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A CITY-RETAIL OUTLET INVENTORY OF PROCESSED DAIRY AND GRAIN FOODS: EVIDENCE FROM MALI

By

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ABSTRACT

The Malian agri-food system is transforming rapidly, in part due to increased demand for processed foods that are easy-to-prepare and ready-to-eat by the growing urban consumers. Yet, little is known about the scale and scope of this ongoing transformation in the agri-food system. To better understand the general trends in terms of diversity, availability and prevalence of imports as well as key characteristics of processed foods, we conducted a city-retail outlet inventory of processed dairy and cereal foods in 2016. We visited 100 retail outlets, including central and neighborhood markets, supermarkets as well as neighborhood and grocery stores, located across low, medium, and high income neighborhoods of four major cities in Mali. Findings show that: 1) there are 15 and 36 different types of processed dairy and cereal products; 2) availability of processed foods differs widely across neighborhoods, cities, and retail outlets; 3) there is a relatively high dependence on imports; and 4) there exist differences in product attributes across local and imported food products. Taken together, our results indicate that the transformation of the agri-food system is still at its early stages in Mali. The greatest opportunity for the expansion of the Malian agro-processing segment lies in making and selling more processed food items out of locally available raw agricultural materials, since it is where local firms are the most competitive.

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1. INTRODUCTION

Transformations in the agri-food system in Mali, as in other sub-Saharan African countries, is occurring in response to demographic and socio-economic changes. Over 40% of the Malian population now lives in cities and per capita income is increasing by 4.5% a year (World Bank 2016). The increasingly urbanized Malian population combined with the growth in disposable income are bringing major changes in lifestyle and diet. There is an unprecedented demand for diversified and easy-to-prepare foods. In the region, urban consumers are shifting away from traditional staples (i.e., roots and tubers) and towards processed rice and wheat-based products (i.e., noodles, pasta, and bread) (Hollinger and Staatz 2015). Income increases are also associated with growth in foods with high-income elasticities of demand, such as meat, dairy products, and fruits and vegetables (Zhou and Staatz 2016). These changes have important implications not only in terms of health and nutrition but also in terms of employment opportunities, notably in the processing and retailing segment of the agri-food system. For instance, processed foods have played a central role in diet transformation in Eastern and Southern Africa (Tschirley et al. 2015) as well as in agricultural value chains and retailing modernization in Asia (Reardon et al. 2015). Yet, little is known about the diversity, source of origin, availability, and affordability of processed food items in Mali, or even in the West African Sahelian region.

Recently, inventories of processed foods across retail outlets in major cities in Tanzania, Mozambique, Ghana, and Nigeria were conducted in order to assess their range and source of origin among other things (see Tschirley et al., 2015; Snyder et al., 2015a,b; Andam et al. 2015; and Liverpool-Tasie et al. 2016). Processed grain, dairy, poultry, and vegetable products are among the groups of processed foods that were inventoried. One common finding across these studies is that some groups of processed foods remain strongly dominated by imports. However, the groups, in which imports outshine locally-processed foods, vary from one country to another. For instance, imports of processed poultry meat dominate in Ghana but not in Nigeria, whereas imported milled rice dominated in both countries. This may suggest that countries are more likely to process more of what they are producing more, which raises the need for more cross-country comparisons.

Building on these recent studies (Tschirley et al., 2016), we conducted a city-retail outlet inventory of processed dairy and grain products in four major cities of Mali in 2016 in order to examine the scope and scale of the ongoing agri-food system transformation. The inventory focused on these groups, since cereal grains remain the principal component of the Malian diet and demand for dairy products is growing fast. In fact, Zhou and Staatz (2016) estimated a large trade deficit for dairy product in the region, due to the combination of rising income with high income-elasticities of demand, and slow growth of local production. This study expands the literature in this area, by documenting the range and source of origin of processed food products in a sub-Saharan African country that is characterized by an even, higher level of poverty and lack of coastal access than countries previously inventoried. Like the previous studies, we are able to address important questions, such as whether supermarkets carry local processed foods.

Our study also includes some methodological enhancements that enable a deeper analysis into the state of processed foods in Mali. First, the inventory collected product prices and was conducted across retail outlets located in low, medium, and high income neighborhoods of the four largest cities of Mali. This allows us to compare not only the diversity, source of origin and availability but also the affordability of processed dairy and grain products across retail outlets (e.g., modern supermarket versus open-air market), cities (e.g., the capital versus secondary cities), and

neighborhoods (e.g., open-air market in a high-income versus open-air market in a low-income of the same city), using descriptive statistics and hedonic regressions. To our knowledge, very few studies have used similar methods to investigate urban consumer prices in Africa (Woldu et al, 2013; Minten and Reardon, 2008). However, their focus was on fresh produce in either East or Southern Africa and dairy products were not included. Second, in addition to prices, information on product ingredients and packaging (i.e., materials and labels) were collected, allowing us to examine aspects related to food safety, healthfulness, and competitiveness. Until now, those aspects have received little attention

The paper is organized as follows. Section 2 presents key concepts related to the processing/retailing food segment. Section 3 describes the data and sampling strategy, including a description of the study areas and retail outlets. Section 4 discusses general trends regarding diversity, availability, and prevalence of imports of processed grain and dairy products. Section 5 looks at key characteristics of processed grain and dairy products, including branding, packaging, labeling, primary ingredients, and pricing. Concluding remarks are provided in Section 6.

2. WHAT DOES PROCESSED FOOD MEAN?

The retailing of processed foods is an important indicator of agri-food system transformations, since it is one of the first food categories to be adopted by modern retailers and widely demanded by urban consumers. Compared to fresh food, processed foods are low-risk for retailers due to their low perishability and highly valued by consumers for their shelf-life, consistent quality, and easiness to consume. According to the International Standard Industrial Classification (ISIC) (United Nations 2008), there are seven categories of processed foods: (1) processed meats; (2) processed fish, crustaceans, and molluscs; (3) processed fruits and vegetables; (4) manufactured dairy products; (5) manufactured grain mill products; (6) other manufactured foods; and (7) animal feeds. A processed food category is composed of different types of processed food products.

A processed food product is defined as "a retail item derived from a covered commodity that has undergone specific processing resulting in a change in the character of the covered commodity, or that has been combined with at least one other covered commodity or other substantive food component" (USDA 2017; 7 CFR § 65.220). Cooking, chopping, pasteurizing, fermentation, curing, smoking, drying, milling, and packaging are example of processing activities that are changing the character of the commodity. Processed foods range on a spectrum from minimally processed (e.g., fresh milk) to heavily processed (e.g., powdered milk). Examples of grain product types include wheat flour, maize-based breakfast cereals and maize semolina. Examples of product types within the dairy category include pasteurized milk, powdered milk, butter, and yogurt.

Within a product type, distinctions can be made between flavors, nutritional enhancement or other key commercial gradations. For instance, yogurt can have many flavors based on secondary ingredients (e.g., peach, strawberry, plain) and grains can be ground coarsely or finely. We define a product sub-type by taking into consideration those distinctions. Finely ground maize semolina and salted butter are examples of processed grain and dairy product sub-types.

3. DATA SAMPLING AND STRATEGY

The inventory focused on processed food products within the grain and dairy categories. Among all food categories, these two were selected on the basis of their importance in domestic production, consumption growth, and presence of processing. They are both pivotal to food and nutritional security, as grains are the main staple and milk and dairy products are a major source of animal protein (Hollinger and Staatz 2015).

