

Characterization of the involvement of French farms in short food supply chains: contributions of the statistical analysis of the agricultural census data.

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Abstract: Relying on exhaustive data at the scale of French farms and quantitative tools rarely used in this type of analysis, we characterize involvement in SFSC (short food supply chain) in terms of share of sales, marketing methods and categories of products sold. Besides highlighting links between these dimensions, we document the increasing importance of SFSC for French farms and show a diversification trend in terms of marketing channels and category of products sold in SFSC. The results are confronted with existing French and international studies on the topic. The relevance of their further development or use for future research is also discussed.

Keywords: Short food supply chain, direct selling, farms, agricultural census

JEL Classification: Q13

1. Introduction

Most economic studies dealing with the involvement of farms in short food supply chains (SFSCs) are interested in the effect of this involvement on the economic performance of farms (turnover, etc.) and/or the determinants of this involvement. In these studies, the characterization of involvement in SFSCs is often reduced to the fact of selling or not in SFSC (Aubert and Enjolras, 2016 a, b and c; Aubert 2015; Pölling and Mergenthaler, 2017; Capt and Wavresky, 2014; Aguglia et al., 2009) or to engage in a particular marketing channel in a SFSC (farmers' market, CSA..., see for example Cox et al 2009, Hvitsand, 2016). However, some studies propose to characterize this involvement in more detail by distinguishing the types of SFSC marketing channels used by producers. This may involve distinguishing between direct

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sales on the farm and outside the farm (Corsi et al, 2018, 2009); the practice of selling directly or via an intermediary, sometimes specifying the type of intermediary (retailers, institutions...) (see e.g. Plakias et al 2020A , Low et Vogel, 2011 ; Martinez et al, 2010, Corsi et al, 2018). Some take into account the number of different SFSC marketing channels at farm level (Oematsu and Mishra, 2011). Finally, others consider the volume of sales made in SFSCs on a territorial scale (Timmons and Wang, 2010) or the share of the turnover made in SFSCs at farm level (Tudisca et al., 2015). Characterizations of SFSC involvement involving several of these dimensions and the possible links between them are rarer. When they do exist, they often concern a small number of farms, focusing on a territory and/or a type of production and often use factorial analyzes and/or typologies/classifications of producers (Eugenio et al. 2017, Lanciano et al. (2012), Bouroullec et al (2016), Ollagnon and Chiffolleau (2008), Pellequer and Chiffolleau (2009) or Capt et al, 2010). However, these typologies are built both on what can be considered as elements of characterization of the degree of involvement and on what can rather be considered as determinants (explanatory factors) of this involvement. To our knowledge, there is no work on the multidimensional characterization of involvement in SFSC involving a large number of individuals and even less on exhaustive data at the country level. However, such a characterization is rich in information. On the one hand, it provides an overview of the diversity of involvement in SFSC and highlights possible relationships between the different dimensions of this involvement (importance in turnover, type of sales channels, etc.). The results of such an analysis can be compared with the results of analyzes of targeted territories and sectors of agriculture or on a particular dimension of involvement SFSC. On some particular points, it can also be compared with some analyses in different countries. Finally, it allows for a discussion on the relevance of mobilizing a multidimensional characterization or the choice of the involvement indicator in the analysis of the determinants or effects of this involvement

Thus, based on exhaustive data on the scale of French farms, we attempt to characterize involvement in SFSC in terms of the share of sales made in SFSCs, the marketing methods used and the categories of products sold, as well as the links between these dimensions. To do this, we used frequency analyzes and measures of association, as well as the calculation of specificity and concentration/specialization indices, which are rarely used in this type of analysis. The results obtained are discussed in the light of the existing literature and then the relevance of their further development or their use for future research.

2. Material and methods

2.1.Data

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We work with data from the 2010 and 2020 French Agricultural Census (FAC). We focus here agricultural holdings located in metropolitan France. The definition of SFSC marketing channels (MC) that we use for this analysis is the one used in the FAC, namely: “A SFSC marketing channels *is a method of marketing agricultural products which is carried out either by direct sale from the producer to the consumer, or by indirect sale provided that there is only one intermediary between the farmer and the consumer*”

The following information is namely available:

- whether or not each farm is involved in selling through SFSC
- the percentage of the total sales realized in SFSC (in levels and for 2010 only);
- the categories of products that are sold in SFSCs by the farm and the percentage of the sales of this categories that is made through SFSCs (for a subset only in 2020)
- the marketing channels (MC) in SFSC used by the holding.

