based on the percentage of juice it contained and its sugar content. This resulted in a final sample size of 1,362 fruit juice and 1,832 fruit drink purchases.

Descriptive Statistics

Descriptive statistics for the fruit beverage prices and attributes are presented in Table 2. Comparing fruit juice to fruit drinks, we find that fruit juice is slightly more expensive, with an average price of $0.07 per ounce versus $0.06 per ounce for fruit drinks. Of particular interest to this study are the differences in the nutritional composition of fruit juice and fruit drinks. The descriptive statistics reveal that fruit juice has significantly higher levels of all key nutrients in comparison to fruit drinks. In particular, fruit juice contains approximately 500% more antioxidants, 400% more Calcium and Vitamin D, and 225% more Vitamin C than fruit drinks. Despite having different vitamin and mineral contents, fruit juice and fruit drinks contain similar amounts of sugar. On average, fruit juice and fruit drinks contain 10.24 and 11.63 grams of sugar per 100g serving respectively.

Putting these numbers into perspective, Figure 1 presents the percentage recommended daily value (%DV) of key nutrients provided by the fruit beverages in the data set (FDA 2013b). On average, an 8oz serving of fruit juice provides 115%, 7% and 6% of the %DV of Vitamin C, Calcium, and Vitamin D, and antioxidants, while fruit drinks provide 50%, 2% and 1% of the %DV respectively. Comparing sugar content, an 8oz serving of fruit juice contains 73% of the %DV, compared to 83% for fruit drinks.

In addition to nutrients, the descriptive statistics reveal key differences in the product attributes of fruit juice and drinks. The distribution of flavors varies significantly between fruit juice and fruit drink purchases. For fruit juice, orange is the top-selling flavor, followed by apple, mixed fruit, vegetable/other flavors, grape/other citrus, and berry. Mixed fruit is the top selling fruit drink flavor, followed by lemonade/other flavors, orange, berry, grape and apple/other citrus. These distributions are similar to those reported by Euromonitor (2015), suggesting that the fruit beverage purchases in the FoodAPS dataset are representative of all US fruit beverage acquisitions.

We also find that while the market share of the top five fruit juice and drink brands are similar, private label products comprise 21% of fruit juice purchases, but only 5% of fruit drink purchases. According to Abate and Peterson (2005), the narrow price difference between private label and branded juice drinks is a possible explanation for private label products' low market share in the fruit drink segment. Considering packaging, a greater share of fruit drinks are purchased in single serve and oversized packages, 22% and 13%, versus 13% and 11% for fruit juice. Conversely, a greater share of fruit juice purchases are in standard size packages, 45%, versus 33% for fruit drinks.

The characteristics of fruit beverage acquisitions also differ significantly between fruit juice and fruit drinks, with both regional and seasonal heterogeneity. Fruit drinks purchases are more prevalent in the Southern portion of the United States, while fruit juice purchases are more prominent in the Midwest. Where acquisitions are made also varies significantly by fruit

beverage type. While the shares of fruit drinks and juice purchased at supermarkets are similar, a greater share of fruit drink purchases are made at convenience retailers and discount stores, while a greater share of fruit juice purchases are made at club stores. We also find that fruit drink (fruit juice) purchases are more common in low-income (low-access) census tracts. Looking at payment type, 8% of fruit juice purchases were made using WIC benefits. While savings from coupons are comparable, store savings are, on average, 20% greater for fruit juice than fruit drinks.

