Organic food retailing and the conventionalization debate

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Abstract: In terms of sustainability, the effects of the development of organic farming are subject to debate, particularly regarding the methods used to compare organic and conventional food systems and the consequences of the conventionalization of organic farming. We propose an empirical study centered on the stage of food retailing and based on two sales databases in France in 2012, one involving conventional food retailing and the other involving specialized organic stores. We examine sustainability from the plant, animal or combined origin of food products and from their degree of processing. The results suggest that sales of organic food products are more plant-based and less processed than sales of conventional products, two criteria for better sustainability. They also show that organic sales in specialized organic stores are more sustainable than those in conventional retail stores according to the same criteria. In addition, the sales structure of organic products in conventional retail stores is very specific. Finally, the average structure of purchases in specialized organic stores is more plant-based and less processed than total food purchases of large buyers of organic products in conventional retail stores, themselves more plant-based and less processed than those of small buyers.

Keywords: sustainable diets; organic farming; retail channel; conventionalization; food environment

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1. Introduction[1]

Sales of organic food products, while remaining relatively small, are increasing significantly in developed countries. In terms of sustainability, the effects of this increase are subject to debate. This research aims to contribute to the knowledge regarding conventional and organic food systems, based on a characterization of purchasing behaviors that considers the differences between conventional and organic products and between the retail channels of organic products.

This analysis examines the issue of the sustainability effects of contemporary food systems. The expansion and intensification of agriculture have major implications for ecosystems, energy use and climate change (Foley, 2011). In particular, pesticides and nitrates cause air, water and soil pollution and damage to biodiversity, with negative impacts on human health and the environment (Bourguet and Guillemaud, 2016; Sutton and van Grinsven, 2011).The ongoing nutritional transition towards more animal products, vegetable oils and sugar, to the detriment of basic plant-based products, accentuates these deleterious effects. Thus, excluding biomass that is edible for animals but not edible for humans, on a world average approximately three calories of plant-based products that could directly feed humans are instead used to feed animals to produce one calorie of edible animal products (meat, dairy products and eggs) (Paillard et al., 2014).The production of animal-based food therefore requires more resources than the production of plant-based food (Tscharntke et al., 2012). In addition, contemporary diets are associated with rising rates of obesity and chronic diseases such as cardiovascular diseases and cancer (Kearney, 2010). Worldwide, nearly two billion adults are overweight, including 600 million who are obese (World Health Organization, 2015). At the same time, nearly one billion people are chronically undernourished (FAO, IFAD and WFP, 2015), and hundreds of millions suffer from nutritional deficiencies (Allen et al., 2011). In this context, a major challenge for the coming period is the transition towards sustainable food systems, with low environmental impacts and a contribution to food, nutrition security and healthy lives for present and future generations (Burlingame and Dernini, 2012, Johnston et al., 2014).

Increasing awareness of sustainability issues raised by chemically intensive food systems has contributed to the sustained growth of organic farming, a production method that excludes synthetic fertilizers and pesticides. The global organic food market has nearly tripled in ten years, from $24.7 billion in 2003 to $70.1 billion in 2012 (Agence Bio, 2014). Growth in demand for organic products is driven mainly by considerations related to health, product quality and the environment (Hughner et al., 2007). However, the development of organic farming generates controversies that revolve around two main elements.

First, some critics indicate that organic farming obtains lower yields than conventional farming. To produce the same quantity of a given crop, more land must be cultivated with

[1] Abbreviation used in this article: PAC: classification of food products that separates plant-based products (or plant products, i.e., foods from plants); animal-based products (or animal products, i.e., foods from animals, including meat, fish, egg, milk, cheese, and yogurt); and combined products (foods from both plants and animals).

organic farming than with conventional farming, leading some authors to conclude that organic farming may have negative impacts on biodiversity and greenhouse gas emissions, offsetting the environmental gains associated with this production method (Kirchmann and Thorvaldsson, 2000; Trewavas, 2001; Emsley, 2001; Hodgson et al., 2010; Gabriel et al., 2013; Pickett et al., 2013; see Tuck et al., 2014 for a discussion). This analysis is consistent with the analysis that a land-sparing strategy (intensive farming that leaves more room for natural areas rich in biodiversity) may encourage the conservation of more biodiversity than a land-sharing strategy (lower-yield farming that allows for a share of cultivated land between agricultural production and biodiversity but that uses more land to produce the same amount of a crop) (Green et al., 2005).

