Got Milk?

Stockholm Municipality's Own- and Cross-Price Elasticities for Organic and Conventional Milk Procurement

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Abstract

This thesis investigates Stockholm Municipality's own-price elasticity for organic milk procurement and cross-price elasticity between organic and conventional milk procurement during 2008-2013. Using log-linear specifications with fixed effects, organic milk was found in most specifications to be relatively elastic, while the cross-price elasticity between organic and conventional milk suggests the two products are substitutes. The estimation strategy relies on the differences in milk consumption within and between organic and conventional product pairs.

Keywords: Organic Milk Consumption, Own-Price Elasticity, Cross-Price Elasticity, Public Procurement

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1. Introduction

Driven by a relatively low price premium, private domestic organic milk consumption in Sweden has seen a steady rise over the past decade (Jörgensen, 2012). From 2004 to 2014, real organic dairy expenditure increased by 153%, growing from 4% of real total dairy expenditure to 7.6%. Among organic commodities, dairy has consistently seen the largest consumption, and as of 2015 real dairy expenditure accounted for 18% of total organic expenditure (Statistics Sweden, 2017). Although dairy represents milk, cheese, and eggs, it is milk that accounts for the lion's share of consumption (Jörgensen, 2012). Swedes are among the largest consumers of milk, and in 2007, Sweden ranked second in global per capita milk consumption, narrowly trailing Finland (FAO, 2017). As a result, the Swedish domestic organic market was among the highest in the world in 2010, trailing only Denmark, Austria, and Switzerland (Jörgensen, 2012). Since then, the organic market in Sweden has grown from 3.9% of real total food expenditure in 2010 to 6.6% in 2015 (Statistics Sweden, 2017). In addition to the private market, organic milk expenditure in the public sector has also seen a rise (EkoWeb, 2015). Given a 2005 national policy enactment mandating Swedish municipalities' food procurement expenditure to be at least 25% organic, it is interesting to examine Sweden's public price elasticities for organic milk (Regeringen, 2005). As organic milk has a relatively low price premium, it is typically the first product to be procured from the conventional to organic variety, and in reaching the 25% organic procurement target, municipalities may not be very price-sensitive (Jörgensen, 2012).

This paper will explore the public side of milk demand in Sweden, specifically investigating milk procurement in Stockholm Municipality. Using 2008-2013 monthly panel data consisting of Stockholm Municipality's expenditure and price quotes for conventional and organic milk, this paper employs log-linear specifications with fixed effects to obtain the municipality's own-price elasticity for organic milk and cross-price elasticity between the two products. To the best of my knowledge, no quantitative research has been conducted on the public demand for milk in Sweden. Procurement data is not readily available in Sweden and must be obtained through municipalities. Even in the private market, long-term price data for organic commodities is limited, making studies of the organic industry difficult to carry out. Stockholm Municipality is a particularly interesting case to investigate due to the fact that it is the largest of Sweden's 290

municipalities and the nation's largest public milk procurer (Statistics Sweden, 2017), (Jörgensen, 2012). It is also unique in that a rich monthly panel dataset is utilized. Panel data at a monthly level is typically difficult to obtain, and most studies settle for using time series data or annual panel data (Meng, et al., 2014).

Specifically, this paper asks the following research question: *driven by organic procurement targets, does Stockholm Municipality have an inelastic demand for organic milk, and are organic and conventional milk substitutes for one another?*

Due to milk's prevalence in satisfying organic policy targets, as well as the added value Stockholm Municipality places on organic production, there is reason to suspect that the demand may not be price-sensitive. Furthermore, despite relatively low price premiums for milk, the conversion from conventional to organic public consumption has enormous aggregate costs (Jörgensen, 2012). Jörgensen (2012) approximated that the average organic price premium for organic food products was roughly 66%, while the organic price premium for milk was roughly 27%. Due to these organic price premiums, Jörgensen estimates that reaching the national legislature's 25% organic public procurement goal could increase annual public expenditure by 350-850 million SEK, or 53-128 million dollars. Concurrently, Jörgensen estimates that the production of the organic market will have a slower increase than this demand, at roughly 16%. This could very well drive up the price for organic products. Moreover, Jörgensen estimates that if Sweden transitioned public food procurement entirely to the organic variety, annual public expenditure could increase by 2/3, equating to roughly 4-5 billion SEK, or 600-750 million dollars (Jörgensen, 2012). Depending on a cost-benefit analysis of procuring organic food at this scale, the costs associated with an increase may very well be worth it. Yet given these large costs, an examination of how Sweden – and this in this paper Stockholm Municipality – responds to changes in the price of organic procurement is of importance.

This paper will utilize elements of previous studies on the demand for other commodities. Log-linear specifications with fixed effects are employed to regress the logged volume of public organic milk procurement in Stockholm Municipality on logged organic and conventional milk prices. The methodology and specifications used in this paper are in line with literature that have calculated price elasticities for products such as alcohol, fuel, and micronutrients. The paper is structured as follows: section 2 provides an overview of organic consumption in Sweden, while

section 3 details the theory and previous research behind prices and consumption. Section 4 outlines the data, methodology, and descriptive statistics, and section 5 provides the regression and robustness results. Lastly, section 6 provides a discussion of the results, and concluding remarks are presented in section 7.

2. Procurement and Organic Consumption – The Swedish Context

In 2005, the Swedish national legislature enacted a policy objective requiring that at least 25% of municipal food procurement should be of organic variety by 2010. The main premise behind this target was to promote Swedish agricultural organic production, most notably milk, eggs, and meat. Additionally, health concerns, GMO avoidance, and animal welfare also contributed to its enactment. The policy's aim was to use increased public expenditure as a tool to increase private demand for organic products. By increasing prices and stimulating the domestic organic agricultural production, firms would be incentivized to expand investment in the organic market to realize potential profits. This would in turn lead to increased organic product availability for private consumers (Regeringen, 2005). This goal was supplemented in 2017, with a new target of 60% public procurement by 2030 (Regeringen, 2017).

In regards to the 2005 policy enactment, which covers the timespan of this paper's data, municipalities are free to exceed this 25% goal, with some setting aggressive targets. The municipalities of Lund, Malmö, and Borlänge, for example, have each set a 100% public organic procurement goal by 2020 (Jörgensen, 2012). Stockholm Municipality, the largest of Sweden's 290 municipalities, has also instituted its own objectives, with organic procurement targets steadily rising over the last decade. Their goal for the end of the 2008-2011 period was to achieve at least a 15% organic procurement rate (Stockholm Stad, 2008). For 2012-2015, their target goal increased to 25% (Stockholm Stad, 2012). Under the Stockholm Environmental Program of 2016-2019, six main goals were outlined in order to pursue a healthy, sustainable urban development. Among them, their "Nontoxic Stockholm" goal aims to reduce hazardous toxins and the environmental impact of their food procurement by shifting towards an organic assortment. In order to meet these objectives, Stockholm Municipality has set a 50% organic public procurement goal. Special emphasis has been outlined for the procurement of organic dairy products, meat, coffee, potatoes, bananas, and fish (Stockholm Stad, 2016). Stockholm Municipality reached the

national policy goal of 25% organic procurement in 2014, and as of 2015 the municipality has achieved a 33% organic procurement rate (EkoWeb, 2015) (EkoMatCentrum, 2016). As for the rest of Sweden, Vellinge Municipality currently has the highest share of organic procurement at 72%, and it is estimated that 32% of public food procurement across Sweden is organic (EkoWeb, 2017).