The data for this study was collected in July and August 2016 across a range of retail outlets and neighborhoods in Mali's four largest cities: Bamako, Sikasso, Kayes, and Segou. The capital, Bamako, is the largest city of Mali, with a population of over 1.8 million (RM/INS 2011). Bamako is the country's administrative center and a major trading hub. The country's commodity trade, including agricultural products, tend to move along the Ouagadougou-Bamako, Dakar-Bamako, and Abidjan-Bamako corridors. The second largest city is Sikasso with a population of ~427,000 (Ibid). Located in the southern-most part of Mali, Sikasso region receives over 800 mm of rainfall per year and holds the reputation of being the breadbasket of Mali (Traore et al. 2013). The cropping systems in Sikasso are quite diversified, with coarse grains (such as millet, sorghum, maize, and rainfed lowland rice) cultivated alongside fruits, vegetables and cotton. Sikasso is also a crossroad point between Ouagadougou, Abidjan and Bamako. The city of Kayes is located in the northwest part of the country, near the Senegalese border and has a population of ~278,000 (RM/INS 2011), which makes it the third largest city in Mali. Since the 2000s, the Kayes region has experienced a boom in its industrial and artisanal gold mining activities (Kevane 2015). With a population of ~200,000, Segou city, which is located approximately 200km northeast of Bamako, is the fourth largest city of Mali (RM/INS 2011). The region of Segou is well-known for its irrigated rice production zone in the *Office du Niger*.

There are five types of retail outlets in Mali: grocery stores, traditional shops, neighborhood markets, central markets, and modern supermarkets. First, grocery stores (*alimentations*), are small self-service stores that mostly carry processed foods, including cold products, and are often equipped with one cash register. Within a city, some neighborhoods have multiple grocery stores whereas others have none. Second, traditional shops (*boutiques*) are small non-self-service shops that sell various non-food goods (e.g., soaps, batteries) along with a limited selection of processed foods, displayed behind a counter. Some traditional shops are equipped with an old refrigerator, making available a limited selection of cold beverages. Traditional shops are much more common than grocery stores. Third, neighborhood markets (*marchés de quartiers*) are relatively small open-aired markets containing multiple vendors selling mostly fresh produce but also some processed foods from stalls.

Fourth, are the central markets (*marchés centraux),* which differ from the neighborhood markets by their larger size as well as the higher volume of traded goods. Central markets are the main source of supply of vendors from neighborhood markets and traditional shops. Consumers can also buy food products from stalls at central markets. Fifth, supermarkets (*supermarchés*) are large and integrated retail spaces that are staffed by more than one employee and equipped with one or more cash registers. They offer an improved shopping ambiance, in terms of space, air-conditioning, and cleanliness (Hollinger and Staatz, 2015). Supermarkets are known to offer a wide selection of fresh and processed foods, including refrigerated and frozen foods. There exist few supermarkets in Mali and all of them are local chains situated in Bamako.

Mixed methods sampling strategies were used to collect the data. The combination of purposive and probability sampling techniques provided us with information that has both depth and breadth (Teddlie and Yu 2007) regarding the scale and scope of the ongoing agri-food system transformation in Mali. In the first stage, we stratified each city into communes (where relevant) then, into neighborhoods. After, each neighborhood was classified as low, medium, or high income. Given that no official information exists on average household incomes by neighborhood, we classified each into one of the three income categories based on the research and enumerator team's knowledge of the neighborhood in terms of housing conditions (e.g., access to electricity), infrastructure (e.g., paved roads), and other socio-economic indicators (e.g., where expatriates reside). The income classification of neighborhoods for Sikasso, Segou, and Kayes was done in collaboration with local agents from the Market Information System[1]. Next, we randomly selected one neighborhood per income level for Sikasso, Segou, and Kayes. For Bamako, we randomly selected one income-level neighborhood for each of the six communes. However, given that two communes do not have neighborhoods in all three income levels, we ended up with 16 neighborhoods instead of 18. Table 1 provides the list of selected neighborhoods, and their associated level of income, for all four cities.

In the second stage, we purposively selected the retail outlets to inventory. For each selected neighborhood across the three secondary cities- Segou, Sikasso, and Kayes- two traditional shops, two grocery stores, and the neighborhood market were visited. In Bamako, one traditional shop and one grocery store were visited along with the neighborhood market. Within every neighborhood, the team was careful to select retail outlets that were few blocks away from each other, as verified by the GSP coordinates of each outlet, to control for geographic variation within the neighborhood. Across the four cities, a total of 30 grocery stores, 36 traditional shops, and 22 neighborhood markets were surveyed[2]. Three central markets (*marchés centraux)* were visited in Bamako and one in Kayes, Segou, and Sikasso. We visited all six supermarkets (*supermarchés*) located in Bamako. At the time of the field work, there was no supermarket in the other cities.

A comprehensive inventory of all processed cereal and dairy sub-products was conducted at each supermarket, neighborhood store, and grocery store- even if the same product was previously documented at another location. At central and neighborhood markets, different stalls were visited until the inventory reached saturation- meaning no new product was inventoried. For each retail outlet and processed food product, the following information was recorded on computer tablets: (i) type, location, and GPS coordinates of the retail outlet, (ii) product information (product category, type, brand name, leading ingredients), (iii) price, (iv) packaging and label characteristics (size, material, nutritional information, manufactured and expiration dates), and (v) information on the manufacturer and distributor (names, addresses).

[1] The agents from the Marketing Information System visit weekly each neighborhood and central markets to collect information on prices. As such, they have a good knowledge of the neighborhood characteristics in their respective cities.

[2] There was no grocery store in three sampled neighborhoods of Bamako. In those three neighborhoods, two traditional shops were visited instead. No traditional shop was visited in one neighborhood of Kayes. The randomly-selected neighborhood of Medine in Sikasso holds a central market. As such, no neighborhood market was listed for Medine. There was no neighborhood market in two neighborhoods of Bamako.

4. GENERAL TRENDS IN THE RETAILING OF PROCESSED FOODS

We begin by discussing the general trends in the processed foods of the retailing segment, including diversity, availability, and dependence on imports of grain and dairy products. In this section, each inventoried food item counts as an observation, since we are particularly interested in understanding what is available where.

a. Diversity of products

The inventory includes information on approximately 4,000 processed dairy and cereal food items observed in 100 retail outlets in Mali.[3] Table 2 shows the range of grain and cereal product types inventoried across all retail outlets. Our inventory revealed a total of 36 and 15 different processed grain and dairy product types, respectively. The grain food category makes up approximately 60% of the full inventory and includes product types made from wheat, fonio, maize, millet, sorghum, and/or rice. The relatively limited number of different grain and dairy product types highlights the high repetition of products across retail outlets. For example, pasta and cookies together are the most frequently inventoried grain product types, accounting for over 20% of the observation in this category. Powdered milk is the most frequently inventoried dairy product types, making up about 20% of inventoried dairy products. Taking into account flavors, nutritional enhancement, and other key commercial gradations, the number of processed grain and dairy product sub-types exceed 60 and 30, respectively. Within grain product types, grain size gradation (i.e., fine, medium, or coarse grind) is the main distinction across product sub-types. Flavoring (e.g., vanilla or strawberry) along with the omission or addition of salt and sugar are what distinguished dairy product sub–types. A list of sub-type products is available in appendix.

