Consumer and Retailer Preferences for Local Dairy Products: Evidence from Stacked Choice Experiments in Urban Mali

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EXECUTIVE SUMMARY

The Malian dairy sector plays a critical role in food security and nutrition and is an important source of employment. However, in recent years the competition between local and imported dairy products has been increasing. In 2015, the European Union ended its milk production quotas, which led to overproduction and low prices. Recognizing the growth potential in Africa, many European dairy firms have increased or extended their trade to the continent, including to Mali (Orasmaa et al., 2016). Despite the large volumes of milk production in Mali (e.g., approximately 600,000 tons in 2017) and qualitative accounts suggesting that Malians have a preference for local fresh milk (GoM, 2017), imported powdered milk continues to capture a large share of the growing market. About one third of dairy consumption in Mali as a whole and over two-thirds in its capital, Bamako, are met through powdered milk (author's calculations from World Bank, 2015).

This paper uses choice experiments to examine Malian retailer and consumer preferences for fresh milk as an ingredient in pasteurized milk products, and to investigate information asymmetry as a problem that can help to explain thin markets (i.e., relatively low traded volumes) in Bamako's fresh milk value chain. One major contribution of our study is that in addition to consumer preferences, we investigate retailer preferences since they are a critical link between farmers and consumers.

We conducted two separate but parallel choice experiment surveys with consumers and retailer, in the spirit of the "stacked survey method" which allows for the statistical analysis of differences across value chain segments (Reardon et al., 2012:32). Compared to the traditional approach of conducting a single consumer choice experiment, our innovation allows us to probe more deeply into potential issues of information asymmetry and to provide additional insights for the marketing of dairy products. We designed discrete choice experiments that focused on three quality-signaling mechanisms that Malian dairy manufacturers might adopt to provide product quality information to buyers. The first was labeling that indicated the ingredient composition of a product (in terms of fresh and powdered milk). The second was a third-party quality certification backed by the government, a private entity, or both. The third mechanism was enhanced packaging (i.e. a sealed pouch, bottle, or carton), compared to traditional plastic sack packaging. Due to preference heterogeneity within these populations, we analyzed the data for each sample using mixed logit and latent-class (LC) models, and in both preference and willingness-to-pay (WTP) space. We then tested for statistical differences in results between the samples.

We collected the data for this study in March 2018, by surveying 218 consumer households and 205 retailers (traditional shops and small grocery stores) located across Bamako. In the first stage of sampling, we stratified the city's neighborhoods into three wealth levels then randomly selected eighteen neighborhoods from the three groups. In the second stage, within each neighborhood we used geographic random sampling to select households and retailers.

Five key findings, with implications for agribusiness strategy and government policy emerge. First, we find a positive and significant WTP for attributes that provide information on product ingredients, safety, and other dimensions of quality. Together, these results provide evidence of

information asymmetry between manufacturers and buyers (i.e., retailer and consumers) of pasteurized milk products. This resonates with Lefevre (2014)'s finding of misinformation in the Dakar dairy market, and we echo that paper's recommendation for government policies that improve information flows amongst consumers and other value chain actors. One such policy option is to require, and better regulate, the labeling of ingredients on product packaging.

Second, we find that consumers have a specific preference for government certification of product quality, compared to private certification, and are willing to pay an important price premium for this assurance. This finding suggests that dairy manufacturers can create value for their brands by improving product quality and adopting the existing (but underutilized) government certification program. However, several other conditions must be met in order for this system to be effective. Among these, the Malian government must improve consumers' awareness of the certification program while simultaneously strengthening enforcement of corresponding regulations in the dairy market.

Third, we find that that Bamako consumers are willing to pay a significant price premium for pasteurized milk that is made purely from fresh milk. Further, results from the LC model shows that nearly 85% of consumers prefer fresh milk compared to reconstituted powdered milk or a blend of these two ingredients. Given the current limited availability of fresh milk dairy products in Bamako, this points to an important market opportunity for fresh milk farmers and processors. However, in order to successfully compete against imported powdered milk, the fresh milk value chain must reduce production and transaction costs while better-differentiating their brands from those that are manufactured from powdered milk (Vroegindewey, 2018). The labeling and certification mechanisms that we analyze in this study are two options for improving differentiation.

Our fourth finding pertains to another option– enhanced packaging. Our analysis shows that only one type of enhanced packaging is valued by just one of the three consumer latent classes (representing about 65% of consumers). Overall, consumers do not have strong preferences for enhanced packaging. This is surprising, given that other dairy consumer studies show that consumers derive value from higher-quality packaging. On the other hand, other research in Bamako shows that consumers may view traditional packaging as a signaling mechanism for fresh milk (Vroegindewey, 2018). We highlight packaging as an important area for further research.

Fifth, our analysis of retailer data demonstrates that retailer preferences are well-aligned with those of consumers. These two groups also have similar WTP for most product attribute levels. These results imply that retailers can be a useful source of information for upstream value chain actors wishing to understand consumer preferences and demand. However, our LC analysis reveals significant segmentation among retailers, implying that pasteurized milk manufacturers should select their distributor partners carefully. For example, fresh milk products may obtain the greatest price premium among high-volume retailers that prioritize being able to offer a variety of dairy products. In contrast, many low-volume, low-variety retailers (representing about 30% of retailers) have no WTP for fresh milk or any other product attribute. A third latent class (representing another 40% of retailers) has positive WTP for each attribute, including packaging.

Overall, these insights demonstrate the usefulness of complementing information on consumers with retailer analysis in a food market study. Our paper illustrates the use of stacked choice experiments as one promising tool for this endeavor.

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ACRONYMS

AIC	Akaike Information Criterion
AMM	l'Autorisation de Mise sur le Marché
BIC	Bayesian Information Criterion
CAIC	Consistent Akaike Information Criterion
CL	Conditional logit
FCFA	Franc Communauté Financière Africaine
RPL	Random parameters logit
USD	U.S. Dollars
WTP	Willingness-to-pay

1. INTRODUCTION

Consumer demand for dairy in West Africa has been growing for several decades and is positively correlated with both income growth and urbanization (Hollinger and Staatz, 2015). For instance, from the late 1980s to mid-2000s, the share of household food expenditure on dairy increased by 50% and by 30% in urban and rural areas of Mali, respectively (Ibid.). The Malian capital, Bamako, consumes over one-fifth of the national dairy production that is marketed (83 of 376 million L/year), which is the equivalent of a per capita dairy consumption of 34 L/person/year (author's calculations from World Bank, 2015).

The potential to meet this growing demand with domestic milk supply is high. Mali ranks 6th in total livestock holdings among African countries (FAO, 2017). The country's cattle holding is estimated at eleven million heads and the potential production of cow's milk is nearly 600,000 tons (GoM, 2017). There is some evidence, although limited, that West African consumers have a preference for dairy products that are manufactured from local fresh milk rather than from imported powdered milk (Vroegindewey et al., 2019; Hollinger and Staatz, 2015; Lèfevre, 2014).

Powdered milk accounts for about one third of dairy consumption in Mali as a whole (author's calculations from World Bank, 2015). This dependence is accented in urban areas, due to higher population densities and greater distances to agricultural production zones, combined with weak overall commercial infrastructure. In Bamako, household purchases of powdered milk account for 70% of volumes consumed in liquid milk equivalents (Ibid.). Fluid milk and yoghurts account for another 18% of consumption (author's calculations from World Bank, 2015). Although Bamako-based companies manufacture most of these products, the most established local brands are mostly or entirely manufactured from powdered milk (Vroegindewey et al., 2019). Most fresh milk-based dairy products that are available in Bamako are manufactured by periurban dairy cooperatives or small artisanal processors (Vroegindewey et al., 2019). This dependence on powdered milk in urban processing and consumption—despite an overall preference for fresh milk—is a common pattern that has been documented elsewhere in Senegal (Lèfevre, 2014) and more generally across West Africa (Hollinger and Staatz, 2015).

One reason for this apparent market failure may be information asymmetry between the manufacturers and buyers of fresh milk-based dairy products. That is, it could be that consumers and retailers of dairy products demand certain credence or experience attributes that may or may not be available on the market, but are in any case difficult or costly for them to verify ex ante (Caswell and Mojduszka, 1996; Rosenman and Wilson, 1991). It could also be the case that certain value actors, such as processors or retailers, are unaware of consumer preferences for certain attributes and, therefore, do not offer them.

Two issues are relevant in developing contexts such as Mali, where food quality and labeling regulations are limited and/or weakly enforced. First, the ingredient composition of a dairy product is a quality attribute that is usually unobservable to consumers prior to the purchase or consumption. For example, Lèfevre (2014) estimates that Senegalese consumers are willing to pay 80% above average prices for a fresh milk-based dairy product; however, in urban markets

this preference is not transmitted into an actual price premium, because many consumers do not know the ingredient composition of different brands and are also misled by ambiguous or deceitful labeling practices. Second, recent qualitative research conducted in several West African capitals found that consumers value local foods, but concerns over product safety and other quality problems lead them to consume foreign brands instead (Hollinger and Staatz, 2015). Other studies conducted in Africa have showed that consumer dairy purchase decisions are influenced by perceptions of aflatoxin levels, unhygienic handling, color and smell, and fat content (Mtimet et al., 2015; Fadiga et al., 2014).

The objectives of this paper are threefold. First, we examine Malian preferences for fresh milk as an ingredient in dairy products. Second, we investigate information asymmetry as a contributing factor to the market failure described above. Third, we analyze three quality-signaling mechanisms—ingredients listing, third-party certification, and enhanced packaging—that manufacturers of fresh milk-based products could be adopted to address information asymmetry. To accomplish this, we use discrete choice experiments to elicit buyer preferences, since quality certification, certain types of packaging, and the clear labeling of ingredients are dairy product attributes that are not yet offered in the Malian market. The study focuses on Mali's largest city and capital, Bamako, given its high dependence on powdered milk. Additionally, large urban markets such as Bamako account for a growing share of food expenditure in developing countries, and also represent the frontier of changing tastes and preferences in these contexts (Hollinger and Staatz, 2015).

