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Do Consumers Pay More for What They Value More? The Case of Local Milk-based Dairy Products in Senegal

Mélanie Lefèvre

Senegalese consumers prefer milk-based dairy products that are local and fresh to ones produced with imported powder. However, prices for fresh-milk-based and powder-based products are not significantly different. I address this puzzle by first confirming the preference using choice-based conjoint data to evaluate whether Senegalese consumers will pay a significant positive premium for fresh local products. I then identify price determinants using a unique dataset of milk product characteristics. The results verify the Senegalese preference for fresh local dairy products and show that consumers' misinformation regarding product composition prevents them from allocating a higher price to local milk-based products.

Key Words: choice-based conjoint analysis, hedonic regression, milk, preference for local origin, Senegal

Consumers often want to purchase local food products because of taste preferences, because they think local goods are healthier, or because they want to support local agriculture. A diverse group of studies has shown that consumers are usually willing to pay a premium for local food (e.g., Alfnes 2004, Loureiro and Hine 2002, Loureiro and Umberger 2003, Mabiso et al. 2005, Nganje, Shaw Hughner, and Lee 2011, Quagrainie, Unterschultz, and Veeman 1998, Tonsor, Schroeder, and Lusk 2013). Less often studied is transmission of

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I am grateful to Jean-Marie Baland, Francis Bloch, Axel Gautier, Tatiana Goetghebuer, Bernard Lejeune, Pierre Pestieau, Ekaterina Tarantchenko, Joe Tharakan, and Vincenzo Verardi for discussion, comments, and helpful suggestions and to participants at the BU Development Reading Group, the 3rd ADDEGeM Doctoral Meeting, the XXIV ASEPELT Conference, the KOF Quantification of Qualitative Data Conference, and the 2013 Northeastern Agricultural and Resource Economics Association workshop. I thank Cécile Broutin and GRET for sharing their data. Benjamin Thiry provided excellent research assistance related to data collection during his master's degree program at University of Liège. I also thank the Belgian American Educational Foundation for its support. An important part of this paper was written while I was visiting scholar at the Institute for Economic Development at Boston University during the 2012/13 academic year. All errors are my own.

This paper is included as part of the special issue of *ARER* related to the workshop "Beverage Markets and Policy" organized by the Northeastern Agricultural and Resource Economics Association (NAREA) in Ithaca, New York, on June 22 and 23, 2013. The workshop received financial support from the Food and Agricultural Marketing and Policy Section of the Agricultural and Applied Economics Association, the Food Industry Management Program at Cornell University, and Zwick Center for Food and Resource Policy at University of Connecticut. The views expressed are the author's and do not necessarily represent the policies or views of the sponsoring agencies.

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this willingness to pay (WTP) to the actual price. This study explores this issue using the case of sour milk products in Senegal.

Milk is an important component of Senegalese food consumption. Dairy products account for 6.6 percent of food expenses in the region of Dakar (Agence Nationale de la Statistique et de la Démographie (ANSD) 2005). This demand is mainly satisfied by imports of milk powder, principally from the European Union. These imports of powder have received considerable public attention in Europe and Africa, where widely publicized campaigns (Oxfam 2002, Comité Français pour la Solidarité Internationale (CFSI) 2007) have claimed that the imports depress local prices and drive local producers of fresh milk, who are mostly impoverished farmers, out of business. Forty-seven percent of the dairy products used by consumers in Senegal in 2004 were purchased directly as powder (Duteurtre 2006) and hydrated at home into fluid milk and sour milk products.

The second most purchased dairy product in Senegal is factory-made sour milk, which accounts for 20 percent of final home consumption (Duteurtre 2006). The fermented milk has a longer shelf life than fluid milk and enhanced taste. Factory-made sour milk is generally produced in local plants that, until recently, used only imported powder as raw material. However, small-scale milk processing units that ensure rural milk collection have been expanding rapidly in Senegal since the early 1990s (Corniaux et al. 2005, Dieye et al. 2005), and those units use fresh local milk.

Several studies have shown that consumers in Senegal have a strong preference for local milk-based products. Broutin et al. (2006) reported that 90 percent of households that consumed locally sourced sour milk would like to increase their consumption. Sissokho and Sall (2001, quoted in Dieye et al. 2005) stated that 79 percent of consumers considered local milk-based dairy products to be higher in quality than imported ones.

Despite the preference, the price of local milk-based products is not higher than the price of products made with imported powder. For instance, Duteurtre (2006) collected prices of factory-made dairy products in supermarkets and smaller shops in Dakar in November 2005. At that time, only one brand (Wayembam) was made with local fresh milk,[1] and the price of one-half of a liter of Wayembam sweetened sour milk in a plastic sachet ranged from 400 to 450 CFA francs.[2] Prices for similar products made with imported powder were about the same; the cheapest brand (Daral) sold for 375–380 CFA francs and the most expensive (Jaboot) for 450–480 CFA francs.

Thus, although consumers prefer local products, the market prices for products made with local fresh milk and with imported powder are about the same. I address this puzzle, first using data on stated preferences to confirm or reject the assertion that local milk-based products are preferred. In particular, I evaluate Senegalese consumers' WTP for local fresh milk in the composition of sour milk products using data from a choice-based conjoint analysis conducted in 2002 on 400 households in the region of Dakar. The results confirm that Senegalese consumers do prefer (and more highly value) local fresh raw milk. I then identify determinants of the price of sour-milk products. The results show that consumers' misinformation regarding the composition of the products they buy prevents them from allocating a higher price to local liquid-milk-based

[1] Note that Wayembam no longer existed in 2011.

[2] One CFA franc corresponds to approximately 0.002 U.S. dollars.

products. This result is consistent with Broutin et al. (2006), which produced evidence of consumers' difficulty in distinguishing between the two types of raw material. The analysis of price determinants is based on a unique dataset collected in 2011 that contains information on more than 4,000 milk products in five regions of Senegal (1,327 observations for sour-milk products in Dakar). The results of this study, which are based on a hedonic regression, indicate that several misleading characteristics of the powder-based products drive up their prices.