Despite being a relatively small country, Sweden's organic market is among the largest in the world. As a share of the Swedish organic market, domestic production has been steadily increasing. In 2012, imports made up roughly 50% of the total organic market, but shrank to 27% as of 2017 (Jörgensen, 2012) (EkoWeb, 2017). The real expenditure share of the total Swedish food market has roughly tripled in the past ten years, standing at 6.6% in 2015 (Statistics Sweden, 2017). The total organic expenditure and its share of the total food market can be seen below in Figure 1. Despite the accelerated growth of the organic market, however, it still relatively small in relation to the total food market.

Table 1: Real Organic Expenditure and Total Market Share

Year	*Real Organic Expenditure*	*Share of Total Market*
2015	14,053	6.6%
2014	11,181	5.5%
2013	7,731	4.0%
2012	6,947	3.7%
2011	7,301	4.0%
2010	6,977	3.9%
2009	6,724	3.7 %
2008	5,913	3.4%
2007	4,446	2.6%
2006	3,629	2.2%
2005	3,562	2.3%
2004	2954	1.9%

Source: Statistics Sweden, expressed in millions of SEK, 2005 CPI base year

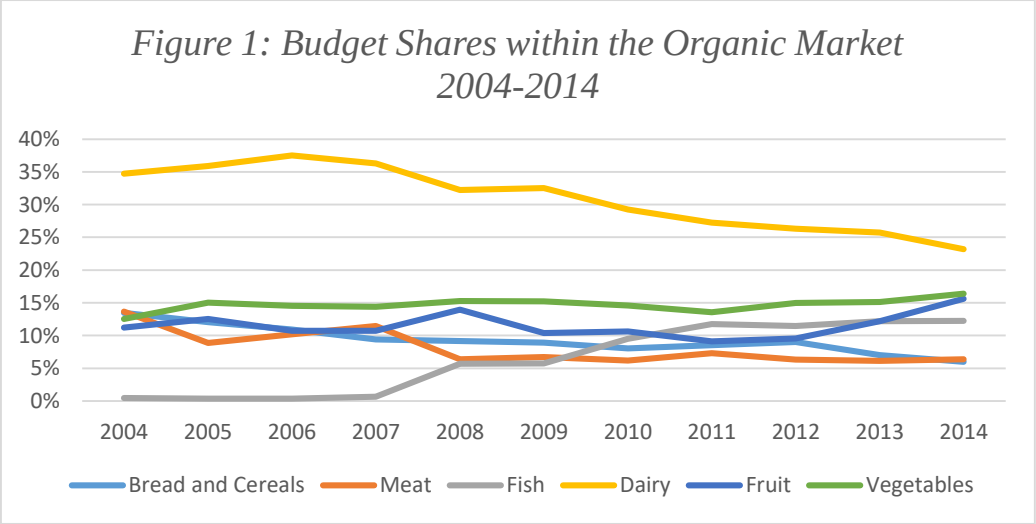
As seen in Figure 2 below, organic dairy has increasingly represented larger shares of the total dairy market. From 2004 to 2014, real organic dairy expenditure increased by 153%, and its share of the total dairy market nearly doubled, rising from 4% to 7.6%

Table 2: Real Organic Dairy Expenditure and Total Dairy Market Share

Year	*Organic Real Dairy Expenditure*	*Share of Total Dairy Market*
2014	2,592	7.6%
2013	1,988	6.1%
2012	1,828	5.9%
2011	1,989	6.6%
2010	2,042	6.8%
2009	2,185	7.2%
2008	1,907	6.6%
2007	1,613	6.0%
2006	1,361	5.1%
2005	1,278	5.1%
2004	1,026	4.0%

Source: Statistics Sweden, expressed in millions of SEK, 2005 CPI base year

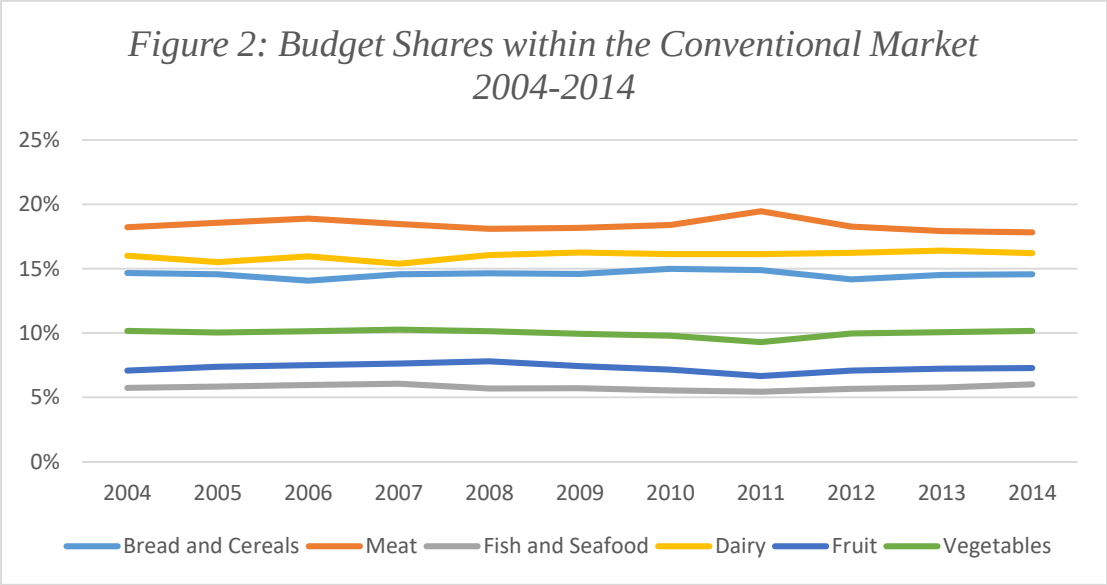
To gain a familiarity with the entire organic market, budget shares within the organic market can be seen below in Figure 3. The shares of organic products within the organic market have been relatively volatile, save for dairy and vegetables. While dairy dominated the organic market in 2004 and peaked in 2006, its market share has steadily decreased as other organic products such as fruit and fish have realized increased growth. Despite the growth of other organic commodities, however, dairy still remained the largest consumed good in the organic market.