A major contribution of this study is that we investigate the preferences of both consumers and retailers, the latter providing a critical link between the consumers and producers of local foods (Trivette, 2018). To do this, we conducted parallel choice experiments with both consumers and retailers, in the vein of the "stacked survey method" which allows for the statistical analysis of differences across value chain segments (Reardon et al., 2012, p. 32). To our knowledge, this is the first study to take this approach in a developing country context. Fernández-Polanco et al. (2013) used a similar approach to study retailer and consumer preferences for seafood products in Europe. This study concludes that retailers understand well the preferences of consumers with respect to several product attributes, but that retailers overestimate the price-sensitivity of consumers. Our study design builds on Fernández-Polanco et al. (2013), by allowing retailer respondents to make choices as firms (rather than as consumers), and by using a larger sample of retailers.

Our approach allows us to probe more deeply into issues of information asymmetry and to provide more useful insights for the marketing of dairy products. Retailer value and procurement decision-making are partly driven by a retailer's knowledge of consumer preferences for product attributes (Skytte and Bove, 2004). If we find evidence that retailer preferences are aligned with those of consumers, then it suggests that retailers have adequate information about consumer preferences. Further, if retailer preferences manifest in positive willingness-to-pay (WTP) for product attributes, then it implies that other determinants of retailer value, such as considerations of cost and competition, are also satisfied for retailers to purchase that product. In this case, dairy processors can have greater confidence that those product attributes will be commercially successful, compared to only having evidence of consumer demand. Further, estimates of retailer WTP for product attributes—which theoretically factors in the marketing margins that retailers

would expect to capture—should provide manufacturers with a more relevant price premium target, compared to consumer WTP.

Finally, because buyer preferences for dairy products are assumed to vary across individuals (Olynk and Ortega, 2013; Wolf et al., 2011; Olynk et al., 2010), we analyze our choice experiment data using models that account for preference heterogeneity. This analysis allows us to identify and characterize distinct consumer and retailer segments. This approach is useful for business strategy and policy, because it enables them to target, and to tailor their approaches to, appropriate consumer groups along with the retailers that these consumers are likely to patronize.

In the next section, we present the theoretical and empirical framework that underlies our analysis of retailer and consumer preferences. In section three, we describe our data and choice experiment design. We discuss the results from our data analysis in section four, then conclude by highlighting implications for agribusiness strategy and government policy in section five. In this paper, "fluid milk" refers to milk in its liquid form, and includes raw, pasteurized, or sterilized (i.e. ultra-high temperature-processed) milk products that are made from fresh milk, reconstituted milk powder, or some combination of the two. *Fresh milk* refers to fluid milk that is locally-sourced, i.e. produced in Mali. Mali does not produce any powdered or sterilized milk. *Pasteurized milk* refers specifically to fluid milk that has been pasteurized for sale as a consumer product. *Dairy* refers to any of these, plus any other product that is manufactured from a milk input.

2. THEORETICAL FRAMEWORK AND ECONOMETRIC MODELING

The theoretical framework of this research is grounded in random utility theory (Manski,1977; McFadden, 1974) and Lancaster (1966)'s consumer theory, which described product quality as a bundle of attributes (related to food safety, nutrition, packaging, processes, etc.) that together determine product performance and attributes, nutritional value, that determine product performance (Caswell and Mojduszka, 1996).

As a flexible empirical method that conforms to these theories (Adamowicz et al., 1998), choice experiments closely simulate real-world purchasing decisions in which an individual must select one product alternative from a set of options. In most applications, the buyer is the final consumer of the product (e.g., Ortega et al., 2011). The literature has given little attention to retailer preferences (one exception is Fernández-Polanco et al., 2013), although there is precedence for such an application given that researchers have adapted the approach to study other actors along livestock value chains, including farmers (e.g., Otieno et al., 2011) and traders (e.g., Ruto et al., 2008).

Consider a situation in which individual *i* faces *K* alternatives contained in ψ (the global set of alternatives), where each alternative *k* represents a bundle of product attributes *x*. Subject to the choice set in situation *t*, the individual will select alternative $j \in \psi$ to maximize her utility U_{ijt}. Because of incomplete information and other errors, we model utility as a latent and unobservable random variable:

$$U_{ijt} = V(x_{ijt}) + \epsilon_{ijt}, \tag{1}$$

where $V(x_{ijt})$ is an observable deterministic utility component generated from the selected alternative, and ϵ_{ijt} is the random component of utility assumed to be independently and identically distributed across all individuals and choice situations. Individual i will choose product j if her utility derived from j *is* greater than or equal to her utility derived from the alternatives; formally $U_{ijt} \geq U_{ikt} \; \forall \, j \neq k$. Thus the probability of her choosing product j is given by:

$$Prob_{ijt} = Prob(V_{ijt} + \epsilon_{ijt} \geq V_{ikt} + \epsilon_{ikt}; \; \forall k \in \psi, \; \forall k \neq j) \tag{2}$$

Assuming that the deterministic component of U_{ijt} is linear in parameters, we can specify individual i's utility function as:

$$V_{ijt} = X'_{ijt}\beta + \epsilon_{ijt} \tag{3}$$

where X'_{ijt} is a vector of attributes for the jth alternative, β is a vector of taste parameters, and ϵ_{ijt} is the stochastic component which follows a Gumbel (extreme value Type I) distribution.

In a simple conditional logit (CL) models, individuals are assumed to have homogenous preferences. However, in reality, consumers preferences for food quality differ from one another. Therefore, we investigate preferences of dairy consumers using two approaches that accoun for preference heterogeneity.

The first approach is the random parameters logit (RPL) model, which relaxes limitations in the CL model by allowing preferences to vary randomly within a sample according to a specified distribution (McFadden and Train, 2000). The probability that individual i selects alternative j from the choice set ψ in situation t is:

$$P_{ijt} = \frac{\exp(V_{ijt})}{\sum_j \exp(V_{ijt})} f(\beta) d\beta \tag{4}$$

where β is a vector of random parameters with distribution $f(\cdot)$.

The second approach is the latent class (LC) model. This model segments individuals into a number of C latent classes across which preferences vary discreetly (Boxall and Adamowicz, 2002). In the LC model, $f(\beta)$ is discrete and takes on C distinct values. The probability that individual i selects alternative j from the choice set ψ in situation t is:

$$P_{ijt} = \sum_{c=1}^{C} \frac{\exp(x_{ijt}\beta_c)}{\sum_j \exp(x_{ijt}\beta_c)} R_{ic} \tag{5}$$

where β_c is the specific parameter for class c, and R_{ic} is the probability that individual i is a member of class c. We can model this probability of class membership as:

$$R_{is} = \frac{\exp(z_n\theta_s)}{\sum_r \exp(z_n\theta_r)} \tag{6}$$

where z_n is a set of observable characteristics that affect individual i's class membership, and θ_s is the parameter vector for consumers in class c.

We use the RPL and LC models to analyze data collected through a choice experiment (see next section for a detailed discussion). For both models, the choice experiment data allows us to estimate parameters in preference-space. These estimated coefficients represent consumers' marginal utilities for different product attributes, while the ratio of any two coefficients represents the marginal rate of substitution of one attribute over the other; use of the price coefficient in the denominator yields willingness to pay. The specification of the RPL model can be reparametrized in WTP-space so that the model coefficients are themselves WTP estimates.[1]

3. DATA AND SURVEY

3.1 Sampling Strategy

We collected the data for this study in March 2018, by surveying 218 dairy consumers and 205 retailers located across Bamako, which has a population of approximately 2.5 million (World Bank, 2018). In order to obtain a sample that is representative of the Bamako population in terms of wealth, we used a stratified random sampling approach. In the first stage, we stratified the city by neighborhood wealth levels. Given that no official information exists on average household incomes by neighborhood, we classified each of Bamako's 61 neighborhoods into one of three wealth levels—low, medium, and high—based on research and field partners' knowledge of the neighborhoods in terms of housing conditions (e.g., access to electricity), infrastructure (e.g., whether roads are paved), and other socio-economic indicators (e.g., where expatriates reside). According to this classification, twenty-five neighborhoods (41%) are low-income, twenty-four (39%) are medium-income, and twelve (20%) are high-income. We randomly selected eight, seven, and four neighborhoods from each class in order to have the same neighborhood weight in the sample as in the population. In the second stage, survey teams randomly sampled households within each selected neighborhood. Because censuses of these populations were not available, we developed a geographic random sampling approach aimed at capturing an appropriate cross-section of the neighborhood.