My aim is to compare consumers' WTP for local origin and the premium they actually pay for this characteristic. I thus estimate the impact of origin on both WTP and price. If WTP is not transmitted to the price, a second objective is to identify characteristics of the products that may confuse consumers and investigate how such characteristics affect the price.

Literature

The existing literature on stated preferences for local origin is large. Most of the studies provide evidence that consumers are willing to pay a positive premium for local products over imported ones (Alfnes 2004, Ehmke, Lusk, and Tyner 2008) or for the presence of a local label (Batte et al. 2010, Darby et al. 2006, Loureiro and Hine 2002, Loureiro and Umberger 2003, Mabiso et al. 2005, Nganje, Shaw Hughner, and Lee 2011, Quagrainie, Unterschultz, and Veeman 1998, Tonsor, Schroeder, and Lusk 2013, Umberger et al. 2003). While the definition of local origin is not always consistent, the effect seems stronger for smaller geographic areas (Meas et al. 2013); however, the difference is small (Burnett, Kuethe, and Price 2011) and the opposite is sometimes observed (Onken, Bernard, and Pesek 2011). Several more recent studies have compared WTP for local and for organic products (Bonilla 2010, James, Rickard, and Rossman 2009, Gracia, Barreiro-Hurle, and Lopez-Galan 2014) and explored links between organic consumption and WTP for local products (Wang, Sun, and Parsons 2010). WTP for local origin can be affected by consumers' beliefs in the presence of other attributes of the product such as freshness and absence of pests and disease and by consumers' familiarity with a product (Dentoni et al. 2009). Furthermore, WTP varies significantly with demographic characteristics such as education, ethnicity, and marital status (George 2010).

Regarding milk in particular, Burchardi, Schröder, and Thiele (2005) found that German consumers had a greater WTP (about 0.12 or 0.18 euros per liter depending on the method) for fresh milk from their own region relative to the same product from another region. In Grebitus et al. (2007), however, the local attribute did not influence purchase decisions for conventional and organic milk. In Belgium, more than 50 percent of the consumers surveyed by Vandermersch and Mathijs (2004) agreed to pay 0.05 or 0.1 euros more for milk certified as Belgian in origin. In a study in the United Kingdom by Fearne and Bates (2003), 43 percent of respondents agreed to pay 1 to 2 percent more for locally produced milk and 42 percent agreed to pay a premium of 3 to 5 percent. Jacob (2012) estimated that Rhode Island consumers are willing to pay a premium for local milk of $1.495 per gallon, which is greater than the premium paid for organic milk. He also found that richer and more educated consumers are willing to pay more for local milk relative to nonlocal milk. Tempesta and Vecchiato (2013) found that consumers in Italy are willing to pay an even larger premium for local milk (up to 1.43 euros per liter) but that the

premium varies widely among various groups of consumers, making it difficult to summarize as a single value.

In addition to the extensive literature on stated WTP for local origin, several studies have analyzed whether products that are certified as local exhibit higher prices. Using a hedonic approach, Loureiro and McCluskey (2000) found that the average Spanish consumer pays a premium of about 0.19 euros for Galician-certified veal relative to unlabeled veal. Bonnet and Simioni (2001) used supermarket scanner data to estimate the impact of French certification on the price of Camembert. Their results, which were based on a mixed multinomial logit model as an alternative to a hedonic one, indicated that the label was not significantly valued. Brand was the relevant information of value. Since Camembert is a well-known product for French consumers, the brand may implicitly indicate the origin. In the wine sector, the reputation of the region of origin was more important than certification (e.g., Panzone and Simões 2009). Using weekly data on prices hand-collected in 30 outlets in five U.S. metropolitan areas, Park and Gómez (2012) calculated that the premium for local origin for lowfat (2 percent) fluid milk was 16.2 percent.

It is important to note that prices, preferences, and purchase decisions regarding dairy products are also influenced by socioeconomic and demographic characteristics (Dharmasena and Capps 2010, 2011, 2012, Schrock 2010, Thompson, Lopetcharat, and Drake 2007) and by intrinsic characteristics of a product (Carlucci et al. 2013, Ueda and Frechette 2002).

This study contributes to the literature on preferences for local origin by providing additional evidence of stated WTP for locally sourced products, investigating the impact of product characteristics on actual market prices, and combining the information from those investigations to explain why stated WTP does not necessarily get transmitted to actual market prices.

Willingness-to-pay Estimation

Choice-based Conjoint Data

To estimate consumers' WTP for locally sourced sour-milk products in Senegal, I use data from a survey of 400 Dakar households (from the departments of Dakar, Pikine, and Rufisque[3]). The survey was completed in April 2002 under the *INCO MPE Agroalimentaires* program coordinated by Groupe de Recherche et d'Echanges Technologiques (GRET), a French nongovernmental organization (Broutin et al. 2006). The survey includes rating/ranking choice-based conjoint (CBC) data about sour-milk products. Eight hypothetical sour-milk products were shown to the respondents (products A–H in Table 1). The products differed by characteristics (or attributes) and price but were chosen to realistically represent products available in the Senegalese market. Each product was made from either fresh milk or milk powder, was packed individually (sachet) or sold by weight, and could be sweetened or unsweetened.[4] Note that no mention

[3] The fourteen regions of the country are subdivided into forty-five departments. The region of Dakar is divided into three departments: Dakar, Pikine, and Rufisque. In 2002, Pikine was further divided into two departments, Guédiawaye and Pikine.