More details about these variables and the 2020's subset of specifically surveyed farms are given in appendix 1.

At the time we designed and perform this analysis, the 2020 Census wasn't released (and we had no idea about the release date nor about the common variables with 2010's census). The 2020 census was release to researcher late April 2022 (when all our analysis were done) and the central variable in our analysis (share of farm's sales in SFSCs) is not present in it and some other variables are in both census but presented in a different way. Therefore, it was not possible to “replicate” our analysis on 2020 data and we decided to only comment our analyses of 2010's data with some statistics from the 2020's census when relevant.

2.2.Methods

Unlike quantitative variables, categorical variables do not lend themselves to analysis using statistical parameters of position (mean, median) or dispersion (variance, etc.), nor to analysis of correlations. However, they are suitable for frequency analysis (flat sorting, cross-tabulation, etc.) and for measuring and testing associations between variables (Pearson's phi coefficient, kendall's tau...). We also analyze specificity indices (more commonly used in spatial analysis) and, if necessary, an indicator of concentration or specialization, the Isard index. Using the specificity and Isard indices, we can classify the terms of a categorical variable according to their degree of specialization/concentration in terms of the terms of another categorical variable. We pay a special attention to the relations with share of sales in SFSCs as a measure of the level of involvement of farms in SFSCs as well as relationships for which international comparison is possible (according to results found in the literature). More details are given about these methods in Appendix 2.

3. Results

3.1. Marketing channels (types) in SFSCs (2010 and 2020) and their combination.

In 2010, 13.75%¹ (i.e. 67,551 farms) of farms in metropolitan France sold in SFSC according to the 2010 FAC. These figures increased over the decades so that in 2020, we observe that 73809 farms sell through SFSCs in Metropolitan France which represent 18,94% of the 389779 farms². These farms can sell exclusively or not in SFSC (see section ...) so in the following when we say that farms sell through “X MC (only)”, we mean “X MC (only) in SFSC” whatever they also sell through long supply chain or not. In 2010, the majority of farms selling in SFSCs did so through one MC, a quarter via 2 MC and the rest via 3 MC or more. There is still more than 50% of farms using 1 MC only in 2020 but their share (and number) as well as the share (and number) of those using 2 MC decreased for the decade. Meanwhile, the share and number of those using 3 MC or more increased, showing a trend to short marketing channels diversification (Table 1).

| <i>Number of MC in SFSCs</i> | 2010 | 2020 |
|------------------------------|-------------|-------------|
| 1 | 57.44 | 51,12 |
| 2 | 26.18 | 20,01 |
| 3 or + | 16,38 | 28,87 |
| Total | 100 | 100 |

Table 1 Distribution of farms according number of MC in SFSC

In most works taking into account the MC in SFSCs, MC are grouped into broad categories (which we have called here "types"): direct-to-consumers sales, in which we can sometimes distinguish on-farm and off-farm sales, and intermediated sales. These types can be combined or not.

In 2010 and 2020, the MC (that is also a type of MC) that is used by the largest number of farms is on-farm sales. Then comes direct-to-consumers off-farm sales among which sales on market concern the largest number of farms. Last, come sales with an intermediary among which sales to retailers concern the largest number of farms. We however observe some changes over the decades, with a decrease of figures (share and number of farms) for on-farm sales but an increase for all other MC or types of MC. This is especially the case for internet sales and intermediated sales, the latter being namely due to the increase in the share of farms selling to commercial catering and large and medium-size store (Table 2).

¹ This figure is slightly lower than that the ones usually presented in works based on this agricultural census because we have not included the overseas departments.

²SFSC Sales of wine, table grapes, spirits made from wine are considered separately in 2010 census so if among 67,551 farm, some sell these products in SFSC, they also sell at least another category of products. In 2020, SFSC sales of wine, table grapes, spirits made from wine are not anymore considered separately but for comparability, we didn't count, in the 73809 farms mentioned here, farms that, in SFSC, only sell this category. Those figures are however expressed in percentage of the total number of farms of Metropolitan France (including those who only produce wine, table grapes, spirits made from wine).