In each neighborhood, random and purposive sampling approaches to select retail outlets were used. Two types of retailers make up the vast majority of shops selling dairy and other food products in Bamako (Theriault et al., 2018). First, traditional shops (*boutiques*) are small non-self-service shops that sell a limited selection of food items and non-food items (e.g., soaps, batteries) displayed behind a counter. Many boutiques are equipped with one or two refrigerators, which vary widely in quality and make available a limited selection of cold beverages and dairy products. Second, larger grocery stores (*alimentations*), are small self-service stores that mostly carry processed foods, including cold products, and are equipped with one cash register. Although most neighborhoods have at least a few grocery stores, these formats

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[1] For more details on models specified in WTP-space, see Train and Weeks (2005).

are much less numerous than boutiques and are typically located on main paved roads, rather than on the smaller residential dirt roads. One retailer survey team followed one of the two residential roads taken by the household survey teams, selecting every three retail shops that had at least one working refrigerator, a prerequisite for marketing pasteurized milk. The second retailer survey team purposively sampled grocery stores located along the main road. A few other retailer types were also sampled as the teams encountered them, including milk kiosks (small shops specializing in fresh milk products), depots (which are large *boutiques* that also wholesale dairy products to other boutiques), and gas station convenience stores. Although Bamako has about half a dozen supermarkets, these were not sampled because of their small number and their unbalanced distribution throughout the city. Figure 1 presents the location of sampled households using their GIS coordinates. The clusters of map markers represent the sampled households in different neighborhoods. As this map shows, the randomly-selected neighborhoods are fairly well-distributed throughout the city.
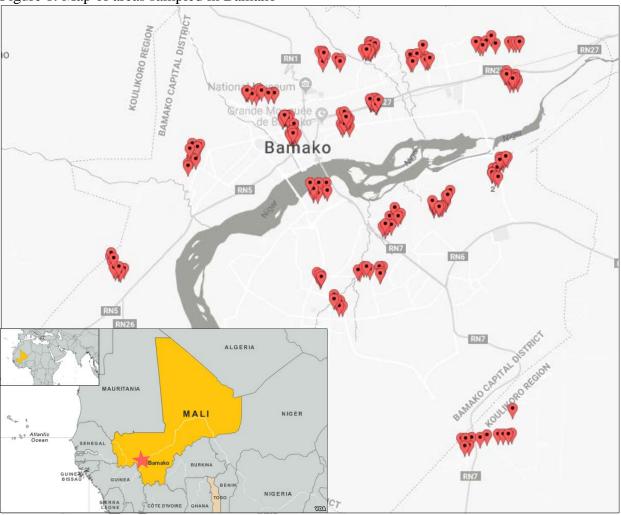
Figure 1: Map of areas sampled in Bamako

3.2 Socio-demographic survey and sample characteristics

The surveys data had two parts: a questionnaire and a choice experiment, each tailored for either a consumer or retailer respondent. The survey teams conducted each consumer survey with the household member who was responsible for food purchasing decisions. In cases where this person was unavailable, the teams conducted the survey with the individual who was second-in-charge.[2] The teams conducted each retailer survey with the owner or manager of each shop (57% of the retailer sample) or, when he was unavailable, the agent on duty.[3] All questionnaires collected data on basic socio-demographic characteristics of the respondent and on knowledge, attitudes, and preferences regarding multiple dairy product quality issues. Additionally, the household survey included variables that might influence dairy preferences, including household composition and income; access to refrigeration, electricity, and a motor-vehicle; and dairy product transactions and consumption in the previous week. The retailer survey aimed at capturing basic information and variables influencing retailer value with respect to the procurement of dairy products, including: how retailers obtain information on consumer preferences and product attributes, customer characteristics, competitive positioning, and drivers of cost (Skytte and Bove, 2004).

Table 1 summarizes relevant characteristics of our consumer sample, disaggregated by neighborhood wealth level. Most respondents were females who had received at least some elementary school education. Almost 60% of the households are poor, based on our estimates of per capita household income and the 2017 national poverty line of 178,000 FCFA (338 USD) per year (GoM, 2018).[4] The data suggests that household assets, access to electricity, and expenditures for fresh milk and all dairy products are statistically different across neighborhood wealth levels, confirming our stratified sampling approach. Just over half of the households have access to both electricity and a refrigerator, with the worst and best access in poor and wealthy neighborhoods, respectively. Depending on the neighborhood type, households had spent an average total of 4,125 FCFA (7.84 USD) to 6,872 FCFA (13.06 USD) on dairy products during the previous week. Households allocated about a quarter of this expenditure to fluid milk, and about one-third to powdered milk. Approximately 70% of households had consumed fluid milk at least once in the previous week. Of these households, about half had consumed fresh milk in the previous week.

Table 2 presents characteristics of the retail shop sample, disaggregated by retailer type. Our sample consists mostly of *boutiques* and grocery stores, along with a few depots and milk kiosks. Average store size, product variety, weekly volumes, and margins are statistically different across categories, highlighting key characteristics that distinguish these different types of retailers. On average, these shops are quite small, each with about two employees and one or two refrigerators. Grocery stores offer the most variety of fluid milk and other dairy products while

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[2] In about 75% of the households where the primary decision-maker was interviewed, this was a male or female household head. In about 70% of the households where the secondary decision-maker was interviewed, this was the female spouse of the household head. Thus, in most households, the household head was the primary decision-maker.

[3] Whenever neither individuals were available in households or shops, or else when they refused to participate, the survey team continued sampling using the same predesignated interval. In total, there were about seventy-five and sixty such cases for households and retailers, respectively.

[4] At the time of field work, the FCFA-to-USD conversion rate was .0019.

smaller and more specialized fresh milk dairy kiosks offer the least variety. Sales depots, which do some retailing but focus on wholesaling to other retail stores, report the largest weekly volumes, followed by kiosks, grocery stores, and *boutiques*. The average marketing margin (i.e., the difference between the unit price at which retailers purchase and resell a product) earned by retailers from fluid dairy products is 17% of the consumer price. *Boutiques* earn slightly below this average while grocery stores and wholesalers earn slightly above-average margins. Kiosks— which typically make bulk purchases of fresh milk from producer cooperatives and repackage it under their own label –earn a 23% margin. We did not find any statistically significant differences in the mean values of these variables when testing across neighborhood wealth levels. However, we do find that the average shop located in neighborhoods of intermediate wealth level experience power outages more frequently and of longer duration, compared to shops in poor or wealthy neighborhoods. Overall, retailers reported an average of five power outages in the previous week, with the longest outage lasting almost two hours.

Table 1: Summary statistics of consumer sample

| | Neighborhood wealth level | | | | | | | | | |
| | Total (N=218) | | Poor (N=92) | | Intermediate (N=81) | | Wealthy (N=45) | | | |
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	p-score	
Respondent characteristics										
Primary HH food purchases decisionmaker (yes/no)	0.31	0.46	0.35	0.48	0.31	0.46	0.22	0.42	0.49	
Female (yes/no)	0.78	0.41	0.76	0.43	0.79	0.41	0.81	0.40	0.89	
Education level attained (yes/no)										
None	0.16	0.36	0.16	0.37	0.16	0.37	0.13	0.34	0.96	
Elementary school or more	0.84	0.37	0.84	0.37	0.83	0.38	0.87	0.34	0.93	
Middle school or more	0.72	0.45	0.72	0.45	0.69	0.46	0.78	0.42	0.72	
Highschool or more	0.44	0.50	0.42	0.50	0.47	0.50	0.44	0.50	0.88	
University	0.34	0.47	0.30	0.46	0.40	0.49	0.31	0.47	0.55	
Household characteristics										
Below the poverty line (yes/no)	0.58	0.49	0.63	0.49	0.54	0.50	0.55	0.50	0.58	
Has access to electricity & refridgerator (yes/no)	0.54	0.50	0.43	0.50	0.60	0.49	0.64	0.48	0.06	*
Household dairy consumption in past week										
Total dairy expenditure (FCFA)	5128.11	5869.56	4124.73	4427.14	5298.69	4734.80	6872.40	9129.26	0.03	*
Expenditure share - all fluid milk (%)	0.26	0.27	0.25	0.30	0.26	0.24	0.27	0.26	0.90	
Expenditure share - milk powder (%)	0.37	0.31	0.33	0.30	0.41	0.32	0.38	0.31	0.25	
Consumed any fluid milk (yes/no)	0.70	0.46	0.61	0.49	0.79	0.41	0.71	0.46	0.12	
Consumed fluid milk made from local milk (yes/no)	0.37	0.48	0.26	0.44	0.43	0.50	0.47	0.50	0.07	*

Table 2: Summary statistics of retailer sample

	Total (N=205)		Retail format type								
			Boutique (N=145)		Grocery/ convenience store (N=50)		Depot (N=4)		Kiosk (N=5)		
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	p-score
Respondent characteristics											
Manager or owner of shop (yes/no)	0.57	0.50	0.61	0.49	0.46	0.50	0.25	0.50	0.80	0.45	0.26
Education level attained (yes/no)											
None	0.13	0.34	0.17	0.37	0.04	0.20	0.25	0.50	0.00	0.00	0.70
Elementary school or more	0.84	0.36	0.83	0.38	0.92	0.27	0.75	0.50	0.80	0.45	0.89
Middle school or more	0.76	0.43	0.74	0.44	0.80	0.40	0.75	0.50	0.80	0.45	0.97
Highschool or more	0.60	0.49	0.60	0.49	0.64	0.48	0.50	0.58	0.60	0.55	0.95
University	0.50	0.50	0.53	0.50	0.46	0.50	0.25	0.50	0.20	0.45	0.46
Shop characteristics and cold chain											
No. employees (#) [1]	2.09	1.30	1.77	0.87	2.76	1.44	5.50	4.04	2.40	0.55	0.00 ***
No. functioning refridgerators (#)	1.47	0.73	1.30	0.49	1.80	0.83	3.75	1.71	1.40	0.55	0.00 ***
No. power outages in previous week (#) [1]	5.07	4.16	4.79	3.62	5.79	5.14	4.00	2.31	5.60	8.08	0.60
Duration of longest power outage (minutes)	106.12	159.92	110.97	175.29	94.70	111.48	150.00	220.45	54.00	33.62	0.87
Product availability and transactions											
No. distinct fluid milk products available - fluid milk (#)	3.14	1.64	2.69	1.39	4.60	1.48	3.25	1.71	1.40	0.89	0.00 ***
No. other distinct products available - other dairy (#)	5.09	3.61	3.78	2.25	9.24	3.86	5.75	1.50	1.80	0.84	0.00 ***
Volumes fluid milk procured in previous week (L) [1]	193.92	1568.33	56.44	57.18	117.65	91.15	7420.00	12283.21	333.10	246.71	0.00 ***
Mean marketing margin on fluid milk (% of consumer price) [1]	0.17	0.05	0.16	0.02	0.18	0.05	0.19	0.17	0.23	0.07	0.00 ***

3.3. Choice experiment and dairy product attributes

In addition to the questionnaire, each survey included a choice experiment that we tailored for either a consumer or retailer respondent. However, both experiments aimed at eliciting preferences regarding four pasteurized milk product attributes: 1) ingredients labeling, 2) third-party quality certification, 3) packaging, and 4) price. Table 3 summarizes the four dairy product attributes and the four levels for each.