[4] When constructing the survey, GRET identified four relevant attributes (packaging, sweetness, raw material, and price) and corresponding attribute levels using Kelly's repertory grid method (e.g., Steenkamp and Van Trijp 1997). Combining the attribute levels gave 24 ($2 \times 2 \times 2 \times 3$) hypothetical products. To make the rating/ranking task feasible for respondents, that number was

Table 1. Hypothetical Sour-milk Products (*Lait Caillé*) Shown to Respondents

Product	Packaging	Sweetness	Raw Material	Price (CFA francs)
A	per weight	no sugar	powder	275
B	per weight	sugar	fresh	325
C	per weight	sugar	powder	225
D	sachet	sugar	fresh	275
E	sachet	no sugar	fresh	225
F	sachet	no sugar	powder	325
G	sachet	sugar	powder	225
H	per weight	no sugar	fresh	225

Notes: There are three types of factory-made sour-milk products in the Senegalese market: *lait caillé*, *soow*, and yogurt. The hypothetical products were presented to respondents as *lait caillé*. The attributes were chosen to represent reality; each hypothetical product could exist in the market. One CFA franc corresponds to approximately 0.002 U.S. dollars.

of the locality characteristic was made. However, the survey used "fresh raw material" as a proxy for "local raw material." Senegal has never produced milk powder so describing the raw material as milk powder implicitly meant that it was imported. Informal discussions with Senegalese consumers confirmed that milk powder is uniformly considered to be imported and fresh milk to be locally produced. However, in this study it is impossible to distinguish valuations of taste that were based on the freshness of local raw material from valuations related solely to the product's geographic local origin.[5]

In the first step, the eight products were presented to survey respondents and they were asked to identify which product(s) they were willing to buy while taking into account its (their) characteristics and price. The survey assigned values to the products based on their responses using a 1–5 scale, and the highest score (5) was given to the products they were willing to buy. Respondents were then asked which products they were not willing to buy given their characteristics and prices, and those products were assigned the lowest score (1). Finally, respondents were asked to assign each of the remaining products to one of three categories that corresponded to scores of 4, 3, and 2.

The survey scheme combined two properties that can be used to evaluate WTP. Scoring the products individually (from 1 to 5) generates a rating CBC analysis. However, the level of the score assigned may depend on unobserved individual fixed effects. The particular design of the question (i.e., giving first a rating of 5, then a rating of 1, and then the other ratings), however, reduces this effect. Ranking the alternatives from most preferred to least preferred generates a ranking CBC analysis. It is commonly accepted that the first two or three rankings and the last two or three rankings reflect real preferences (e.g., Sinclair 1995). Since the GRET survey contains five rankings, one can be confident that they reflect true preferences.

reduced to eight using the SPSS Orthoplan procedure to create a subset designed to capture the primary effects for each attribute level.

[5] See Darby et al. (2008) for a discussion of the independence of WTP for freshness and local origin.

Given the reliability of the ratings and rankings, both interpretations are used in the analysis. Note that tied rates/ranks are allowed since there were eight products and only five possible rates/ranks.[6] I interpreted observations in which two products were given the same score as indifference between the products.

The product that received the highest average score (4.10) was D, which was individually packaged (in a sachet), sweetened, made with fresh local milk, and cost 275 CFA francs; 57 percent of the interviewed consumers gave it a score of 5 (the highest score). The product that received the lowest average score (2.59) was A, which also cost 275 CFA francs but was made with powder, was unsweetened, and was sold by weight; 40 percent of the respondents gave it the lowest score (1).

In addition to the CBC data, the GRET survey includes information about respondents' and their households' socioeconomic and demographic characteristics such as the regional department in which they live and their ethnicity, education, size of household, and food expenses. Table 2 reports descriptive statistics. Overall, the sample is representative of the population of Dakar, although the sampling of respondents per department does not correspond exactly with the departments' actual population proportions. The proportion of medium-sized households is larger in the sample (62.5 percent) than in the population (43 percent). On average, the households in the sample are also more educated but poorer.

Only households that reported consumption of sour milk were surveyed. However, selection bias is negligible since virtually all households consume sour milk. For instance, in a survey of 82 Dakar households, Duteurtre and Broutin (2006)[7] observed that every household had consumed sour milk during the month following Ramadan. Thus, valuations of sour milk by nonconsumers would have only a minor impact because they are such a small part of the population. Moreover, when making inferences, the population of interest is sour-milk consumers. Indeed, the aim of the analysis is to measure the additional price those consumers are willing to pay to consume a local product rather than an imported one. We can reasonably assume, therefore, that individuals who do not consume any sour milk are unwilling, *a fortiori*, to pay an additional premium for it.

Model Specifications

Consumers' responses to the survey are modeled according to McFadden's random utility model (e.g., Anderson, de Palma, and Thisse 1992, Louviere, Hensher, and Swait 2000). This model assumes that, given a set of alternatives, consumers choose alternatives that maximize their individual utility. The utility, U_{ij}, that individual i obtains from choosing alternative j is unobservable (is a latent variable) but can be defined by a deterministic component (V_{ij}) that is observable and a stochastic error term (ε_{ij}) that is not observable:

$$U_{ij} = V_{ij} + \varepsilon_{ij}. \tag{1}$$

[6] On average, consumers gave a score of 5 (most preferred) to 2.6 products and a score of 1 (least preferred) to 1.7 products. Note that all five ratings did not have to be used. Almost all of the respondents (98.5 percent) gave a score of 5 to at least one product, 83.5 percent gave a score of 1 to at least one product, and 55 percent gave a score of 2 to at least one product.

[7] Referenced by Dia et al. (2008, p. 39).

Table 2. Survey Data: Descriptive Statistics

	Percent of Population of Dakar Region	Percent of Sample
Department		
Dakar	42.00	48.50
Pikine	45.40	40.25
Rufisque	12.60	11.25
Ethnicity		
Wolof	42.01	52.25
Peul/Toucouleur	26.55	18.50
Other (ethnic minority)	31.44	29.25
Education		
Illiterate	45.66	31.25
Primary school	20.96	22.50
Secondary school	22.25	32.00
Higher education	9.36	7.50
Other	1.76	6.75
Household Size		
Less than 5	23.15	10.50
5 to 10	43.06	62.50
More than 10	33.79	27.00
Television		
No	33.10	23.75
Yes	66.90	76.25
Mean monthly food expenses (CFA francs)	107,590	101,668

Notes: Data sources are as follows. Population of Dakar – ANSD (2005); 1,598 households. Sample – GRET 2002; 400 households. Department – ANSD (2006). Ethnicity – ANSD (2008).In 2002, Pikine was divided into Guédiawaye and a new department of Pikine. The Pikine population for 2006 is calculated as the sum of the population of both departments.