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| MC or type of MC in SFSCs | 2010 | 2020 | %2020-%2010 |
|--|--------------|--------------|--------------|
| on farm (Far/ON) | 66,84 | 60,05 | -6,79 |
| Collective point of sale (CPS) | 9,91 | 16,92 | 7,01 |
| Markets (Mar) | 28,72 | 30,45 | 1,73 |
| on Tour/at home (TH) | 9,89 | 12,59 | 2,7 |
| Internet (net) | 1,97 | 14,88 | 12,91 |
| Community Supported Agri. (CSA) | 4,07 | 8,62 | 4,55 |
| Shows and fairs (SF) | 3,34 | 7,07 | 3,73 |
| at least one mode of off-farm direct sale (OFF) | 41,67 | 46,9 | 5,23 |
| Commercial catering (ComC) | 3,83 | 14,45 | 10,62 |
| Collective catering (ColC) | 1,31 | 6,35 | 5,04 |
| Retailers (except LMS) (Ret) | 22,31 | 29,81 | 7,5 |
| Large and medium-sized stores (LMS) | 6,76 | 15,11 | 8,35 |
| At least one indirect sales mode in SFSCs (IS): | 30,46 | 42,12 | 11,66 |

Table 2 : Distribution of farms selling in SFSC across marketing channels and types of marketing channels in percentage of farms selling in SFSC (n.b.: absolute variation in the number of farms varies in the same direction as the differences in percentages)

If we consider combination of types of MC, we observe that most farms use direct sales only both years but their share decreased from nearly 70% to barely 60% for the decade. To the contrary, shares of farm using only intermediated sales or combining direct and intermediated sales increased (Table 3).

| | 2010 | 2020 | % 2020 -%2010 |
|--|--------------|--------------|---------------|
| On Farm only (ON) | 32,72 | 23,97 | -8,75 |
| Off farm only (OFF) | 16,96 | 20,03 | 3,07 |
| On farm and off farm (ON+OFF) | 19,85 | 13,88 | -5,97 |
| Direct Selling Only (DSO) | 69,54 | 57,88 | -11,66 |
| Intermediated selling only (ISO) | 11,39 | 16,66 | 5,27 |
| On farm + Intemediated selling (ON+IS) | 8,22 | 12,48 | 4,26 |
| Off farm + Intemediated selling (OFF+IS) | 4,81 | 3,26 | -1,55 |
| On fram + Off farm + Intemediated selling (ON+OFF +IS) | 6,04 | 9,73 | 3,69 |
| Direct and Indirect Selling (DIS) | 19,07 | 25,46 | 6,39 |

Table 3 Distribution of farms according the combination of types of MC in SFSCS (in % of the number of farms selling in SFSC) (n.b.: absolute variation in the number of farms varies in the same direction as the differences in percentages)

Relative importance of MC in the share of sales (in 2010) as well as most frequent combinations of MC and Pearson's Phi coefficients of association between MC are presented in Appendix 4.

3.2. Marketing channels in SFSC and their relationships with the global share of sales in SFSCs (2010)

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The 2010 census does not allow knowing the proportion of farms selling exclusively in SFSCs but at least 60% combined sales in long and short supply chains with, among them, an half that made less than 10% of their sales in SFSCS. The other 40% made more than 75% of their sales in SFSC (see last row of Table 4). In 2020, the information about the total share of sales in SFSC is not available but on the subset of more completely surveyed farms we consider (see appendix 1), 6255 farms out the 15228 using SFSC (i.e. 41%) would sell exclusively thought SFSC.

In 2010, whatever the share of sales in SFSC, the most numerous farms are those having only one MC in SFSC (and whatever the number of MC the most numerous farms are those making more than 75% of their sales in SFSC except for farms having only one MC in SFSCs, see Appendix 4). Besides, the Kendall's tau c and specificity also show a positive association between the number of MC and share of sales in SFSCs (see Table 1 and appendix 4)

| share of sales in SFSC | | Frequencies (Column %) | | | | All farms selling in SFSCs |
|---|---------------|------------------------|---------|---------|----------|----------------------------|
| | |]0-10] |]10-50] |]50-75] |]75-100] | |
| <i>Number of MC in SFSCs</i> | 1 | 77.45 | 52.67 | 43.24 | 47.39 | 57.44 |
| | 2 | 17.18 | 29.43 | 31.54 | 30.35 | 26.18 |
| | 3 or + | 5.37 | 17.91 | 25.22 | 22.26 | 16.38 |
| Total | | 100 | 100 | 100 | 100 | 100 |
| <i>Farms making this share of sales in SFSC in % of farms selling in SFSC</i> | | 30,98% | 20,72% | 8,57% | 39,73% | |

Table 4 : Distribution of farms according their share of sales and number of MC in SFSC in 2010 (In % of the number of farm making this share of sales in SFSC, except for the last row). Rows percentages, person phi coefficients and specificity and Isard indexes are presented in appendix.