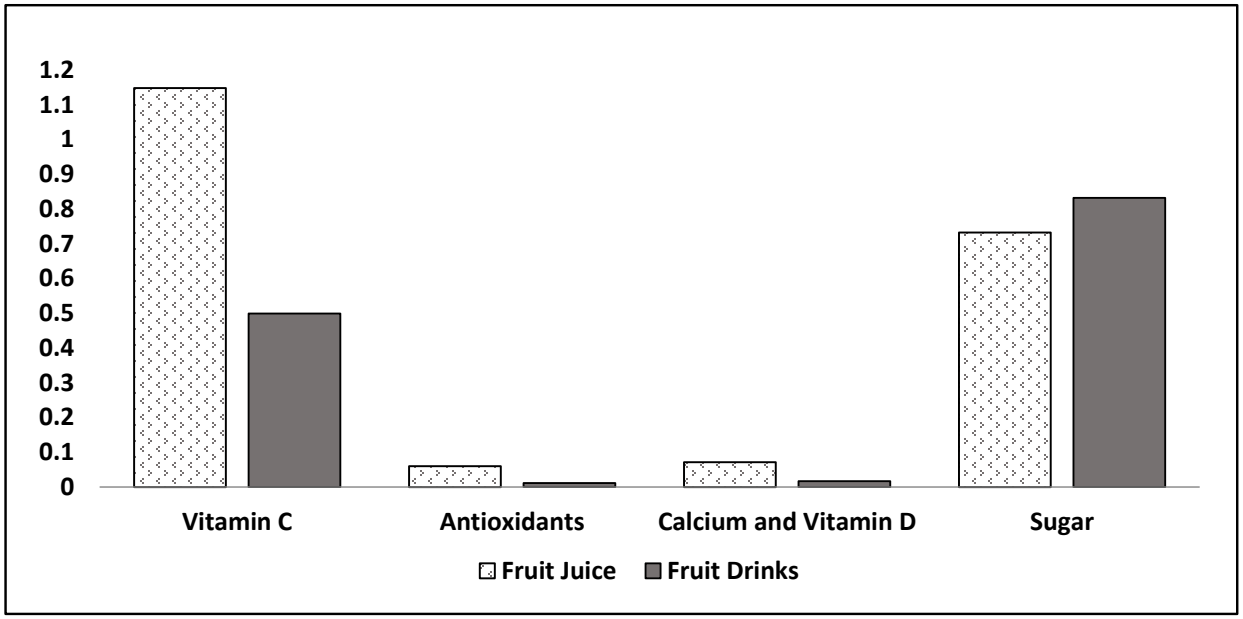

Figure 1. Percent daily value of key nutrients in fruit beverages based on a 2000 calorie diet

Results

Estimates of the log-linear fruit juice and fruit drink hedonic price equations are obtained using ordinary least squares regression techniques and are presented in Table 3. The estimated models explain a significant portion of the variation in fruit juice and fruit drink prices, with r-squared values of 0.64 and 0.62 respectively. Breush-Pagan test results suggest the presence of heteroskedasticity, thus we calculate White-Huber standard errors.

Nutrients

Of particular interest to this study, are the price premiums associated with nutrients and sugar in fruit beverages. The hedonic price estimates in Table 3 show that price premiums for nutrients and sugar vary between fruit juice, non-diet fruit drinks and diet fruit drinks.

Table 3. Fruit beverage hedonic price function estimates

	Fruit Juice (N=1,362)		Fruit Drinks (N=1,832)	
Variable	**Coeff.**	**SE**	**Coeff.**	**SE**
Nutrients				
Antioxidants	0.05*	0.03	0.01	0.04
Diet*Antioxidants	---	---	-0.36**	0.17
Vitamin C	2.20E-03***	6.33E-03	0.01***	1.32E-03
Diet*Vitamin C	---	---	-0.02**	0.01
Calcium and Vitamin D	4.95E-04**	2.20E-04	0.02***	0.01
Diet*Calcium and Vitamin D	---	---	-0.06***	0.03
Total Sugar	2.75E-04	6.33E-04	0.01***	3.06E-03
Diet*Total Sugar	---	---	-0.06**	0.03
Product Attributes				
Brand 1	0.07	0.06	-0.31***	0.04
Brand 2	0.25***	0.03	-0.08*	0.05
Brand 3	0.15***	0.03	0.39***	0.05
Brand 4	0.05	0.04	-0.01	0.04
Brand 5	0.29***	0.04	0.05	0.05
Private Label	-0.25***	0.03	-0.22***	0.04
Other Citrus	0.21***	0.05	0.10	0.07
Berry	0.18***	0.05	0.23***	0.05
Apple	-0.02	0.04	0.33***	0.13
Lemonade	---	---	0.24***	0.06
Mixed Fruit	0.04	0.04	0.20***	0.04
Vegetable	-0.42*	0.24	---	---
Grape	0.16***	0.06	0.05	0.09
Other Flavors	0.19***	0.07	0.01	0.05
Diet	---	---	1.43***	0.44
Organic	0.30***	0.07	0.86***	0.06
Packaging				
Oversized Package	-0.38***	0.04	-0.53***	0.04
Single Serve Package	0.67***	0.06	0.66***	0.06
Standard Size Package	-0.30***	0.04	-0.06*	0.04
Acquisition Attributes				
Low-Access Tract	9.03E-03	0.02	0.02	0.03
Low-Income Tract	-0.08***	0.02	-0.12***	0.02
Fall	0.04*	0.02	-0.02	0.03
Spring	0.12***	0.03	-0.06*	0.04
Winter	0.01	0.04	-0.12**	0.06
Midwest	-0.08**	0.03	-0.03	0.04
South	-0.06*	0.04	-0.06*	0.04
West	3.43E-03	0.04	0.02	0.04
WIC	0.12***	0.03	---	---
Convenience	0.26***	0.07	0.18	0.12
Club Store	-0.14	0.10	0.02	0.08
Discount Store	-0.42***	0.12	0.03	0.07
Supermarket	-4.20E-03	0.06	-0.01	0.05
Coupon Used	-0.52*	0.32	-0.10	0.09
Store Savings	-0.18***	0.02	-0.15***	0.04
Constant	-2.87***	0.07	-3.82***	0.07
R-Squared	**0.64**		**0.62**	