Table 3: Pasteurized milk product attributes and levels in choice experiments

Attribute	Attribute levels
Ingredient composition claim	No claim (*status quo*) 100% reconstituted milk powder Fresh milk mixed with milk powder 100% fresh milk
Food safety certification	No certification (*status quo*) Certified by the Malian government Certified by a private third-party Double-certification by government and private third-party
Packaging	Tied transparent plastic sack (*status quo* for fresh milk) Sealed opaque plastic pouch Sealed transparent plastic bottle Sealed cardboard carton
Price (FCFA/.5L)	Consumers: 280, 370, 460, 550 Retailers: 240, 310, 380, 450

Note: The size of the hypothetical product was held constant at .5 L, which is a common size for packaged milk.

3.3.1. Ingredients Composition

The first product attribute is labeling that indicates the product's composition in terms of milk ingredients. Many Bamako retailers state that inquiries about the purity and origin of dairy products are the most frequent questions that they receive from customers (Vroegindewey et al., 2019). In this market, pasteurized milk comes in two forms (Ibid.). First, there are a few semi-industrial and industrial processors that pasteurize milk that they reconstitute entirely from powdered milk or that is some blend of reconstituted and fresh milk. According to some of these processors, blending milk ingredients is a strategy that reduces input and transaction costs while preserving some of the taste of local milk that many consumers desire.

Second, there is a number of milk producer cooperatives and small artisan processors that pasteurize fresh milk that is sourced from peri-urban farms on the belief that many Bamako consumers prefer such purity to blended or milk powder-based products. However, this is difficult to confirm from actual product data. Although most pasteurized milk products do provide some indication of ingredients, the location of this information on packaging varies

across products. Terminology (i.e. indicating fresh or powdered milk) also varies across products, and in any case is always in French. This is a key observation, given high illiteracy rates in Mali and the presence of other packaging elements (e.g., icons of cows or the use of Bambara words) on powder milk-based products that could misinform buyers about the type and origin of the milk ingredients. For example, in our sample only 20% of retailers could correctly identify the ingredient composition of the most common brand of pasteurized milk. Lèfevre (2014) documented a similar situation in neighboring Senegal. She used stated and revealed choice data to confirm that urban consumers have strong preferences for fresh milk, while showing that misinformation regarding ingredient composition prevents them from actually allocating higher prices to these products.

To obtain a detailed assessment of consumers' and retailers' preferences for milk ingredient composition, and how they value information on composition, we include an ingredients label attribute in the experiment, with four levels: no ingredients label provided (*status quo*); a label indicating that the product is composed of 100% fresh milk; a label indicating that the product is composed of 100% reconstituted powdered milk; or label indicating that the product is composed of a blend of fresh milk and reconstituted powdered milk. We expect findings consistent with Lèfevre (2014) – that consumers have the strongest preferences for products labeled with 100% fresh milk but that no labeling (which can give the false impression that a product is made from fresh milk) is preferred to labeling that indicates any milk powder.

3.3.2. Quality certification

The second product attribute is a third-party quality certification that can assure retailers and consumers regarding the quality and safety of a product. Experts cite two categories of dairy food safety hazards—biological and chemical—that pose significant public health risks. Biological hazards include food-borne pathogens (e.g., *Salmonella*, brucellosis, and tuberculosis) and aflatoxins, as well as spoilage organisms and hygienic contamination that can affect reconstituted powdered milk as well as fresh milk (Kenny, 2013; Bonfoh et al. 2003; Hetzel et al., 2005). Chemical hazards include residues from antibiotics and other veterinary drugs, which enter milk when herds are improperly treated, farmers do not respect withholding periods between treatment and milking, or when handlers intentionally adulterate milk to forestall spoiling (Kenny, 2013).

The Malian government has already set up a system, called *l'autorisation de mise sur le marché (AMM),* to certify quality for pasteurized milk (as well as other foods) according to product-specific norms and standards adapted from CODEX (Government of Mali, 2006). By law, all dairy products must carry the AMM certification; however, adoption has been extremely limited, due to high certification and compliance costs, combined with historically weak enforcement by the government and limited recognition of the certification by Malian consumers (Vroegindewey et al., 2019).

In order to provide useful information on how consumers would value AMM certification if they were sensitized to its significance, we provided a short explanation to respondents, and included the AMM seal as one level of the quality certification attribute. The other attribute levels were: no certification (*status quo*), quality certification backed by a hypothetical private third party

(e.g., a non-government organization or a private company), or double-certification (i.e. AMM seal plus another private certification).

Our expectations regarding preferences for these attributes fall in line with similar research that has used experimental methods to investigate food quality certification. Focusing on Malian preferences for infant food quality, Masters and Sanogo (2002) found that Bamako consumers have a positive WTP for products that are backed by third-party quality certification. Other studies outside of Mali have used choice experiments to investigate the welfare gains associated with the certification of dairy products in particular. In Kenya, Mtimet et al. (2015) found large welfare effects for milk that is certified aflatoxin-free. Several studies considering different certification schemes in the U.S. context find welfare gains associated with most certification options (as opposed to none at all) but show that consumers prefer government to other industry of private certifying agencies (Olynk and Ortega, 2013; Wolf et al., 2011; Olynk et al., 2010).

3.3.3. Packaging

The third product attribute is packaging, which can create value for retailers and consumers by protecting product contents and improving convenience. Packaging quality can also potentially convey information about unobservable product attributes to buyers. Hollinger and Staatz (2015) observed that improved product presentation, labeling, and packaging are key strategies for earning consumer acceptance of locally-processed products in West Africa. Recent research conducted in Bamako found that dairy processors use enhanced packaging features to differentiate their brands from those of rivals (Vroegindewey et al., 2019). For example, hedonic price analysis of retailer inventory data revealed that sterilized milk packaged in imported materials (e.g., cartons) earned a premium over locally-available materials (plastic pouches and bottles) (Theriault et al., 2018). In Senegal, analysis of choice-based conjoint data indicated that yoghurt consumers are willing to pay a price premium for individually-sized pouch packaging (possibly for its convenience value), and hedonic price analysis of product data revealed price premiums for cup packaging (versus simple pouch packaging) (Lèfevre, 2014). In Kenya, Mtimet et al. (2015) estimated positive WTP associated with plastic bottles and TetraPak packaging of fluid milk.

However, research also cautions that the welfare effects of different packaging types can be sensitive to consumer demographics and other factors. For example, Fadiga and Makokha (2014) found that fluid milk consumers living in Nairobi or belonging to middle or wealthy classes preferred sealed to unsealed packaging, while consumers who were poor or living in another city were indifferent. In Bamako, the value of packaging may also depend on the ingredient composition of the product. Vroegindewey et al. (2019) found that many consumers identify fresh milk products by on particular form of packaging: hand-tied transparent plastic sacks (Vroegindewey et al., 2019). However, this packaging poorly protects product contents while its low cost potentially undercuts its value as an effective quality-signaling mechanism. Although factory-sealed plastic pouches and bottles are a common type of enhanced packaging for dairy products, many consumers associate this packaging with powdered milk-based products (Vroegindewey et al., 2019). Meanwhile, there are other types of packaging that local processors have not yet introduced. For example, cardboard cartons are recyclable and offer superior product protection compared to plastic, but their use in Mali is currently limited to imported

sterilized milk. In the choice experiment, we include four packaging attribute levels to explore preferences towards each of these four packaging types.

3.3.4. Price

Finally, we included price as a fourth product attribute to allow for the estimation of money-metric measures of WTP and in order to make welfare comparisons. For each experiment, we specified four price levels that were consistent with actual market prices and margins. Specifically, we selected consumer price levels that covered the full range of actual consumer prices for pasteurized milk in Bamako retail shops. The retailer price levels reflect a 14-18% margin on the consumer price levels. As a reference point, the second levels of consumer and retailer prices correspond roughly to the retail and wholesale unit prices of the most established and widely-distributed pasteurized milk product in Bamako, *Mali Lait* milk. This industrially-manufactured product has opaque plastic pouch packaging without certification or clear labeling of its ingredients, and thus represents two the three *status quo* product attribute levels.

The choice tasks were designed following Street, Burgess, and Louviere (2005). The product attributes and corresponding levels were first used to develop an orthogonal fractional factorial design reducing the original attribute level combinations to 16. Following, the generators described by Street and Burgess (2007), were used to generate 16 choice tasks composed of two product alternatives and no purchase option (design D-efficiency of 94.49%). We designed the experiments using the Ngene software. Each choice experiment included sixteen choice-sets, each of these consisting of two hypothetical half-liter product alternatives with the above attributes and one opt-out option. To avoid respondent fatigue, the design was blocked in two so that each respondent evaluated eight choice tasks.[5] To facilitate comprehension among choice experiment participants with varying levels of literacy, the survey teams presented illustrations of each choice to the participants. Figure 2 displays a sample choice task for a consumer and retailer, respectively.

Figure 2: Example choice task for a consumer (left two images) and retailer (right two images)

To reduce hypothetical bias in the choice experiment results, the survey teams delivered a cheap talk script to all participants (Lusk, 2003). The teams instructed consumer respondents to

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[5] This yielded a statistical sample size of 1,744 observations for consumers and 1,640 observations for retailers, after taking into account a few respondents who did not complete all eight choice sets.

imagine themselves in an actual retail shopping scenario, while they instructed retailer respondents to imagine themselves purchasing merchandise from a supplier which they would resell in their shops.