Assume that V_{ij} can be represented by the following additive linear function:

$$V_{ij} = \gamma \mathbf{Z}_j + \theta p_j + \delta \mathbf{X}_i \tag{2}$$

where $\mathbf{Z}_j$ is a vector of attributes of product j, p_j is the price of product j, $\mathbf{X}_i$ is a vector of individual i's characteristics, γ and δ are vectors of coefficients to be estimated, and θ is a coefficient to be estimated (and is expected to be negative). This simple utility function provides the main effects of the model. It indicates how each attribute affects the level of utility when isolated from all other attributes. γ_k (element k of vector γ) represents how attribute z_k (element k in each vector $\mathbf{Z}_j$) contributes to an individual's utility. From this expression, one can easily define the (deterministic) WTP for an attribute (Champ, Boyle, and Brown 2003). Indeed, by differentiating equation 2, one can see that coefficient γ_k represents the marginal utility provided by attribute z_k (i.e., $\partial V_{ij} / \partial z_k$). The

coefficient θ is interpreted in the same way as the marginal utility of money ($\partial V_{ij} / \partial p_j$); the ratio $-\gamma_k / \theta = -(\partial V_{ij} / \partial z_k) / (\partial V_{ij} / \partial p_j)$ represents the marginal rate of substitution between attribute z_k and money.[8] When faced with any change in attribute z_k that would increase utility (V_{ij}), the individual is willing to pay the premium, $-\gamma_k / \theta$, that keeps the utility constant. Alternatively, the individual has to be paid $-\gamma_k / \theta$ to accept a change in attribute z_k that would decrease the utility.

Ordered logit and probit models (random utility models) are suitable to evaluate WTP.[9] However, ordered logit models require that an assumption of independence of irrelevant alternatives (IIA) holds (see Long and Freese 2006). A Hausman test comparing the full model with a reduced model on a subset of alternatives demonstrates that the IIA assumption does not hold. I thus use an ordered probit model since it does not rely on the IIA assumption. The ordered logit model was tested for comparison and produced similar results (not reported).[10]

The dependent variable of interest is the score, m, given by individual i to hypothetical product j.[11] The ordered probit model assumes that alternative j receives score m if the individual's utility from that product crosses an unknown threshold:

$$score(j) = m \text{ if } \alpha_{m-1} < U_{ij} \leq \alpha_m. \tag{3}$$

As U_{ij} crosses increasing threshold levels (from $\alpha_0 = -\infty$ to $\alpha_M = \infty$), the score attributed to j moves up the scale (1–5). The probability that individual i will give a score of $m = 1, \ldots, 5$ to product j is given by

$$P_{ijm} = \text{Prob}[\alpha_{m-1} < V_{ij} + \varepsilon_{ij} \leq \alpha_m] = \text{Prob}[\alpha_{m-1} - V_{ij} < \varepsilon_{ij} \leq \alpha_m - V_{ij}]. \tag{4}$$

Using equation 2,

$$P_{ijm} = \Phi(\alpha_m - \gamma \mathbf{Z}_j - \theta p_j - \delta \mathbf{X}_i) - \Phi(\alpha_{m-1} - \gamma \mathbf{Z}_j - \theta p_j - \delta \mathbf{X}_i) \tag{5}$$

where $\Phi(\cdot)$ is the cumulative density function for standard normally distributed errors.

Results

The first column under Model A in Table 3 reports the results of the ordered probit model, which does not control for individual characteristics. All of the coefficients are statistically significant at the 1 percent level. As expected, individuals prefer sour milk that is individually packed (sachet), sweetened, and made with fresh raw material. Packaging has the most important effect ($\gamma_1 = 0.63$). The preference for fresh milk is also important; when keeping the other attributes (packaging and sweetness) unchanged, marginal WTP

[8] $-\gamma_k / \theta$ is expected to have the sign of γ_k since θ is expected to be negative.

[9] As previously noted, the data can be interpreted as scores and as ranks, which allows use of both ordered and rank-ordered models. For simplicity, I provide results for the ordered models only. The results of the rank-ordered models are similar.

[10] The results are not reported but are available upon request.

[11] The database contains 3,200 observations (400 households times eight alternatives to be rated) for the dependent variable.

Table 3. Ordered Probit Models

Variable		Model A		Model B	
		Coefficient	(p-value)	Coefficient	(p-value)
Package (sachet = 1)	γ_1	0.630***	(0.000)	0.611***	(0.000)
Sweetness (sugar = 1)	γ_2	0.205***	(0.000)	0.206***	(0.000)
Raw material (fresh = 1)	γ_3	0.402***	(0.000)	0.371***	(0.000)
Price	θ	–0.002***	(0.000)	–0.002***	(0.000)
Pikine	δ_1			0.120**	(0.011)
Rufisque	δ_2			0.211**	(0.035)
Ethnic minority	δ_3			–0.002	(0.975)
Peul	δ_4			0.050	(0.455)
Small household	δ_5			–0.091	(0.180)
Big household	δ_6			–0.061	(0.227)
Illiterate	δ_7			0.177*	(0.072)
Primary school	δ_8			0.052	(0.601)
Secondary school	δ_9			0.015	(0.882)
Higher education	δ_{10}			0.141	(0.213)
Food expenses (CFA/month)	δ_{11}			–0.000	(0.999)
	α_1[a]	–0.715***	(0.000)	–0.587***	(0.000)
	α_2	–0.349***	(0.002)	–0.202	(0.187)
	α_3	–0.021	(0.853)	0.139	(0.368)
	α_4	0.654***	(0.000)	0.808***	(0.000)
Estimate of WTP for Fresh Raw Material[b]					
CFA francs	$-\gamma_3 / \theta$	228.32 [113.82, 342.81]		224.45 [98.68, 350.22]	
Percentage[c]		83.03 [41.39, 124.66]		81.62 [35.99, 127.35]	
Log-pseudolikelihood		–4,338.4961		–4,676.2297	
Number of observations: 3,200 (400 groups)					

[a] α_1–α_4 are the cut points from the ordered probit model.