The share of farms selling on-farm is high whatever the share of sales in SFSC (from 61% of the farms making the higher shares of sales in SFSC to 75% of those making the lowest ones). The share of farms using intermediated sales is the lowest whatever the share of sales in SFSC (from 21% of the farms making less than 10% of their sales in SFSC to between 34 and 39% of the other the farms). Sales to retailers is the most used MC by farms using intermediated sales. There is a huge variation in the share of farms using off-farm direct sales according the share of sales in SFSC. Indeed, the share of farms using off-farm direct sales goes from 28% of farms making less than 10% of their sales in SFSC, to 61% of farms making more than 75% of their sales in SFSC. Among the MC belonging to this type, sales on markets is the most commonly used whatever the level of sales in SFSC and the share of farms using it increase with the share of sales in SFSC. Rows percentages and association measures (appendix 5) confirm the link between off-farm direct sales (especially in market and in CSA) and high share of sales in SFSC and the link between on- farm sales and low share of sales un SFSC.

| MC or MC types | share of sales in SFSC → |]0-10] |]10-50] |]50-75] |]75-100] | All farms selling in SFSCs |
|----------------|--------------------------|--------|--------------|--------------|-------------|----------------------------|
| | Far /ON | | 74.61 | 67.56 | 65.4 | 60.71 |
| CPS | | 5.63 | 10.07 | 12.96 | 12.49 | 9.91 |
| Mar | | 12.04 | 27.8 | 35.74 | 40.68 | 28.72 |

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| | | | | | |
|------------|--------------|--------------|--------------|--------------|--------------|
| TH | 9.29 | 12.29 | 10.85 | 8.91 | 9.89 |
| Mail | 0.91 | 2.19 | 2.82 | 2.52 | 1.97 |
| CSA | 1.27 | 2.93 | 4.91 | 6.67 | 4.07 |
| SF | 1.59 | 3.08 | 4.61 | 4.56 | 3.34 |
| OFF | 27,69 | 48,76 | 57,14 | 60,62 | 47,66 |
| ComC | 2.19 | 4.52 | 5.1 | 4.47 | 3.83 |
| RCol | 1.07 | 1.64 | 1.35 | 1.31 | 1.31 |
| Ret | 15.91 | 24.84 | 28.61 | 24.61 | 22.31 |
| LMS | 3.42 | 8.31 | 9.66 | 7.93 | 6.76 |
| IS | 20,94 | 34,55 | 39,44 | 33,82 | 30,46 |

Table 5 Distribution of farms according their share of sales and MC or MC type in SFSC in 2010 (in % of farms making this share of sales in SFSC) Sum of percentages over Types or over MC in a given column exceed 100% as a farms can use several MC or several types of MC in SFSC. Rows percentages, person phi coefficients and specificity and Isard indexes are presented in appendix.

Last, we observe that among farms making up to 50% of their sales in SFSC, the most used “combination” of types of MC is “on-farm only” (ONO). Among the other farms, it is the combination of “on- and off-farm direct” sales that is the most frequent (ON+OFF) (Table 6). Besides, using on-farm sales only to sell in SFSC is strongly associated with making a low share of sales in SFSC while using off-farm direct sales, especially in addition with another or the two other types of MC, is associated with high share of sales in SFSC (see appendix 6)

| | | [0-10] | [10-50] | [50-75] |]75-100] | All farms selling in SFSCs |
|-------------------------------------|-----------|--------|---------|---------|----------|----------------------------|
| share of sales in SFSC → | | | | | | |
| Columns: combination of types of MC | ONO | 55.1 | 28.19 | 19.76 | 20.44 | 32.72 |
| | OFFO | 12.47 | 15.25 | 15.74 | 21.62 | 16.96 |
| | ON+OFF | 11.5 | 22.01 | 25.06 | 24.12 | 19.85 |
| | ISO | 11.15 | 12.77 | 12.23 | 10.69 | 11.39 |
| | ON+IS | 6.07 | 10.28 | 10.87 | 8.26 | 8.22 |
| | OFF+IS | 1.78 | 4.42 | 6.63 | 6.98 | 4.81 |
| | ON+OFF+IS | 1.94 | 7.08 | 9.71 | 7.9 | 6.04 |
| | total | 100 | 100 | 100 | 100 | 100 |