4. RESULTS AND DISCUSSION

4.1 Results from the consumer random parameters logit models

We first fitted the consumer choice data with an RPL model, in order to analyze preferences and to test for heterogeneity within the sample.[6] We also estimated results in WTP-space. Both models Table 4 presents results from the RPL model.. On average, consumers prefer some certification compared to no certification and any ingredient label compared to no label. Of the packaging attributes, they only have a preference for plastic bottle packaging in comparison to plastic sacks. The results in WTP-space are similar to those in preference-space, except that there is no significant WTP for any packaging attribute. These results, which represent mean effects for the entire consumer sample, are useful for providing an overall picture. However, the statistical significance of the standard deviation of every random variable in the RPL model supports our hypothesis of preference heterogeneity among consumers. In section 4.3 we will examine this heterogeneity more closely. Below, we explore the RPL results for each product attribute more closely.

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[6] In the RPL model, we keep price and opt-out as fixed, while assuming the other parameters to be fixed (Ubilava and Foster, 2009).

Table 4: Results from the consumers random parameters logit model

	RPL (preference space)			RPL (WTP space)		
	Coeff.	Std. Error		Coeff.	Std. Error	
Parameter means						
Government certification	3.47	0.31	***	431.96	45.72	***
Private certification	0.92	0.30	***	103.53	37.94	***
Double-certification	3.95	0.33	***	505.04	51.02	***
Pouch packaging	-0.18	0.21		-30.91	25.51	
Bottle packaging	0.38	0.22	*	29.39	27.17	
Carton packaging	-0.13	0.20		-10.34	29.64	
100% powdered milk claim	1.13	0.28	***	138.44	36.88	***
100% fresh milk claim	2.27	0.27	***	280.21	35.83	***
Blended ingredients claim	1.11	0.29	***	146.73	38.35	***
Opt-out	-0.53	0.47		-676.23	0.37	
Price	-0.01	0.00	***	1.00		
Random parameter standard deviations						
Government certification	1.63	0.29	***	178.68	37.07	***
Private certification	1.99	0.33	***	237.62	45.30	***
Double-certification	1.54	0.29	***	200.51	38.53	***
Pouch packaging	0.83	0.36	**	101.26	51.81	*
Bottle packaging	1.17	0.27	***	159.97	27.89	***
Carton packaging	0.73	0.35	**	128.38	44.13	***
100% powdered milk claim	2.42	0.36	***	314.73	39.96	***
100% fresh milk claim	1.84	0.30	***	225.14	41.13	***
Blended ingredients claim	2.33	0.40	***	268.34	40.35	***
N	1720			1720		
d.f	20			20		
Log-Likelihood	1213.14			1209.35		
AIC	2466.30			2458.70		

The results in Table 4 confirm that, on average, consumers value the ingredient composition of 100% fresh milk more than either 100% reconstituted powdered milk or a blend thereof. This confirms other stated preference data that we collected: 92% of consumers in our sample said that they prefer pasteurized milk that is made purely from fresh milk while less than 1% prefer blended milk ingredients. The estimated WTP for fresh milk labeling versus no labeling is 280 FCFA (.53 USD) per half-liter, which about 140 FCFA (.27 USD) more than the WTP for any labeling indicating powdered milk. This fresh milk-powdered milk price difference represents about one-third of the average price of the hypothetical products. In comparison, Lèfevre (2014) estimated a fresh milk-powdered milk price differential that amounted to about 80% of the average price in her choice-based conjoint experiment in the Dakar context.[7] In our results, the

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[7] In Lèfevre (2014)'s analysis, 100% powdered milk was the sole alternative to 100% fresh milk and ranged between 225 FCFA and 325 FCFA for an unspecified package size. In this analysis, the lower bound of the confidence intervals for the fresh milk-powdered milk price difference amounted to 36% of the average price.

marginal utility and WTP for blended ingredients are almost the same as for 100% powdered milk. This challenges the belief that consumers view the practice of blending milk ingredients as a value-addition to using only powdered milk. On the contrary, our results indicate that the average Malian—when clearly informed about the ingredient composition of pasteurized milk—has a strong preference for pure fresh milk-based products.

Additionally, our results suggest that Malians are willing to pay for clear labeling in and of itself, regardless of the actual ingredient composition of a product. Because current packaging often does not provide clear labeling of ingredients, this result provides evidence of information asymmetry in the pasteurized milk consumer market. Yet, it is also somewhat surprising: in Lèfevre (2014)'s hedonic price analysis of market data, she found that "ambiguous" ingredients labeling actually earns a small price premium in the Dakar dairy market, possibly because it sometimes leads consumers to falsely believe that a given product is manufactured from fresh milk. In the absence of clear labeling, consumers should impose their own assumptions about a given product's ingredient composition. Even if this assumption reflects the least-desired composition of milk ingredients (e.g., 100% milk powder), we should find no significant difference between preferences for no labeling and preferences for labeling indicating that particular ingredient composition. One possible explanation is that consumers are also concerned about the presence of non-dairy ingredients (e.g., preservatives) in pasteurized milk, and that participants in our choice experiment were mindful of this possibility when considering the hypothetical products with no labeling. It is also possible that the value of clear ingredients labeling goes beyond what it says about the product contents themselves, and that it also instills consumer trust in the brand.

Table 4 also shows that each certification variable has a positive and statistically significant influence on consumer utility, confirming that Malians are concerned about safety and demand more information on these attributes. Stated preference data from the survey indicates that consumers and retailers appear to be most concerned about quality issues originating in the processing and distribution stages of the value chain (i.e., unhygienic handling, inadequate pasteurization, adulteration of product with water spoilage due to a weak cold chain) and less concerned about issues originating at the farm-level (i.e., feed quality, aflatoxins, pesticide and antibodies residues).

The significant WTP coefficient for government certification suggests that consumers would pay a sizeable price premium—equal to about 100% of the average product price—for pasteurized milk products that carried the AMM certification (compared to the *status quo* of no certification), if they were better-informed about the AMM seal. While the magnitude of this premium is striking, it is smaller in comparison to results from Mtimet et al. (2015)'s Kenya study, which estimated a WTP of almost 140% of the average product price for aflatoxin-free certification of fluid milk. We emphasize that better awareness of the AMM seal among Malian consumers is a critical condition for this WTP to be realized in actual markets. In our sample, only about 20% of consumers and retailers in our sample recognize the AMM seal on packaging, and just over 10% of the sample had some idea of the meaning.

Significant differences in WTP across certification types confirms that part of the value of certification is derived from who is verifying the claim (Olynk et al., 2013). In our results,

consumer WTP for government certification is four times the WTP for private certification. Double certification provides only a little additive value compared to government certification alone. This pattern of greater consumer confidence in government certification (compared to private certification) resembles the preferences of U.S. dairy consumers as reported in several other choice experiment studies in this context (Olynk and Ortega, 2013; Wolf et al., 2011; Olynk et al., 2010). The consumer survey probed further into this question by asking respondents to rate their level of confidence in different verifiers on a four-point Likert scale ranging from one (no confidence at all) to four (complete confidence). Consumers gave the highest average rating (3.5) to government, an intermediate rating to a Malian consumer association (2.3), and the lowest rating (less than two) to a Malian industry association, or to a local or international company or non-government association. Overall, the relatively weak WTP for private certification may also explain why there is no alternative third-party certification option in Mali, especially when one considers the large costs of setting up and maintaining such systems.

Turning to packaging, the mean estimates of WTP suggest that consumers do not value any of the three types of enhanced packaging any more than they do plastic sacks. On one hand, this seems surprising, given that other choice experiments examining dairy preferences in Africa have found positive and statistically significant WTP for enhanced packaging features (Mtimet et al., 2015; Fadiga et al., 2014; Lèfevre 2014). Additionally, when we asked consumer respondents to state their ideal type of packaging for pasteurized milk, the three most popular responses were plastic bottle (49% of respondents), carton (22%), and plastic pouch (8%). Only one respondent stated that plastic sack packaging was ideal. On the other hand, this result does seem to be consistent with qualitative accounts that many consumers in Bamako associate such traditional packaging with local fresh milk (Vroegindewey et al., 2019). It also seems consistent with consumer responses, when asked to rate the level of importance they accord to packaging as a source of information about a product. The average rating was only 1.9, on the basis of a four-pout Likert scale ranging from one (not important) to four (very important). In the next sub-section, we will examine the variation of consumer preferences with respect to packaging, which will help shed some light on this puzzle.

4.2 Comparison of consumer and retailer preferences and WTP

In order to compare the preferences and marginal rates of substitution of consumers and retailers, we fitted the retailer choice data with the same RPL model used for consumers. Table 5 presents these results. Overall, the preferences and WTPs of the two groups are well-aligned, in terms of sign, significance, and ordering of the estimated coefficients. One exception is that for retailers the estimated coefficient on bottle packaging in preference space is not significant, while the corresponding estimate for consumers is statistically significant and positive at the 10% level of significance. This overall pattern of alignment suggests that retailers have good knowledge of consumer preferences with respect to the dairy product attributes in question. In their study of the Spanish seafood market, Fernández-Polanco et al. (2013) also found that retailer preferences towards several experience and credence attributes were well-aligned with customer preferences in terms of sign and significance, although the rank-order of marginal utility varied across actors.