The inventory indicates the coexistence of modernity with tradition. Traditional dairy products, such as fermented milk, sirime[4] and fene[5] (Doufils 2010) exist alongside modern ones, such as yogurt and powdered milk. Likewise, both traditional (e.g., monikourou[6], bachi djalan[7]) and modern (e.g., cookies, breakfast and infant cereals) grain products are inventoried. However, traditional grain and dairy products account for very few of the observations. This may suggest that modern foods are increasingly replacing traditional foods, as it has been observed in neighboring countries. As noted by Hollinger and Staatz (2015:177), "the demand for speed and convenience is resulting in a gradual departure from traditional cooking and eating habits." This is also supported by the inventory that lists mostly dairy and grain products that are convenient to prepare and consume.

b. Availability by region, neighborhood, and retail outlet

As highlighted in Section 3, the four largest Malian cities differ in terms of economic activities and geographical locations. As such, it is important to examine how processed food availability varies from one to another. The number of different processed grain and dairy products available in Bamako is about two times the number in Kayes and Sikasso and 1.5 times the number in Segou.

[3] At each outlet, all dairy and grain products were inventoried and were counted as a new observation.
[4] Sirime is a liquid butter, similar to ghee, obtained through traditional processing methods.
[5] Fene is full cream milk that has been fermented. It differs from locally made yogurts, which are commonly made from skimmed local milk and/or powdered milk, and with a commercial fermenter.
[6] Monikourou is a grain-based dough rolled into balls.
[7] Bachi djalan is a parboiled grain-based flour.

There are also 1.5 times more grain products available in Bamako than in the other major cities. Pasta, couscous, wheat-based cookies, and most milled grain products are available in all cities, whereas maize-based products, such as maize flour and cornmeal are only found in Bamako. The regional differences in product availability is even more striking for dairy. The number of dairy products available in Bamako is about threefold and twofold more than in Kayes/Sikasso and Segou, respectively. Powdered, evaporated, fermented, and sterilized milk as well as plain yogurts are available in all cities. However, most cheese, butter, and ice cream products are only available in Bamako.

Table 3 shows the availability of products by neighborhood income-levels. Several staple grains, imported wheat products (e.g. pasta and couscous), and non-perishable dairy products (e.g., powdered and evaporated milk) are widely available across all neighborhood types. In contrast, some dairy products and "quick-preparation" grains are less available in low income neighborhoods compared to higher income neighborhoods. The limited access may restrain consumers, from low income neighborhoods, to consume dairy products. This would be aligned with recent findings that shows consumption patterns are affected by households' physical access to foods (Hollinger and Staatz, 2015). Table A2 in the appendix shows the extent to which a product is available (or not) by neighborhood type.

The availability of processed grain and dairy products not only differs across cities and neighborhoods but also across retail outlets. For example, supermarkets and grocery stores (*alimentations*) do not carry sorghum-based products, such as flour and semolina, which are largely found in central and neighborhood markets. However, supermarkets are the only ones to sell hard chesses and some flavored yogurts and milk. With the exception of one traditional store located in a wealthy neighborhood of Bamako, ice cream is exclusively available at supermarkets. Wheat-based products (i.e., pasta, cookies, and couscous) and all kind of processed milk products (i.e., powdered, evaporated, sterilized milk) are found across all outlets. Once flavors, nutritional enhancement and other key commercial gradations are taken into account, more food items are available at the supermarkets than at other retail outlets. This is consistent with previous findings that modern retailers offer a wider selection of processed foods compared to traditional retailers as a way to attract consumers (e.g., Minten, 2010; Neven, et al., 2005). The small number of supermarkets in Mali may also suggest that modern retailing has not penetrated the mass markets yet, and therefore that the transformations in the agri-food system is at early stages (Hollinger and Staatz 2015).

c. Dependence on imports

Little is known about the capability of locally processed foods to compete with imported products in modern retailing. Although some supermarkets in Eastern and Southern Africa have sourced the bulk of processed foods domestically, it may not be the case for the less developed agri-food system of West Africa. As pointed out by Hollinger and Staatz (2015), West Africa food import chains have shortened over time and many large modern retail outlets, such as supermarkets, are owned by foreigners who are also operating as importers. As such, modern retail outlets may be more likely to favor imported foods. Here, we look at the overall prevalence of imported grain and dairy products, as an indicator of dependence on imports.

Table 4 reports the sources of origin of processed grain and dairy foods in Mali. About one-quarter of all inventoried products are manufactured locally- within Mali (1,000 out of 4,000 observations).

This indicates that locally processed foods have not been able to compete with imported modern retailing in Mali, yet. The proportion of locally processed products is higher for grain-based (~30%) than dairy products (~20%). Processed dairy products, especially powdered, concentrated, and sterilized milk, are dominated by imports from Europe. Yet, fermented milk (*lait caille*), fene, and sirime are predominantly from Mali. Yogurts are mostly processed in two countries: Mali and France. Soft cheeses are mostly imported from Morocco[8], followed by France and Holland. Fresh and hard cheeses are mostly from France or Italy. Butter is mostly imported from France.

Millet/fonio-based products are almost entirely locally manufactured, with very few imports from Burkina Faso and Ivory Coast. Processed sorghum products are exclusively from Mali. Over half of maize-based products come from Mali, followed by imports from Europe and African neighboring countries. Asia dominates the rice-based products (60%), followed by Mali (25%). Wheat-based cakes and breads are dominantly processed in Mali. In contrast, wheat-based cookies are processed in 28 different countries, including Mali. Traditional food, such as monikourou, degue, and bachi djalan are exclusively from Mali. France is also a major exporter of grain-based products, such as breakfast cereals, infant cereals, couscous, and pasta.

Four key points emerge from this analysis. First, imports from the Americas are quasi-nonexistent for both processed dairy and grain products. Second, France is a major exporter of processed dairy and grain products to Mali, which might be expected given the importance of the agri-food sector in France and the long history between the two countries. Third, some locally processed dairy and grain products have been minimally processed while others have been heavily processed. This suggests that the Malian processing sector has been developing and has the potential to be further developed. Fourth, more processing is occurring on foods that can be locally sourced (e.g., sorghum, millet, and fonio). This has important implications for employment in the agri-food sector. Further developing the processing segment of sorghum, millet, and fonio products and, to some extent of processed maize and rice products, could contribute to increase demand for raw agricultural commodities through local purchases and, thereby, generating employment opportunities on and off-farm.

Tables 5 and 6 report the sources of origin of processed grain and dairy products by retail outlet. Imports from Europe dominate in supermarkets, accounting for approximately 60% and 75% of inventoried processed grain and dairy products. In comparison, locally processed grain and dairy products account for less than 20% of the supermarket inventory. Imported dairy products from Europe remain important across the other retail outlets, accounting for half of the inventory. Note that France and Holland account for 45% and 35% of all European imports, respectively.

Local dairy products are found across supermarkets, grocery stores, and markets. These include modern dairy products, such as ice cream and yogurts as well as traditional dairy products, such as fene and fermented milk. Yet, most of dairy products sold in supermarkets are imported from Europe. In contrast to supermarkets, the largest share of processed grain products sold in traditional stores and markets are from Mali, followed by African countries (e.g., Algeria, Ghana, Ivory Coast, and Tunisia). Imported processed grain products from Asia are less common in supermarkets than in other retail outlets. Few products are imported from Americas, regardless of the type of retail outlets.