One answer to these criticisms is that conventional and organic farming cannot be compared on a production-by-production basis; instead, it is necessary to evaluate food systems as a whole to compare their effects in terms of sustainability. On the production side, organic farming may exhibit differences in terms of crop rotations, associations between crops and livestock, and rearing methods, contributing to a specific balance of different types of production and a better nutritional quality (Reganold and Watcher, 2016). On the consumption side, the higher cost of organic products compared to similar conventional products can lead regular organic consumers to adjust the composition of food product bundles to control their expenditures (see Desquilbet et al., 2016, for a description of the mechanisms leading to this adjustment). However, the motivation of organic consumers in terms of nutrition, health, environment and social criteria are likely to guide their diets. Thus, based on survey data in France, Kesse-Guyot et al. (2013) and Baudry et al. (2015) suggest that the regular consumers of organic products have a healthier diet than other consumers, including more vegetables, less meat, less alcohol and fewer sweet products.

The second element of the controversy is the tendency of organic farming to develop certain characteristics of the conventional food system, converse to its original intent. This trend has been described in the academic literature as the conventionalization of organic farming, introduced by Buck et al. (1997) and developed in particular by Guthman (2004) from the analysis of industrial organic farming in California. Conventionalization can be defined as organic farming that approaches conventional farming in terms of scale and structure. Previous literature notes an increase in the size of organic farms, less stringent agronomic methods, the rapid growth of intermediaries that coordinate organic food supply chains, the entry of conventional retailing operators into organic farming, the increase in imports of organic products, the majority of value added going to the downstream sectors, and a loss of the dimension of social protest movement (Darnhofer et al., 2010; Constance, 2015). Conventionalization covers a wide variety of processes, and its intensity and consequences continue to be debated. Overall, however, different authors agree that it is likely to diminish the benefits of organic farming in terms of sustainability.

The stage of product retailing is related to the controversy surrounding the conventionalization of organic farming. Despite national differences in European countries, the region is characterized by a predominance of conventional large- and medium-sized stores. Specialized organic retail channels also account for a relatively large share of sales, and direct sales represent a smaller share (IFOAM, 2016, Figure 7). Previous literature on the conventionalization of organic farming has not included empirical analyses focusing on this

consistent with the existence of other retail channels of organic products besides conventional large- and medium-sized stores (specialized channel, direct sales).[2]

The database on specialized organic stores covers all sales of 22 stores in the specialized channel. Although these are typical stores in this channel, we do not have information on their location or their representativeness within the specialized organic channel considered. For each customer visit to a store, this database provides the date of purchase, a customer identifier, the label of each product and the purchase price. We exclude two stores from our study, one because its sales decrease sharply in August, and the other because its sales structure is very different from that of other stores. We use data from 20 stores with more than 13 million purchases of food products.

We study the structure of product bundles in these two retail channels on an annual basis. This time step avoids biases resulting from products having various storage potentials and households having various purchasing frequencies.

2.2. Product Classification

Two food classifications are used in each database (Table 1).[3]

The first, which we call the PAC classification, separates plant-based products (or plant products, i.e., foods from plants); animal-based products (or animal products, i.e., foods from animals, including meat, fish, egg, milk, cheese, and yogurt); and combined products (foods from both plants and animals). This classification provides an indicator of the environmental impact of the bundle of purchased products. Indeed, animal products have a higher environmental impact than plant products, especially in terms of land use (Hallstrom et al., 2014) and carbon impact, eutrophication and acidification (Masset et al., 2014). The high level of animal consumption observed in the wealthiest countries imposes significant pressure on agricultural resources and greenhouse gas emissions (Tilman and Clark, 2014). It also provides a health indicator, given the negative health effects of a high level of red and processed meat consumption (World Cancer Research Fund/American Institute for Cancer Research, 2007; Perignon et al., 2017). This indicator is limited, however, because we cannot distinguish all red and processed meats in the database of specialized organic stores, as detailed in the next section.

[2] More specifically, in 2012, when the national share of organic food was 2.4%, 47% of organic food sales were made in conventional retail stores (which accounted for 70% of total food sales), 36% in specialized organic stores (which, by definition, sell only organic products) and 17% in other channels.

[3] We adapted the classification of products to the specificities of each database. Kantar data for non-alcoholic food products are organized into 322 files, each file corresponding to one type of product. Of these, 301 files could be assigned directly to one of the nine groups. It was necessary to divide 21 files to account for either the plant-based or animal-based nature of the product (for example, we separated plant-based and animal-based conditioned fats) or its degree of processing (for example, we separated fruit juices from fruit nectars). For this process, we used variables providing specific information about the products. Data from specialized organic stores contain a detailed label for each purchased product. After removing accents, punctuation, double spaces, parentheses, etc., the database contained 44,367 product labels. We compiled a list of keywords (or chain of words) to classify them within the nine groups. The classification of products was carried out by a careful examination of the labels, and for many of them, an online check of the corresponding product and its ingredients. A total of 6,835 keywords were required to rank all labels in the nine groups, and the validity of the resulting ranking was thoroughly verified.

Table 1: Classification of food products

PAC	NOVA	Products
P	1	Fresh, frozen and dried fruits; fresh, dried, germinated, frozen and lyophilized vegetables; fresh peas, fruit juices, compotes without added sugar, puree, rice, semolina, polenta, flour, pasta, muesli without added sugar, raw potatoes, pepper, spices, herbs, non-lyophilized coffee, chicory and roasted cereals, teas and herbal teas
	2	Mustard, vinegar, soy sauce, pastry aids, salt, oil, sugar and sweet products, honey
	3	Canned vegetables and legumes, olives, frozen soups, tomato coulis, pre-packaged bread, cooked potatoes, compotes, frozen ready-to-eat vegetables, unfrozen and undehydrated soups, fries, salted fruits, pickles, vinaigrette dressings
	4	Plant substitutes for dairy products, crispbread, pastry, jams, sodas, energy drinks, syrups, non-alcoholic beers, fruit nectars, other prepared meals containing no animal products, lyophilized coffee, chicory and roasted cereals
A	1	Unprocessed or minimally processed meat, eggs, fresh or frozen fish, crustaceans, unflavored animal milk, natural yogurt, margarine
	2	Butter, cream, duck fat
	3	Ham, bacon; salted, minced, candied or smoked meat; smoked, salted or marinated fish; cheeses, unpasteurized fresh cheeses
	4	Sausages, pâté, rillettes, foie gras, breaded poultry, other charcuterie, animal milk, yogurt and flavored white cheese
C	4	Sweetened biscuits and breakfast cereals, chocolate spread, chocolate powder, ice cream, sorbets, prepared meals containing animal products (meat, fish, egg and/or dairy products), other salted aperitif products, sauces, baby foods

For each classification, the sales structure is defined as the percentages of sales in each class, which characterizes the sustainability of purchases in a given retail channel. However, the data used in our study do not allow an assessment of the sustainability of the overall food consumption of buyers. Because we do not have prices in the specialized organic channel, we cannot assess to what extent our comparison of sales structures in euros reflects a comparison of structures in quantities, which is a limit in our analysis.

2.3. Typology of buyers in conventional retail stores

The second is the NOVA classification, which includes the following four classes of products according to the extent and purpose of the processing they undergo (Moubarac et al., 2014; Fardet et al., 2016; Monteiro et al., 2016): unprocessed or minimally processed foods (class 1), processed culinary ingredients (class 2), processed foods (class 3) and ultra-processed food and drink products (class 4). This classification provides a health indicator of

the bundle of purchased products. Indeed, diets rich in ultra-processed products are associated with a higher risk of obesity (Louzada et al., 2015; Canella et al., 2014), metabolic syndrome (Tavares et al., 2012) and dyslipidemia (Rauber et al., 2015).

We also study the purchasing patterns of different types of buyers within conventional retail stores (section 3.2). The aim is to identify whether certain consumer groups within conventional retail stores have a purchase structure similar to that observed in the specialized organic channel. The purpose is therefore to identify possible differences in customer purchasing behaviors within the channel of conventional retail stores, which would limit the significance of any differences observed between the average sales structures of the two retail channels. Conversely, because of the strategic nature of the specialized organic channel that provided us with data, we do not present results that differentiate buyers in this channel.

The typology of buyers in conventional retail stores defines a gradient between small and large buyers of organic products and is conducted according to the share of organic products in their total annual food expenditures. Organic spending represents 0% (for 519 buyers) to 61.8% of annual household expenditures in the sample, with an uneven distribution of households over this interval; half of households spend less than 0.6% on organic products; 75% of households spend less than 1.51%; and only 0.25% spend more than 40%. The analysis of the distribution reveals as extreme values organic expenditures above 3.42% of food expenditures.[4] The 942 households concerned constitute the groups of the largest buyers of organic products (group 5 of our typology). The remaining 6,941 buyers are divided into four classes of similar headcount. The five household groups are described in Table 2 below. We ensured that the buyer groups are not distinguished by the number of weeks in which they are active, by their total expenditures, nor by the variability of their weekly expenditure.

Table 2: Typology of buyers in conventional retail stores

Group of buyers	1	2	3	4	5
% of organic products in food expenditures	[0%; 0.2%[	[0.2%; 0.49%[	[0.49%; 1.05%[	[1.05%; 3.42%[	[3.42%; 61.75%[
Number of buyers	1749	1709	1752	1731	942

[4] The first three quartiles of the distribution are $q_1 = 0.235\%$, $q_2 = 0.598\%$ and $q_3 = 1.511\%$. The bound of the extreme values is defined by $q_3 + 1.5\ (q_3 - q_1) = 3.42\%$.

classifications of these meats in classes 1, 3 and 4 of the NOVA classification (class 2 contains no meat).

According to these tests, the proportions of conventional and organic sales in conventional retail stores are significantly different for each of the four NOVA classes, while the proportions of conventional sales in conventional retail stores and organic sales in specialized organic stores are significantly different with the exception of processed culinary ingredients. The comparison between organic sales in conventional retail stores and in the specialized organic channel shows that the proportions of the processed culinary ingredients and those of processed foods are significantly different; those of unprocessed or minimally processed foodstuffs represent more than 20.6% of the unclassified meat of the specialized organic channel in this class, or more than 49.3% of sales in this channel, whereas those of ultra-processed foods represent less than 55.6% of the unclassified meat of the specialized organic channel in this class, or less than 30.3% of sales in this channel. These conditions, detailed in Table 4, are realistic given the allocation of meat sales in this channel that can be classified according to NOVA, 53% of which are in class 1 and 20% in class 4.

The NOVA-PAC cross-classification (Table 5) allows a more detailed analysis of the sales structures. It shows that the specificity of organic sales in conventional retail stores for processed culinary ingredients concerns both plant and animal products, whereas for processed products, organic sales in conventional retail stores are distinguished primarily for animal products. Organic sales in conventional retail stores are also distinguished by the highest share of sales of unprocessed or minimally processed animal products (A1).

More precisely, for seven of the nine classes, the proportions of conventional and organic sales in conventional retail stores and of organic sales in specialized organic stores are significantly different. The proportions in class V3 are not significantly different between conventional and organic sales in conventional retail stores. For class A4, the proportions are significantly different when less than 40% of unclassified meat falls within this class (which then represents less than 3.5% of sales in the specialized organic channel). This assumption is realistic because only 20% of the meat that we can classify falls into category A4.[6]

[6] They also are under the unrealistic assumption that between 54% and 75% of unclassified meat is ultra-processed, such that the A4 class accounts for between 4.4% and 5.7% of sales in the specialized organic channel.

Table 5: Sales structure, PAC and NOVA classifications

	Sales structure			Significant difference between sales structures (chi-square test, 5% level)		
Classification	Conventional products, conventional retail stores (a)	Organic products, conventional retail stores (b)	Organic products, specialized organic channel (c)	(a) / (b)	(a) / (c)	(b) / (c)
V1	16.4%	28.3%	41.2%	yes	yes	yes
V2	2.4%	5.9%	3.3%	yes	yes	yes
V3	4.6%	4.6%	6.4%	no	yes	yes
V4	6.8%	10.3%	10.8%	yes	yes	yes
A1	18.1%	19.8%	6.8% + δ 6,3%	yes	yes	yes
A2	2.2%	3.8%	1.2%	yes	yes	yes
A3	18.0%	6.5%	8.0% + ε 6,3%	yes	yes	yes
A4	6.3%	3.9%	C = 1.0% + ζ 6.3%	yes	yes if ζ < 75% (i.e., C < 5.7%)	yes if ζ < 40% (i.e., C < 3,5%) or ζ > 54% (i.e., C > 4,4%)
M4	25.5%	17.2%	15%	yes	yes	yes
Total	100%	100%	100%			

Note: The presentation is similar to that in Table 4. In specialized organic stores, sales of unclassified meat are divided among classes A1, A3 and A4 in unknown proportions δ, ε and ζ = 1 - δ - ε.

Table 6 illustrates the specificity of organic sales in conventional retail stores in the case of eggs and milk (mainly category A1, except for a small proportion of flavored milk in category A4).[7] For these products, the differences between the proportions of conventional and organic sales in conventional retail stores and of organic sales in the specialized organic channel are even higher than for NOVA-PAC classes studied previously, with a share for

[7] We do not detail sales by product families as they are of a strategic nature for the specialized organic channel that provided us with data.

organic sales in conventional retail stores six times higher for eggs (7.7%) and nearly four times higher for milk (9.0%) compared to the two other types of sales.

Table 6: Share of eggs and milk in sales

	Conventional products, conventional retail stores	Organic products, conventional retail stores	Organic products, specialized organic stores
Eggs	1.1%	7.7%	1.2%
Milk	2.3%	9.0%	1.4%

3.2. Sales structure in conventional retail stores according to the typology of the buyers

We now examine to what extent the structure of product bundles purchased in conventional retail stores varies depending on the type of buyer in that retail channel and how it differs from the sales structure in specialized organic stores based on the PAC and NOVA classifications. We consider both conventional and organic purchases of each household type.

Table 7: Sales structure, PAC classification and typology of buyers in conventional retail stores

	Typology of buyers in conventional retail stores					Sales in specialized organic stores
	1	2	3	4	5	
Plant-based	27.6%	28.9%	30.3%	31.9%	34.4%	61.7%
Animal-based	44.8%	45.2%	44.9%	44%	42%	23.3%
Combined	27.6%	25.9%	24.9%	24.1%	23.6%	15.0%
Total	100%	100%	100%	100%	100%	100%

Note: The tests do not suggest a difference between two adjacent groups in the typology of buyers in conventional retail stores at the 5% significance threshold. For groups of the smallest and largest buyers of organic products (groups 1 and 5), we examined the differences in sales structures compared to other groups. The proportion of plant products for the buyers in group 1 is lower than that of the buyers of group 4 (at the significance level of 1%) and the buyers of group 5 (at the significance level of 0.1%). The proportion of products of mixed origin for this group is higher than those of groups 4 and 5 (at the significance level of 5%). For the buyers of group 5, the proportion of plant product purchases is higher not only than for the buyers of group 1 but also than for the buyers of group 2(at the significance level of 1%) and group 3 (at the significance level of 5%). For the groups 1 and 5, no other difference between the proportions of the other groups is significant.

For each of the PAC classes (Table 7), the difference between retail channels is more substantial than the difference within the conventional retail channel. Indeed, chi-square test results do not show a significant difference between the proportions of the two adjacent groups of the buyers' typology. Comparing the group of the smallest buyers and that of the largest buyers to all other groups, the most significant difference is the proportion of plant products between groups 1 and 5 (see note to Table 7 for details). The proportion of plant

product sales in each class of the typology of buyers in conventional retail stores is lower than in the organic specialized channel, including class 5 of the largest buyers of organic products in conventional retail stores that comes closest to it. The opposite result is observed for animal and combined products.

Table 8: Sales structure, NOVA classification and typology of buyers in conventional retail stores

NOVA classification	Typology of buyers in conventional retail stores					Sales in specialized organic stores
	1	2	3	4	5	
1	32.3%	33.9%	35.7%	36.7%	36.4%	48.0% + η 6.3%
2	4.2%	4.2%	4.3%	4.5%	5.1%	4.5%
3	22.1%	22.4%	22.2%	22.3%	22.9%	14.4% + θ 6.3%
4	41.5%	39.5%	37.9%	36.6%	35.6%	26.8% + ρ 6.3%
Total	100%	100%	100%	100%	100%	100%

Note: $\eta + \theta + \rho = 1$. For each NOVA class, chi-square tests do not suggest significant differences between the proportions of the two adjacent groups of the buyer typology at the 5% significance threshold. For the buyers of groups 1 and 5, we performed the same tests as in Table 7. The proportion of class 1 is lower for the buyers of group 1 than for the buyers of groups 3 and 5 (at the significance level of 5%) and lower than for the buyers of group 4 (at the significance level of 1%). The proportion of class 4 in buyer group 1 is higher than that of group 3 (at the significance level of 5%) and higher than those of groups 4 and 5 (at the significance level of 1%). One cannot reach conclusions regarding differences in the proportions of classes 2 and 3 for buyer group 1 compared with those of other buyer groups. For buyer group 5, apart from the differences with respect to group 1 cited above, it cannot be concluded that there are differences of proportions compared to the other buyer groups.

For each of the NOVA classes (Table 8), regardless of the group of buyers in conventional retail stores, the share of unprocessed or minimally processed products is lower than in the specialized organic channel, and the shares of processed and ultra-processed foods are higher. The difference between the two retail channels is substantial when meats that cannot be classified according to NOVA are distributed quite similarly to classified meats in the specialized organic network. Chi-square test results also do not reveal a difference in the proportions between the two adjacent groups of the buyer typology. Comparing the group of the smallest organic buyers and that of the largest organic buyers to all other groups, group 1 is distinguished from groups 3, 4 and 5 by a lower proportion of purchases of unprocessed or minimally processed products and a higher proportion of purchases of ultra-processed foods (see note to Table 8 for details). The comparison between product bundles of buyers in conventional retail stores and the sales structure in the specialized organic channel reveals a significant difference for each NOVA class, regardless of the distribution of unclassified meat.[8]

[8] Except under one of the following extreme assumptions: more than 95% of unclassified meat is in the NOVA third class, or more than 93% of unclassified meat is in the NOVA fourth class.

4. Discussion and conclusion

The main results of our study suggest that sales of organic food products are more sustainable than sales of conventional products because they are more plant-based and less processed and that organic sales in specialized organic stores are more sustainable than those in conventional retail stores according to the same criteria. By highlighting a differentiation of product ranges between organic retail channels, these results provide an original contribution to the analysis of the conventionalization of organic farming. The study provides a call to consider not only the aggregate share of organic products but also the weight of the various retail channels of organic products to characterize the consumption of organic products at the national level.