To investigate this further, we expressed WTP estimates (from the RPL model) as a share of a fixed reference price for consumers and retailers, then compared these shares in Table 6. We

used the *Mali Lait* retail price (750 FCFA or 1.43 USD per L) as the reference, because it is quite uniform and well-known to consumers throughout Bamako. In paired t-tests, we failed to reject the null hypothesis that there are statistically significant differences between price shares in the consumer and retailer datasets.[8] At the same time, we note that for almost every attribute that has statistically significant coefficients in both datasets (i.e., all certification and ingredients composition variables except for private certification), the average retailer WTP is 17% to 71% less than the average consumer WTP, depending on the attribute.[9] This is unsurprising, because we would expect a share of consumer price to be captured by retailers' marketing margins.[10] We conjecture that retailer WTP can be interpreted as the maximum procurement price that retailers are willing to pay for each attribute, which theoretically takes into account retailers' expectations about marketing costs, consumers' WTP, and competition-related considerations.

Taken together, these results suggest that any information asymmetry in the pasteurized milk value chain regarding these attributes is not due to retailers' limited understanding of consumer preferences. On the contrary, Bamako retailers of dairy products appear to understand well what their customers desire and what they are willing to pay.

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[8] In contrast, although Polanco et al. do not conduct a similar test between consumer and retailer WTP estimates, they conclude that retailer and consumer WTP diverge on the basis of statistically significant differences in some marginal utilities including that of price (on which the estimated WTP is based). They also acknowledge that one weakness of their analysis is large standards errors for retailers, due to a small sample size.

[9] Fernández-Polanco et al. (2013) report a similar pattern, although in their results retailer WTP was as much as 194% less than consumer WTP.

[10] However, we note that the percentage point differences in price shares that we examine here are not calculations of market shares.

Table 5: Results from the retailers random parameters logit models

	RPL (preference space)			RPL (WTP space)		
	Coeff.	Std. Error		Coeff.	Std. Error	
Parameter means						
Government certification	2.29	0.24	***	342.99	55.61	***
Private certification	0.69	0.22	***	111.90	36.86	***
Double-certification	2.53	0.25	***	377.73	60.15	***
Pouch packaging	-0.02	0.18		-3.61	28.99	
Bottle packaging	0.13	0.18		13.49	28.78	
Carton packaging	-0.09	0.18		1.17	30.75	
100% powdered milk claim	0.49	0.23	**	80.99	36.71	**
100% fresh milk claim	1.47	0.22	***	228.75	40.33	***
Blended ingredients claim	0.81	0.23	***	125.57	38.68	***
Opt-out	-1.33	0.40	***	-1358.85		
Price	-0.01	0.00	***	1.00	0.37	
Random parameter standard deviations						
Government certification	1.33	0.28	***	220.95	53.10	***
Private certification	1.36	0.28	***	208.75	46.29	***
Double-certification	1.16	0.29	***	204.15	51.25	***
Pouch packaging	1.11	0.27	***	148.17	46.78	***
Bottle packaging	0.98	0.28	***	138.91	34.72	***
Carton packaging	1.02	0.30	***	172.16	48.70	***
100% powdered milk claim	1.83	0.28	***	267.82	47.26	***
100% fresh milk claim	1.57	0.24	***	272.80	54.59	***
Blended ingredients claim	1.40	0.32	***	217.04	53.58	***
N	1624			1624		
d.f.	21			21		
Log-Likelihood	-1,253.04			-1,250.00		
AIC	2,546.10			2,540.00		

Table 6: Comparison of Consumer and Retailer WTP

| Attribute | Consumers (N=218) | | | | Retailers (N=204) | | | | Tests for Differences Between Shares |
	Mean WTP (FCFA/.5L)	Share of Mali Lait retail price (FCFA/.5L)	SE		Mean WTP (FCFA/.5L)	Share of Mali Lait retail price (FCFA/.5L)	SE		P-value
Government certification	431.96	115%	0.12	***	342.99	91%	0.15	***	0.22
Private certification	103.53	28%	0.10	***	111.90	30%	0.10	***	0.88
Double-certification	505.04	135%	0.14	***	377.73	101%	0.16	***	0.11
Pouch packaging	-30.91	-8%	0.07		-3.61	-1%	0.08		0.48
Bottle packaging	29.39	8%	0.07		13.49	4%	0.08		0.69
Carton packaging	-10.34	-3%	0.08		1.17	0%	0.08		0.79
100% powdered milk claim	138.44	37%	0.10	***	80.99	22%	0.10	**	0.15
100% fresh milk claim	280.21	75%	0.10	***	228.75	61%	0.11	***	0.34
Blended ingredients claim	146.73	39%	0.10	***	125.57	33%	0.10	***	0.70

Note: Mali Lait retail price is 375F/.5L

4.3 Results from the latent class models

Given the statistical significance of the standard deviation estimates in our RPL models, we fitted the consumer and retailer datasets with LC models in order to further investigate preference heterogeneity among these actors. The comparative advantage of the LC model is that it facilitates the identification of market segments (i.e., different groups of consumers and retailers with similar underlying preference) via covariates in the class membership function. Because formal statistical tests are not available for identifying an optimal number of segments in a population, in empirical applications it is common to make this choice based on information criteria, such as the Akaike Information Criterion (AIC), Bayesian Information Criterion (BIC), and the Consistent Akaike Information Criterion (CAIC) (Pacifico and Yoo, 2013).[11] We identified three classes as optimal for each model based on these criteria, while ensuring class shares of sufficient size for statistical analysis.

We also tried multiple combinations of potential class membership variables and ultimately selected a combination of variables that improved model fit and resulted in negative statistically significant price coefficients (as is consistent with conventional demand theory). For the consumer model, we included three covariates in the latent class membership model. The first two covariates are a dummy variable estimating whether or not the household is below the national poverty line and a continuous variable indicating the share of household members that under the age of fourteen. We expect households with higher incomes and more children to have stronger preferences for product quality, while greater income should also positively influence WTP by reducing price sensitivity. The third covariate is household ownership of a motor vehicle, reflecting the hypothesis that access to a means of transportation affects fluid milk preference by improving household access to fresh milk, and perhaps. Additionally, consumers transporting milk by a motor-vehicle (e.g., by motorcycle, the most common means of transportation in Bamako) may have different preferences for packaging compared to others.

For retailers, we included two covariates. The first is a dummy for whether the retail shop is a *boutique.* Because these shops have limited shelf-space and their main clientele are nearby residents, we expect these retailers to have weaker preferences for novel product attributes such as enhanced packaging. Related, the second covariate is the total number of unique fluid milk brands sold by the retailer, which we expect to be associated with stronger preferences for novel product attributes.

We present results from the consumer and retailer LC models in Tables 7 and 9, respectively, along with derived WTP estimates. Each probability reported at the top of these tables refers to the probability that a randomly-selected household or retailer belongs to that class. The estimated thetas, when statistically significant, indicate whether the class membership variable is positively or negatively correlated with membership in that class, compared to membership in class three

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[11] AIC, BIC, and CAIC are each estimators of the relative quality of a model. Each takes into account the model goodness of fit (measured by $-2\ln L$ where L is the maximized sample log likelihood statistic) and the simplicity of the model (measure by some function of the number of parameters). The criteria differ only in how each measures the latter aspect, with BIC and CAIC penalizing models with extra parameters more heavily (i.e., by using penalty functions that increase in the number of choice makers) compared to AIC (Pacifico and Yoo, 2013).

(the base class in each model). In Tables 9 and 10, we also present descriptive statistics for each consumer and retailer class to allow for additional class profiling.

Table 7: Results from latent class analysis of consumers

	Class 1					Class 2					Class 3				
	Model results			Derived WTP		Model results			Derived WTP		Model results			Derived WTP	
	Coeff.	SE		Coeff.	95% Confidence Intervals	Coeff.	SE		Coeff.	95% Confidence Intervals	Coeff.	SE		Coeff.	95% Confidence Intervals
Parameter means															
Government certification	2.94	0.00	***	362.49	[60.08, 664.91]	-0.30	0.32		-107.26	[-346.04, 131.53]	3.11	0.28	***	980.78	[400.06, 1561.50]
Private certification	-2.36	0.79		-291.43	[1241.59, 658.74]	0.49	0.29		175.16	[-65.66, 415.98]	1.70	0.30	***	534.82	[167.90, 901.74]
Double-certification	3.35	3.95	***	413.80	[77.81, 749.78]	-0.30	0.35		-107.13	[-376.14, 161.88]	3.60	0.33	***	1136.91	[452.77, 1821.05]
Pouch packaging	-0.07	0.78		-8.30	[-185.18, 168.58]	0.43	0.29		154.73	[-79.62, 389.07]	-0.06	0.20		-18.58	[-138.14, 100.97]
Bottle packaging	-0.29	0.74		-36.05	[-182.18, 110.08]	0.32	0.31		114.95	[-115.91, 345.80]	0.58	0.25	**	183.28	[-24.75, 391.30]
Carton packaging	-0.68	0.65		-83.34	[-220.00, 53.33]	0.25	0.27		90.03	[-114.66, 294.72]	0.09	0.21		29.95	[-108.60, 168.49]
100% powdered milk claim	1.56	0.62	**	192.38	[-79.88, 464.64]	0.48	0.30		171.63	[-64.27, 407.52]	0.83	0.21	***	261.99	[48.07, 465.90]
100% fresh milk claim	2.89	0.85	***	356.88	[68.39, 645.36]	1.54	0.28	***	551.11	[76.66, 1025.56]	1.38	0.23	***	435.68	[107.92, 763.44]
Blended ingredients claim	3.25	0.75	***	401.51	[60.83, 742.18]	0.45	0.32		159.37	[-105.40, 424.15]	0.84	0.25	***	266.10	[40.70, 491.50]
Opt-out	1.89	0.81		233.37	[-338.18, 804.92]	-0.51	0.56		-181.55	[-478.08, 114.98]	0.52	0.64		164.90	[305.62, 635.43]
Price	-0.01	1.90	***			0.00	0.00	***			0.00	0.00	***		
Class probability	0.17					0.21					0.63				
Thetas in class probability model															
HH owns motor-vehicle	0.57	0.83				-1.93	0.58	***							
Share of HH members who are <15 years	-2.09	1.40				3.42	1.40	**							
HH below international poverty line	0.10	0.48				-1.14	0.57	**							
N	5175														
No. of parameters	42														
Log-Likelihood	-1182.01														
AIC	2446.01														
BIC	2714.63														