Note. *, ** and *** denote significance at the 10%, 5% and 1% level, SE refers to White Huber standard errors

Looking first at fruit juice, we find that all nutrients garner a price premium. Adding an additional mg of antioxidants (Vitamin C) to fruit juice leads to a 5% (0.01%) increase in the price per ounce. For a standard 60oz container, this corresponds to a $0.21 and $0.01 premium for an additional mg of antioxidants and Vitamin C respectively. While Calcium/Vitamin D also garners a price premium, the premium itself is extremely small. Adding an additional mg of Calcium/Vitamin D increases the per ounce price of fruit juice by just 0.0005%, or a $0.002 premium for the standard 60oz container. These price premiums for nutrients in fruit juice likely reflect both manufacturers' costs and consumers' willingness-to-pay. For manufacturers, fortifying fruit juice with vitamins and minerals leads to increased production costs. On the demand side, consumers may pay a premium for fruit juice containing more nutrients given their positive health benefits. Unlike nutrients, sugar is not associated with a price premium in fruit juice. This finding is likely the result of the fact that manufacturers do not incur the cost of adding sugar to fruit juice, as juice naturally contains large amounts of sugar (O'Neil and Nicklas 2008). Consumers may also pay a premium price for fruit juice containing more sugar given the growing public concern over the adverse health effects of sugar consumption.

Unlike fruit juice, an additional gram of sugar is associated with a 1% price premium for non-diet fruit drinks. For the standard 60oz container, this corresponds to $0.04 for each additional gram of sugar. This premium is partly attributable to the added costs manufacturers face when adding sugar to non-diet fruit drinks. On the demand side, consumers that prefer the taste of sweeter drinks may also pay a premium for non-diet fruit drinks containing additional sugar.

Also differing from fruit juice, only select nutrients garner price premiums in non-diet fruit drinks; Vitamin C and Calcium/Vitamin D are associated with a price premium, while antioxidants are not. Adding an additional mg of Vitamin C (Calcium/Vitamin D) to a non-diet fruit drink leads to a 1% (2%) increase in the price per ounce. For the standard 60oz container, this corresponds to a $0.04 and $0.07 premium for Vitamin C and Calcium/Vitamin D respectively. As with fruit juice, these premiums likely reflect the costs incurred by manufacturers to fortify the fruit drinks with nutrients, as well as consumers' willingness to pay for nutrients given their positive health benefits. However, the price premiums for Vitamin C and Calcium/Vitamin D in non-diet fruit drinks are larger than those for fruit juice. One plausible explanation for this difference is the fact that fruit drinks contain less naturally occurring nutrients than fruit juice. (Harris et al. 2011; Empty 2015). Thus, to achieve the same level of nutrients, non-diet fruit drink manufacturers must incur higher fortification costs than fruit juice manufacturers.