[8] Mostly, the soft cheese "Vache qui rit".

The high dependence on imports for processed dairy and grain products suggest that the Malian processing sector has great potential to grow. Yet, how can locally processed products capture market share from imports remains challenging. It would require that large enough quantity of products are processed to result in increased product availability across retail outlets. In addition, locally processed products would have to be competitive in terms of prices and product attributes, such as nutritional contents and food product safety. As highlighted by Hollinger and Staatz (2015), constraints related to high cost structure of local production as well and inadequate marketing and transport infrastructure would have to be overcome.

5. KEY CHARACTERISTICS OF PROCESSED BRANDED GRAIN AND DAIRY SUB-PRODUCTS

In this section, we examine key characteristics of processed grain and dairy products, including branding, packaging, primary ingredients, and pricing. Here, the unit of analysis is at the "branded" sub-type product level. A repeated inventoried sub-product made by the same firm is only counted once, since product attributes are of interest.

a. Branding

To get a sense of the level of competition for processed grain and dairy products, we look at the number of brands that exist. Table 7 shows that many branded processed foods are available to Malian urban consumers. For instance, the number of inventoried brands is above 40 for powdered milk, about 30 for pasteurized milk, and condensed sweetened milk, while the number of branded grain products is about 8 for cookies, about 70 for pasta, and 40 for couscous. There is also a notable number of brands for more traditional foods, such as djouka (16 brands), monikourou (9 brands), and degue djalan (8 brands).

Not included in these counts is an important number of inventoried food products that are unlabeled (no brand), including both local and imported products. Exclusively imported products, such as powdered milk and pasta, have been inventoried with no brand label in several instances, suggesting the incidence of repackaging activities (i.e. probably in smaller quantity denominations) for retail in Mali.[9]

Within a country, the agri-food system transformation is considered to be at advanced stages when the geographic reach of value chains have expanded to supply secondary growing cities (Reardon 2015). To explore the geographic extent of value chains in Mali, we examine the presence of brands (i.e., manufacturing firms) across its four major cities. As seen in Table 8, there are 80 and 27 different manufacturing firms operating in Mali that market branded grain products and branded dairy products, respectively. Fewer than 30% of these grain and dairy firms have a presence in more than one city, and only 2 grain processors and 1 dairy processor operating in Mali have a presence in all four cities. Of the branded sub-products with distribution limited to one city, approximately two thirds are confined to Bamako. This indicates that the bulk of domestic processing takes place in the capital. Approximately 30% of the single-city brands are inventoried in Sikasso and Segou, suggesting the presence of an active processing sector in these secondary cities, while only 2 single-city brands (both cereals) are inventoried in Kayes. Markets remain geographically fragmented, especially for locally processed foods, reflecting the limited scale of local firms to compete nationwide due in part to high transaction costs, including transport. This suggest that the agri-food system transformation is still at an early stage in Mali.

[9] The Malian government has developed national norms for over 100 food products based on the CODEX alimentarius international food standards, which includes guidelines on nutritional labeling. However, those norms are not strictly enforced. Many local processors informally operate and therefore, may not comply with those food standards (i.e.; artisanal processors whose businesses are unregistered and who mostly distribute through traditional shops and markets).

b. Packaging

Packaging is a key product attribute since it influences consumers' perception of product quality, and thereby, consumers' purchasing decision (Edward 2013; Silayoi and Speece 2007). Table 9 reports information on the types of packaging materials for branded grain and dairy products across retail outlets. Plastic is the most common packaging material across retail outlets. Both flexible (e.g., bags and wrappers) and rigid (e.g., bottles and containers) plastic packaging, all of various sizes and colors (including transparent), are widely used to package processed foods.
Although plastic packaging has the advantages of being light, cheap, and easily available, one drawback is that it is not easily degradable, which poses serious threats to the environment. Most of the processed products sold in non-plastic packages are imported (e.g., evaporated milk, pasta, and cookies). Indeed, locally processed grain products are almost exclusively sold in plastic packages. With few exceptions, most locally processed dairy products are also sold in plastic packages (Table 10).

Next, we look at the presence of barcodes on processed food packaging, which allows for faster and more reliable cash out and facilitates inventory management in modern outlets. In contrast to imports, locally processed foods do not have bar codes. According to our data, about 75% of all branded sub products sold in supermarkets have barcodes. In comparison, around 60%-65% of all branded products sold in traditional retail outlets have barcodes, even though these outlets do not use the scanning technology. This suggests that most manufacturers keep needs of modern retail outlets in mind when designing packaging, even if their brands are distributed to a wide range of retail types.

Food date labels such as "manufacturing and expiration dates/best if used by" are often seen by consumers as indicators of food quality and safety. Table 11 shows the presence of food date labels on processed grain and dairy products across retail outlet types. For processed grains in supermarkets, 81% and 95% of branded sub products have manufacturing and expiration dates, respectively. For dairy sold in supermarkets, 95% and 90% of branded sub products in display manufacturing and expiration dates, respectively. Most branded food sub-products sold in other retail outlets also have date labels on their packaging, but at lower rates compared to supermarkets. Nearly all (97%) of imported branded grain and dairy sub products have expiration dates on their packaging compared to 73% of local branded sub products.

c. Ingredients

On one hand, the transformation in the agri-food system has the potential to increase food and nutrition security by improving the availability and affordability of foods that are rich in macro and micro nutrients (Gomez et al. 2013). On the other hand, the increasing availability and cheapness of some ingredients used in processed foods, such as sugar and solid fats, can increase consumer risks for obesity, hypertension, and other chronic diseases (Gomez et al. 2013). As explicitly stated by Miller and Welch (2013: 115), processed foods "can be detrimental to nutritional quality when it manufactures foods that are high in added sugar, fat, and sodium or when it removes nutrient dense fractions from whole foods as is often the case in cereal milling operations."

In light of these concerns, we look at the extent to which sugars and vegetable fats are listed as a

primary ingredient in processed grain and dairy foods (Table 12). Of the 797 branded sub-products, 97% provide a list of their primary ingredients. Sugar is the first ingredient in 14 cookies and evaporated milk branded sub products, and the second or third ingredient in 290 of branded sub-products, two-thirds of which are cookies, yogurt, and evaporated milk. Vegetable oil is the first ingredient of two brands and second or third ingredient in 164 grain and dairy branded sub products, two thirds of which are cookies and evaporated milk. More than one-third and one-fifth of all branded processed sub-products contain vegetable fats and sugar, respectively, as a top-three ingredient. Traditional grain and dairy products are less likely to include sugar and/or fat as their key ingredients.

d. Pricing

We now look at how processed food prices differ across retail outlets and cities without controlling for product attributes. Tables 13 and 14 show the spatial price differences for two commodities, one widely available (powdered milk) and one less widely available (wheat flour)[10]. In Bamako, it is more expensive to purchase both powdered milk and wheat flour at the supermarket than at other retail outlets. The average price of powdered milk is over 6,000 FCFA/kg at a supermarket compared to approximately 5,500 FCFA/kg at a grocery store, and less than 5,000 FCFA/kg at a neighborhood or central market. Likewise, the average price of wheat flour is much higher at the supermarket than at markets. This is consistent with Hollinger and Staatz (2015) who found that low prices are a primary reason for urban shoppers in Accra and Lagos to frequent open markets rather than modern retail outlets. Compared to other cities, the average prices of wheat flour is much higher across all retail outlets in Kayes. No wheat flour is inventoried across central markets in Kayes. There is no major price difference in wheat flour across Bamako, Segou, and Sikasso. No spatial price pattern is found for powdered milk, which is widely available across cities and retail outlets.

The hedonic pricing model is based on the premise that consumers' utility is derived from the product attributes rather than from the entire product itself (Costanigro and McCluskey 2013). Differences in quality attributes differentiate one product from another. Although we cannot directly observe attribute prices, we do observe the equilibrium market price of a product, p_i, which is a function of its attributes. Since the seminal theoretical work of Lancaster (1966) on hedonic utility and Rosen (1974) on hedonic pricing, many studies have empirically examined the relationship between product attributes and prices for a wide range of food commodities. For instance, hedonic pricing models have been used in Mali to examine consumer preferences for quality attributes in cowpeas (Mishili et al., 2009), cattle (Williams, Okike, and Spycher 2006), and fonio (Dury and Meuriot 2010). Yet, to our knowledge, little research has analyzed pricing of processed food across retail outlets in Mali or even, in sub-Saharan Africa, through hedonic models. Two exceptions are Asseffa et al (2015) and Minten and Reardon (2008), who investigated cereal prices in Ethiopia and Madagascar, respectively.

Here, we employ a hedonic pricing model to examine attributes and prices of powdered milk across retail outlets located in four cities of Mali. The observed market price of product *i* -powdered milk- is a function of *n* attribute, $X_1, \dots X_n$, as follow:

[10] The dataset include over 800 observations of powdered milk compared to over 80 of wheat flour.

$$Pi\ (X) = P(X_1, X_2, \ldots X_n) \quad (1)$$

where the partial derivative of P(•), with respect to the k^{th} attribute represents the consumers' marginal willingness to pay for the attribute *k*. We hypothesize that prices of product *i* are determined by attributes, such as type of packaging, nutrition facts label, manufacture date, manufacturing location, type of retail outlet, and cities. A linear functional form is chosen to empirically examine the relationship between prices and product attributes. The empirical model is:

$$Pi = \beta ikXik + \epsilon, \quad \text{where i=1,2} \quad \text{and} \quad \text{k= 1,….,n} \quad (2)$$

Where β is a vector of coefficient parameters, X are product attributes affecting P, and ϵ is a random error term. All covariates are dummy variables. Table 15 show the OLS results of the hedonic pricing model for powdered milk.

Results from the hedonic model show that product attributes are highly significant. The coefficient estimate of size is negative, suggesting economies of scale. Consumers who purchase larger quantity of powdered milk pay significantly less per kilogram. Powdered milk packaged in plastic bag is less expensive than other type of packaging materials (e.g., rigid plastic containers and tin cans). The presence of bar codes positively affect powdered milk prices but not dates of manufacturing. This can be explained by the fact that most packages of powdered milk display manufacturing dates.

Compared to powdered milk that is locally manufactured, powdered milk that is manufactured in Europe (France and Holland) and in the region (e.g., Ghana and Senegal)[11] is more expensive. In the case of powdered milk, which is widely used to feed babies, product safety is highly value. Brand names associated with higher safety standards are generally sold at higher prices. Our findings show that the brand *Nido,* marketed by the multinational *Nestle*, is highly valued by consumers, as evidenced by its positive and highly significant coefficient estimate. This is consistent with previous findings that show consumers' willingness to pay premium prices for milk products that are HACCP-certified, which are seen as safer to consume (Wang, Mao, and Gale 2008) and for internationally branded products because consumers trust the quality of these products more than local alternatives (Hollinger and Staatz 2015).

After controlling for diverse product attributes, prices at supermarket remain significantly higher compared to other retail outlets. This might indicate that modern retailers are targeting the higher end segment of the market, which is often the case in developing countries (Schipmann and Qaim 2011). There is no statistically significant difference in prices between Bamako and other large cities. Our results can be seen as an indication that the agri-food system transformation has not fully taken off in Mali (Minten and Reardon 2008; Reardon et al. 2003). Otherwise, supermarkets would be selling processed foods at competitive prices with traditional retailers, not at mark-up prices. Take for instance, India, where basic food products are sold at the same or lower prices in modern retail outlets than in traditional ones (Minten et al. 2010).

[11] The multinational Nestle has offices in both Senegal and Ghana.

6. CONCLUSIONS

As with many sub-Saharan African countries, Mali is experiencing an unprecedented rate of urbanization and with it, changes in its agri-food system. As more people live in urban areas, demand for processed food has been increasing rapidly. Urban consumers are seeking food that is easy-to-prepare and ready-to-eat. Yet, little is known about the scale and scope of the transformation in the processed/retailing segment of the agri-food system. To better understand the general trends in terms of diversity, availability and prevalence of imports as well as key characteristics of processed foods, a city-retail outlet inventory of processed dairy and grain products was conducted in four major cities of Mali in 2016. A total of 100 retail outlets, including central and neighborhood markets, traditional and grocery stores as well as supermarkets, located in low, medium, and high income neighborhoods of Bamako, Segou, Sikasso, and Kayes were visited. Information on source of origin, brand, key ingredients, packaging, and price were collected.

Our results show that there are 36 and 15 different processed grain and dairy product types sold in retail outlets in the largest urban cities of Mali. Once flavors, nutritional enhancement, and other key commercial gradations are taken into consideration, the number of processed grain and dairy product sub-types exceed 60 and 30, respectively. The grain food category accounts for approximately 60% of the full inventory. The relatively small presence of traditional food products in the inventory suggest that modern foods are taking over this segment of the agri-food system. The availability of processed grain and dairy products differs across cities, neighborhoods and retail outlets. More processed grain and dairy products are available in the capital Bamako compared to other cities. Some dairy products and "quick-preparation" grains are also more available in high income neighborhoods compared to lower income neighborhoods. Supermarkets have a wider selection of processed foods compared to traditional retailers. The relatively small number of supermarkets in Mali, all located in Bamako, suggest that modern retailing has not penetrated the mass markets yet. The dependence of imports on processed grain and dairy products is relatively high, especially in supermarkets where approximately 60% and 75% of those product come from Europe. More local processing is occurring on food that is locally available.

Our study also highlights some interesting patterns at the product attribute level. First, some imported products do not have a brand label, indicating some levels of repackaging activities in the retail segment. Second, the geographic reach of local value chains are quite limited, with only 30% of local manufacturing firms distributing in more than two of the inventoried cities. Third, plastic is the most common packaging materials for both imported and local food products, with local products relying almost entirely upon this packaging material. The packaging of local products also less frequently feature bar codes and food date labels. Fourth, ingredients are listed on most food packages, with sugars and vegetable fats being main ingredients for one-third and one-fifth of branded sub-products. Fifth, results from the hedonic model for powdered milk, which is widely available across retail outlets, neighborhoods and cities, provide evidence that Malian consumers do value a number of product attributes. European manufacturing, durable packaging, and bar codes each associated with positive price premiums. Moreover, our findings indicate that powdered milk is sold at mark-up prices in supermarkets.

Taken together, our results indicate that the transformation in the processed and retailing segments of the Malian agri-food system is still at an early stage. The expected benefit of lower prices and greater selection of processed products for the mass market from the expansion of modern retailing has not fully taken off. Yet, the Malian agri-food system is somewhat vibrant, especially in

manufacturing processed food items made out of locally available raw agricultural materials. The continued growth of the processing and retailing segments over the next few years create economic opportunities for Malian grain and dairy value chain stakeholders. There is room for the Malian processing segment to be further developed, especially for products that can be locally sourced. Especially if they can deliver quality products at competitive prices. The ability of the local food processing segment to compete in modern retailing will depend on the country's ability to understand the ongoing changes and overcoming market barriers, including poor infrastructure and policy constraints.

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ANNEX: TABLES AND FIGURES

Table 1. List of selected neighborhoods, and associated income level, per city

City	Neighborhood	Commune	Income Level
Bamako	Banconi	Commune I	Low
	Korofina nord	Commune I	High
	Bozola	Commune II	Medium
	Hippodrome	Commune II	High
	Bakaribougou	Commune II	Low
	Quartier du fleuve	Commune III	High
	Badialan II	Commune III	Medium
	Sogonafing	Commune III	Low
	Lassa	Commune IV	Low
	Djikoroni Para	Commune IV	Medium
	Badalabougou Sema I	Commune V	High
	Torokorobougou	Commune V	Medium
	Daoudabougou	Commune V	Low
	Faladiè	Commune VI	High
	Senou	Commune VI	Low
	Sokorodji	Commune VI	Medium
Kayes	Liberté	-	High
	Plateau	-	Medium
	Khasso	-	Low
Sikasso	Kaboïla	-	High
	Medine	-	Medium
	Mamassoni	-	Low
Ségou	Angoulème	-	High
	Medine	-	Medium
	Ségou-Coura	-	Low

Source: Authors

Table 2. Diversity of grain and dairy products retailed in urban Mali

Processed grain foods		Processed dairy foods	
Maize semolina	Wheat flour	Butter	Yogurt
Maize breakfast cereals	Cake	Flavored milk	Ice cream
Maize flour	Bread	Pasteurized milk	Powdered milk
Maize-based cookies	Pasta	Milk-based beverages	Sterilized milk
Milled maize	Couscous	Fermented milk	Evaporated milk
Pop corn	Didegue	Fene	
Maize chips	Milled fonio	Sirime	
Bachi djalan	Pre-cooked fonio	Soft cheese	
Bendegue/ Degue	Rice-based cookies	Hard chesse	
Millet flour	Parboiled Rice	Fresh cheese	
Milled millet	Perfumed rice		
Monikourou	Broken rice		
Milled sorghum	Milled rice		
Sorghum semolina	Djouka		
Wheat-based cookies	Rice cereal breakfast		
Milled wheat	Rice vermicelli		
Wheat breakfast cereals	Rice toast		
Infant cereals	Rice pudding		

Source: Inventory dataset (2016), as computed by the authors.

Table 3: Availability of products across neighborhoods

	Low Income (n=9)	Medium Income (n=10)	High Income (n=11)	Obs.
Bachi djalan	0%	33%	67%	6
Bendegue/ Degue	15%	27%	58%	26
Bread	35%	27%	38%	12
Broken rice	31%	34%	34%	145
Butter	16%	16%	68%	37
Cake	30%	37%	33%	10
Couscous	24%	33%	43%	7
Didegue	0%	0%	100%	16
Djouka	10%	31%	59%	134
Evaporated milk	29%	33%	38%	156
Fene	13%	25%	63%	34
Fermented milk	33%	19%	48%	35
Flavored milk drink	25%	26%	49%	13
Fresh cheese	14%	0%	86%	37
Hard cheese	0%	0%	100%	40
Ice cream	0%	19%	81%	4
Infant cereals	17%	32%	51%	105
Maize breakfast cereals	4%	13%	83%	185
Maize chips	29%	35%	35%	53
Maize flour	0%	45%	55%	65
Maize semolina	12%	35%	53%	60
Milled fonio	26%	48%	26%	27
Milled maize	43%	30%	27%	32
Milled millet	43%	33%	25%	4
Milled rice	38%	32%	30%	49
Milled sorghum	52%	26%	22%	42
Milled wheat	54%	23%	23%	31
Millet flour	20%	50%	30%	11
Monikourou	0%	23%	77%	3
Parboiled Rice	29%	34%	37%	7
Pasta	24%	32%	43%	5
Pasteurized milk	19%	29%	51%	40
Perfumed rice	18%	29%	53%	9
Pop corn	15%	28%	58%	51
Powdered milk	20%	39%	41%	522
Pre-cooked fonio	13%	38%	50%	37
Rice breakfast cereals	0%	25%	75%	8

Rice pudding	0%	0%	100%	5
Rice vermicelli	0%	67%	33%	510
Rice-based cookies	8%	33%	58%	13
Sirime	20%	20%	60%	59
Soft cheese	18%	25%	57%	23
Sorghum semolina	0%	60%	40%	2
Sterilized milk	14%	37%	49%	842
Sweet corn	29%	29%	43%	4
Milk-based beverages	11%	22%	67%	17
Wheat vermicelli	22%	41%	37%	75
Wheat breakfast cereals	14%	26%	60%	29
Wheat flour	20%	31%	49%	48
Wheat-based cookies	19%	26%	55%	134
Yogurt	14%	17%	69%	143
Total				3962

Source: Inventory dataset (2016), as computed by the authors.

Table 4. Source of origin of processed grain and dairy food products

Source	Processed Grain Products		Processed Dairy Products		Total	
	%	Obs.	%	Obs.	%	Obs.
Mali	32	729	21	360	27	1089
Africa	26	583	11	185	19	768
Europe	29	674	61	1022	43	1696
Asia	12	283	6	94	10	377
Americas	1	17	1	21	1	38
Total	100	2,286	100	1,682	100	3,968

Source: Inventory dataset (2016), as computed by the authors.

Table 5. Source of origin of processed grain food products across retail outlets

Source	Supermarket		Grocery Store		Traditional Store		Neighborhood market		Central market	
	%	Obs.	%	Obs.	%	Obs.	%	Obs.	%	Obs.
Mali	17	81	24	149	41	175	44	236	42	88
Africa	16	76	26	162	29	126	29	159	29	60
Europe	63	304	35	215	11	46	15	82	13	27
Asia	4	21	15	90	18	81	11	61	14	30
Americas	<1	3	<1	3	1	4	<1	3	2	4
Total	100	485	100	619	100	432	100	541	100	209

Source: Inventory dataset (2016), as computed by the authors.

Table 6. Source of origin of processed dairy food products across retail outlets

Source	Supermarket		Grocery Store		Traditional Store		Neighborhood market		Central market	
	%	Obs.	%	Obs.	%	Obs.	%	Obs.	%	Obs.
Mali	19	60	20	135	29	94	21	48	16	23
Africa	3	9	15	98	11	36	11	25	12	17
Europe	76	244	59	393	51	166	59	132	62	87
Asia	1	3	5	35	9	28	7	15	9	13
Americas	1	4	1	8	1	3	2	5	<1	1
Total	100	320	100	669	100	327	100	225	100	141

Source: Inventory dataset (2016), as computed by the authors.

Table 7. Number of unique brands, by sub-product

Grains sub-product	# of brands
Bachi djalan	5
Bendegue	1
Bread	10
Cake	20
Couscous	39
Degue djalan	8
Degue mougou	4
Didegue	2
Djouka	16
Infant cereal with fruit	2
Infant cereal, banana	1
Infant cereal, enriched with phosphate	1
Infant cereal, enriched with vitamins	2
Infant cereal, simple	7
Infant cereal, strawberry	1
Infant cereal, vanilla	1
Infant cereal, with honey	1
Maize chips	13
Maize flour	8
Maize semolina, course	3
Maize semolina, fine	7
Maize semolina, medium	8
Maize-based breakfast cereals	14
Milled fonio	2
Milled maize	3
Milled millet	2
Milled sorghum	2
Milled wheat	4
Millet flour	7
Monikourou	9
Parboiled rice	11
Pasta, bow-tie	2
Pasta, spaghetti	48
Pop corn	15
Precooked fonio	17
Rice porridge	3
Rice vermicelli	3

Dairy sub-product	# of brands
Butter, salted	10
Butter, unsalted	1
Cheese, fresh	4
Cheese, hard in bloc	2
Cheese, hard shredded	1
Cheese, soft	9
Condensed milk, sweetened	31
Condensed milk, unsweetened	10
Evaporated milk	4
Fene	3
Fermented milk, sweetened	11
Fermented milk, unsweetened	1
Ice cream, chocolate	1
Ice cream, strawberry	1
Ice cream, vanilla	1
Milk, chocolate	1
Milk, pasteurized	31
Milk, sterilized	16
Milk, strawberry	4
Milk-based beverages	8
Milk, vanilla	4
Powdered milk	43
Sirime	2
Yogurt, banana	2
Yogurt, plain sweetened	18
Yogurt, plain unsweetened	3
Yogurt, strawberry	10
Yogurt, vanilla	11
Total	243

Rice-based breakfast cereal	3
Rice-based cookie	4
Rice, 100% broken	12
Rice, 20-25% broken	3
Rice, 40% broken	3
Rice, long blanched	8
Rice, perfume broken	4
Rice, perfume whole	6
Sorghum semolina	1
Sweet corn	6
Wheat flour	13
Wheat vermicelli	18
Wheat-based breakfast cereal, with fruit	4
Wheat-based breakfast cereal, without fruit	16
Wheat-based cookies, banana	1
Wheat-based cookies, butter	14
Wheat-based cookies, chocolate	15
Wheat-based cookies, mango	1
Wheat-based cookies, orange	4
Wheat-based cookies, salted	4
Wheat-based cookies, with cream	25
Wheat-based cookies, with egg	13
Total	480

Source: Inventory dataset (2016), as computed by the authors.

Table 8. Presence of grain and dairy brands manufactured by Malian firms, by city

Category	1 city		2 cities		3 cities		4 cities		Total
Grains	64	80%	11	14%	3	4%	2	3%	80
Dairy	19	70%	4	15%	3	11%	1	4%	27

Source: Inventory dataset (2016), as computed by the authors.

Table 9. Type of packaging materials of branded sub products, by retail outlet

Packaging type	Supermarket	Grocery Store	Traditional Store	Neighborhood Market	Central Market
Flexible plastic	60%	55%	71%	73%	67%
Rigid plastic	12%	12%	5%	4%	4%
Metal	9%	15%	13%	13%	16%
Paper or carton board	19%	18%	11%	9%	13%
N	329	383	201	225	135

Source: Inventory dataset (2016), as computed by the authors.

Table 10. Type of packaging materials of Malian branded sub products

Type of packaging materials	Grains	Dairy
Flexible plastic	99%	64%
Rigid plastic	1%	33%
Metal	0%	2%
Paper or carton board	0%	2%
Others	1%	0%
N	149	55

Source: Inventory dataset (2016), as computed by the authors.

Table 11. Food date labels on branded sub products

	Grains			Dairy		
	Manufactured date	Expiration date	N	Manufactured date	Expiration date	N
Supermarket	81%	95%	245	73%	90%	138
Grocery Store	70%	86%	132	77%	94%	69
Traditional Store	67%	82%	82	72%	92%	53
Neighborhood market	74%	84%	164	78%	95%	63
Central Market	63%	92%	230	55%	94%	99
Total			853			429

Source: Inventory dataset (2016), as computed by the authors.

Table 12. Branded sub products containing fat or sugar as top three ingredient

	Sugar				Fat				
Sub product	Not listed	1st	2nd	3rd	Not listed	1st	2nd	3rd	N
Bachi djalan	100%	0%	0%	0%	100%	0%	0%	0%	4
Bendegue/Degue	75%	0%	17%	8%	100%	0%	0%	0%	12
Bread	67%	11%	22%	0%	89%	0%	0%	11%	9
Broken rice	100%	0%	0%	0%	100%	0%	0%	0%	14
Butter	89%	0%	11%	0%	89%	0%	11%	0%	9
Cake	42%	0%	47%	11%	74%	5%	11%	11%	19
Couscous	97%	0%	0%	3%	97%	0%	3%	0%	38
Didegue	50%	0%	0%	50%	100%	0%	0%	0%	2
Djouka	100%	0%	0%	0%	100%	0%	0%	0%	15
Evaporated milk	40%	18%	33%	10%	33%	0%	25%	43%	40
Fene	50%	0%	0%	50%	100%	0%	0%	0%	2
Fermented milk	23%	0%	31%	46%	100%	0%	0%	0%	13
Flavoured milk drink	8%	0%	33%	58%	100%	0%	0%	0%	12
Fresh cheese	50%	0%	0%	50%	100%	0%	0%	0%	4
Hard cheese	100%	0%	0%	0%	100%	0%	0%	0%	1
Infant cereals	40%	0%	47%	13%	93%	0%	0%	7%	15
Maize chips	83%	0%	8%	8%	25%	0%	50%	25%	12
Maize flour	71%	0%	14%	14%	100%	0%	0%	0%	7
Maize semolina	100%	0%	0%	0%	100%	0%	0%	0%	15
Maize-based breakfast cereals	31%	0%	54%	15%	92%	0%	8%	0%	13
Milled fonio	100%	0%	0%	0%	100%	0%	0%	0%	1
Milled maize	100%	0%	0%	0%	100%	0%	0%	0%	2
Milled millet	100%	0%	0%	0%	100%	0%	0%	0%	1
Milled rice	100%	0%	0%	0%	100%	0%	0%	0%	6
Milled sorghum	100%	0%	0%	0%	100%	0%	0%	0%	1
Milled wheat	100%	0%	0%	0%	100%	0%	0%	0%	3
Millet flour	67%	0%	0%	33%	100%	0%	0%	0%	6
Monikourou	100%	0%	0%	0%	100%	0%	0%	0%	8
Parboiled rice	100%	0%	0%	0%	100%	0%	0%	0%	8
Pasta	99%	0%	0%	1%	97%	0%	2%	1%	96
Pasteurized milk	83%	0%	10%	7%	77%	0%	13%	10%	30
Perfume rice	100%	0%	0%	0%	100%	0%	0%	0%	5
Pop corn	38%	0%	46%	15%	85%	0%	15%	0%	13
Powdered milk	83%	0%	10%	8%	68%	3%	15%	15%	40
Pre-cooked fonio	100%	0%	0%	0%	100%	0%	0%	0%	12
Rice porridge	100%	0%	0%	0%	67%	0%	33%	0%	3
Rice vermicelli	100%	0%	0%	0%	100%	0%	0%	0%	2

Rice-based breakfast cereals	67%	0%	33%	0%	67%	0%	0%	33%	3
Rice-based cookies	100%	0%	0%	0%	100%	0%	0%	0%	3
Sirime	100%	0%	0%	0%	100%	0%	0%	0%	1
Soft cheese	88%	0%	0%	13%	75%	0%	25%	0%	8
Sterilized milk	93%	0%	7%	0%	93%	0%	7%	0%	15
Sweet corn	0%	0%	25%	75%	100%	0%	0%	0%	4
Milk-based beverages	50%	0%	38%	13%	88%	0%	13%	0%	8
Wheat based breakfast cereals	58%	0%	5%	37%	89%	0%	0%	11%	19
Wheat based cookie	17%	4%	52%	27%	49%	0%	17%	34%	166
Wheat flour	90%	0%	10%	0%	90%	0%	0%	10%	10
Wheat vermicelli	100%	0%	0%	0%	100%	0%	0%	0%	16
Yogurt	31%	0%	39%	29%	98%	0%	0%	2%	51
Total	62%	2%	22%	14%	79%	0%	9%	12%	797

Source: Inventory dataset (2016), as computed by the authors.

Table 13. Price differences of wheat flour across retail outlets and cities (FCFA/kg)

	Bamako	Segou	Sikasso	Kayes
Central market	360	375	400	N/A
Supermarket	950	---	---	---
Grocery store	600	350	450	1000
Traditional store	392	383	385	500
Neighborhood market	386	363	400	400

N/A: no wheat flour found at the central market, ---: no supermarket
Source: Inventory dataset (2016), as computed by the authors.

Table 14. Price differences of powdered milk across retail outlets and cities (FCFA/kg)

	Bamako	Segou	Sikasso	Kayes
Central market	4890	4798	3586	4731
Supermarket	6157	---	---	---
Grocery store	5559	5580	5960	5406
Traditional store	5315	4487	5135	5334
Neighborhood market	4859	4774	6209	5639

---: no supermarket
Source: Inventory dataset (2016), as computed by the authors.

Table 15. Hedonic price regressions for powdered milk (FCFA/kg)

	Linear-OLS
Constant	3012.36***
	(406.92)
Packaging	
Size	-262.44***
	(28.33)
Bar code	1294.29***
	(249.95)
Date of manufacture	170.43* (256.97)
Brand (Nido)	86.60***
	(14.11)
Flexible plastic packaging	-1295.52***
	(121.48)
Manufacturing location	
Africa	1176.83***
	(364.72)
Europe	1265.97***
	(214.66)
Retail outlets	
Neighborhood market	-142.90
	(224.10)
Traditional shop	25.56
	(218.03)
Grocery store	-92.30
	(198.20)
Supermarket	470.77**
	(234.92)
Neighborhood	
Medium-income	-117.35
	(143.29)
High-income	-21.84
	(146.41)
Cities	
Segou	-48.60
	(151.61)
Sikasso	97.72
	(151.00)
Kayes	94.49
	(151.55)
R^2-ajd=	0.4035
N=	690

The omitted categories include central market, and low-income neighborhood, and Bamako. Africa excludes Mali.

Table A1. Range of grain and dairy sub-type products

Processed grain sub-type products		Processed dairy sub-type products	
Maize semolina- fine grind	Wheat flour	Salted butter	Plain sweetened yogurt
Maize semolina- medium grind	Wheat vermicelli	Unsalted butter	Plain unsweetened yogurt
Maize semolina- coarse grind	Cake	Flavored chocolate milk	Strawberry yogurt
Maize breakfast cereals	Bread	Flavored strawberry milk	Vanilla yogurt
Maize flour	Couscous	Flavored vanilla milk	Other flavored yogurt
Maize-based cookies	Pasta- spaghetti	Strawberry ice cream	Evaporated sweetened milk
Milled maize	Pasta- farfelle	Chocolate ice cream	
Pop corn	Pasta- shells	Vanilla ice cream	Evaporated unsweetened milk
Maize chips	Pasta- penne	Pasteurized milk	Powdered milk
Bachi djalan	Pasta- elbow	Milk-based beverages	Sterilized milk
Bendegue	Pasta- spirali	Fene	
Degue djalan	Didegue	Sirime	Fermented sweetened milk
Degue mougou	Milled fonio	Fresh cheese	Fermented vanilla milk
Monikourou	Djouka	Soft plain cheese	
Millet flour	Pre-cooked fonio	Soft blue cheese	
Milled millet	Rice-based cookies	Hard "block" of cheese	
Sorghum semolina	Rice flour	Grated hard chesses	
Milled sorghum	Parboiled Rice		
Wheat-based egg cookies	Long grain rice		
Wheat-based cookies, orange flavor	Perfumed long grain rice		
Wheat-based cookies, butter flavor	Perfumed broken rice		
Wheat-based cookies, chocolate flavor	100% broken rice		
Wheat-based cookies, cream flavor	40% broken rice		
Wheat-based salty cookies	25% broken rice		
Milled wheat	Milled rice		
Wheat breakfast cereals, no fruit	Djouka		
Wheat breakfast cereals, with fruits	Rice cereal breakfast		
Infant cereals, plain	Rice pudding		
Infant cereals, fruits	Rice vermicelli		
Infant cereals, vanilla	Rice toast		

Source: Based on the inventory dataset (2016), prepared by the authors.

Table A2: Product availability per neighborhoods (yes/no)

	Low income (n=9)	Medium income (n=10)	High income (n=11)
Bachi djalan	0%	20%	36%
Bendegue/ Degue	33%	50%	55%
Bread	89%	60%	64%
Broken rice	89%	90%	91%
Butter	33%	30%	73%
Cake	67%	70%	82%
Couscous	100%	100%	100%
Didegue	0%	0%	18%
Djouka	22%	60%	91%
Evaporated milk	100%	100%	100%
Fene	11%	20%	45%
Fermented milk	100%	70%	91%
Flavored milk drink	56%	40%	45%
Fresh cheese	11%	0%	36%
Hard cheese	0%	0%	9%
Ice cream	0%	10%	27%
Infant cereals	78%	80%	100%
Maize breakfast cereals	22%	40%	55%
Maize chips	78%	70%	55%
Maize flour	0%	30%	27%
Maize semolina	33%	70%	73%
Milled fonio	67%	80%	55%
Milled maize	100%	80%	73%
Milled millet	89%	80%	73%
Milled rice	67%	60%	64%
Milled sorghum	100%	60%	36%
Milled wheat	44%	30%	27%
Millet flour	22%	30%	27%
Monikourou	0%	20%	64%
Parboiled Rice	56%	60%	73%
Pasta	100%	100%	100%
Pasteurized milk	78%	100%	100%
Perfumed rice	22%	50%	64%
Pop corn	67%	90%	64%
Powdered milk	100%	100%	100%
Pre-cooked fonio	33%	50%	82%
Rice breakfast cereals	0%	10%	27%

Rice pudding	0%	0%	27%
Rice vermicelli	0%	20%	9%
Rice-based cookies	11%	30%	36%
Sirime	11%	10%	18%
Soft cheese	78%	80%	82%
Sorghum semolina	0%	30%	18%
Sterilized milk	44%	40%	36%
Sweet corn	22%	20%	18%
Milk-based beverages	11%	20%	27%
Wheat Vermicelli	78%	90%	91%
Wheat breakfast cereals	33%	60%	73%
Wheat flour	78%	100%	91%
Wheat-based cookies	100%	90%	91%
Yogurt	78%	80%	91%

Source: Based on the inventory dataset (2016), prepared by the authors.