Table 8: Profiles of consumers from each latent class

Variable	Total (N=218)		Class 1 (N=32)		Class 2 (N=36)		Class 3 (N=148)		p-value	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD		
Househld access to, storage of, and consumption of milk (yes/no)										
Consumed any fluid milk in past week	0.70	0.46	0.75	0.44	0.58	0.50	0.72	0.45	0.40	
Purchased any dairy product from a traditional outlet in past week[+]	0.18	0.24	0.24	0.25	0.16	0.25	0.17	0.23	0.24	
Purchased any dairy product from a boutique in past week[+]	0.53	0.37	0.38	0.37	0.45	0.37	0.58	0.36	0.01	***
Purchased any dairy product from a modern outlet in past week[+]	0.15	0.26	0.20	0.33	0.15	0.27	0.14	0.24	0.76	
Owns a vehicle	0.86	0.35	0.94	0.25	0.64	0.49	0.89	0.31	0.04	**
Owns a functioning refridgerator and has access to electricity	0.54	0.50	0.53	0.51	0.53	0.51	0.54	0.50	0.99	
Household composition										
Total household members[+]	12.59	9.39	10.09	7.68	11.22	6.61	13.47	10.17	0.12	
Share of household members that are under 14 years of age[+]	0.32	0.17	0.26	0.16	0.37	0.17	0.32	0.17	0.02	**
Household includes an infant (< 2 years) (yes/no)	0.52	0.50	0.41	0.50	0.42	0.50	0.56	0.50	0.21	
Share of household members who are infants an infant (< 2 years) [+]	0.06	0.07	0.50	0.51	0.44	0.50	0.62	0.49	0.42	
Household includes a pregnant or lactating mother (yes/no)	0.58	0.50	0.05	0.07	0.06	0.08	0.07	0.07	0.19	
Share of household members who are mothers[+]	0.06	0.07	0.05	0.07	0.06	0.08	0.07	0.07	0.49	
Knowledge and preferences regarding dairy products (1/disagree - 5/strongly agree)										
Recognize and know meaning of AMM seal	1.40	0.89	1.59	1.04	1.14	0.49	1.43	0.93	0.26	
Food safety of imports is superior to Malian dairy products[+]	2.85	1.65	3.28	1.55	2.51	1.63	2.86	1.66	0.19	
Environmental issues are key element in packaging preferences	1.55	0.99	1.63	1.07	1.39	0.84	1.58	1.02	0.71	
Closeability is key element in packaging preferences	3.20	1.08	3.25	1.08	2.61	1.29	3.35	0.96	0.02	**
Transparence is key element in packaging preferences	3.13	1.25	3.56	0.84	2.89	1.39	3.13	1.25	0.26	
Respondent characteristics										
Educational attainment of respondent (1/little none - 4/university)[+]	2.35	1.45	2.25	1.46	1.97	1.54	2.46	1.42	0.24	
Respondent is primary household decisionmaker (vs secondary) purchases (yes/no)+	1.69	0.46	1.50	0.51	1.63	0.49	1.75	0.44	0.07	*

Table 9: Results from latent class analysis of retailers

| | Class 1 (.405 class probability) | | | | | | Class 2 (.297 class probability) | | | | | | Class 3 (.298 class probability) | | | | |
| | Model results | | | Derived WTP | | | Model results | | | Derived WTP | | | Model results | | | Derived WTP | |
	Coeff.	SE		Coeff.	95% Confidence Intervals		Coeff.	SE		Coeff.	95% Confidence Intervals		Coeff.	SE		Coeff.	95% Confidence Intervals
Parameter means																	
Government certification	0.97	0.18	***	357.35	[108.40, 606.31]		16.43	1041.38		737.01	[541.26, 932.75]		0.98	0.25	***	179.84	[56.37, 303.30]
Private certification	0.68	0.18	***	248.87	[50.20, 447.54]		12.48	1041.36		449.16	[282.31, 616.01]		0.24	0.28		45.04	[-61.40, 151.48]
Double-certification	0.97	0.17	***	356.17	[97.98, 614.36]		33.66	2082.69		1530.63	[1140.41, 1920.84]		1.09	0.23	***	201.46	[71.86, 331.06]
Pouch packaging	0.31	0.16	**	112.90	[-22.93, 248.73]		-2.76	1.31	**	-201.98	[-307.60, -96.37]		-0.03	0.23		-4.81	[-87.08, 77.46]
Bottle packaging	0.46	0.18	***	168.26	[6.85, 329.67]		8.41	1041.43		150.07	[95.33, 204.81]		-0.39	0.25		-71.36	[-154.04, 11.33]
Carton packaging	0.44	0.16	***	162.09	[7.96, 316.50]		13.66	1041.49		531.49	[350.66, 712.32]		-0.19	0.23		-34.40	[-115.68, 46.89]
100% powdered milk claim	-0.01	0.17		-4.61	[-127.51, 118.29]		18.13	1041.43		858.38	[581.70, 1135.05]		0.64	0.29	**	118.37	[-2.71, 239.44]
100% fresh milk claim	0.76	0.16	***	277.97	[63.14, 492.80]		15.85	1041.51		690.91	[419.10, 962.72]		1.76	0.27	***	323.36	[147.65, 499.06]
Blended ingredients claim	0.20	0.18		71.60	[-68.63, 211.83]		14.44	1041.41		589.89	[404.98, 774.79]		1.32	0.28	***	243.28	[92.93, 393.63]
Opt-out	-3.31	0.71	***	-1216.66	[-1936, -496.77]		23.41	2083.30		777.16	[493.67, 1060.65]		-0.03	0.59		-5.36	[-215.33, 204.61]
Price	0.00	0.00	***				-0.01	0.01	***				-0.01	0.00	***		
Class probability	0.41						0.30						0.30				
Thetas in class probability model																	
Retail outlet is a *boutique*	1.15	0.45					0.68	0.48									
Dairy variety (no. of unique products)	0.04	0.12					-0.21	0.15									
N	4,893																
No. of parameters	39																
Log-Likelihood	-1183.85																
AIC	2445.69																
BIC	2699.02																

Table 10: Profiles of retailers from each latent class

Variable	Total (N=204)		Class 1 (N=80)		Class 2 (N=64)		Class 3 (N=60)		p-value	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD		
Retailer type, size, product availability										
Retailer is *boutique* format (yes/no)	0.71	0.46	0.79	0.41	0.77	0.43	0.53	0.50	0.02	**
Store is grocery store format (yes/no)	0.24	0.43	0.19	0.39	0.20	0.41	0.35	0.48	0.21	
Total number of employees	2.10	1.30	2.13	1.25	1.90	1.00	2.27	1.61	0.30	
Total number of unique fluid milk products available	3.15	1.65	3.24	1.61	2.72	1.33	3.48	1.91	0.03	**
Total number of other unique dairy products available	5.08	3.61	5.23	3.74	4.31	3.40	5.72	3.58	0.09	*
Volumes (L) of fluid milk purchased per week [1]	80.38	97.10	71.46	69.65	61.19	63.11	114.54	143.76	0.01	***
Knowledge and preferences regarding dairy products (1/disagree - 5/strongly agree) [1]										
Recognize and know meaning of AMM seal	1.42	0.96	1.38	0.92	1.50	1.02	1.40	0.94	0.79	
Food safety of imports is superior to Malian dairy products	2.52	1.81	2.43	1.80	2.42	1.78	2.78	1.89	0.57	
Does respondent know ingredients of milk products? (1/no, 2/partially, 3/yes)	1.76	0.76	1.72	0.72	1.78	0.77	1.81	0.84	0.88	
Unaware and unconcerned about milk quality issues (yes/no)										
Feed quality of dairy herd	0.64	0.48	0.61	0.49	0.75	0.44	0.57	0.50	0.18	
Aflatoxins	0.84	0.36	0.81	0.39	0.88	0.33	0.85	0.36	0.81	
Pesticide residues	0.68	0.47	0.69	0.47	0.69	0.47	0.67	0.48	0.97	
Pathogens associated with unvaccinated herds	0.54	0.50	0.65	0.48	0.48	0.50	0.47	0.50	0.11	
Antibiotic residues	0.69	0.46	0.73	0.45	0.70	0.46	0.63	0.49	0.64	
Pathogens associated with unhygienic milk handling	0.27	0.45	0.28	0.45	0.27	0.45	0.28	0.45	0.99	
Inadequate pasteurization	0.37	0.48	0.48	0.50	0.28	0.45	0.33	0.48	0.11	
Quality deterioration due to weak cold chain	0.32	0.47	0.40	0.49	0.19	0.39	0.37	0.49	0.07	*
Adulteration of product with water	0.24	0.43	0.34	0.48	0.22	0.42	0.13	0.34	0.11	
Respondent characteristics										
Whether respondent is owner or manager	0.56	0.50	0.61	0.49	0.63	0.49	0.43	0.50	0.11	
Education level attained [1]	2.78	1.47	2.63	1.60	3.09	1.29	2.64	1.45	0.18	

The largest "quality-conscious" consumer class (class three, representing 63% of consumers) appears to be the most conscious of dairy quality. It has the highest WTP for government certification and is the only class to significantly value private certification. It is also the only class with a statistically significant WTP for an enhanced type of packaging, i.e. factory-sealed plastic bottles. The class profiles (Table 9) highlight a factor that may be driving this distinct preference. We asked respondents to rate the ability to re-close product packaging as an important consideration when purchasing dairy products, on a Likert scale ranging from one (not at all important) to four (very important). Respondents in class three had the highest average rating (3.4), compared to classes one (3.2) and two (2.6). Finally, consumers in this class have positive WTP for any ingredients label, but value 100% fresh milk the most. They value blended ingredients about the same as 100% powdered milk.