Table 6 Distribution of farms according the share of sales and combination of MC types in SFSC in 2010 (in % of farms making this share of sales in SFSC). Rows percentages, person phi coefficients and specificity and Isard indexes are presented in appendix.

3.3. Categories of products sold in SFSCs and their relationship with the global share of sales in SFSCs (2010)

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In 2010 and 2020, a huge majority of the farms selling in SFSC sell only one category of products in SFSC (among the 7 presented in Table 8, i.e. not considering the category “wine, table grapes, spirits made from wine) but the share of farms selling more than one category of products slightly increase over the decade. The diversification in terms of category of products (inter-categories) seem to be less important than the diversification in terms of MC or MC types but we have no information about the change in number of products sold among a given category (intra-category diversification).

| | 2010 | 2020 |
|--------------|-------|-------|
| 1 category | 83,98 | 81,67 |
| 2 categories | 13,34 | 14,68 |
| 3 categories | 2,68 | 3,65 |

Table 7 Distribution of farms according the number of category of products they sell in SFSC in 2010 and 2020 (in % of the farms selling in SFSC)

In 2010, whatever the share of sales in SFSC, a very large majority of farms sells only one category of product in SFSC, this being all the more marked than the share of sales is low (Table 8). Thus, we observe a positive relationship (but relatively weak if we refer to the phi of association and Kendall's tau c) between the share of sales in SFSCs and the number of categories of products sold (**Erreur ! Source du renvoi introuvable.** 7).

| | Share of sales in SFSC in 2010 → | Frequencies (Column %) | | | |
|--|-------------------------------------|------------------------|---------|---------|----------|
| | |]0-10] |]10-50] |]50-75] |]75-100] |
| Number of product categories sold in SFSC | 1 | 91.97 | 82.16 | 77.42 | 80.11 |
| | 2 | 7.24 | 14.79 | 18.03 | 16.32 |
| | 3 ou + | 0.78 | 3.05 | 4.54 | 3.57 |
| | Total | 100 | 100 | 100 | 100 |

Table 8 Distribution of farms according the number of category of products and the share of sales in SFSC in 2010 (in % of farms making this share of sales in SFSC).

In both years, the category of products sold by the largest number of farms (more than third of farm selling in SFSC) is “other animal products” (other than dairy, eggs and poultry and honey i.e. mainly meat), followed by vegetables. The share of farms that sells dairy, eggs and poultry or honey decreased over the decades due to a decrease in the number of farms selling eggs and poultry or honey and to an increase in the number of farm selling “other animal products”, vegetable, fruits, or “others” (Table 9).

| Product categories↓ | 2010 | | 2020 | | Number in 2020 - Number in 2010 | | % in 2020 - %in 2010 |
|--------------------------|--------|----------------------------------|--------|---------------------------------------|--|-------|-------------------------|
| | number | In % of farms selling in SFSC | Number | % In % of farms selling in SFSC | | | |
| Dairy | 7719 | 11,43 | 7747 | 10,46 | 28 | -0,97 | |
| Eggs and poultry | 8060 | 11,93 | 7654 | 10,37 | -406 | -1,56 | |
| Other animal products | 22683 | 33,58 | 25600 | 34,68 | 2917 | 1,10 | |

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| | | | | | | |
|-------------------|-------|-------|-------|-------|------|-------|
| Vegetables | 14248 | 21,09 | 18552 | 25,14 | 4304 | 4,05 |
| Fruits | 8530 | 12,63 | 10279 | 13,93 | 1749 | 1,30 |
| Honey | 6164 | 9,12 | 5261 | 7,13 | -903 | -1,99 |
| Others | 13153 | 19,47 | 16434 | 22,27 | 3281 | 2,80 |

Table 9 Distribution of farms according the categorie of products sold in SFSC in 2010 and in 2020