Differing from both non-diet fruit drinks and fruit juice, nutrients and sugar in diet fruit drinks are associated with negative price premiums. An additional mg of antioxidants, Vitamin C and Calcium/Vitamin D leads to a 35%, 1% and 4% decrease in the price per ounce respectively. For the standard 60oz container, this corresponds to a $1.26, $0.04 and $0.14 discount for an additional mg of antioxidants, Vitamin C and Calcium/Vitamin D. Similarly, an additional gram of sugar leads to a 5% decrease in the price per ounce for diet fruit drinks or a $0.18 discount for the standard 60oz container. Given that manufacturers still incur additional costs when adding nutrients and sugar to diet fruit drinks, these negative price premiums suggest that diet fruit drink consumers pay a premium to reduce nutrients and sugar. Given the nature of diet fruit drinks, consumers intuitively seek to reduce to nutrients and sugar in diet fruit drinks in order to reduce

the fruit beverages' caloric content; by reducing the nutrient and sugar content of a diet fruit drink, one also decreases the calories in the drink.

Based on these results, three main generalizations are made about the price premiums for nutrients and sugar in fruit beverages:

1. All nutrients garner premium prices in fruit juice
2. Sugar and select nutrients garner premium prices in non-diet fruit drinks
3. All nutrients and sugar are associated with negative price premiums in diet fruit drinks

Product Attributes

In addition to nutrients, several product attributes also garner price premiums in fruit beverages. As found by Szathvary and Trestini (2014), nearly all of the top fruit juice and fruit drink brands garner a price premium, ranging from 15% to 39%. However, fruit drink Brands 1 and 2 have negative coefficients, suggesting that these are discount or value brands. Unlike branded products, private label fruit beverage products are associated with a negative price premium. Relative to branded products, private label fruit juice, and fruit drink products cost 25% and 22% less per ounce respectively. The hedonic price equations also highlight flavors' effect on fruit beverage prices. Relative to orange juice, berry, grape, other citrus and other flavors garner price premiums ranging from 16% to 21%. Conversely, vegetable flavored juice is shown to cost 42% less per ounce than orange juice. Considering fruit drinks, nearly all flavors are associated with higher prices than orange flavored drinks, with price premiums ranging from 20% for mixed fruit to 33% for apple flavored drinks.

The estimation results also indicate that organic and diet fruit beverages are associated with significant price premiums. Compared to non-organic fruit beverages, organic fruit juice, and fruit drinks price is 30% and 86% higher per ounce respectively. This finding is comparable to that of Szathvary and Trestini (2014), who found a 48% price premium for organic fruit beverages sold in Australia. Diet fruit drinks also garner a substantial price premium, with prices 143% higher than those of non-diet fruit drinks.

Packaging

Similar to the findings of Fox and Melser (2014) for soft drinks, we find that fruit beverages sold in single serve packages are associated with higher prices, relative to other package types. Single serve packages garner 67% and 60% price premiums for fruit juice and fruit drinks respectively. Also mirroring the results of Fox and Melser (2014), we find that fruit beverages sold in standard sized and oversized packages are associated with lower per ounce prices than other package types. This negative price premium is greater for oversized packages than for standard sized packages, with oversized packages priced 38% (53%) less per ounce for fruit juice (drinks) and standard sized packages priced 30% (6%) less per ounce respectively.

Acquisition Attributes

Several attributes of the acquisition event also affect the price of fruit beverages. The estimation results indicate there is both seasonal and regional variation in fruit juice and fruit drink prices. Further, while fruit drinks prices appear to be similar across retailer types, the type of store fruit juice is purchased at has a significant impact on its price. Relative to grocery stores, fruit juice prices are 26% higher at convenience retailers and 42% less at discount retailers.

Further, the estimation results confirm that store savings and coupon usage are associated with lower prices for fruit beverages. When store savings are applied to an item, prices decrease by 18% and 15% for fruit juice and fruit drinks. Similarly, fruit juice prices decrease by 52% when a coupon is used; for fruit drinks, the coefficient for coupon usage is negative but not significant. The hedonic price equation estimates further indicate a 12% price premium for fruit juice purchased using WIC benefits. This finding supports this studies hypothesis that because size, flavor, and brand that WIC participants can purchase are predetermined, WIC consumers likely do not consider price when purchasing fruit juice.

Dummy variables for acquisitions made in low-income census tracts also significantly affect fruit beverage prices. Low-income census tracts are associated with fruit juice and fruit drink prices 8% and 12% less than those in non-low-income census tracts. This is likely attributable to retailers charging lower prices in low-income areas where households have less disposable income.