Compared to class two (i.e., based on the class two membership covariates), households owning a motor vehicle are more likely to belong to this class, as are households that are below the poverty line. Although the pairing of these household characteristics may seem counterintuitive, they may be explained by the fact that poor households have a much larger number of household members (sixteen on average) compared to non-poor households (eight on average), which overall should increase the likelihood that the household includes at least one person who owns a vehicle. Households with larger shares of adult members are also more likely to belong to this class, compared to class two. Table 8 shows that these consumers are also the most-likely to have purchased a dairy product from a boutique in the previous week.

The second largest "fresh milk-focused" class (class two, representing 21% of consumers) is exclusively focused on the purity and freshness of product ingredients. Of all classes, it has the highest WTP for 100% fresh milk, and does not value any other ingredient composition nor any other product attribute. Compared to class three, above the poverty line, households with larger shares of children, and households without a motor-vehicle are most likely to be in this consumer class. These households are also the least-likely to have purchased a dairy product from a boutique in the previous week.

The smallest "price-sensitive" consumer class (class one, representing 17% of consumers) is the most price-sensitive, as indicated by its relatively low price coefficient in preference-space. This class demands more quality and product information than the fresh milk-focused consumers. However, it values fewer attributes than quality-conscious consumers, i.e. it does not value certification that is not at least backed by the government and does not value any enhanced packaging. Additionally, WTP values are also generally smaller than those of the quality-conscious consumers. One exception is that, of all consumers, this class has the highest WTP for blended milk products, and even values this attribute more than 100% fresh milk products. Table 8 shows that these consumers have the lowest average share of children under fourteen in their households. These households also have the highest share of motor vehicle ownership and were the least likely to purchase a dairy product from a boutique in the previous week (but may have purchased from another outlet).

Turning now to the LC results for retailers (Tables 9 and 10), the largest "fresh milk only" class (class one, representing 41% of retailers) has statistically significant WTP for all attributes except for any product containing powdered milk. In addition to having the highest WTP for

government certification, this class is the only one to positively value private certification by itself and any type of enhanced packaging. While these positive valuations for packaging might seem misaligned with consumer preferences, we note that some retailers may derive more value from higher-quality packaging than consumers, on the basis of its potential to reduce losses and protect products while they are stored and displayed in shops. These retailers are also the only class with a negative statistically significant WTP for opt-out, which suggests that making available pasteurized milk product to clients is a priority for these retailers. Consistent with this hypothesis, Table 10 suggests that retailers from this class, along with those from class three, offer the most choice in terms of pasteurized milk products. The class membership covariate indicates that boutique shops are most likely to belong to this class, compared to class three.

The two remaining classes are approximately equal in size, each representing about 30% of retailers in our sample. The "*status quo*" Class two is the most price-sensitive and appears to have a strong overall preference for the *status quo*, with no statistically significant WTP for any attribute except for sealed plastic pouch packaging which it negatively values compared to hand-tied plastic sack packaging. These results seem to reflect an overall lack of concern for product quality. For example, as Table 10 shows, these retailers gave the smallest average rating of cold chain-related quality problems. Although the *boutique* class membership covariate was not significant for this class, Table 10 suggests that this class does include a high share of boutiques. Finally, these retailers have the lowest variety of unique pasteurized milk products and other dairy products, and also sold the smallest volume of pasteurized milk in the previous week.

Finally, the "high volume and variety" class is made up of retailers that have statistically significant WTP for any government certification. It also has statistically significant WTP for all of the ingredient composition labels, with the highest WTP of all classes for fresh milk claims. We call this third class of retailers "high volume and variety" vendors, to reflect these characteristics from Table 10. On average, these shops carry more than three unique pasteurized milk products, in addition to more than five other dairy products. Only about half of this class includes boutique shops.

5. CONCLUSION

This study investigates information asymmetry as a potential problem that can help to explain the limited consumption of fresh milk in urban Mali, despite accounts that Malians largely prefer fresh milk to imported powdered milk. In a novel approach to using choice experiments to study an issue that has value chain-wide implications, we conducted parallel discrete choice experiments on random samples of consumers and retailers in Bamako. Due to preference heterogeneity within these populations, we analyzed the data using random parameters logit and latent-class models and compared the results across samples. Five key findings emerge from this analysis, which have several implications for agribusiness strategy and government policy.

First, we find a positive and significant WTP for attributes that provide information on product ingredients, safety, and other dimensions of quality. Together, these results provide evidence of information asymmetry between the manufacturers and buyers of pasteurized milk products. This resonates broadly with Lèfevre (2014)'s study of the Dakar dairy market, and we echo that

paper's recommendation for measures that improve information flows amongst consumers and other value chain actors.

One policy option is to require dairy manufactures to clearly indicate milk ingredients on product packaging using standardized wording or icons (to accommodate illiterate consumers). Manufacturers' compliance with such a regulation should cost them little; furthermore, the fact that consumers have a positive WTP for clearer ingredients labeling in and of itself (i.e., regardless of what milk ingredients the product actually contains) should operate as a positive incentive for compliance. The Malian government could develop other labeling regulations that more specifically aim at improving the competitiveness of fresh milk-based dairy products, although passing and enforcing such policies are likely to be more challenging. For example, the government could limit the use of certain words (e.g., local terms for milk), phrases (e.g., "made in Mali"), and imagery (e.g., images of cows in pastures) on powdered milk-based product packaging, which might mislead Malian consumers to believe that they are consuming locally-sourced fresh milk-based products (Lèfevre, 2014).

Our second finding identifies another example of a policy enhancement that could improve information flows and reduce information asymmetry. We find that consumers have a specific preference for government certification of product quality, compared to private certification, and are willing to pay an important price premium for this assurance. This result suggests that dairy manufacturers can create value for their brands by improving product quality and adopting the existing government AMM certification, which is also required by law. However, several other conditions must be met in order for the AMM system to be effective. Among these, the Malian government must improve consumers' awareness of AMM certification, e.g., through public information campaigns and requiring more prominent placement of the AMM seal on packaging. Simultaneously, it must strengthen enforcement of corresponding regulations in the dairy market, e.g., through better monitoring and sanctioning for counterfeit certifications.

Third, we find that that Bamako consumers are willing to pay a significant price premium for pasteurized milk that is made purely from fresh milk. Further, LC analysis indicates that nearly 85% of consumers prefer fresh milk most, compared to pure or blended powdered milk which these consumers value similarly. Given the current limited availability of fresh milk-based dairy products in Bamako, this finding points to an important market opportunity for fresh milk producers and processors. However, in order to successfully compete against imported powdered milk, the Malian fresh milk value chain must identify upgrades that reduce production and transaction costs while better differentiating their brands from those that are manufactured from powdered milk (Vroegindewey et al., 2019). The ingredients labeling and certification mechanisms that we analyze in this study are two options for improving differentiation.

Our fourth finding pertains to another possible upgrade – enhanced packaging. However, our analysis showed that only one type of enhanced packaging (bottle packaging) is valued by just one consumer segment (representing about 65% of consumers) who may especially appreciate their ability to reclose this packaging. Overall, consumers do not have strong preferences for upgrades from transparent plastic sack packaging. On one hand, this finding is surprising, given that other dairy consumer studies show that consumers derive value from higher-quality packaging. On the other hand, other research in Bamako shows that many consumers may view

traditional packaging as a signaling mechanism for fresh milk-based products (Vroegindewey et al., 2019). We suggest that packaging preferences are especially dependent on particular packaging features and can vary widely across consumers, and we this as an important area for further research.

Fifth, our analysis of retailer data demonstrates that retailer preferences and WTP are well-aligned with those of consumers. These results suggest that retailers can be a useful source of information and, hence, a strategic distribution partner for upstream value chain actors wishing to better understand consumer preferences and demand. However, our LC analysis reveals significant segmentation among retailers, implying that pasteurized milk manufacturers should carefully select their distributors. For example, fresh milk products may obtain the greatest price premium among high-volume retailers that prioritize being able to offer a variety of dairy products. In contrast, many low-volume, low-variety retailers (representing about 30% of retailers) have zero WTP for fresh milk and any other product attributes. A third segment (representing another 40% of retailers) has positive WTP for each attribute, including packaging. Overall, these insights demonstrate the usefulness of complementing information on consumers with retailer analysis in a food market study. Our paper illustrates the use of stacked choice experiments as one promising tool for this endeavor.

As with any stated preference method, there are some limitations that need to be considered. The hypothetical nature of choice experiments can potentially introduce a negative bias in estimates of the marginal utility of price, and thus potentially overinflate WTP. Ideally, comparable future research should evaluate our results against results generated from other methods that mitigate hypothetical bias, i.e. analysis of actual market data (once available) or the use of incentive-compatible valuation methods. Additionally, one potential limitation of adapting choice experiments for retailers is that the design requires them to select a single product alternative, while in reality retailers may purchase multiple products at once in order to offer variety to their clients or to test out demand for new products. This could possibly introduce an upward bias on the marginal utilities estimated for retailers, which would lead to greater overestimates of retailer WTP. Taking these words of caution together, value chain managers and policy makers may wish to focus on the lower bound values of the WTP confidence intervals. Nonetheless, because the present study is the first of its kind to estimate WTP in the Malian dairy sector—as well as the first to compare retailer and consumers preferences using choice experiment methods in a developing market context—we expect that it will help to inform and benchmark future research in these areas.

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