[b] Confidence intervals at a 95 percent level calculated with the delta method are reported under the estimate.

[c] Expressed as a percentage of the average price of the hypothetical products (275 CFA francs).

Notes: Model A is an ordered probit that does not control for individual characteristics. Model B is an ordered probit that controls for individual characteristics. The standard errors are clustered. ***, **, and * indicate significance at a 1 percent, 5 percent, and 10 percent level, respectively.

for fresh raw material ($-\gamma_3 / \theta$) is around 228 CFA francs. Thus, all else being equal, a representative consumer is willing to pay 228 CFA francs more for a product made with fresh milk than for one made with powder. As shown under Model B in Table 3, controlling for individuals' demographic and socioeconomic characteristics did not change the results much. Marginal WTP for fresh raw material ($-\gamma_3 / \theta$) is around 224 CFA francs. This corresponds to a premium of 82 percent above the average price of the hypothetical products shown to the respondents.

Since individuals' characteristics may affect not only their utility level but also their relative preferences for attributes of the products, I determined whether the results were robust to inclusion of interaction effects.[12] Those results (not reported) indicated that WTP for fresh raw material was not affected by wealth (approximated by food expenditures), education level, or ethnicity. However, large households (more than ten members) did not exhibit significant WTP for fresh raw material while small and medium households did.[13]

One may suspect that the rating/ranking CBC data overestimate WTP because individuals are not actually making purchases (they do not have to spend money) or because of difficulty associated with choosing rankings, a task that generally is not familiar to consumers. In any case, the results are significant and positive and show that individuals are willing to pay a premium for fresh raw material. The lower bound of a 95-percent confidence interval can be used as the lower limit for WTP. Thus, the true value of WTP has a 0.975 probability of being above this limit.

Confidence intervals for the main estimates of WTP for fresh raw materials are reported at the bottom of Table 3. They were calculated using the delta method assuming that WTP is normally distributed. Indeed, it is reasonable to suppose that coefficients of an ordered probit model are normally distributed when the sample is large. Because WTP is a ratio of two normally distributed variables, its distribution is approximately normal when the coefficient of variation of the denominator is small (Hole 2006). The confidence intervals are quite large, indicating that estimation of the mean is imprecise. However, the lower bound of the confidence interval is largely positive, which suggests that individuals are willing to pay a positive premium for fresh raw material. One can be confident that individuals are willing to pay a premium of more than 36 percent of the average price.

While we can reliably assume that products that received a score of 5 were the most preferred and products that received a score of 1 were the least preferred, one could argue that consumers may not be able to accurately rank their preferences for intermediate products. To test for the robustness of the model in this regard, I used two alternative specifications. In the first, I gathered the responses for the middle scores (2, 3, and 4) and used an ordered probit model with three categories instead of five. I then used a binary probit model in which the product was considered to have been chosen (choice = 1) if it received a score of 5 and not chosen (choice = 0) if it received any other score (1–4). Under these alternative models (results not reported), the main results were the same in terms of both significance and sign.

Consumers' Product Knowledge

The preceding analysis assessed whether consumers were willing to pay a positive premium for local milk-based products. As illustrated earlier, however, there is no price premium for the fresh local product in the market in Senegal.

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[12] Specifically, I estimate $U_{ij} = V_{ij} + \varepsilon_{ij}$ where $V_{ij} = \gamma \mathbf{Z}_j + \theta p_j + \delta \mathbf{X}_i + \beta(\mathbf{X}_i \mathbf{Z}_j)$. In that case, WTP for attribute z_k is estimated by $-(\partial V_{ij} / \partial z_k) / (\partial V_{ij} / \partial p_j) = -(\beta \mathbf{X}_i + \gamma_k) / \theta$ and differs among individuals.

[13] This result may be partially explained by an income effect since, *ceteris paribus*, larger households have lower incomes per capita and the control variable *Food Expenses* only represents total income. Differences in taste between members of large and small families also certainly play a role.

A possible explanation for this lack of transmission of WTP to a price premium is that consumers cannot distinguish between the two products.

In the GRET survey, 85.75 percent of respondents reported that they could identify which products were made with fresh raw material and which were not. However, when asked to describe the type of raw material used in the products they consume, they were often incorrect. For example, only 17 percent of the respondents who consumed Niw products were aware that they are made with powder. More than 50 percent thought they were made with fresh raw material. Other brands made with powder exhibited the same pattern of ignorance. However, more than 75 percent of the respondents who consume Wayembam correctly knew that it was made with fresh milk. These results indicate that people who consume a product made with fresh milk make informed choices and that people who consume sour milk made with powder might choose another product if they were better informed.

To determine whether such misperceptions have an impact on WTP, an indicator of knowledge was added to the previous model specifications as a control variable.

$$K_i = \frac{\text{no. of brands consumed and correctly known by individual } i}{\text{no. of brands consumed by individual } i}$$

This indicator was not significant when included in the ordered probit model alone or when interacted with the variable for raw material (results are not reported here). The same applied for inclusion of a dummy variable to indicate whether the score of K_i (between 0 and 1) was higher than a threshold value such as 0.5. Consumers with better product knowledge are not significantly different from other consumers in how they value the fresh raw material.

Product Analysis

Product Data

The second part of the analysis identifies determinants of the price of sour-milk products in Senegal. Data regarding characteristics of the products were collected in 2011[14] by a master's degree student at University of Liège thanks to support from CNCR (Conseil National de Concertation et de Coopération des Ruraux), a Senegalese farmers' organization. The data set provides prices and descriptions for more than 4,000 products collected from five regions of Senegal. I restrict the analysis to the 1,327 sour-milk products from Dakar.