Conclusions

Given the increased importance consumers and manufacturers have placed on the functional nutrients found in fruit beverages, as well as the changing federal guidelines on fruit beverage consumption, this study sought to determine whether specific nutrients garner price premiums in fruit beverages sold in the US. Using the National Household Food Acquisition and Purchase Survey, hedonic price models for fruit juice and fruit drinks are estimated to determine whether specific nutrients, product characteristics, packaging type and acquisition characteristics are associated with price premiums. Based on the results from the hedonic price models, three generalizations are made about the price premiums for nutrients and sugar in fruit beverages: (1) all nutrients garner premium prices in fruit juice, (2) sugar and select nutrients garner price premiums in non-diet fruit drinks and (3) all nutrients and sugar are associated with negative price premiums in diet fruit drinks. Findings further suggest that product attributes such as brand, flavor, organic labels, diet labels and package type, and acquisition characteristics such as store type, region, season and payment type are associated with price premiums in fruit beverages.

This study's price premium estimates for nutrients can provide valuable insight to fruit beverage manufacturers, particularly in their design of future marketing initiatives and new product development. Given the growing concern over the healthfulness of fruit beverages in recent years, manufacturers are employing marketing tools such as front-of-package labels and advertisements to emphasize the nutrients found in fruit beverages. Estimates of price premiums for these nutrients can help fruit beverage manufacturers determine which specific nutrients to emphasize in these marketing initiatives. Assuming that the marginal costs of different nutrients are similar, fruit beverage manufacturers should emphasize the nutrients that garner the largest

price premium. Results from this study suggest that fruit juice marketing initiatives should focus on antioxidants, while non-diet drink marketing efforts should emphasize Vitamin C and Calcium/Vitamin D. For diet fruit drinks, all nutrients are associated with a negative price premium, suggesting that marketing efforts should focus on calorie content instead of nutrient content.

Estimates of price premiums for nutrients can also help guide fruit beverage manufacturers in new product development. In developing a new fruit beverage product, manufacturers must determine whether or not to fortify the product with nutrients and, in the case of fortification, which specific nutrients should be used. Negative price premium estimates suggest that fortification will not lead to increased returns for diet fruit drink manufacturers. However, positive price premium estimates from this study suggest that fruit beverage manufacturers should consider fortifying fruit juice and non-diet fruit drinks with certain nutrients. Fruit juice and non-diet fruit drink manufacturers can compare the price premiums for specific nutrients estimated in this study to their marginal costs of fortification to determine which specific nutrients to use in fortifying their product.

Acknowledgement

Any opinions, findings, recommendations or conclusions are those of the authors and do not necessarily reflect the views of the Economic Research Service, United States Department of Agriculture.

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Appendix

Table A1. Percent of the daily value of nutrients in eight ounces of assorted fruit juices. Based on a 2,000 calorie diet.

Nutrient	Apple Juice	Cranberry Juice Cocktail	Grape Juice (Purple)	Grapefruit Juice (White)	Orange Juice	Pineapple Juice	Prune Juice
Energy, kcal	6%	7%	8%	5%	5%	7%	9%
Protein, g	0%	0%	3%	2%	3%	3%	3%
Total sugars, g	76%	94%	119%	49%	63%	109%	109%
Dietary fiber, g	1%	0%	0%	1%	3%	2%	10%
Total fat, g	0%	0%	0%	0%	1%	0%	0%
Vitamin A, RAE	0%	0%	0%	4%	1%	0%	0%
Vitamin E, mg	0%	3%	0%	1%	2%	0%	2%
Vitamin C, mg	4%	100%	0%	156%	143%	42%	18%
Calcium, mg	2%	1%	0%	2%	2%	3%	3%
Phosphorous, mg	2%	0%	3%	4%	4%	2%	6%
Magnesium, mg	2%	1%	6%	8%	7%	8%	9%
Iron, mg	5%	1%	3%	3%	6%	4%	17%
Sodium, mg	0%	0%	0%	0%	0%	0%	0%
Potassium, mg	8%	1%	10%	11%	12%	9%	20%

Sources. O'Neil & Nicklas (2008); FDA (2013b)