Source: Statistics Sweden, 2005 CPI base year

The organic portfolio is in contrast with that of the conventional, which can be seen below in Figure 4. Contrary to the organic market, the conventional market has seen relatively stable

shares within its market. Meat has consistently seen the largest expenditures, yet dairy and bread and cereals have not been far behind.



Source: Statistics Sweden, 2005 CPI base year

3. Prices and Consumption

3.1 Theoretical Aspects of Price Elasticity of Demand and Supply and Demand

According to Parkin (2013), the price elasticity of demand measures the responsiveness of a quantity demanded to a change in its price. If the percent change in the quantity demanded is less than the percent change in price, the demand for a good is said to be inelastic. Alternatively, if the percent change in the quantity demanded is greater than the percent change in price, the good is considered elastic. An inelastic good has a price elasticity between 0 and 1, while an elastic good has an elasticity greater than 1. The cross-price elasticity of demand measures the responsiveness of a quantity demanded for a certain good to a change in price of another good. If the cross-price elasticity is positive, then the two goods are substitutes. Alternatively, if the cross-price elasticity is negative, the two goods are complements (Parkin, 2013). Graphical notation of a price-inelastic and price-elastic good is shown below Figures 3 and 4, respectively.

Figure 3: Price-Inelastic Demand

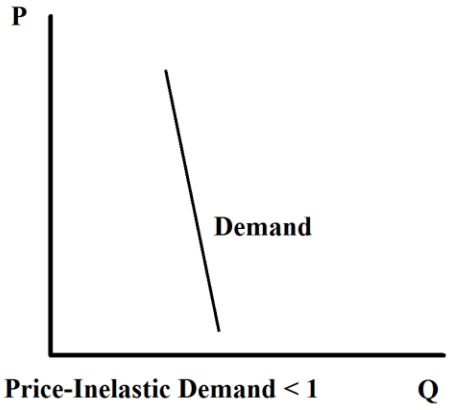
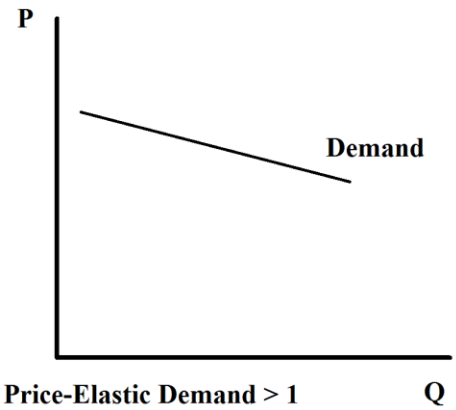
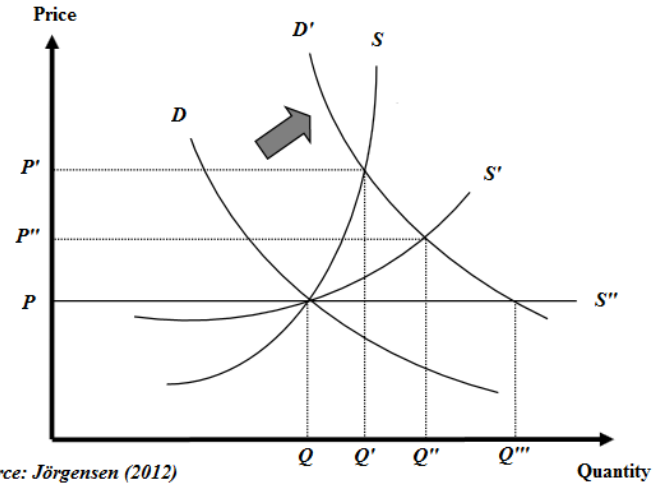


Figure 4: Price-Elastic Demand



In his comprehensive review of the organic market in Sweden, Jörgensen (2012) outlines the effect of organic procurement targets on the supply and demand. He writes that increasing procurement of organic commodities can raise the price in the short- and long-run. Jörgensen (2012) posits that an inelastic supply curve – represented by *S* in Figure 5 below – may exist for organic milk, at least in the short-run. Increasing organic milk production in the short-run is difficult, as investments in land, machinery, and distribution can take years to yield output. Furthermore, a company with market power can exploit high demand by limiting supply in order to keep prices high. As it is costly for new entrants, established firms within the organic market can utilize their strong market power to increase prices in the face of high demand (Jörgensen, 2012).

Figure 5: Supply and Demand of Organic Milk Procurement



Source: Jörgensen (2012)

With a positive demand shock spurred by organic procurement goals, the demand curve rises from point *D* to *D'* on the supply curve *S*. This causes the price to rise from *P* to *P'*. Should the supply curve be more elastic, as shown by *S'*, the positive shock in the demand curve would results in a price increase to *P''*. A more elastic supply can occur when investments have been made and realized, with new entrants in the market. With a fully elastic supply curve with constant marginal costs and perfect competition, represented by *S''*, price remains the same as consumption increases or decreases.

Jörgensen (2012) also outlines four different procurement approaches that municipalities can pursue, with each approach entailing different cost implications. The first approach is when a municipality is fully compensated for the price premiums of organic procurement. In this case, the municipality could procure any organic products that are desired, regardless of the price premium. As a result, the municipality's expenditure would likely rise as organic food is procured absent of cost minimization. This approach is the most costly. The second approach also utilizes an expanding budget that compensates for the cost of increased organic procurement. Unlike the first approach, however, cost minimization is employed. In other words, organic products with the lowest price premiums would be targeted. Under the third and fourth approaches, the budget is not expanded to compensate for the extra cost of organic procurement. In the third approach, the municipality would ignore the price premiums between organic products and procure whatever is desired, subject to the budget constraint. The fourth approach utilizes optimization, whereby the municipality procures organic products with the lowest price premiums, such as milk, coffee, and bananas, subject to its budget constraint. Since there is no budget compensation in these latter two approaches, increased organic expenditure must be offset by buying cheaper conventional food. The food basket will change – not just according to organic or conventional food – but rather the items in the basket will change in order to satisfy the budget constraint. The first and third approaches are similar to each other, as are the second and fourth. The difference between these pairs is the budget expansion through cost compensation. Despite a mix of all approaches, Jörgensen believes that municipalities generally lean on the second and fourth approach whereby the municipality optimizes procurement. Since the increased cost of organic procurement is typically not fully compensated, municipalities often target cheaper items in addition to procuring organic products with relatively low price premiums (Jörgensen, 2012).