In 2010, we observe that among farms making less than 75% of their sales in SFSC, the most frequently sold category is “other animal products”, this percentage decreasing as the share of sales in SFSC increases. Among farms making more that 75% of their sales in SFSCs, selling vegetables is slightly more frequent than selling “other animal products” (Table 10). . The percentage of farms selling vegetables increases when the share of sales in SFSC increase and, except for “other animal products”, this also the case for all other categories (see rows % in appendix 8). Selling “other animal product” is especially associated with low share of sales in SFSC while selling vegetables or honey is associated with high shares (see appendix 8)

| categories of product sold in SFSC↓ |]0-10] |]10-50] |]50-75] |]75-100] |
|--|---------------|----------------|----------------|-----------------|
| Dairy | 9.36 | 12.52 | 14.54 | 11.79 |
| Eggs and poultry | 10.08 | 14.56 | 14.72 | 11.4 |
| Other animal products | 41.86 | 37.37 | 32.89 | 25.29 |
| Vegetables | 13.32 | 19.16 | 22.89 | 27.77 |
| Fruits | 9.5 | 12.91 | 14.92 | 14.42 |
| Honey | 4.95 | 5.54 | 8.55 | 14.38 |
| Others | 19.8 | 19.36 | 19.62 | 19.24 |

Table 10 Distribution of farm according their share of sales and categories of products sold in SFSC in 2010: (in % of farms making this share of sales in SFSC). Sum of percentages in a column exceed 100% as a farm can sell several categories in SFSC.). Rows percentages, person phi coefficients and specificity and Isard indexes are presented in appendix

3.4. Categories of products sold in SFSCs and their relationship with the share of sales in SFSCs per category of products (2010 and 2020)

The share of sales of each category of products that is made in SFSC is available under a different form in the two censuses. In 2010, it is given in levels for all farms selling in SFSCs. In 2020, it is only available for a subset of 15528 farms selling in SFSC (more details about this subset in appendix 1) but in a continuous form.

As for global share of sales, and whatever the category, we observe a polarity in the distribution. Indeed, both years, farms making 10 to 50% or 50 to 75% of the category sales in SFSC are the less numerous. Moreover, whatever the category of product sold except “other animal products”, the most frequent case is to make more than 75% of this category’s sales in SFSFC. This is far more marked in 2020 than in 2010, suggesting in increasing importance of SFSC in the sales of farms. Along with what we observe previously when crossing the category sold in SFSC and the share of global sales made in SFSC in 2010 (section..), categories for

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which there are the largest shares of farms making more than 75 % of the category’s sales in SFSC are “honey” and “vegetables” both years (and “eggs and poultry”, “Olive Oil” and “Others” in 2020). Dairy is the category for which the increase in the share of farms making more than 75% of the category’s sales in SFSC is the lowest.

| Category of products↓ | Sales share of the category in SFSC in 2010 | | | | | Category of products↓ | Sales share of the category in SFSC in 2020 | | | | | Difference % 2020 - %2010 | | | | |
|------------------------------|---|---------|---------|----------|-------|-------------------------------|---|---------|---------|----------|-------|---------------------------|---------|---------|----------|-------|
| |]0-10] |]10-50] |]50-75] |]75-100] | Total | |]0-10] |]10-50] |]50-75] |]75-100] | Total |]0-10] |]10-50] |]50-75] |]75-100] | |
| Dairy | 25.92 | 20.86 | 10.64 | 42.58 | 100 | Dairy | 19.6 | 8.18 | 0.76 | 71.46 | 100 | -6.32 | -12.68 | -9.88 | 28.88 | |
| Eggs and poultry | 33.57 | 21.33 | 7.53 | 37.57 | 100 | Eggs and poultry | 8.81 | 4.18 | 0.38 | 86.64 | 100 | - | 24.76 | -17.15 | -7.15 | 49.07 |
| Other animal products | 37.12 | 22.76 | 7.3 | 32.83 | 100 | Other animal products | 23.00 | 9.69 | 0.68 | 66.63 | 100 | - | 14.12 | -13.07 | -6.62 | 33.8 |
| Vegetables | 19.93 | 20.41 | 9.2 | 50.46 | 100 | Vegetables | 10.55 | 5.44 | 0.52 | 83.49 | 100 | -9.38 | -14.97 | -8.68 | 33.03 | |
| