The Swedish consumer market for organic and conventional milk: A demand system analysis*

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Abstract

Increasing the production of organic food is becoming an important environmental target for many governments, and consumer demand for organic food is pivotal in reaching these targets. This paper studies consumer demand for organic and conventional milk, using weekly scanner data from the Swedish retail market for the years 2011–2017. Own- and cross-price elasticities of demand are estimated using a quadratic almost ideal demand system. While previous studies on this topic show that demand for organic milk is commonly more price elastic than for its conventional alternative, this paper complements previous literature by (i) studying a market with relatively small organic price premiums, (ii) using a highly representative sample of retailers, and (iii) differentiating between private labels and brands. Results show that demand for organic milk is relatively elastic, despite relatively small organic price premiums in the Swedish milk market. Results also show that demand for branded products is, generally, less elastic compared to private label products, suggesting that consumers have strong preferences for traditional, regional brands.

JEL: D12, Q11, Q18

Keywords: Environmental policy analysis; Organic food policy; Demand system analysis

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1. Introduction

During the past decades, organic food production has gained large interest from stakeholders worldwide, including consumers, producers, and policy makers (Reisch et al., 2013; Stolze & Lampkin, 2009). Organic production is commonly recognized for its dual potential, as it can contribute to environmental protection and improved animal welfare, and also provide a private good by responding to an increased demand for organic food products (European Commission, 2004). Since the early 2000's, market shares for organic food have tripled to more than 5% in Germany and the US, and even larger increases are found in Sweden and Denmark with shares reaching 9–12% in 2018 (FiBL, 2020a). Similarly, organic production has increased over the past decades. While shares of organic farmland are still below 1% in the US and China, the average share within EU is just above 7%, and around 20% in Sweden and Austria (FiBL, 2020b).

Targets on organic production are increasingly being launched. For example, in 2006 the Swedish government launched a plan to increase the share of organic agricultural land to 20% by 2010, and its current target is to reach 30% by 2030 (Swedish Government, 2006). Similarly, Germany set a target in 2017 for the share of organic land to reach 20% by 2030 (European Commission, 2019), and the European Green Deal states a goal of 25% organic land within the European Union (EU) by 2030 (European Commission, 2021). A variety of public policies are implemented to increase organic production. While the US has opted for a more market-oriented approach focusing on labelling standards, research, and marketing (Willer & Lernoud, 2019), policies within the EU mainly include a coherent EU labelling standard, and organic subsidies, where the latter are designed and co-financed by member states (European Commission, 2019). The EU also encourages member states to increase public organic food purchases in order to stimulate organic production (European Commission, 2014) with national plans launched in, e.g., Sweden and Denmark (Lindström et al., 2020; Swedish Government, 2006; European Commission, 2019). Environmental taxes on food consumption have been discussed and studied for some products, as a means to regulate greenhouse gas emissions and promote a less polluting diet (Säll & Gren, 2015). On European level, policy discussions also include a differentiated VAT system for organic and conventional food products, or input factors, in order to reduce the price premium of organic products (Oosterhuis et al., 2008).

This price premium varies over products, markets and time, and is mainly caused by higher costs for the organic farmer due to lower productivity and more fluctuating yields, but also by higher costs in later stages of the supply chain (Furemar, 2004). As organic producers rely on consumers' willingness to pay the organic price premium, consumers' role in increasing organic production is heavily emphasized (Aschemann-Witzel & Zielke, 2017; Oosterhuis et al., 2008; Swedish Government, 2006). Knowing what the market demand looks like, and how consumers react to price changes, is thus central for decisions regarding the design of organic subsidies, and other price altering policies, e.g., differentiated VAT rates for organic and conventional products or input factors. In general, studies tend to show a more price elastic demand for organic food, compared to conventional food, although magnitudes of own-price elasticities differ largely between markets, products, and over time (Bunte et al., 2007; Oosterhuis et al., 2008; Schröck, 2012). A general conclusion is that demand for organic food is more price sensitive when organic price premiums are large, compared to when these premiums are low (Bunte et al., 2007; Glaser & Thompson, 2000; Schröck, 2012).

The aim of this paper is to study consumer demand for organic and conventional milk products in the Swedish market. While studies analysing demand for organic and conventional products are not lacking (see, e.g., Aschemann-Witzel and Zielke (2017) for an overview), previous studies using scanner data to study demand for organic and conventional milk specifically, are mainly from markets with small organic market shares, large organic price premiums, and with scanner data often restricted to general retailers, meaning that price elasticities are estimated on a sample which excludes the more committed organic buyers (see, e.g., Glaser and Thompson (2000); Jonas and Roosen (2008); and Monier et al. (2009) for studies in the US, Germany and France). The Swedish market for foods is characterized by relatively large organic market shares, relatively small organic price premiums, and by the fact that general retailers represent practically all organic sales (Furemar, 2004; European Commission, 2019). Similar market characteristics are found in, e.g., Denmark (Furemar, 2004). However, the most recent studies on organic consumer demand from these markets are from the early 2000's by Wier and Smed (2000), and Jörgensen (2001), neither of which includes milk in the analysis.

The sample used in this study consists of weekly scanner data on fluid milk sales for six Swedish regions during the period Jan 2011–Nov 2017. Within the organic and conventional segments, I distinguish between private labels and brands, something which has been largely overlooked in previous studies. Own- and cross price elasticities of demand, and expenditure elasticities are estimated using a quadratic almost ideal demand system (Q-AIDS) (Banks et al., 1997; Deaton & Muellbauer, 1980), while instrumenting for endogenous prices and expenditures. Results suggest that demand for organic milk in Sweden is generally more price elastic than for conventional milk within the branded segment, and slightly less elastic than for conventional milk within the private-label segment. Further, demand for private label products is more price elastic compared to branded products, suggesting strong preferences for the traditional, branded products. Cross-price elasticities point, in line with previous literature, to asymmetric substitution between organic and conventional products.

Studying milk is, from a policy perspective, interesting for many reasons. First, organic and conventional fluid milk are considered close substitutes in terms of taste and appearance (Swedish Competition Authority, 2011). This facilitates eliciting the effect of organic labelling on demand. Second, dairy is often among the top-selling category within the organic segment. For example, organic sales within the milk segment are (in value) 18.5% in Austria, 24% in Sweden (Statistics Sweden, 2020a, 2020b; Willer & Lernoud, 2019), and 5.4% (in weight) in the US (United States Department of Agriculture, 2017, 2020). The milk sector is also an important agricultural sector, making up about 18% of the total value of agricultural goods in Sweden, and about 17% of the Swedish raw milk is currently produced under organic production forms (EUROSTAT, 2021; Swedish Board of Agriculture, 2020). Organic milk consumption may thus have a tangible impact on domestic organic production and the prospect of reaching related environmental targets. Third, milk is a perishable good which is purchased frequently, and has few substitutes (Dhar & Foltz, 2005). Policies affecting (relative) prices of milk can therefore be important matters for households.

The rise of private labels in the retail food industry in recent years have provided retailers an opportunity to differentiate with respect to both quality and price, avoiding the double markup faced by branded products (Bergès-Sennou et al., 2004). For a detailed analysis, this paper therefore distinguishes between private labels and brands within the organic and conventional segments. This division is largely missing in previous studies of consumer demand for milk, particularly for the organic category, and when accounted for, results are ambiguous as shown in Schröck (2012). Private label milk products were not introduced in Sweden until 2011. Due to long-prevailing regional monopolies, one can therefore expect strong preferences for established brands among Swedish consumers.

The remaining part of the paper is structured as follows: Section 2 presents previous literature. Section 3 describes the Swedish market for milk. In Section 4, the data is described. Section 5 covers the method and empirical specification, and Section 6 presents the results from the estimations. Finally, conclusions are presented in Section 7.

2. Previous literature

Studies related to organic consumer behavior mainly focus on one of three strands: (i) attitudes towards and willingness to pay for organic food, (ii) sociodemographic factors affecting the probability of buying, and/or the willingness to pay for organic food, and (iii) Price responsiveness among organic food consumers.

A majority of the studies related to the first strand employs surveys or experiments (see, e.g., Schröck (2012), and Aschemann-Witzel and Zielke (2017) for an overview), with results potentially differing from actual purchase behavior (Frykblom, 1997). The second strand of studies commonly use actual purchase data and household surveys. The organic consumer profile is often presented as female, well educated, and with high income, although results may differ depending on time, place, access to markets, product group, and methods (see, e.g., Dimitri and Dettmann (2012) for an overview). Related to consumer profile, there is also a number of studies on the different barriers to buying organic food (e.g., price, availability, quality, etcetera). These studies mainly report price as the main barrier for consumers when faced with the choice between organic and conventional food products (Aschemann-Witzel & Zielke, 2017), and especially for occasional or non-organic buyers (Jensen et al., 2011). The third strand of the literature is where the present paper belongs. These studies aim to elicit consumers' revealed preferences in terms of demand for and substitution of organic food due to changes in price and income. They typically use household or retail scanner data in order to estimate a system of demand equations providing own- and cross-price elasticities.

A brief summary of studies that estimate price elasticities of demand for organic and conventional milk is found in Table 1, and discussed below. The table lists the market studied, sample period, level of data, data source, method and own-price elasticities. Cross-price elasticities are not reported in the table, but are discussed below if reported in the study.

Among the first to analyse demand for organic and conventional milk, Glaser and Thompson (2000) use national scanner data from the US, where organic milk, within the 1% fat segment, had a market share of 0.7–3.5% and an average price premium of around 60%. Using AIDS, the authors find that demand for organic milk is highly price elastic (-9.7) compared to both branded and private label conventional milk, and that the price elasticity of demand for organic milk decreases (in absolute value) as the product's market share increases, while organic price premiums do not alter much. Cross-price elasticities are positive and asymmetric, implying that organic and conventional milk are substitutes, and that changes in conventional prices affect

Table 1: Previous studies analysing the demand for organic milk

Study	Market	Sample period	Data	Method	Own-price elasticities Organic	Conventional
Glaser & Thompson (2000)[a)b)]	United States	Nov 1996–Dec 1999, (M)	Retail scanner data from AC Nielsen/IRI	AIDS	-9.7**	-0.9**(CB), -2.1**(CPL)
Dhar & Foltz (2005)[c)]	United States	March 1997–Feb 2002, (W)	Retail scanner data from IRI	Q-AIDS	-1.4*	-1.0*
Bunte et al., (2007)[c)]	Netherlands	March 2005–Aug 2006, (W)	Retail scanner data from IRI	AIDS/VECM	-2.0*	-1.0*
Jonas & Roosen (2008)[b)]	Germany	2000–2003, (Y)	GfK ConsumerScan household panel	LA/AIDS	-10.2*	-1.0*(CB), -1.0*(CPL)
Alviola & Capps (2010)[c)d)]	United States	2004, (Y)	Nielsen Homescan Panel	Heckman 2–step	-2.0	-0.9
Schröck (2012)	Germany	2004–2008, (Y)	GfK ConsumerScan household panel	LA/AIDS	-0.3**(OB), -0.4**(OPL)	-0.9***(CB), -0.4***(CPL)
Chen et al. (2018)	United States	2013, (Y)	Nielsen Homescan Panel	LA/AIDS	-2.5*	-1.2*(CB) -1.2*(CPL)

Note: (Y), (M), and (W) denote data analysed at yearly, monthly, and weekly level, respectively.
Note: ***, **, and * denote significance at 0.1 %, 1 % and 5 %, respectively.
Note: OB, OPL, CB and CPL denote Organic brand, Organic private label, Conventional brand, and Conventional private label, respectively.
a) Elasticities estimated for several fat contents. The one for 1 % fat content presented here.
b) Does not distinguish between branded and private label organic milk.
c) Does not distinguish between branded and private label products.
d) Significance level not reported

organic purchases more than changes in organic prices affect conventional purchases. Jonas and Roosen (2008) find similar large magnitudes for organic milk using German household scanner data and a linear approximated AIDS (LA/AIDS). The organic price premiums in the sample range between 35 and 46%. However, by excluding specialized organic food stores in the samples, Glaser and Thompson (2000) only account for two thirds of US organic milk sales, and Jonas and Roosen (2008) for about 36% of Germany's organic milk sales. The elasticities are thus not necessarily representative for the population.

Dhar and Foltz (2005) use weekly retail scanner data from 12 US cities for the years 1997–2002, also excluding specialized organic food stores. The sample shows an average organic milk price premium of 100%, and organic milk market shares of less than 1%. Results from employing a quadratic AIDS (Q-AIDS) indicate that demand for organic milk is more price elastic than demand for conventional milk, but moderately elastic (-1.4) compared to the estimates of Glaser and Thompson (2000) and Jonas and Roosen (2008). Somewhat larger magnitudes of the organic own-price elasticities are found in Bunte et al. (2007) who use weekly retail scanner data from 84 Dutch supermarkets, excluding specialized organic food stores. When introducing a price reduction of, on average, 14% for organic milk, the authors find that the own-price elasticity of demand for organic milk falls, from -2.0 to -1.2. Alviola and Capps (2010) use household scanner data, including all retail outlets in four US regions during 2004. While the two latter samples show similar organic milk market shares, around 5%, the US organic price premium is, at 77%, almost twice as large as in the Dutch sample. Despite differing organic price premiums, own-price elasticities for organic and conventional milk are indeed similar for both markets. Notably, cross-price elasticities are asymmetric and positive also in Dhar and Foltz (2005), Bunte et al. (2007), and Alviola and Capps (2010), reinforcing the picture that demand for organic milk increases more following a price increase of conventional milk, than demand for conventional milk does following a price increase in organic milk.

In a latter study of the German market, Schröck (2012) includes specialized organic food stores among the retail outlets when estimating own- and cross-price elasticities for organic and conventional milk, using household scanner data. The organic price premium is around 37% within the branded segment, and 51% within the private label segment. In contrast to much of the previous literature, demand for organic milk is found to be price inelastic, and even more inelastic than demand for conventional milk. The author attributes this to the increased availability of organic milk among general retailers, the inclusion of occasional and committed organic buyers in the sample, and a low degree of differentiation in the German milk market, implying few substitutes for consumers. Demand for private labels is less price elastic than for brands within the conventional segment, but more price elastic compared to brands, within the organic segment. Cross-price elasticities are reported, but not discussed, and generally show statistically significant and negative estimates, suggesting that products are complements and not substitutes.

A recent study on demand for organic fluid milk is from Chen et al. (2018) which employs the Nielsen Homescan Panel for US households during 2013. Although organic market shares are larger in Chen et al. (2018) compared to previous studies from the US, the shares of private label and branded organic milk are combined into one “organic” group, due to their small respective shares of household purchases, and the sample's organic price premiums range between 60 and 90%. Findings suggest own-price elasticities generally in line with Alviola and Capps (2010) and Bunte et al. (2007) regarding organic and conventional milk, and with Jonas and Roosen (2008) regarding CB and CPL milk.

From this review, one can conclude three things: First, while conventional milk commonly shows a unit elastic demand, price elasticities for organic milk vary between markets, samples, and models, and are generally larger in absolute values, although the opposite is also found, as in Schröck (2012). Second, previous studies are mainly from markets with small organic market shares, large organic price premiums, and where specialized organic stores represent a large portion of the sales which is not necessarily included in the sample. Third, own-price elasticities for branded and private label products differ, as in, e.g., Glaser and Thompson (2000) and Schröck (2012). However, within the organic segment, private labels and brands are analysed separately only in Schröck (2012), showing ambiguous results, and with cross-price elasticities not discussed. The present paper contributes to previous literature by studying demand for organic milk when organic price premiums are relatively small, organic market shares are relatively large, and by using a sample which does not exclude a large portion of the organic sales. Further, by distinguishing between brands and private labels within both the conventional and organic segment this paper may complement the study by Schröck (2012).

3. The Swedish market for milk

The Swedish market for organic foods is considered relatively well-functioning in terms of distribution and sales. This means that organic products are found at general retailers, that the organic labels are few and well known, that organic market shares are relatively large, and that organic price premiums are relatively small (Furemar, 2004). For example, comparing organic and conventional prices in five EU member states, Furemar (2004) finds an average organic price premium of about 40% in Sweden and Denmark, compared to above 60% in Germany and France. And while general retailers represent about 90% of all organic retail sales in Sweden, specialized organic food stores are still prominent distribution channels in, e.g., France, Germany, and Italy (Ekoweb.nu, 2018; Willer & Lernoud, 2019).

In Sweden, all dairies are producer-owned cooperatives, and are thus obligated to collect all milk produced by its members, who, in turn, have to deliver most or all of their produced milk to their cooperative (Swedish Competition Authority, 2011). Compared to, e.g., Germany and the US, concentration is high within the Swedish fluid milk production with three dairies (Arla, Skånemejerier, Norrmejerier) accounting for about 90% of the total production in 2014 (Fink-Keßler, 2015; Swedish Competition Authority, 2016; United States Department of Agriculture, 2005). All main dairies concurrently act as wholesalers of both organic and conventional milk under their own brands. Although geographic dairy monopolies in Sweden were abolished in the early 2000's, catchment areas for the dairies still prevail to a large extent, and sales for a producer brand tend to be largest within its catchment area, suggesting strong consumer preferences for the "local" brand (Swedish Competition Authority, 2016).

Sweden's food retail sector is also highly concentrated with four actors accounting for about 95% of the market, and one of them for about 50% (Swedish Competition Authority, 2016). During the last decades, Swedish retailers have strengthened their market positions relative to producer brands by launching their own, so-called, private labels, thereby following a global trend. Private labels within the Swedish fluid milk segment were introduced quite recently, in 2011, first as low-price alternatives, and subsequently offering added values such as extended shelf life (ESL), organic, etcetera. Today, the four largest retail chains offer both conventional and organic milk under private labels, e.g, ICA I love ECO, Änglamark (COOP), Garant (Axfood) and Favorit (Bergendahls). Since retailers purchase milk from incumbent producers, private labels have, to some extent, disintegrated geographic fluid milk markets. Private labels' share of total milk sales increased substantially from 10% in 2013 to 21% in 2017, but is still small compared to other western European countries (Swedish Competition Authority, 2016).

4. Data

The main data source in this study is retail scanner data for organic and conventional milk products, retrieved by the market research company AC Nielsen for the period Jan 2011–Nov 2017. The scanner data consists of weekly barcode level observations on sales volume (litres), sales units, sales value in Swedish Kronor (SEK), and average price, aggregated by AC Nielsen to six Swedish regions, encompassing all Swedish municipalities.[1] Data is collected from a large sample of stores in every region, intended to provide an accurate representation of the market. For each product there is also information on, e.g., fat content, container size, whether its labelled organic or not,[2] lactose content, and manufacturer (private label/brand).

[1] A map of these regions is provided in Figure A.1 in Appendix A.
[2] An organic label indicates that production is certified in compliance with regulation EC 834/2007.

The present study is limited to fluid milk, with some exceptions. In a ruling from 2011, the Swedish Competition Authority states that, based on consumer surveys, the market for conventional and organic fluid milk includes milk with extended shelf life, but not lactose-reduced products, ultra-pasteurized (UHT) products, or vegetable milk substitutes made from, e.g., soy, almond or oat (Swedish Competition Authority, 2011).[3] Those products are therefore excluded from this study's analysis, in accordance with studies in the previous literature section. Observations are dropped also for milk products that are flavored, non-fluid, protein enhanced, and in the case when information on fat percent, or sales is missing.[4] The remaining products are divided into the following four categories based on labelling (conventional or organic), and type of manufacturer (brand or private label): Organic Brand (OB), Conventional Brand (CB), Organic Private Label (OPL) and Conventional Private Label (CPL).

About two thirds of the sample's units are sold in 1 litre containers, and one third in 1.5 litre containers. Table 2 shows the share of category sales for each container size. Since OPL milk is practically non-existent among 1.5 litre products, the analysis is limited to 1 litre containers. Of the remaining 89 000 observations, the vast majority belongs to one of the following fat segments; 0.5% (low) fat (18.2%), 1.5% (medium) fat (50.4%), and 3% (whole) fat (28.9%), with each segment containing both organic and conventional branded and private label products. The main analysis estimates a demand system including these three fat segments. A sensitivity analysis is carried out estimating a separate demand system for each fat segment.

Table 2: Volume sales per category and container size

Product category	1 litre	1.5 litre
CB	74.5%	80%
CPL	8.4%	14.1%
OB	13.6%	5.3%
OPL	3.8%	0.6%

Note: CB, CPL, OB, and OPL denote Conventional Branded, Conventional Private Label, Organic Branded and Organic Private Label milk, respectively.
Source: Nielsen data 2011–2017.

[3] Among total milk sales, vegetable milk substitutes increased its market share (in volume) in the sample from 1.8% in 2011 to 4.6% in 2017. Among non-vegetable milk sales in the sample, lactose reduced milk increased its market share (in volume) from 5.3% in 2011 to 13.9% in 2017.
[4] A missing observation of sales (price and quantity) is indicated by a 0 in the raw data, indicating one of the following scenarios: That the product had not yet been introduced in that region; That the product had been introduced, but was temporarily not in stock; That the product was in stock and sampled, but not sold during that week; That the product was in stock, but the retailer(s) selling it was not sampled that week.

Average yearly prices for each product category are provided in Table 3. The price gap between OB milk and CB milk is, on average, 1.23 SEK per litre, representing a 15.8% organic price premium. In the private label segment this gap is, on average, 1.61 SEK, representing a 27.0% organic price premium. Organic price premiums are thus considerably smaller in this sample compared to previous studies. Consumers choosing between branded and private label milk face a brand price premium of, on average, 13.2% within the organic segment, compared to 24.1% within the conventional milk segment. From 2014 and onward, branded milk prices generally show larger variation compared to private label milk. This could be due to more coherent pricing policies for private labels across regions.

Table 3: Average price per category and year, 1 litre fluid milk

	CB		CPL		OB		OPL	
Year	Price	SD	Price	SD	Price	SD	Price	SD
2011	7.29	.175	5.99	.202	8.63	.240	7.80	.297
2012	7.27	.181	6.16	.276	8.80	.312	7.53	.290
2013	7.44	.221	6.14	.292	8.78	.271	8.20	.412
2014	7.73	.308	6.46	.143	8.99	.280	8.51	.272
2015	8.07	.421	6.36	.169	9.13	.377	7.81	.174
2016	8.26	.313	6.41	.137	9.38	.483	7.84	.211
2017	8.48	.350	6.37	.248	9.41	.556	8.00	.202
Total	7.78	.537	6.27	.268	9.01	.470	7.96	.409

Note: CB, CPL, OB, and OPL denote Conventional Branded, Conventional Private Label, Organic Branded and Organic Private Label milk, respectively.
Source: Nielsen data 2011–2017. Deflated prices using CPI and base year 2007.

Weekly average prices for each product category are shown in Figure 1.[5] Gaps in graphs indicate that no sales (and prices) are observed for that category that week. For OB milk and CB milk, an upward trend in prices can be distinguished. The average price of CPL milk varies around 6 SEK, and increases slightly during the period, but does not exhibit the upward trend of branded milk. Average prices for OPL milk increase substantially around 2013, with prices varying around 9.2 SEK, followed by a sharp decrease around 2015, from which prices are just below CB prices. This pattern for OPL prices is similar across regions, as shown in regional figures in Appendix A, suggesting that the pattern is not due to data error, or regional outliers.

[5] Note that figures 1-3 report descriptive statistics for national level. Corresponding figures for regional levels are found in Appendix A.

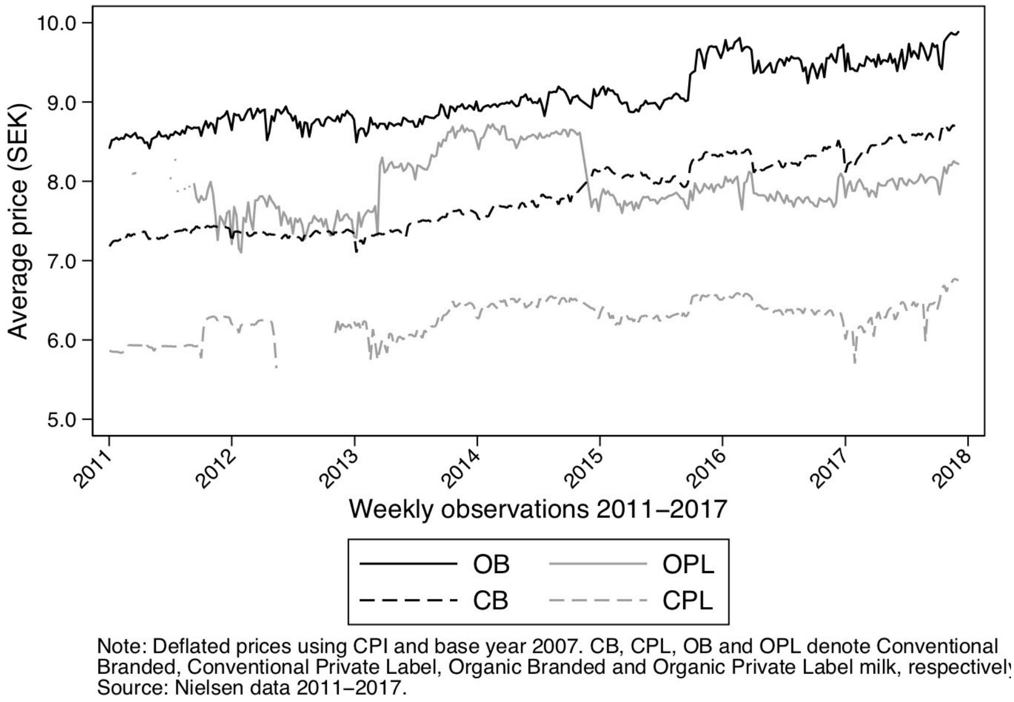


Figure 1: Average prices, 1 litre fluid milk, 2011–2017

National level market shares (%) in volume sales for each product category are presented in Figure 2. Note that national market shares are based only on those weeks when sales of all

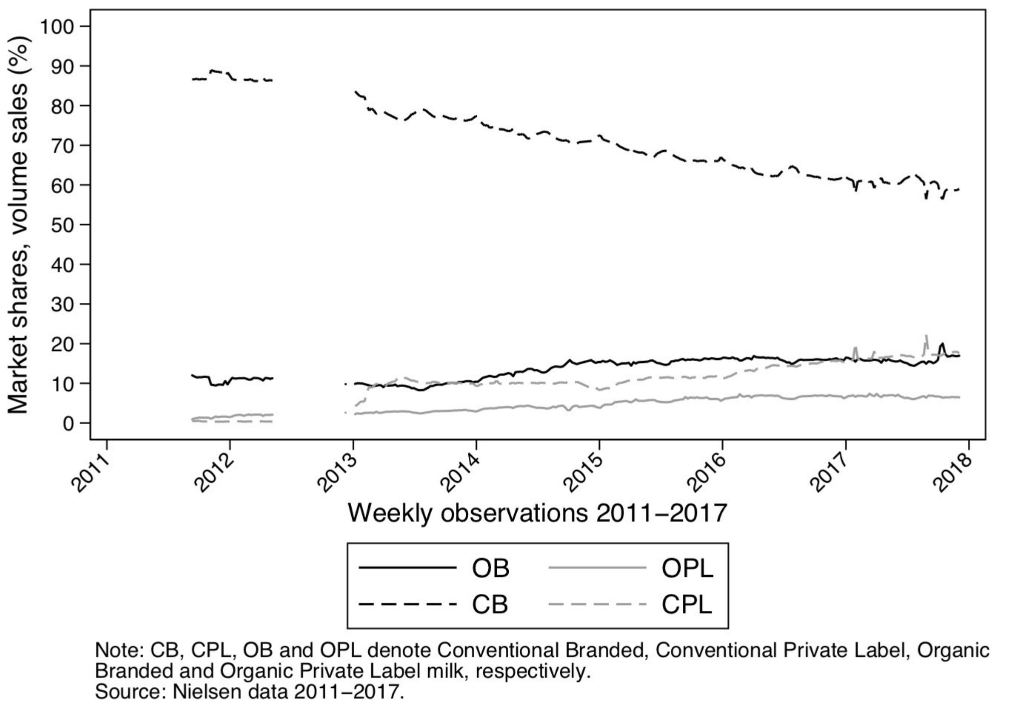
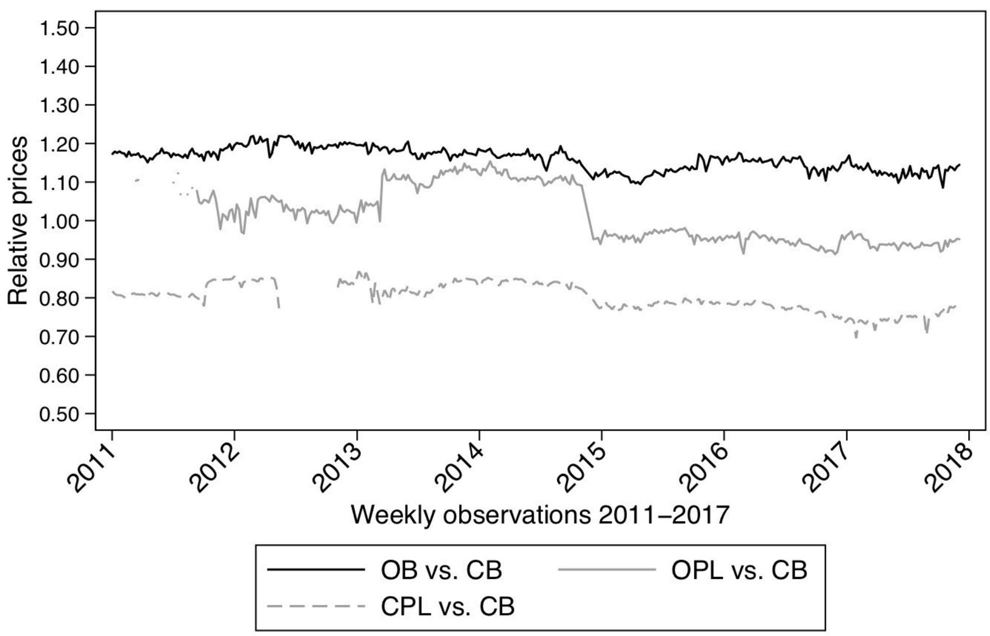


Figure 2: Market shares (volume), 1 litre fluid milk, 2011–2017

categories are observed in all six regions. CB milk has the largest share, but also shows the largest decline over the sample period, from around 85% in 2011 to around 55% in 2017. The graph suggests that the other categories increase their market shares at the expense of CB milk, starting from around 2013. Since introduced in 2011, the market share of CPL milk has increased to more than 10% in 2017, whereas OPL milk has increased to around 6%. A smaller growth rate is found for OB milk, with an increase in market share from 10% to almost 20% during the sampled period. The organic market share in this sample is thus, compared to previous studies, relatively large and ranges from 10% to 25%.

Relative prices are illustrated in Figure 3. The graph depicts the relative price of OB milk, OPL milk and CPL milk, respectively, in relation to CB milk, as CB milk has the largest market share. The relative prices are quite stable over the sample period, although it increases substantially for OPL milk around 2013–2015.



Note: CB, CPL, OB and OPL denote Conventional Branded, Conventional Private Label, Organic Branded and Organic Private Label milk, respectively.
Source: Nielsen data 2011–2017.

Figure 3: Relative prices, 1 litre fluid milk, 2011–2017

Descriptive statistics of the variables used in the estimations are presented in Table 4. The role of these variables in demand system estimation, and how they are used to address endogenous prices and expenditures is more thoroughly explained in the next section, where the empirical model is presented.

Table 4: Descriptive statistics of variables used in estimations

Variable	Label	Obs	Mean	SD.	Min	Max
CBshare	Expenditure share CB milk	1770	0.72	0.11	0.41	0.92
CPLshare	Expenditure share CPL milk	1770	0.08	0.05	0.00[a]	0.21
OBshare	Expenditure share OB milk	1770	0.16	0.05	0.06	0.30
OPLshare	Expenditure share OPL milk	1770	0.04	0.03	0.00[a]	0.11
priceCB	Price CB milk	1770	7.90	0.52	6.82	9.40
priceCPL	Price CPL milk	1770	6.32	0.24	4.31	6.96
priceOB	Price OB milk	1770	9.09	0.47	7.43	10.41
priceOPL	Price OPL milk	1770	8.00	0.39	6.09	8.86
totexp	Total milk expenditures (10 000 sek)	1770	676.79	296.39	229.43	1966.27
income	Mean regional income (1000 SEK)	1770	268.65	24.13	230.08	333.34
fgpriceC	Farmgate price conventional milk (SEK/kg)	1770	2.68	0.29	2.04	3.15
fgpriceO	Farmgate price organic milk (SEK/kg)	1770	3.47	0.21	2.96	3.84

Note: CB, CPL, OB, and OPL denote Conventional Branded, Conventional Private Label, Organic Branded and Organic Private Label milk, respectively.
[a] Min share > 0. Due to space constraints, numbers are rounded to two decimals.

5. Empirical model

In order to estimate own- and cross-price elasticities of demand for organic and conventional milk, this study applies, in line with much of the previous literature, an almost ideal demand system (AIDS), originally developed by Deaton and Muellbauer (1980). When using aggregate-level data, AIDS can be interpreted as a demand system for the representative consumer. Milk purchases is assumed to be weakly separable from all other purchases, which means that a multi-stage budgeting framework is applied. This means that consumers, in one stage, decide on the level of milk expenditures, and in the next stage, the expenditure shares for each product category. In principle, assuming weak separability from all other purchases is necessary when estimating a disaggregated demand system. As argued by Dhar and Foltz

(2005), this assumption may be valid given that fluid milk is often seen as a necessity good, without close substitutes.

The original AIDS model is linear in income. However, in the case of non-linear impacts of changes in expenditures on demand, the quadratic AIDS model (Q-AIDS) developed by Banks et al. (1997) can be more appropriate, as it allows for goods to be luxury goods at one income level and necessities at others. By estimating Engel curves using Lowess smoothing technique (as applied in Dhar and Foltz, 2005), a non-parametric analysis of the relationship between per capita expenditures on each milk type and total milk expenditures per capita is performed. These Engel curves, presented in Figures A.5–A.8 in Appendix A, do indeed indicate a non-linear relationship, especially for organic milk products, which is why the Q-AIDS model is used for the analysis.

Within the Q-AIDS, the expenditure share equation for each of the four product categories i=1, ..., N in region r in week t, w_{irt}, is obtained by the expression:

$$w_{irt} = \alpha_i + \sum_{j=1}^{N} \gamma_{ij} \ln p_{jrt} + \beta_i \ln\left(\frac{x_{rt}}{a(\boldsymbol{p}^{rt})}\right) + \frac{\tau_i}{b(\boldsymbol{p}^{rt})}\left[\ln\left(\frac{x_{rt}}{a(\boldsymbol{p}^{rt})}\right)\right]^2 + u_{irt} \quad (1)$$

where p_{jrt} denote prices, x_{rt} is total milk expenditure, and u_{irt} is an error term. α, β, γ and τ are the parameters to be estimated. $\ln a(\boldsymbol{p}_{rt})$ is a non-linear price index which, in translog form, is expressed as:

$$\ln a(\boldsymbol{p}_{rt}) = \delta + \sum_{i=1}^{N} a_i \ln p_{irt} + \frac{1}{2}\sum_{i=1}^{N}\sum_{j=1}^{N} \gamma_{ij} \ln p_{irt} \ln p_{jrt} \quad (2)$$

and $b(\boldsymbol{p}_{rt})$ is the Cobb-Douglas price aggregator defined as:

$$b(\boldsymbol{p}_{rt}) = \prod_{i=1}^{N} p_{irt}^{\beta_i} \quad (3)$$

Estimation of (Q-)AIDS requires that constraints of additivity ($\sum_i \alpha_i = 1, \sum_i \beta_i = 0, \sum_i \gamma_{ij} = 0$), homogeneity ($\sum_j \gamma_{ij} = 0$), and symmetry ($\gamma_{ij} = \gamma_{ji}$) are imposed. Parameter δ in (2) is unidentified and can be set to 0 or any fixed value. Following Banks et al. (1997), and Deaton and Muellbauer (1980), δ is set to slightly less than the lowest value of $\ln x_{rt}$.

One way to account for regional heterogeneity and seasonal trends is through the α_i in (1). Using demographic translating (Pollak & Wales, 1981), α_i can be modelled as linear combinations of variables according to:

$$\alpha_{irt} = \alpha_{io} + \sum_{k=1}^{K} \lambda_{ik} Z_{krt} \quad (4)$$

where Z_{krt} is the k_{th} variable in region *r* in week *t.* The variables included here are six regional dummy variables, four seasonal dummy variables, and a linear, monthly time trend. This way of accounting for regional heterogeneity allows demographic and time variables to change the level of demand, but not alter the slope (Dhar & Foltz, 2005; Lecocq & Robin, 2015). Note that this makes regional heterogeneity enter the demand system linearly via the intercept in (1), but also non-linearly via the price index $\ln a(\boldsymbol{p}_{rt})$ in (2). For theoretical consistency, the restriction of additivity requires that $\sum_i \alpha_{i0} = 1$, and $\sum_i \lambda_{ik} = 0$.

Parameters are estimated using the Iterated Linear Least Squares (ILLS) estimator, which exploits the fact that equation (1) is conditionally linear, i.e., linear in all parameters conditional on $a(\boldsymbol{p}_{rt})$ and $b(\boldsymbol{p}_{rt})$.[6] For given initial values of $a(\boldsymbol{p}_{rt})$ and $b(\boldsymbol{p}_{rt})$, the ILLS estimator iterates estimations of parameters using a linear moment estimator.[7] Estimates are used to update the functions $a(\boldsymbol{p}_{rt})$ and $b(\boldsymbol{p}_{rt})$, with iterations continued until convergence occurs, yielding consistent and asymptotically normal estimates.

5.1 Endogeneity

Due to potential endogeneity of prices and expenditures, the expenditure share equation in (1) may give rise to biased estimates. Specifically, whenever there are unobserved factors affecting consumer demand and that are also related to price determination and/or allocation of expenditures, p_{jrt} and x_{rt} will be correlated with the error term, u_{irt}, and endogeneity issues arise (Dhar et al., 2003). A common way of handling endogeneity in these types of demand systems is by the technique developed by Hausman (1978) and Holly and Sargan (1982), using instrumental variables (IV) and augmented regressions. In a first stage, reduced form equations for p_{jrt} and x_{rt} are estimated using IVs and all other exogenous variables, including those in Z_{krt}. In a second stage, equation (1) is augmented with the residuals, $\widehat{v_{jrt}}$ and $\widehat{v_{rt}}$, calculated from the reduced form equations. Using SUR to estimate a demand system, where equations are augmented with these predicted residuals, corresponds to 3-SLS.[8]

The identifying IVs in the reduced form price equations exploit the panel nature of the data (Hausman et al., 1994), i.e., the price of the category of interest from another region, is used as instrument for the corresponding category's price in the current region. This is based on the

[6] The ILLS estimator was originally constructed by Browning and Meghir (1991). Blundell and Robin (1999) later derived conditions for consistency and asymptotic normality.
[7] The initial value for $a(\boldsymbol{p}^{rt})$ is the Stone price index, which can be written as $\log P_{rt} = \sum_{j=1}^{N} \overline{w}_{jt} \log p_{jrt}$. Initial value for $b(\boldsymbol{p}^{rt})$ is the unit vector.
[8] For more details on ILLS, see Blundell and Robin (1999) and Lecocq and Robin (2015).

assumption that a region's price for a certain category reflects both category-specific costs, and region-specific factors. Price from one region can thus serve as instrument for another region's price, as long as the stochastic region-specific factors are uncorrelated with each other. After controlling for category- and region fixed effects with the α_{irt}, as well as seasonal and time trend factors, the argument is that the price of a category in one region is driven by the same underlying costs as the price of the corresponding category in another region, thus strengthening the validity of the IV (Hausman & Leonard, 2005).

A concern with this type of instrument, as pointed out by Bresnahan (1997), is if the error terms in the reduced form equations are in fact correlated across panels, due to, e.g., national advertisement resulting in common demand side shocks. This leads to correlation between the IV and the error term in equation (1), violating the validity of the IV. However, in the case of the Swedish fluid milk market, branded products are rarely advertised on national level, due to the traditional brands' regional strongholds. This absence of national campaigns reduces the risk of common demand side shocks. To the extent that these shocks may still be present, e.g., private label products are, to a larger extent, sold and advertised on a national level, this is controlled for by including seasonal and time trend factors within the demand system, following Hausman and Leonard (2005). Additional instruments in the reduced form price equations are monthly, national farmgate prices of conventional and organic milk, $fgpriceC$ and $fgpriceO$. According to Furemar (2004), the farmgate price accounts for about 40% of the retail price in Sweden and can thus be seen as a reasonable proxy of the costs of manufacturing milk, in line with Dhar and Foltz (2005). Identifying IVs in the reduced form expenditure equation are the log of mean yearly income in region r, $\ln income$, as well as a quadratic monthly time trend, $monthtrend^2$, intended to capture unobserved time specific effects on expenditures. Alternative instruments are discussed in Section 6.2.

6. Results

Results from estimating expenditure share equation (1) for each of the four product categories within the demand system are presented in Table 5. Note that the number of observations used in the estimations are restricted by (i) that prices are observed for all four categories in a region, and (ii) that prices are observed for the corresponding category in the region used for price IV. Most parameter estimates are significantly different from zero, and the choice of a quadratic model is validated by the statistically significant coefficient for the quadratic expenditure term.

Among the coefficients for the residuals augmenting the demand system, most are statistically significant, indicating endogenous prices and expenditures.

Table 5: Quadratic Almost Ideal Demand System regression estimates

	CBshare	CPLshare	OBshare	OPLshare
lnpriceCB	-0.143*	-0.144**	0.251***	0.036*
	(0.069)	(0.051)	(0.054)	(0.035)
lnpriceCPL	-0.144*	-0.134**	0.072*	0.205***
	(0.060)	(0.044)	(0.047)	(0.031)
lnpriceOB	0.251***	0.072*	-0.141**	-0.182***
	(0.057)	(0.042)	(0.044)	(0.029)
lnpriceOPL	0.036*	0.205***	-0.182***	-0.059***
	(0.019)	(0.014)	(0.015)	(0.010)
lntotexp	0.006	-0.049**	0.014*	0.029*
	(0.024)	(0.019)	(0.020)	(0.012)
lntotexp^2	0.133***	-0.062***	-0.053***	-0.018***
	(0.006)	(0.005)	(0.004)	(0.002)
$\hat{v}_1$priceCB	-0.004	0.206***	-0.240***	0.038*
	(0.069)	(0.051)	(0.053)	(0.035)
$\hat{v}_2$priceCPL	0.097*	0.113*	0.001	-0.211***
	(0.064)	(0.048)	(0.050)	(0.032)
$\hat{v}_3$priceOB	-0.333***	-0.021	0.127**	0.227***
	(0.058)	(0.042)	(0.044)	(0.029)
$\hat{v}_4$priceOPL	-0.117***	-0.134***	0.189***	0.063***
	(0.030)	(0.023)	(0.023)	(0.013)
$\hat{v}_5$totexp	0.095***	-0.037*	-0.024*	-0.034**
	(0.027)	(0.021)	(0.021)	(0.013)
constant	0.906***	-0.127***	0.163***	0.058***
	(0.022)	(0.016)	(0.017)	(0.011)
N	1770	1770	1770	1770
R-sq	0.963	0.900	0.900	0.924
F(20, 1749)	2384.14	830.39	826.61	1122.94
Prob>F	0.000	0.000	0.000	0.000

Note: CB, CPL, OB and OPL denote Conventional Branded, Conventional Private Label, Organic Branded and Organic Private Label milk, respectively.
Standard errors in parenthesis. *p<.05, **p<.01, ***p<.001. Homogeneity and symmetry constrained estimates. Coefficients for regional dummies, seasonal dummies, and monthly time trend are not reported in the table.

A joint test of the exogeneity of prices and expenditures is also performed, with results in Table 6 rejecting the null hypothesis of exogeneity at the 1% level for all prices and expenditures. Results from the first-stage IV regressions are found in Appendix B. F-tests from these show that IVs are jointly significant in the first-stage regression for the endogenous variables.

Table 6: Results from joint test of exogeneity for prices and expenditures

Residual	chi²	Prob>chi²
$\hat{v}_1$priceCB	25.77	0.000
$\hat{v}_2$priceCPL	66.35	0.000
$\hat{v}_3$priceOB	65.10	0.000
$\hat{v}_4$priceOPL	95.56	0.000
$\hat{v}_5$totexp	12.94	0.005

Note: CB, CPL, OB and OPL denote Conventional Branded, Conventional Private Label, Organic Branded and Organic Private Label milk, respectively.

6.1 Elasticity estimates

Elasticities are calculated at the sample mean of the variables, with standard errors calculated using the delta method.[9,10] Estimates show that compensated (Hicksian) price elasticities are smaller in magnitude, but not significantly different from the uncompensated (Marshallian) ones. In line with previous literature, and for the sake of comparison, the analysis will focus on uncompensated price elasticities of demand.

Own- and cross-price elasticities for each product category are presented in Table 7. Own-price elasticities are found on the diagonal and represent the percentage change in demand for a product given a 1% change in the product's price. They are all statistically significant and negative, implying that Swedish consumers are price sensitive to all four categories of milk. Demand is least price elastic for CB milk (-1.053), followed by OB milk (-1.944). Demand is most price elastic for CPL milk (-2.445), and OPL milk (-2.278). An elasticity around -1 for CB milk is in line with previous literature and expectations. For OB milk, an own price

[9] Formulas for elasticities are found in Lecocq and Robin (2015). Omitting superscripts for regions and time, expenditure elasticities are calculated as: $e_i = 1 + \frac{\mu_i}{w_i}$ where $\mu_i = \beta_i + \frac{2\tau_i}{b(\boldsymbol{p})}\left[\ln\left(\frac{x}{a(\boldsymbol{p})}\right)\right]$ is the marginal effect on expenditure shares due to a change in expenditures. Uncompensated own- and cross-price elasticities are calculated as $e_{ij}^u = \frac{\mu_{ij}}{w_i} - \delta_{ij}$ where $\mu_{ij} = \gamma_{ij} - \mu_i\left(\alpha_j + \sum_k \gamma_{jk} \ln p_k\right) - \frac{\tau_i \beta_j}{b(\boldsymbol{p})}\left[\ln\left(\frac{x}{a(\boldsymbol{p})}\right)\right]^2$ is the marginal effect on expenditure shares due to a change in price j, and δ_{ij} is the Kronecker delta, which is equal to 1 if $i = j$ and 0 otherwise.

[10] Yearwise estimations are also performed, with results available upon request. However, note that $income_{rt}$ is the yearly mean for regions. This variable is therefore dropped in the instrument equation for expenditures.

elasticity of -1.944 is considerably smaller, in absolute value, than results from both the US (Glaser & Thompson, 2000) and German market (Jonas & Roosen, 2008). According to previous literature, this difference in magnitude could be due to large differences in price premiums, market shares, and sample characteristics across studies. Compared to Glaser and Thompson (2000) and Jonas and Roosen (2008), the Swedish sample displays larger organic milk market shares, smaller organic price premiums, and does not exclude a large portion of the organic retail sales. Notably, demand for organic milk is more price elastic within the private label segment, where the organic price premium is, on average, larger (27% compared to 15.8% within the branded segment). The argument that demand for organic products is less elastic when organic market shares are large and organic price premiums are relatively small, thus appears to have some merit. It is, however, striking that the own-price elasticities for organic milk in the Swedish market are relatively similar to those in Bunte et al. (2007), Alviola and Capps (2010), and Chen et al. (2018) when the organic price premiums in the Swedish sample are considerably smaller. Also when the estimation method is similar, as in Dhar and Foltz (2005), but markets differ substantially, demand for organic milk is more price elastic for the Swedish sample. Moreover, comparing results to those in Schröck (2012), it is notable that while the Swedish organic market in 2011–2017 could be considered even more mature than the German organic market was in 2004–2008 in terms of market shares, price premiums, and sales channels, demand for organic milk in the Swedish market is considerably more elastic.

Table 7: Uncompensated own- and cross-price elasticities

Expenditure shares	Price CB	Price CPL	Price OB	Price OPL
CB	-1.053***	-0.183*	0.413***	0.068*
	(0.097)	(0.089)	(0.082)	(0.028)
CPL	-1.717***	-2.445***	0.693	2.129***
	(0.514)	(0.473)	(0.434)	(0.146)
OB	1.187***	0.382	-1.944***	-1.126***
	(0.307)	(0.287)	(0.259)	(0.087)
OPL	0.051	4.114***	-3.958***	-2.278***
	(0.698)	(0.650)	(0.588)	(0.200)

Note: CB, CPL, OB, and OPL denote Conventional Branded, Conventional Private Label, Organic Branded and Organic Private Label milk, respectively. Standard errors in parenthesis. *p<.05, **p<0.01, ***p<.001

A possible explanation to the relatively large own-price elasticity for organic milk, within the branded segment, could be that the local setting of traditional brands in Sweden already appeals to consumers' sense of making sustainable purchasing decisions, i.e., by buying "locally" produced conventional milk. If the difference in perceived quality, or status, between organic and conventional branded milk, is less pronounced in the Swedish market compared to markets in previous studies, this would translate into Swedish consumers having a relatively price elastic demand for organic branded milk, in spite of a relatively low organic price premium.

The difference in estimates between branded and private label milk is noteworthy, with demand for CB milk being least elastic overall, and demand for OB milk being less elastic than demand for both OPL milk and CPL milk. This finding partly supports the results in Schröck (2012). That the own-price elasticities within the private label segment, are of roughly the same size for organic and conventional milk (-2.278 and -2.445, respectively), is similar to results in Schröck (2012), although magnitudes differ. The fact that demand for branded milk is the least price elastic in each segment (organic and conventional) may be due to the relatively late introduction of private label milk products in the Swedish market, following a long period of regional monopolies, with consumers developing strong preferences for traditional brands. Although it is not unusual for retailers to use regionally sourced milk in their milk containers, private labels do not typically communicate any local specifics on their milk products.

Most cross-price elasticities in Table 7 are statistically significant. They show that product categories are substitutes when looking at the organic/conventional dimension, as one would expect, and complements when looking at the branded/private label dimension. Substitution between organic and conventional milk is asymmetric. For example, demand for OB milk increases by 1.187% given a 1% increase in CB prices, while demand for CB milk increases only by 0.413% following a 1% price increase in OB milk. Negative cross-price elasticities are found for OB and OPL milk, as well as for CB and CPL milk, implying that products are complementary. Cross-price elasticities between OB and CPL milk are not statistically significant. The cross-price elasticity of CB with respect to OPL is statistically significant and positive, albeit small in magnitude. An asymmetric substitution pattern between conventional and organic milk products is in line with most previous studies and may suggest that once consumers buy organic milk, they experience a higher perceived quality, and are less likely to switch back to conventional milk. The finding of negative cross-price elasticities between brands and private labels is less straightforward. In Dhar and Foltz (2005), complementarity is found between organic milk and rBST-free milk,[11] suggesting that products aimed at the more

[11] rBST stands for recombinant bovine somatotropin, which is a genetically modified hormone.

environmentally or health-concerned consumer are complementary. Complementarity between CB and CPL milk is found also in, e.g., Jonas and Roosen (2008), Glaser and Thompson (2000), and Schröck (2012). According to Glaser and Thompson (2000), this result may be plausible if retailers place branded and private label milk on promotional sales simultaneously.

Table 8 presents the expenditure elasticity estimates, i.e., the percentage change in expenditure shares due to 1% change in total milk expenditures. Positive elasticities around and below unity suggest that the good is a necessity, which seems to be the case for CB milk, in particular. The expenditure elasticity for OPL milk suggests that as total milk expenditures increase by 1%, the expenditure share for OPL milk increases by more than 2%. One explanation to this is that when total milk expenditures increase as a result of higher income, consumers of conventional milk aiming for the organic segment move first to the "budget" alternative which is OPL milk.

Table 8: Expenditure elasticities

Expenditure shares	Expenditure elasticity
CB	0.755***
	(0.035)
CPL	1.342***
	(0.195)
OB	1.502***
	(0.116)
OPL	2.070***
	(0.259)

Note: Standard errors in parenthesis. *p<.05, **p<0.01, ***p<.001

To summarize, elasticity estimates suggest that demand for organic milk in the Swedish market is own-price elastic, and slightly more so for private label organic milk compared to branded organic milk. In general, demand for private label milk is more elastic than for branded milk, suggesting that Swedish consumers are less price sensitive when it comes to traditional branded products. Cross-price elasticities are all in line with previous studies and suggest that substitution is asymmetric for organic and conventional products, within the private label and branded segment, respectively. However, private labels and brands appear to be complementary goods within the organic and conventional segment, respectively. While the latter finding is somewhat counterintuitive, it is in line with results from previous studies.

6.2 Sensitivity analysis

In order to test the robustness of the results, a number of sensitivity checks are performed, concerning fat segments, and instrumental variables, and sample period. Tables from some of these checks are presented in Appendix B.

In line with most of the previous studies on milk demand, the main analysis in this paper does not separate milk products according to their fat content. However, in Li et al. (2012), milk products are viewed as fundamentally differentiated by their fat content, and the authors estimate a demand system with eight goods, made up by organic and conventional milk products of four different fat contents. Another take on fat segments is laid out by Glaser and Thompson (2000) who estimate separate demand systems for each fat segment, arguing that the approach of Li et al. (2012) is bound to give rise to many irrelevant cross-price elasticity estimates. In order to investigate whether elasticities differ much within different fat segments, I also estimate three separate demand systems for each fat segment. Results are found in Table B.2 in Appendix B and are mainly in line with the results above, although own-price elasticities are not statistically significant for CB milk within the medium fat segment, nor for CPL milk in the low fat segment. Demand for OB milk is least elastic, instead, in these segments.

Since the mean expenditure share of OPL is relatively small (4%), a sensitivity analysis is performed where OPL products and OB products are bundled in the same organic category, in line with Chen et al. (2018). The combined category, ORG, has a mean expenditure share of 20%. The elasticities from this demand system of three product categories are presented in Table B.3 in Appendix B. While the own-price elasticity for CB milk is similar to the main model, demand for CPL milk is more elastic (-5.815). The own-price elasticity for ORG milk is relatively large in absolute value (-3.590), but considering that the category includes both OPL and OB milk, the magnitude is not unreasonable.

Additional sensitivity analysis is performed using alternative instruments in the reduced form price equations. Instead of using other regions' prices, one-period lagged prices are used to instrument for prices in period *t*. The F-values in the first-stage regression show that IVs are jointly significant in the reduced form equations. The risk of serial correlation is, however, present when instrumenting with lags. Own- and cross-price elasticities from this specification are presented in Table B.4 in Appendix B. Estimates remain similar, although demand for CPL milk and OB milk is considerably less elastic compared to estimates in Table 7.

The substantial increase in OPL milk price during the years 2013–2014 is not mirrored in declining market shares (in volume) during the same period. A small reaction from OPL consumers during this period may possibly lead to a small absolute value of OPL milk's own-price elasticity. When estimating the demand system and only including the years 2015–2017, the own-price elasticity of OPL milk does increase (in absolute value) to -3.184. However, so does the demand elasticity for CPL milk.[12]

7. Conclusions

Increasing the organic production is becoming a common target within sustainability and climate policy, and consumer demand for organic food plays a pivotal role in reaching these targets. This paper analyses consumer demand for organic and conventional milk products in the Swedish retail market during the years 2011–2017 using retail scanner data. It contributes to previous literature by (i) using data from a highly mature organic market in terms of market shares, organic price premiums, and sales channels, (ii) providing elasticity estimates from a sample which does not exclude a large portion of the organic retail sales, and (iii) distinguishing between private labels and brands, something which has been largely overlooked in previous studies, especially within the organic segment. Using weekly scanner data from AC Nielsen on fluid milk sales for six Swedish regions, this paper estimates own- and cross-price elasticities of demand, as well as expenditure elasticities, by employing a quadratic almost ideal demand system (Q-AIDS). Endogenous prices are instrumented for using Hausman instruments which exploits the panel nature of the data.

Results suggest that, within the branded segment, demand for organic milk is more price elastic than demand for conventional milk, but not within the private-label segment. Further, demand for private label products is more elastic compared to branded products. Cross-price elasticities point, in line with previous literature, to asymmetric substitution between organic and conventional products. Given the sample's relatively small organic price premiums, the magnitude of the own-price elasticities of organic milk are slightly larger (in absolute value) than one would expect, based on previous studies. One possible explanation to this difference within the branded segment is that the local setting of traditional brands in Sweden already appeals to consumers' sense of making sustainable purchasing decisions. Results also speak of the importance of separating private labels from brands. The fact that demand for branded milk is less price elastic than for private label milk, within both the organic and conventional segment, may be due to private labels' relatively late entrance in the Swedish market, following

[12] Results not presented, but available upon request.

a long period of regional dairy monopolies, with consumers developing strong preferences for traditional milk brands. Notably, results show similar own-price elasticities of demand for OPL and CPL milk, and even a slightly less elastic demand for organic milk compared to conventional milk. When lacking the local setting that surround branded products, it is interesting to see that own-price elasticities are of the same magnitude for organic and conventional products.

Concluding, results show that although organic price premiums are relatively small in the Swedish market, consumers are still quite price sensitive regarding organic milk price, and quite price sensitive regarding private label milk products in general. There is thus potential to expand organic milk sales in Sweden, by means of price (premium) reductions, especially within the private label segment where the added value of "organic" is, perhaps, clearer from the consumer’s perspective.

This paper shows that studies on demand for sustainable consumption could benefit from analysing the relation between organically and locally produced food. For example, analysing demand for the organic and conventional alternatives of different milk brands in "local" and "non-local" markets in Sweden. Studying organic demand for other food products would also contribute to a broader understanding of consumer behavior surrounding sustainable consumption. Although the sample used in this study is representative in the sense that the Swedish retail market does not contain specialized organic food stores, there is scope for investigating further how demand for organic food differs across households within Sweden. This would, however, require scanner data on household level.

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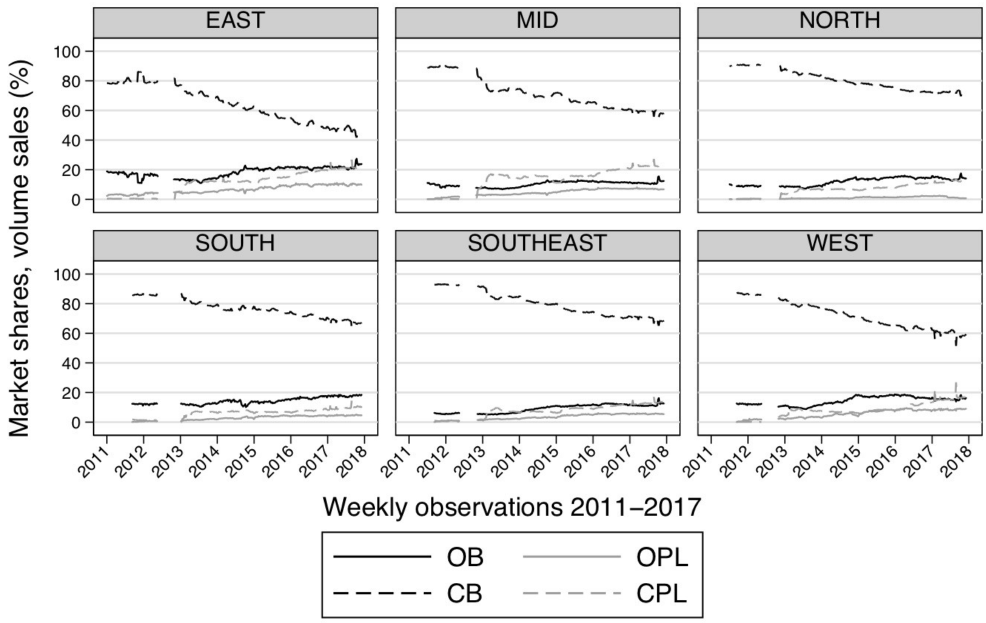
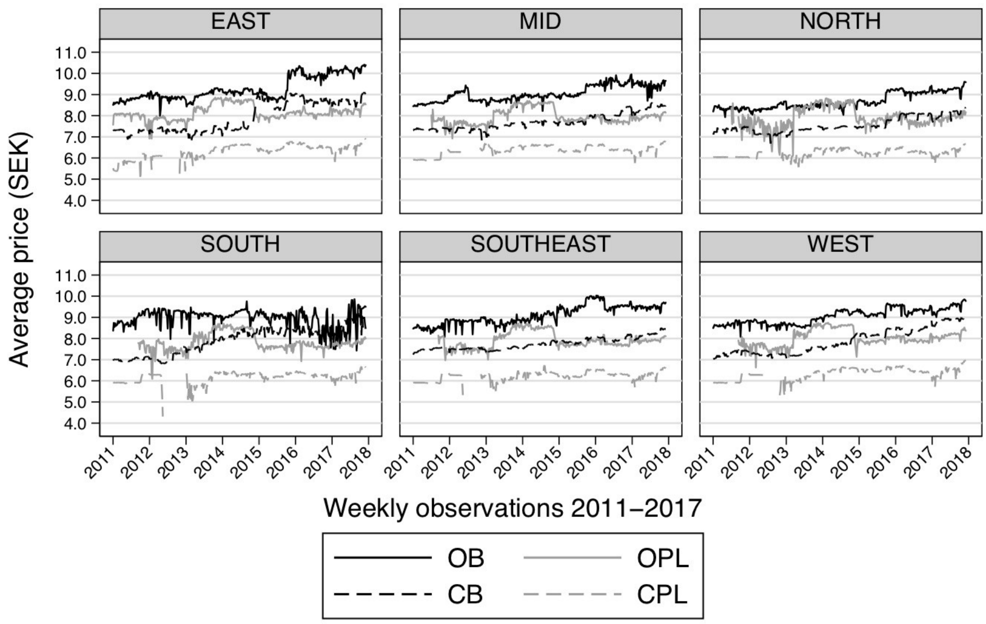
Appendix A

Figure A.1: Map of Swedish regions in AC Nielsen data.



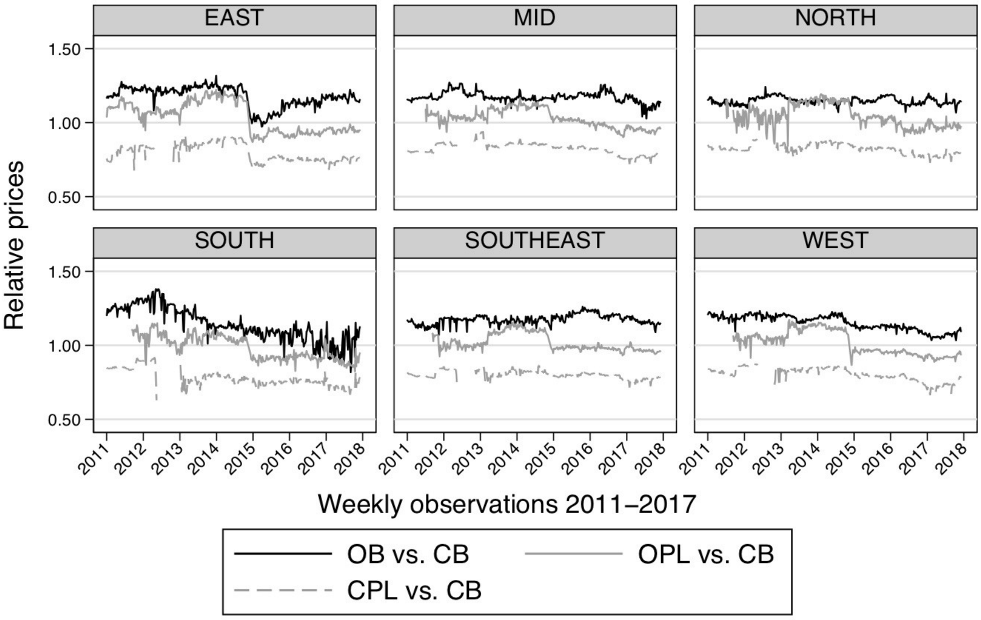
Note: CB, CPL, OB and OPL denote Conventional Branded, Conventional Private Label, Organic Branded and Organic Private Label milk, respectively.
Source: Nielsen data 2011–2017.

Figure A.2: Market shares (volume), 1 litre flud milk, 2011–2017



Note: Deflated prices using CPI and base year 2007. CB, CPL, OB and OPL denote Conventional Branded, Conventional Private Label, Organic Branded and Organic Private Label milk, respectively.
Source: Nielsen data 2011–2017.

Figure A.3: Average prices, 1 litre fluid milk, 2011–2017



Note: CB, CPL, OB and OPL denote Conventional Branded, Conventional Private Label, Organic Branded and Organic Private Label milk, respectively.
Source: Nielsen data 2011–2017.

Figure A.4: Relative prices, 1 litre fluid milk, 2011–2017

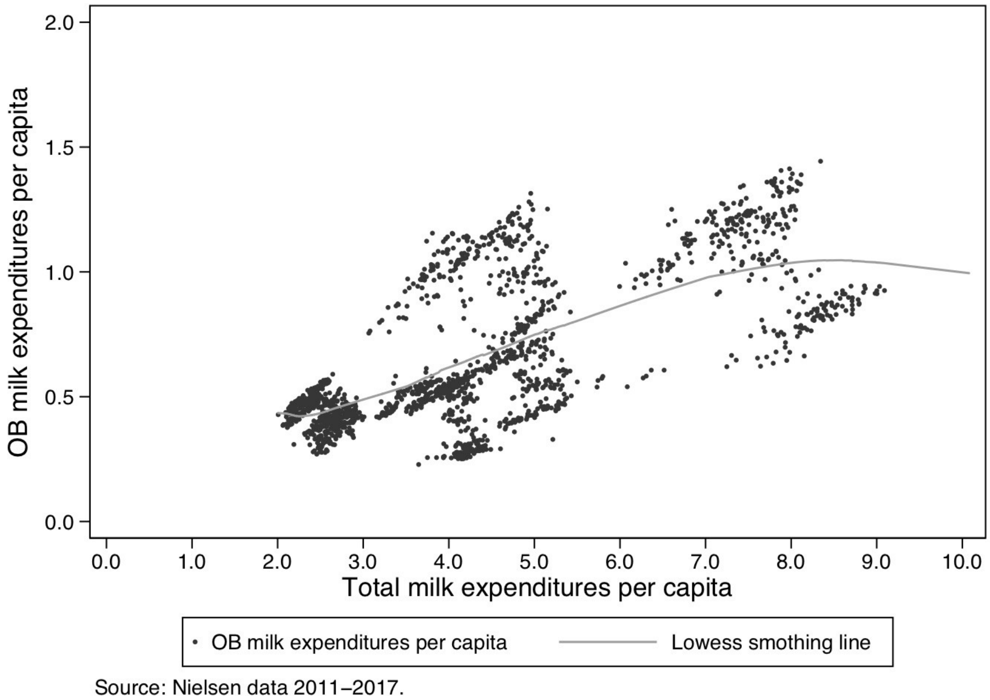


Figure A.5: Engel curve, organic branded milk expenditures

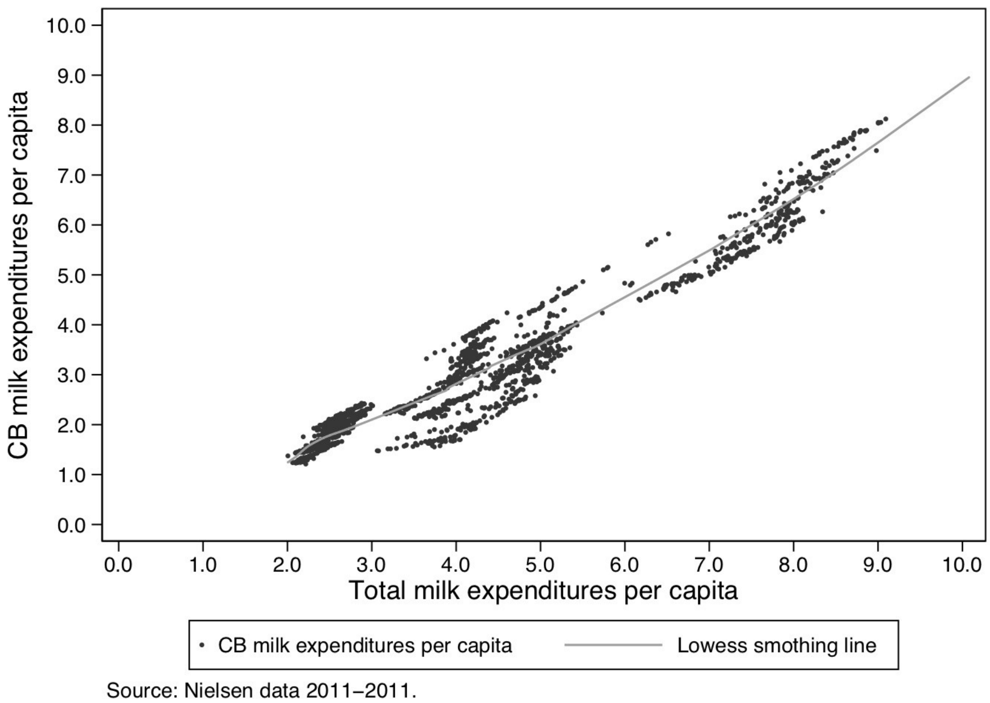


Figure A.6: Engel curve, conventional branded milk expenditures

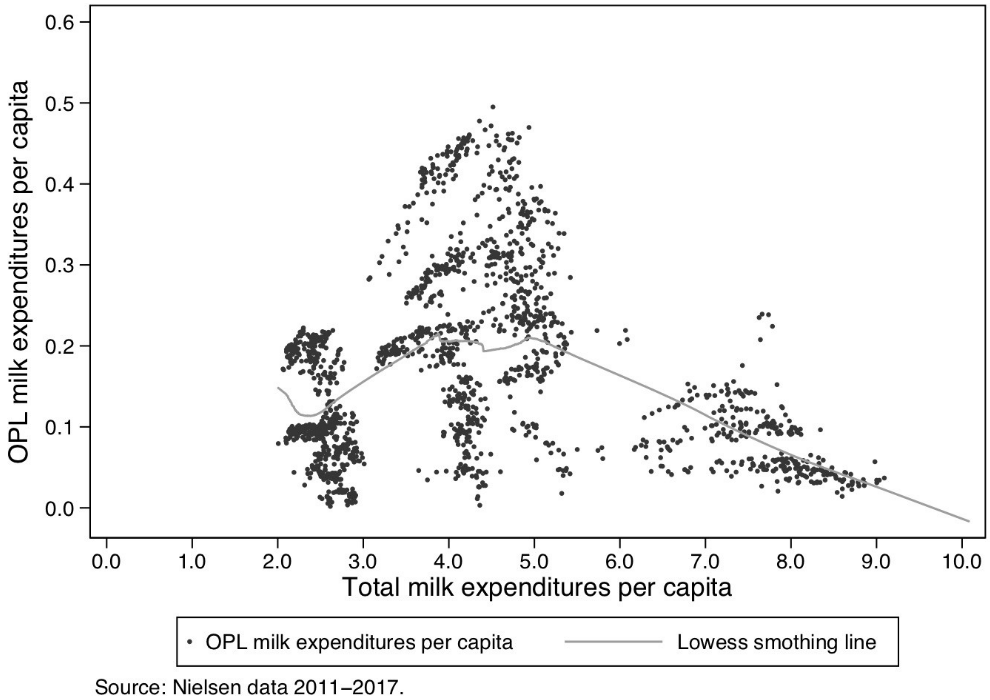


Figure A.7: Organic private label milk expenditures

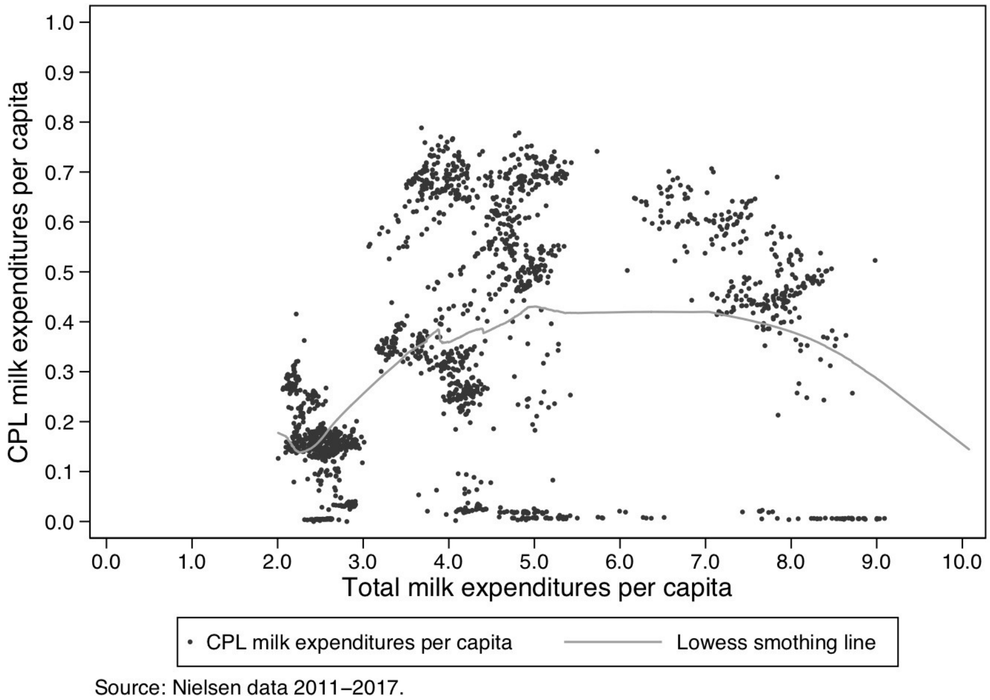


Figure A.8: Conventional private label milk expenditures

Appendix B

Table B.1: Results from first-stage IV regressions

	lnpriceCB	lnpriceCPL	lnpriceOB	lnpriceOPL	lntotexp
lnaltpriceCB	0.247***	0.172***	0.137***	0.040*	0.130**
	(0.022)	(0.019)	(0.028)	(0.017)	(0.040)
lnaltpriceCPL	0.203***	0.495***	0.154***	0.053**	0.366***
	(0.024)	(0.021)	(0.029)	(0.018)	(0.042)
lnaltpriceOB	0.063**	0.035*	-0.134***	0.048**	0.089**
	(0.019)	(0.017)	(0.024)	(0.014)	(0.034)
lnaltpriceOPL	0.056*	0.090***	0.210***	0.619***	0.128**
	(0.025)	(0.022)	(0.031)	(0.019)	(0.045)
lnfgpriceC	-0.038**	-0.020	-0.143***	0.111***	-0.093***
	(0.012)	(0.011)	(0.015)	(0.009)	(0.022)
lnfgpriceO	-0.055**	0.060**	0.106***	0.051**	0.138***
	(0.020)	(0.018)	(0.025)	(0.015)	(0.036)
lnincome	-0.427***	-0.285**	-0.161	0.244**	-1.112***
	(0.102)	(0.088)	(0.125)	(0.075)	(0.179)
$monthtrend^2$	0.000***	-0.000**	0.000***	-0.000***	-0.000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
region2	-0.106***	-0.035	-0.050*	0.034*	-0.697***
	(0.021)	(0.018)	(0.025)	(0.015)	(0.036)
region3	-0.123***	-0.057***	-0.093***	0.037**	-0.682***
	(0.019)	(0.016)	(0.023)	(0.014)	(0.034)
region4	-0.055**	-0.061***	-0.071**	0.015	-1.610***
	(0.019)	(0.016)	(0.023)	(0.014)	(0.034)
region5	-0.108***	-0.075***	-0.046	0.026	-0.805***
	(0.021)	(0.018)	(0.025)	(0.015)	(0.036)
region6	-0.065***	-0.040**	-0.049**	0.006	-1.148***
	(0.014)	(0.012)	(0.017)	(0.010)	(0.024)
seas2	-0.007**	-0.001	-0.003	0.007***	-0.027***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.004)
seas3	-0.003	0.001	-0.001	0.003	0.026***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.004)
seas4	0.002	0.002	0.011***	-0.007***	0.037***
	(0.002)	(0.003)	(0.002)	(0.002)	(0.004)
monthtrend	-0.001	0.002***	-0.003***	0.005***	0.011***
	(0.001)	(0.000)	(0.001)	(0.000)	(0.001)
constant	3.402***	1.780**	2.515***	-1.255***	11.560***
	(0.571)	(0.491)	(0.699)	(0.420)	(1.004)
N	1770	1770	1770	1770	1770
R-sq	0.798	0.584	0.517	0.806	0.987
F(17,1752)	406.31	144.74	110.24	428.69	7909.08
Prob > F	0.000	0.000	0.000	0.000	0.000

Note: CB, CPL, OB and OPL denote Conventional Branded, Conventional Private Label, Organic Branded and Organic Private Label milk, respectively.
Standard errors in parenthesis *p<.05, **p<.01, ***p<.001

Table B.2: Uncompensated own- and cross-price elasticities, per fat segment

Whole fat segment, N=1554				
Exp. Shares	Price CB	Price CPL	Price OB	Price OPL
CB	-0.707***	-0.358***	-0.072	0.118*
	(0.093)	(0.064)	(0.090)	(0.050)
CPL	-1.732***	-1.488***	2.028***	0.833***
	(0.459)	(0.316)	(0.442)	(0.245)
OB	-0.776*	1.585***	-1.308***	-1.080***
	(0.327)	(0.225)	(0.313)	(0.173)
OPL	2.755***	2.702***	-3.983***	-1.946***
	(0.808)	(0.557)	(0.775)	(0.433)
Medium fat segment, N=1770				
Exp. Shares	Price CB	Price CPL	Price OB	Price OPL
CB	-0.129	-0.530***	-0.245	0.073**
	(0.278)	(0.153)	(0.185)	(0.026)
CPL	-3.337*	-2.302**	3.655***	1.532***
	(1.299)	(0.716)	(0.865)	(0.120)
OB	-1.288*	1.695***	-0.998*	-0.959***
	(0.608)	(0.335)	(0.403)	(0.056)
OPL	0.098	2.511***	-3.469***	-1.140***
	(1.304)	(0.725)	(0.865)	(0.119)
Low fat segment, N=1554				
Exp. Shares	Price CB	Price CPL	Price OB	Price OPL
CB	-1.271***	-0.475***	0.185*	0.339***
	(0.057)	(0.068)	(0.091)	(0.050)
CPL	-3.746***	1.397	-0.176	4.900***
	(0.703)	(0.819)	(1.100)	(0.647)
OB	0.718**	-0.340	-1.103**	-1.287***
	(0.240)	(0.285)	(0.390)	(0.214)
OPL	5.993***	4.712***	-2.131*	-7.988***
	(0.568)	(0.741)	(0.971)	(0.478)

Note: CB, CPL, OB and OPL denote Conventional Branded, Conventional Private Label, Organic Branded and Organic Private Label milk, respectively.
Standard errors in parenthesis *p<.05, **p<.01, ***p<.001

Table B.3: Uncompensated own- and cross-price elasticities, using three categories

Exp. shares	Price CB	Price CPL	Price ORG
CB	-1.042***	-0.083	0.119*
	(0.052)	(0.080)	(0.061)
CPL	-2.296***	-5.815***	4.801***
	(0.430)	(0.605)	(0.478)
ORG	1.186***	2.467***	-3.590***
	(0.224)	(0.364)	(0.262)

Note: CB, CPL, OB and OPL denote Conventional Branded, Conventional Private Label, Organic Branded and Organic Private Label milk, respectively.
Standard errors in parenthesis *p<.05, **p<.01, ***p<.001

Table B.4: Uncompensated own- and cross-price elasticities, using lagged prices as price IVs

Exp. shares	Price CB	Price CPL	Price OB	Price OPL
CB	-0.970***	-0.038	0.145***	0.069**
	(0.025)	(0.038)	(0.026)	(0.021)
CPL	-1.208***	-1.351***	-0.311	0.717***
	(0.155)	(0.234)	(0.159)	(0.132)
OB	0.621***	-0.051	-1.025***	-0.323***
	(0.090)	(0.143)	(0.096)	(0.079)
OPL	-0.100	1.356***	-1.291***	-2.263***
	(0.138)	(0.218)	(0.144)	(0.121)

Note: CB, CPL, OB, and OPL denote Conventional Branded, Conventional Private Label, Organic Branded and Organic Private Label milk, respectively. Standard errors in parenthesis. *p<.05, **p<0.01, ***p<.001