Four types of stores were identified: boutiques, superettes, gas stations, and supermarkets. Boutiques and superettes are two types of convenience stores. In a boutique, the buyer usually asks for products at a counter while a superette is self-service. In the department of Dakar, stores were randomly selected in each of its nineteen administrative subdivisions (*communes d'arrondissement*).[15]

[14] Between the time of the CBC survey (2002) and collection of the product data (2011), the market for factory-made sour milk had evolved somewhat. Some brands had appeared (e.g., Ardo and Dolima) and others had disappeared (e.g., Sen Sow and Wayembam). Nevertheless, the market in 2011 was still composed of a dozen brands, some of which were owned by one company. Sour-milk products made in a factory from fresh local milk had gained a foothold but remained a small part of the market.

[15] The administrative subdivisions were created in 1996 to partition large urban territories.

Table 4. Product Data: Descriptive Statistics

		Percent		
Variable		**All Sour-Milk Products**	**Made with Fresh Milk**	**Made with Powder**
Department	Dakar	73.02	71.72	73.25
	Pikine	9.12	6.06	9.65
	Guédiawaye	14.24	17.68	13.64
	Rufisque	3.62	4.55	3.45
Raw material	Fresh	14.92		
	Powder	85.08		
Appellation	Yogurt	44.08	35.86	45.53
	Lait caillé	44.54	10.61	50.49
	Soow	11.38	53.54	3.99
Store	Boutique	14.09	18.69	13.29
	Superette	22.23	18.69	22.85
	Gas station	47.40	54.04	46.24
	Supermarket	16.28	8.59	17.63
Flavored		57.80	79.80	53.94
Light		1.21	0.00	1.42
Sweetened		29.39	11.62	32.51
Package	Sachet	40.62	62.63	36.76
	Pot	56.22	37.37	59.52
	Bottle	3.17	0.00	3.72
Package color	Several colors	78.90	100.00	75.20
	Mostly white	21.10	0.00	24.80
New brand[a] (not in market in Nov. 2005)		34.89	100.00	23.47
Volume in liters (mean)		0.53	0.65	0.51
Misleading Characteristics	Ambiguous ingredient[b]	54.71	100.00	46.77
	Made in Senegal[c]	18.46	88.38	6.20
	Local picture[d]	63.00	100.00	56.51
	Local name[e]	70.23	100.00	65.01
Observations		1,327	198	1,129

[a] Equals 1 if the brand was not recorded by Duteurtre (2006) and 0 otherwise.
[b] Equals 1 if the ingredient is *lait* (milk), *lait frais* (fresh milk), or *lait de collecte* (milk collected in farms) and 0 if the ingredient is *lait en poudre* (milk powder) or *lait reconstitué* (reconstituted milk).
[c] Equals 1 if "fabriqué au Sénégal" (made in Senegal) is mentioned and 0 otherwise.
[d] Equals 1 if presence of a zebu cow, a peul character, etc., and 0 otherwise.
[e] Equals 1 if the brand name sounds Wolof and 0 if the brand name sounds French.
Notes: Observed products are from nine brands made with powder (Ardo, Cremor, Jaboot, Niw, Simlait, Saprolait, Daral, Sarbi, and Banic) and two made with fresh milk (Dolima and Galoya).

In the other departments within the Dakar region, the stores were randomly selected at the department level. In each store, the student collected relevant information concerning all of the milk products available.

Table 4 provides summary statistics for the sour-milk product characteristics. Most of the observations (73 percent) were collected in the department of

Pikine is divided into sixteen such communes, Rufisque into three, and Guédiawaye into five.

Dakar. The largest number of products came from gas stations (47 percent); the other types of stores were equitably represented in the remainder of the sample.

The sample includes eleven brands. Two were made with fresh milk and the rest with powder. Most of the brands were offered in at least five volumes that ranged from 0.9 to 5.0 liters. In addition, most of the brands were offered in at least two types of packaging (pots, sachets, and/or bottles). Among the eleven brands, 35 percent were new—they did not exist in 2005. Both of the fresh-milk brands were new. Other fresh-milk brands had existed prior to 2005 but were no longer on the market in 2011.

Of the 1,327 products in the data set, 85 percent were made with powder. This is representative of the market: products made with powder are still much more common than ones made with fresh milk. Products made with fresh milk tended to be more often available in gas stations and less available in supermarkets. They were most commonly sold in sachets while powder-made products were most often sold in pots. Three types of sour-milk products are common in Senegal: *lait caillé*, *soow*, and yogurt. The first two are very similar products. Products made with fresh milk are more likely to be called *soow*, a Wolof word, while products made with powder are more likely to be called *lait caillé* (*soow*'s translation in French). Yogurt (44 percent of the sour-milk products in the sample) is slightly different as it is fermented with a different species of bacteria. Other characteristics of the products were recorded: presence of sweetener, whether it was a light/diet product, flavoring (e.g., strawberry, chocolate, and vanilla), and package color.

There are several reasons why consumers of powder-based sour milk tend to think it is made with fresh milk. First, the packages do not always disclose the type of milk used. Although producers are obliged to indicate that a product is made with more than 5 percent powder (decree 69-891, July 25, 1969), they do not always do so. The ingredient list is supposed to denote "milk powder" or at least "reconstituted milk," but some producers choose to mention only "milk." In addition, some producers of powder-based products label them as "made in Senegal." While the processing takes place in Senegal, the raw material is imported. Thus, the mark, while not technically incorrect, can be misleading for consumers. Some of the packaging for powder-based products presents images of zebu cows or Senegalese characters that suggest to consumers that the product is local. And most of the brand names are in Wolof, which also implies local origin.

The bottom panel of Table 4 gives summary statistics regarding these misleading characteristics of products in the sample. Obviously, none of the products made with fresh milk lists milk powder or reconstituted milk as one of its ingredients. However, almost 50 percent of the products made with powder fail to mention it. All of the fresh-milk products and more than 50 percent of the powder-based ones present a local picture and/or a Wolof brand name. Most of the fresh-milk products (88 percent) and 6 percent of the imported-powder-based products are marked as "made in Senegal."