As a public entity, municipalities may face soft-budget constraints. As such, a public entity may go beyond their budget knowing that the state can absorb the costs. Unlike with private firms, there is little risk in bankruptcy, and thus a public entity may lack the efficiency that a private company has to strive for. As a result, it may not be appropriate to assume the municipality is a rational, optimizing agent (Kornai, 1980). Ignoring this concern, however, the municipality would likely aim to maximize the output of their budget, through a combination of quality and quantity. In this case, the second or fourth procurement strategy outlined by Jörgensen (2012) would make most sense, depending to what degree organic procurement is compensated. In order to meet organic procurement requirements, while optimizing the budget constraint, a municipality would likely choose to procure organic products with low price premiums. As mentioned above, milk has one of the lowest relative organic price premiums, and is often the first product chosen when transitioning procurement to the organic variety (Jörgensen, 2012). Should the price of organic milk rise, the procurement volume may very well not be affected if the relative price premium is low relative to other organic commodities.

3.2 Earlier Approaches and Results

In the absence of public analysis, several studies have investigated private food and milk demand in Sweden, finding low, negative own-price elasticities. Edgerton et al. (1996), Säll and Gren (2015), and Hjerstrand (2007) all used an Almost Ideal Demand System in their analyses of consumer behavior of food commodities. Edgerton et al. (1996) investigated the demand for food in Nordic countries using national accounts data from 1963 to 1991. The authors found that the commodities' own-price elasticities were generally negative, and that they were normal goods. Among the various products, however, the consumption of milk, cheese, and eggs, along with other basic food products, were found to be relatively insensitive to price. The authors note, however, that there may exist misspecification to the separability structure of Sweden's aggregate data, and that alteration of the separability structure could improve the findings (Edgerton, et al., 1996). Säll and Gren (2015) analyzed annual private Swedish per capita time series consumption data to estimate the effect of environmental taxes on price elasticities for meat and dairy products, with their results showing negative yet relatively inelastic own-price elasticities for milk (Säll & Gren, 2015). Hjerstrand (2007) investigated food demand in the Swedish market using annual and quarterly time series data from 1963 to 2002, 1980Q1 to 1998Q4, and 1993Q1 to 2003Q2. Notably,

using an implied separability structure as well as the traditional separability structure, Hjerstrand (2007) found that milk, eggs, & cheese are significant necessities in both methods (Hjertstrand, 2007). In his review of the private organic market, Jörgensen (2001) estimated the consumer demand in Sweden. Utilizing cross-sectional micro data for several organic products, Jörgensen estimated a log-linear OLS, regressing logged volume on logged price. His findings suggested negative price effects existed for organic flour and potatoes, but none for milk (Jörgensen, 2001). While these studies investigated the Swedish food market, they focused on private demand. Among public analysis, Jörgensen (2012) conducted a comprehensive overview of the Swedish public organic market. Jörgensen speculated that due to increasing public organic procurement targets, as well as rising organic milk procurement in the face of rising prices, public demand for organic milk may be inelastic (Jörgensen, 2012). This paper will attempt to build on the current research on the Swedish private market by analyzing the public side of consumption, with the intention in examining whether Jörgensen's (2012) expectation of inelastic public milk demand holds for Stockholm Municipality.

Moreover, there exists additional literature investigating price elasticities for other commodities, of which elements of their methodology can be applied in this paper. Meng et al. (2014) used a pseudo-panel log-linear fixed effects approach to estimate cross- and own-price elasticities for alcohol products in the UK (Meng, et al., 2014). Logged consumption of beer was regressed on logged prices of beer and other types of alcohol while controlling for income, age, and marital status. Hatz II (2011) used a log-linear fixed effects model to generate price elasticities for fuel by regressing vehicle-miles travelled on fuel prices, controlling for a range of socio-economic factors (Hatz II, 2011), while Lui et al. (2006) used a log-linear fixed effects model to estimate the determinants of micronutrient consumption in China (Liu & Shankar, 2006). Using similar methodology to Meng et al., Lui et al., and Hatz II, this paper employs log-linear specifications with fixed effects to regress the logged volume of public organic milk procurement in Stockholm Municipality on logged organic and conventional milk prices.

4. Empirical Approach

4.1 Data

The data consists of Stockholm Municipality's monthly organic and conventional milk procurement from Arla Foods from 2008 to 2013, expressed in terms of weight in kilograms, expenditure in the Swedish Kronor, and corresponding prices. Arla Foods is the world's largest organic dairy supplier and Stockholm Municipality's main supplier of dairy products (EkoWeb, 2017). Stockholm Municipality procures from Arla for large orders, with a minimum purchase of 1000 SEK or 100 kg. The overwhelming share of Stockholm Municipality's food procurement serves their public schools, while elderly homes are also a significant recipient. The contract between Arla Foods and Stockholm Municipality stipulates that Arla can change the price for their different products up to four times a year (Lilja, 2017). It is assumed that the prices are in real terms, as inflation should theoretically be considered during negotiations. The data was obtained from Stockholm Municipality via Christian Jörgensen of Lund's Agrifood Economics Center.

4.2 Variables

The dependent variable is a vector of logged organic milk procured, measured in total kilograms. The independent variables are vectors of logged price/kg of the organic milk product and a logged price/kg for its respective conventional counterpart. The product pairs are chosen based on their relative magnitude in procurement, and the necessity of organic/conventional counterparts with the same quantity types. The variables are their descriptive statistics can be seen below in Table 3.

Table 3: Descriptive Statistics

Product	*Variable*	*N*	*Mean*	*Std. Dev.*	*Min*	*Max*
0.5% Milk 20L	Organic quantity (kilograms)	54	36,447.5	15,244.45	13,863.8	72,512
	Organic price (SEK per liter)	54	7.69	0.55	6.74	8.50
	Conv. price (SEK per liter)	54	5.84	0.38	5.45	6.50
1.5% Milk 20L	Organic quantity (kilograms)	54	28,179.88	12,080.75	9,642.5	53,612.3
	Organic price (SEK per liter)	54	8.05	0.64	7.12	8.95
	Conv. price (SEK per liter)	54	6.18	0.40	5.76	6.88
0.5% Milk Bag 10L	Organic quantity (kilograms)	54	12,595.37	5,910.05	1,730.4	25,657.3
	Organic price (SEK per liter)	54	8.10	0.65	7.05	9.49
	Conv. price (SEK per liter)	54	6.27	0.38	5.76	6.86
1.5% Milk Bag 10L	Organic quantity (kilograms)	45	6,789.3	2,560.78	1,730.4	10,918
	Organic price (SEK per liter)	45	8.51	0.51	7.79	9.49
	Conv. price (SEK per liter)	45	6.60	0.41	6.07	7.23
1.5% Milk 20x1L	Organic quantity (kilograms)	25	13,052.2	2,197.67	9,167	17,180.4
	Organic price (SEK per liter)	25	7.52	0.33	7.06	8.37
	Conv. price (SEK per liter)	25	6.20	0.19	6.11	6.82
Total	Organic quantity (kilograms)	233	20,697.64	15,066.51	1,730.4	72,512
	Organic price (SEK per liter)	233	8.01	0.65	6.74	9.49
	Conv. price (SEK per liter)	233	6.21	0.45	5.45	7.23

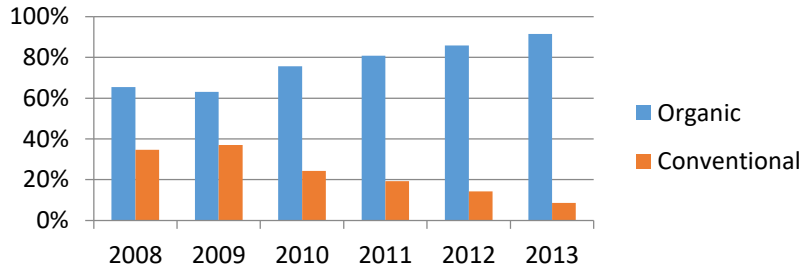
There exists missing observations for organic 1.5% milk 20L from the periods between September 2008 and December 2009. During this absence, however, the city temporarily procured organic 1.5% milk 20L from Denmark. Starting in January 2010, Stockholm Municipality once again began procuring original organic 1.5% milk 20L. Since they are the same quantities, it

assumed in this paper that these two products are the same. As a result, the Danish variety is substituted in for the missing values of the Swedish organic 1.5% milk 20L. From this point forward, the organic variety will simply be referred to as organic 1.5% milk 20L. Observations for organic 1.5% milk 10L bag are missing from September 2008 through December 2008. As a result, all observations for 2008 are removed, and the paired product data instead begins in January 2009. Similarity, observations for organic 1.5% milk 20x1L exist from January 2008 through October 2010, and are missing thereon. Therefore, paired observations exceeding these dates have been removed. As a result of the final two product pair's missing observations, the panel is unbalanced. Lastly, observations for the summer months of June, July, and August are removed, since procurement totals are extremely low. This is likely due to school closures during these months. As a result, there are nine monthly observations for the six years from 2008 to 2013.

4.3 Descriptives

Within the data from 2008-2013, Stockholm Municipality's milk procurement progressively shifted towards the organic variety, as seen below in Figure 6. After peaking with a 37% procurement rate in 2009, conventional milk procurement gradually decreased to just 9% of total milk procurement by 2013.

Figure 6: Stockholm Municipality Organic & Conventional Milk Expenditure Share



Source: Stockholm Municipality via Christian Jörgensen, Agrifood Economics

As seen in Table 4 below, the five product pairs chosen for this study make up between 72.4% and 78.5% of Stockholm Municipality's total milk procurement in volume. The omitted difference is excluded from this study, as it is spread out amongst many smaller products. Table 5 below shows the volume of the chosen variable pairs respective to Stockholm Municipality's total organic and conventional milk procurement. The five organic products make up 80.2% to 86.7%

of the total organic milk procurement from 2008 to 2013, while – despite their low total procurement shares – the five conventional products ranged from 42.9% to 64.3% of Stockholm Municipality's total conventional milk procurement.

Table 4: Volume of Variable Pairs Chosen Respective to Stockholm Municipality's Total Procurement

	2008	*2009*	*2010*	*2011*	*2012*	*2013*
Organic	53.0%	49.0%	61.2%	62.31%	66.7%	73.9%
Conventional	19.4%	27.4%	16.7%	12.8%	7.5%	4.6%
Total	72.4%	76.4%	77.8%	75.1%	74.2%	78.5%

Table 5: Volume of Variable Pairs Chosen Respective to Stockholm Municipality's Total Organic and Conventional Procurement

	2008	*2009*	*2010*	*2011*	*2012*	*2013*
Organic	86.7%	85.4%	86.2%	81.0%	80.2%	82.7%
Conventional	49.8%	64.26%	57.4%	55.3%	44.3%	42.9%

As can be seen in Figure 7 below, the volume of Stockholm Municipality's total milk procurement decreased steadily by 31% between 2008 and 2013. Furthermore, despite a 31% decrease in quantity procured, total milk expenditure decreased by only 15%, seen in Figure 8.

Figure 7: Stockholm Municipality's Milk Procurement (kg)

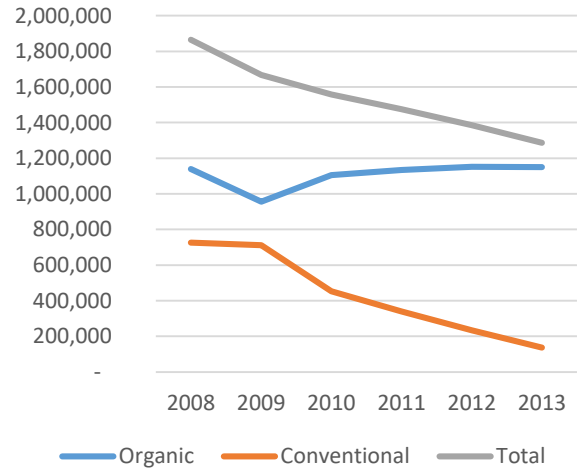
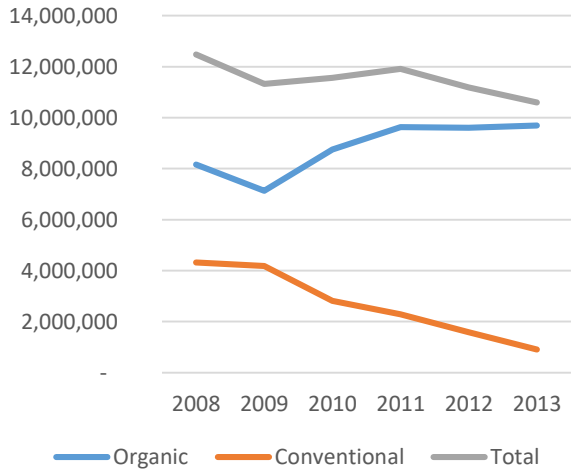


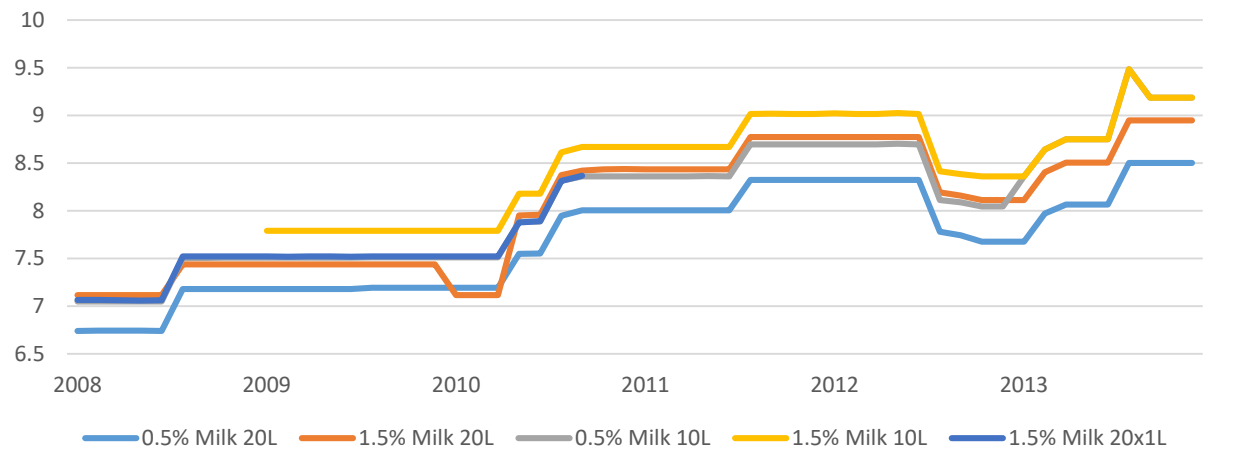
Figure 8: Stockholm Municipalitys's Milk Expenditure (SEK)



Source: Stockholm Municipality via Christian Jörgensen, Lund Agrifood Economics

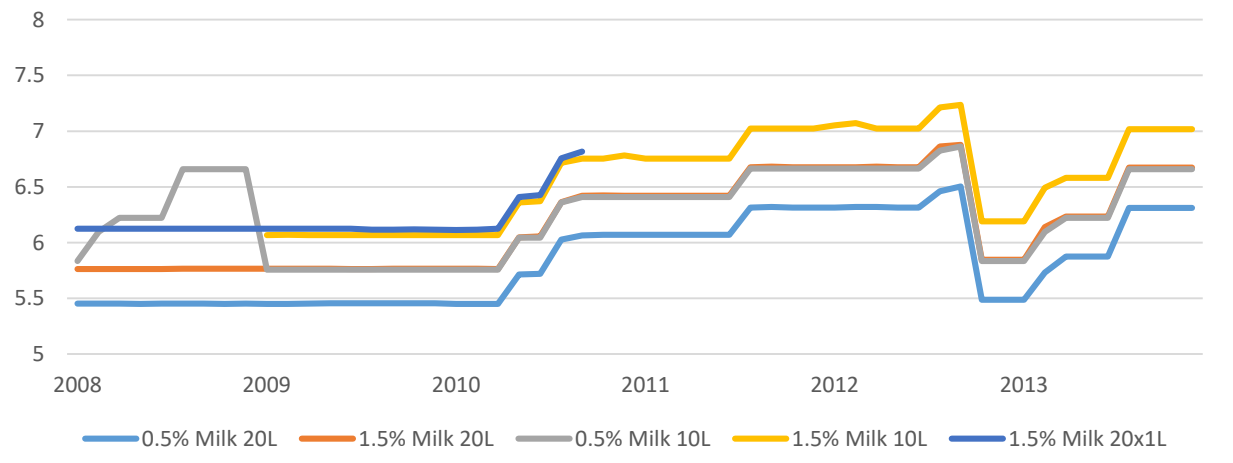
This discrepancy is due to rising prices paid by Stockholm Municipality for both organic and conventional milk, which can be seen in Figures 9 and 10 below. Organic prices are higher than conventional milk prices, as is expected. It is important to bear in mind that for each milk product, prices can be changed up to four times a year. What is also evident is the price changes for these five products are highly correlated.

Figure 9: Monthly Organic Milk Prices (SEK), 2008-2013



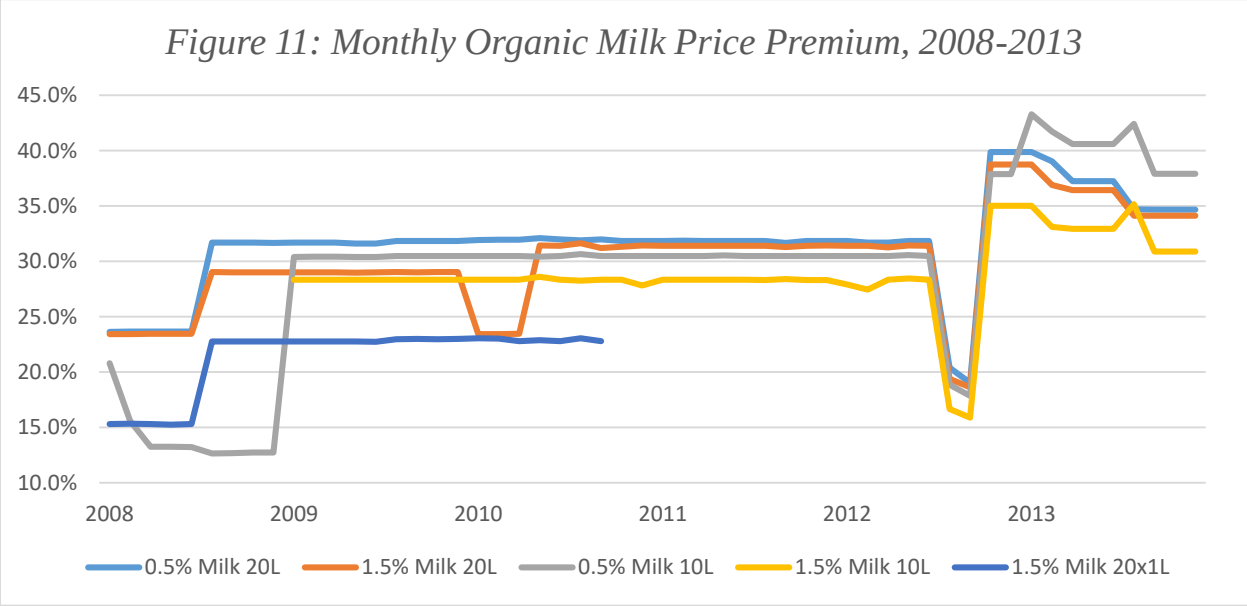
Source: Stockholm Municipality via Christian Jörgensen, Lund Agrifood Economics