The differences in sales structures are particularly important in the case of the plant-based or animal-based nature of products. Regarding the extent to which the products are processed, the interpretation of results is based on assumptions concerning the classification of certain meat sold in the specialized organic channel; however, differences in sales structure remain significant under realistic assumptions regarding the classification of these meat sales. Given the importance of the differences in sales structures, which we observe as a percentage of the different amounts of sales, it seems reasonable to consider that they also reflect differences in structure in terms of quantities, not merely differences in relative prices between channels.

The drivers of these differences in sales structures, which extend beyond the scope of our study, may be related to the organization of the supply channels of the retail channels, the policy of these channels (in particular, the specialized organic channel considered in this study has a target of healthy and local supply and responsible consumption), the characteristics of buyers, or the product prices. It is not possible to determine whether the differences between conventional and organic sales reflect differences in consumption patterns, or whether customers buy elsewhere what they do not buy in a given channel. Our finding that the sales of organic products are more sustainable than those of conventional products is consistent with studies on the diets of consumers of organic or conventional products, based on data from the French Nutrinet-Santé survey, that show more sustainable eating behaviors among the regular consumers of organic products (Kesse-Guyot et al., 2013; Baudry et al., 2015). This finding tends to corroborate the notion that differences in sales structures between organic and conventional channels do reflect differences in consumption patterns. Moreover, these differences in sales structures imply that buyers are faced with a different food environment depending on the retail channel in which they make their purchases. As discussed in the literature on food environments inside stores, food availability, shelf organization, promotional activity and packaging can affect consumers' purchasing decisions in stores and their diets, and the presence of a healthy food choice may positively affect eating behaviors (Caldwell et al., 2008; Chapman et al., 2006). Thus, the healthier food environment in specialized organic stores noted in our results could help improve the food choices of customers in this channel.

Organic sales in conventional retail stores present specificities in relation to both conventional sales in conventional retail stores and organic sales in the specialized organic channel: more culinary plant-based and animal-based ingredients, more unprocessed or minimally processed animal products, and fewer processed animal products. This finding

suggests that the sales structure of organic products in conventional retail stores is very specific, as illustrated by the much larger shares of eggs and milk in these sales.

By differentiating different groups of buyers in conventional retail stores based on the share of organic products in their food purchases, the results show a (weak) trend towards more sustainable purchases for larger buyers of organic products. However, the difference between the purchase structure of the largest organic buyers in conventional retail stores and the average sales structure in the specialized organic channel is much more substantial. This result emphasizes the singularity of the specialized organic channel in terms of food sustainability.

Our results on the greater sustainability of the sales structure in specialized organic stores are consistent with the policy of French private organic standards (Nature et Progrès, Demeter, Bio Coherence, etc.); products are almost exclusively sold in specialized organic stores or directly to consumers, and out of conventional retail stores (Poméon et al., 2015). Compared with the European standard, their specifications impose additional sustainability requirements in terms of environmental impacts, farm autonomy and local origin of products.

The data used in this study do not allow a detailed comparison of the nutritional contents of the different product bundles. Indeed, the database of specialized organic stores does not provide exhaustive information on product weights. In addition, the existing database on the nutritional composition of foods in France (Anses, 2016), which contains data for 2,600 generic foods, would not allow the data to be matched very precisely, in particular for processed organic products, whose recipes are often different from the recipes from equivalent conventional products. It is therefore not possible to match these data with nutritional data giving the caloric and nutrient content of each product. Using this data, it is also not possible to compare product prices or costs per calorie in the different retail channels, or to investigate the extent to which the more planted-based and less processed product bundles in specialized organic stores offset the additional cost of organic food. The explicit consideration of this economic dimension would be interesting, because the higher cost of organic products is often put forward as a hindrance to their consumption. Moreover, neither database contains information on the provenance of products, another often debated dimension of organic farming sustainability (with organic product imports representing 25% of their value in France, according to Agence Bio, 2013).

An interesting way to extend this study would be to gather data on food ingredients to compare the composition of organic and conventional processed products and to study to what extent the compositions of organic products vary depending on the retail channel. Another interesting track would be to analyze the existence and importance of off-season sales for conventional versus organic fruits and vegetables, taking into account the retail channel.

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