Empirical Strategy

The main question is whether misinformation about the composition of a product is important in determining its price and specifically whether price is predominantly affected by the source of the raw material or by misleading characteristics about the source. To answer those questions, I use a hedonic

regression model to quantify the impact of a product's attributes on its price. The semi-log model takes the following form:

$$\log(p_j) = \alpha + \beta l_j + \sum_k (\delta_k \mathbf{z}_{kj}) + \varepsilon_j \quad (6)$$

where p_j is the observed price of product j, l_j is a dummy variable that takes a value of 1 when the product is made with local fresh milk and zero otherwise, $\mathbf{z}_{kj}$ is a vector of the other attributes of product j, and ε_j is an error term. β and δ_k are parameters to be estimated and represent the shadow prices of l and z_k, respectively.

Several specifications are modeled. The first regression analyzes only the impact of the fresh raw material and controls for other observable characteristics of the product that are not related to its origin. The second explores the impact of misleading characteristics by including four variables—*Ambiguous Ingredient*, *Made in Senegal*, *Local Picture*, and *Local Name*.

Use of the semi-log functional form rather than a linear specification is justified by two elements. First, interpretation of the coefficients in the semi-log form as a percentage of the average price makes it easier to compare the results of this regression with the WTP estimates from the 2002 survey. It is likely that prices evolved between 2002 and 2011, so comparing premiums for fresh raw material in absolute terms could overestimate differences between them. Second, following Loureiro and McCluskey (2000), I used a Box-Cox test to choose between semi-log and linear functional forms. The chi-squared test with one degree of freedom showed that the models were significantly different in terms of goodness of fit and that the semi-log form performed better.

Results

Model A in Table 5 displays the results from the ordinary least square (OLS) regression (equation 6) in which l_j equals 1 when product j is made with fresh milk and 0 otherwise. The results clearly demonstrate that use of fresh raw material had no significant impact on the product's price. The coefficients associated with the control variables have the expected signs. Sweetened products exhibited a higher price, a result that is consistent with the CBC analysis. The same applies to light and flavored products. Regarding packaging, pots commanded a higher price than sachets. New products had lower prices; brands that had been on the market for less than six years were significantly cheaper. Colorful packages were also positively valued, probably because consumers associated more interesting packages with higher quality. The type of store had no impact on the price of the product. Finally, on average, sour-milk products were cheaper in the department of Pikine, which is generally more impoverished than the department of Dakar.

The categories *soow* and *lait caillé* did not have different effects on price, which reflects the fact that they are simply translations of one another. However, yogurt had a higher price. Since the fermentation process for yogurt is slightly different, its higher price could be related to more expensive processing or a consumer preference for its taste. The present analysis does not allow for exclusion of either hypothesis.

Model B in Table 5 presents results from the OLS regression modified to control for misleading characteristics. Fresh raw material did not have a positive impact on price (instead, its impact was negative and significant), but

Table 5. Hedonic Regressions

	All Sour Milk Products				*Lait Caillé* and *Soow* Only			
	Model A		Model B		Model C		Model D	
Variable	Coefficient	p-value	Coefficient	p-value	Coefficient	p-value	Coefficient	p-value
Fresh raw material	0.020	(0.388)	–0.230***	(0.000)	0.097***	(0.000)	–0.106***	(0.003)
Ambiguous ingredient			0.158***	(0.000)			0.069***	(0.000)
Made in Senegal			0.082***	(0.000)			0.196***	(0.000)
Local picture			–0.075***	(0.002)			0.019	(0.455)
Local name			–0.068***	(0.007)			0.131***	(0.000)
Soow	0.028	(0.207)	0.060***	(0.008)	–0.046***	(0.003)	–0.100***	(0.003)
Yogurt	0.205***	(0.000)	0.203***	(0.000)				
Volume (liters)	–0.167***	(0.000)	–0.136***	(0.000)	–0.112***	(0.000)	–0.102***	(0.000)
Sweetened	0.053***	(0.008)	0.089***	(0.000)	0.072***	(0.000)	0.101***	(0.000)
Light	0.195***	(0.000)	0.197***	(0.000)	0.055	(0.630)	0.022	(0.843)
Flavored	0.184***	(0.000)	0.202***	(0.000)	0.182***	(0.000)	0.128***	(0.000)
Pot	0.388***	(0.000)	0.360***	(0.000)	0.311***	(0.000)	0.290***	(0.000)
Bottle	–0.059*	(0.085)	0.062**	(0.047)				
New brand	–0.138***	(0.000)	0.070***	(0.001)	–0.081***	(0.000)	–0.060**	(0.012)
Colored package	0.053***	(0.002)	–0.050***	(0.007)	0.054***	(0.000)	0.132***	(0.000)
Superette	–0.005	(0.779)	–0.008	(0.641)	–0.006	(0.628)	–0.006	(0.658)
Gas station	0.004	(0.800)	–0.001	(0.939)	0.011	(0.351)	0.006	(0.577)
Supermarket	–0.031	(0.123)	–0.064***	(0.000)	–0.027*	(0.080)	–0.041***	(0.006)
Pikine	–0.062***	(0.001)	–0.028*	(0.086)	–0.028*	(0.085)	–0.038**	(0.017)
Rufisque	–0.016	(0.565)	0.001	(0.967)	0.014	(0.499)	0.013	(0.497)
Guédiawaye	–0.006	(0.707)	–0.009	(0.493)	–0.014	(0.249)	–0.010	(0.412)
Constant	6.837***	(0.000)	6.853***	(0.000)	6.796***	(0.000)	6.600***	(0.000)
Observations	1,327		1,327		742		742	
Adjusted R-square	0.737		0.802		0.692		0.721	

Notes: ***, **, and * indicate significance at a 1 percent, 5 percent, and 10 percent level, respectively. The dependent variable is the natural logarithm of the price per liter. The reference product is a sachet of *lait caillé* that is made with powder and is unsweetened, nonlight, unflavored, and sold in a boutique in the department of Dakar.

ambiguity regarding the source of the raw material positively and significantly affected price. A product that seemed to be made with fresh milk in that the packaging did not state that it was "made with milk powder" received a higher price—on average, 16 percent more per liter—than products that were labeled as powder-based. The same was true for packages labeled as "made in Senegal," which were, on average, 8 percent more expensive than packages without such labeling.

In this specification, products were a bit cheaper in supermarkets and the effect associated with the department of Pikine was smaller. Surprisingly, new brands exhibited a higher price; one would have expected that well-established brands could set higher prices thanks to their reputations. Also, products with colorful packaging were cheaper than products in plain white packaging despite likely being considered more attractive. The results regarding the presence of a picture representing a local character and the Wolof brand name are also unexpected. Their presence had a strong negative impact on the price of the product. Perhaps these surprising results are driven by the yogurt products in the sample. Because yogurt is not connected with traditional Senegalese consumption habits (as opposed to *soow* and *lait caillé*), consumers may have different preferences regarding the attributes of these products. They also may value characteristics related to imported raw materials because Senegalese producers may be seen as having less expertise in production of yogurt.

Because yogurt is slightly different from the other sour-milk products, models C and D in Table 5 show results from the same regressions for *lait caillé* and *soow* only. While the sample size is smaller, the analysis is particularly interesting because the results can be compared with those of the CBC analysis in which consumers chose between various hypothetical *lait caillé* products. In model C (using the same regression as model A), fresh raw material had a positive impact on price. However, in model D, which controlled for misleading characteristics (using the same regression as model B), the effect of fresh raw material is negative. These results confirm that consumers pay more not only for products that actually are made with local fresh milk but for all products that seem to be produced that way. Ambiguity regarding the milk source increases the price of *lait caillé* and *soow* products by 7 percent. Labeling as "made in Senegal" increases their price by almost 20 percent. The local picture and local name have the expected effect for *lait caillé* and *soow*. Model D shows evidence of a strong positive impact from the local name on price; on average, products with a Wolof brand name were 13 percent more expensive per liter than products without. The control variables, including *New Brand* and *Colored Package*, had expected impacts. Sweetened and flavored products garnered higher prices, pots were preferred to sachets, and products were cheaper in supermarkets than in smaller stores.

Since there is likely to be correlation between the misleading characteristics and the source of the raw material, potential multicollinearity is a concern. Following Fox and Monette (1992), I calculated the variance inflation factors—the degree to which the variance of each estimated coefficient is increased due to correlation that exists between the explicative variables. All of the variance inflation factors were inferior to the commonly used threshold of 10. I also checked the robustness of the results by separately estimating models similar to A and C in which I replaced the fresh raw material with each of the misleading characteristics. These specifications avoided multicollinearity but were subject to potential omitted-variable bias. For all sour-milk products, the results were

robust to this change of specification in terms of both sign and significance. For *lait caillé* and *soow* only, the variable *Local Picture* became significant; the other results were not affected. However, since *Local Name* and *Local Picture* are positively correlated and both positively affect price, omitting *Local Name* led to overestimation of the effect of *Local Picture*.

Conclusions

Using choice-based conjoint data, this study estimated Senegalese consumers' WTP for a fresh (or local) raw material in the composition of sour milk. An ordered probit model that controlled for consumer heterogeneity estimated this WTP at 224 CFA francs with a large confidence interval (from 99 to 350 CFA francs at the 95 percent level). Even if the estimation is suspected to be biased upward due to the hypothetical nature of the question, one can be reasonably confident that true WTP exceeds the lower bound of the confidence interval and is significantly positive. Thus, consumers are ready to pay a premium of at least 36 percent of the average price to obtain sour-milk products made with fresh milk rather than with powder. This result gives a strong indication that Senegalese consumers prefer local products and are willing to pay more for them.

While consumers appear to be willing to pay more for local sour milk, the market price for such products is not higher than the price of products made from imported powder. Indeed, consumers often cannot identify the source of milk in sour-milk products and believe that they are buying fresh local milk products when they are not. Several attributes associated with package labeling may mislead consumers about the nature of the raw material. Using data on the characteristics of more than 1,300 products, I provide evidence that those misleading characteristics drive up the price of powder-based products. In particular, ambiguity in the list of ingredients (i.e., absence of a proper "made with milk powder" label) and the presence of labels identifying a product as "made in Senegal" increase the price of all types of sour milk. In the case of *lait caillé* and *soow*, a local brand name also has a positive impact on price.

The major limitation of this analysis is that it cannot distinguish a preference for local origin from a preference for freshness because in Senegal fresh milk as a raw material is always locally produced and milk powder is always imported. Despite this limitation, the study provides the first insights into consumer preferences and market price determination for sour-milk products in Senegal.

Policy Implications

A clear implication of this analysis is that any policy that leads to better information for consumers could allow producers of locally sourced sour milk to earn higher prices without diminishing demand. An opportunity thus exists for local-origin certification, which has been considered by nongovernmental organizations and producer organizations (Prolait 2009). Certification would increase the value of products made with local fresh milk relative to powder-based products, allowing local producers to compete effectively with imports despite having higher production costs. While a reliable local-origin certification mechanism may be difficult to implement in a developing country, at least producers who use local fresh milk could advertise the local origin of their products to consumers.

From a policy perspective, better enforcement of existing regulations would be valuable. Producers are legally required to mention milk powder as an ingredient when it represents more than 5 grams per 100 grams of milk (Broutin and Diedhiou 2010). Currently, this requirement is frequently ignored, and the results of this study show that the absence of that information significantly increased the price of powder-based products. Labeling as "made in Senegal" also could be better regulated since it has a positive impact on price even when it does not represent local raw material. Better regulation of packaging of powder-based sour milk should also be encouraged. Currently, products made with imported powder can legally be branded with a Wolof word, a practice that often convinces consumers that the products are made with local milk. In the case of *lait caillé* and *soow* at least, products with Wolof brand names earned higher prices.

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