Figure 10: Monthly Conventional Milk Prices (SEK), 2008-2013



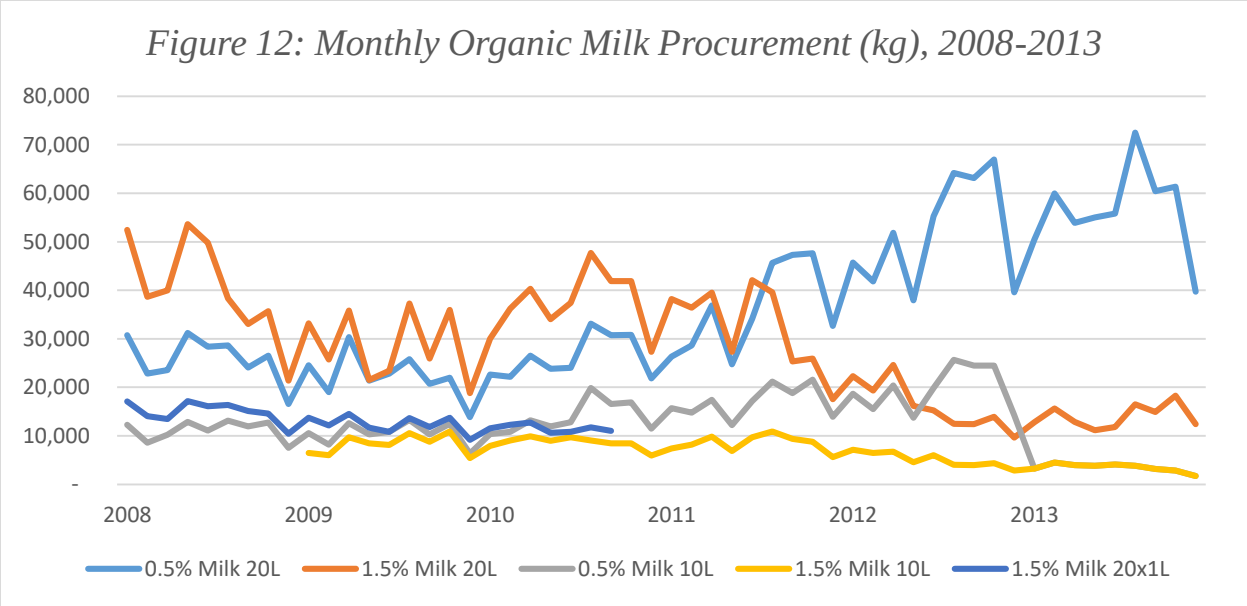
Source: Stockholm Municipality via Christian Jörgensen, Lund Agrifood Economics

Figure 11 below shows the monthly organic milk price premium for Stockholm Municipality from 2008-2013. The price premiums stayed relatively constant between 22%-32% from 2009 to 2012, before dropping in unison to 15%-20%, followed by a dramatic increase in the latter half of 2012 to 35%-40% levels.



Source: Stockholm Municipality via Christian Jörgensen, Lund Agrifood Economics

When examining the procurement for the five organic milk products in Figure 12 below, four of the five saw decreases in procurement. 0.5% Milk 20L, however, experienced a large increase in procurement, averaging roughly 50,000-60,000 monthly kilograms.



Source: Stockholm Municipality via Christian Jörgensen, Lund Agrifood Economics

4.4 Specifications

As mentioned earlier, Edgerton et al. (1996), Säll and Gren (2015), and Hjertstrand (2007) used Almost Ideal Demand Systems in their research. This approach is not suitable for this paper, however, as budget shares for a wide range of products cannot be constructed. Rather, previous studies from Meng et al. (2014), Lui et al. (2006), and Hatz II (2011) that use log-linear specifications with several fixed effects are suitable to emulate. Such a specification is advantageous as it allows the coefficients to be directly interpreted as elasticities without any transformations. Using similar methodology, I use the following specification:

$$\ln(kg_{EKO})_{i,t} = \alpha_i + \beta_1 \ln(p_{EKO})_{i,t} + \beta_2 \ln(p_{CONV})_{i,t} + \delta_j + \gamma_h + \varepsilon_{i,t}$$

where kg_{EKO} denotes the organic quantity in kilograms procured for one of the five product types i at time t, α is the unobserved time-invariant fixed effects for the product type i, p_{EKO} denotes the price/kg for the organic product type i at time t, p_{CONV} denotes the price/kg for the corresponding conventional product type i at time t, and β_1 and β_2 are the own- and cross-price elasticity parameters, respectively. δ_j is a full set of dummy variables that captures year-specific effects common for all products, while γ_h captures month-of-year specific effects. Since the low monthly observations of June, July, and August were removed from the sample, each year contains nine months. Therefore, γ_h contains eight dummy variables for the nine observed months. Lastly, ε is

the error term for product type i at time t. In various models, a linear annual time trend is substituted for the fixed effects yearly dummy variables as additional method for controlling time trends. Alternative specifications are used in order to see how robust the results are.

5. Results

5.1 Regression Results

The results can be seen below in Table 6. In all six models, the organic own-price elasticities have negative coefficients, with significant results in three of the six models. Among these three significant coefficients, the magnitudes indicate a relatively elastic demand. Only model (5), which includes a month-of-year fixed effect dummy variable as well as a yearly linear time trend, has an own-price elasticity that is relatively inelastic, though the result is insignificant. All six models feature cross-price elasticities with positive coefficients, with significant results in all but model (6). Four of these cross-price elasticities were highly-significant at 1% levels with relatively high coefficients, indicating substitutability between organic and conventional milk. Both elasticities in model (1) are highly significant at 1% levels, however, this model does not control for trends in consumption. Alternatively, model (6) captures the most variation with fixed effects dummy variables for year and month-of-year, yielding a relatively lower own-price elasticity and a low cross-price elasticity, albeit insignificant. Model (4), which controls only for the month of year, shows highly significant results at a 1% level for both elasticities.

Table 6: Log-Linear Specification Results

VARIABLES	(1) Log Organic KG	(2) Log Organic KG	(3) Log Organic KG	(4) Log Organic KG	(5) Log Organic KG	(6) Log Organic KG
Log Organic Price	-3.195***	-1.213	-2.148*	-2.977***	-0.455	-1.620
(Own Price-Elasticity)	(0.707)	(1.061)	(1.106)	(0.697)	(1.076)	(1.129)
Log Conventional Price	3.244***	2.702***	1.548*	2.981***	2.405***	0.947
(Cross-Price Elasticity)	(0.836)	(0.855)	(0.934)	(0.842)	(0.848)	(0.935)
Yearly Trend		-0.0868**			-0.109***	
		(0.0350)			(0.0359)	
Constant	10.39***	181.9***	11.24***	10.44***	225.8***	11.27***
	(0.931)	(69.10)	(1.591)	(0.933)	(70.89)	(1.729)
Observations	232	232	232	232	232	232
R-squared	0.084	0.108	0.238	0.166	0.200	0.326
Product Fixed Effects	5	5	5	5	5	5
Year Fixed Effect	NO	NO	YES	NO	NO	YES
Month of Year Fixed Effect	NO	NO	NO	YES	YES	YES
Yearly Linear Trend	NO	YES	NO	NO	YES	NO

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

5.2 Robustness Check

Robustness checks, which can be seen in Table 7 below, were performed in order to confirm the results achieved from the log-linear specifications with fixed effects. Regarding the high correlation between organic and conventional milk prices, one could question the decision to analyze them as five different products, when they all are inherently just milk. Instead of a differentiation between the types and quantity sizes of milk, they could be combined and treated as one encompassing milk product. Therefore, the first robustness check, denoted as model (1) in the results below, is a times series in which monthly procurement was summed for each product, and ran on the monthly means of the organic and conventional milk prices, along with a yearly annual time trend. First differences were taken in order to make the variables stationary and to avoid obtaining spurious results. The results, not only insignificant, showed contrasting coefficient signs to those obtained from the log-linear specifications with fixed effects in Table 6. The own-price elasticity for organic milk is positive, while the cross-price elasticity between organic and conventional milk is negative. An additional log-linear specification with fixed effects, denoted as model (2) in the results below, was also used to check for robustness. The prices for which Swedish farmers were paid for their conventional and organic milk production from 2010-2013 were used as instruments for the prices Stockholm Municipality paid for their milk procurement, as well as month-of-year and yearly-specific effect dummy variables as controls. Although the use of these farmer's prices as instruments is questionable given that they too are likely endogenous to Stockholm Municipality's milk consumption, no other suitable instrument could be found. Like model (1), the results are insignificant. While the coefficient signs are consistent to those obtained from the log-linear specifications with fixed effects in Table 6, the magnitudes are extremely high, indicating highly elastic own-price elasticity for organic milk as well as high substitutability between organic and conventional milk. In the face of a low number of observations, the results from the robustness checks were highly insignificant, casting some uncertainty on the main results in Table 6.

Table 7: Robustness Check

VARIABLES	(1) Log Organic KG	(2) Log Organic KG
Log Organic Price (Own Price-Elasticity)	1.676 (4.036)	-4.941 (12.991)
Log Conventional Price (Cross-Price Elasticity)	-1.119 (1.656)	4.771 (10.8)
Yearly Trend	0.005 (0.023)	
Constant	-9.625*** (47.063)	8.799*** (3.187)
Observations	47	151
R-squared	0.0125	0.1668
Product Fixed Effects		5
Year Fixed Effect	NO	YES
Month of Year Fixed Effect	NO	YES
Yearly Linear Trend	YES	NO
First Differences	YES	NO

6. Discussion

The central research question in this paper is to see whether Stockholm Municipality had an inelastic demand for organic milk, and if organic and conventional milk acted as substitutes. The results from the log-linear specifications with fixed effects suggest that the demand for organic milk is elastic and responds negatively to higher price, and that there exists substitutability between organic and conventional milk. This is contrary to Jörgensen's (2012) expectations that the public demand for organic milk in Sweden may be inelastic. As we do not observe Stockholm Municipality's procurement of other organic products, nor their respective price premiums, it is unknown whether the budget was compensated or not. Although organic milk expenditure increased in the face of rising prices, total milk expenditure experienced a decrease. It is unlikely that the budget decreased, so expenditure may very well have been allocated to other commodities.

Under the fourth procurement approach that Jörgensen's (2012) outlined, it is possible that budget optimization resulted in a changing consumption bundle whereby some expenditure was redirected towards other organic commodities. If the gap in relative organic price premiums between milk and the other organic commodities did in fact decrease, it could explain why the results show Stockholm Municipality's milk procurement to be price-sensitive as budget optimization shifted expenditure to other commodities.

It is important to bear in mind, however, that the cross-price elasticity was not unanimously significant in every specification. Thus, the relationship between organic and conventional milk is a little uncertain, which can allow some leeway in interpreting whether they are in fact substitutes. Furthermore, the robustness check did not confirm the main results. Uncertainty in this relationship would be in line with the national policy goals to increase the share of organic public procurement, and lend credence to Jörgensen's (2012) posit. Additionally, it is difficult to compare these elasticities with those generated by Edgerton et al. (1996), Säll and Green (2015), and Hjertstrand (2007) as they studied the private market and did not examine organic milk. Nevertheless, the own-price elasticity in this paper, while also negative, is relatively more elastic than those derived by the aforementioned authors. It is also contradictory to Jörgensen's (2001) finding that organic milk demand did not have negative price effects, although his study also concerned private demand.

An advantage of using monthly panel data, as opposed to cross-sectional data, is that it reduces the risk of endogeneity, as time-invariant variables can be controlled using a fixed effects model. Furthermore, specific packaging types are controlled for. Despite this advantage, however, there still likely exists endogeneity problems. There may exist reverse causality, since by increasing demand for a particular organic product, Stockholm Municipality may be able to negotiate a lower price. In other words, increased quantity consumption may drive the price down, rather than the other way around, which could result in reverse causality. Furthermore, the national and municipal organic procurement goals could be driving demand, as opposed to changes in the price. Additionally, there could be omitted variables shifting the demand curve, where changes in procurement may be in response to something other than price. Owing to these possibilities, these results for Stockholm Municipality may not be externally valid for Sweden as a whole, despite Stockholm being Sweden's largest public food procurer. Further analysis in public procurement demand is necessary.

7. Conclusion

This study uses monthly panel data to estimate log-linear specifications with fixed effects to generate own- and cross-price elasticities for Swedish public consumption of organic and conventional milk. The log-linear specifications with fixed effects suggested Stockholm Municipality has a price-elastic demand for organic milk procurement, and that organic and conventional milk act as substitutes. However, the specifications were not unanimous in significance, and combined with the insignificant robustness results, the relationship between organic and conventional milk is a bit uncertain. Uncertainty in the cross-price elasticity results could lend weight that national and municipal public organic procurement targets are driving a heavy demand for organic milk procurement. On the other hand, unobserved and potentially decreasing relative price premiums of other organic commodities could be shifting procurement away from milk as Stockholm Municipality's budget is optimized, rendering the municipality's demand for milk as price-sensitive.

Nevertheless, it is important to consider that these findings may not be externally valid for Sweden as a whole. Endogeneity was likely present, and reverse causality could have impacted the results. Therefore, in a shifting climate with increasing organic procurement goals, more research should be conducted across municipalities in Sweden. Given the potentially large costs of increasing organic procurement levels, more research on elasticity estimates could perhaps incentivize the government to re-examine their public procurement policies through a cost-benefit analysis, or consider direct subsidization to organic milk production as opposed to procurement-based support. Furthermore, an analysis of public organic procurement across all municipalities would be useful in seeing how reaching various organic procurement goals affect the procurement bundles of all organic commodities, as well as the price interactions these products have on each other.

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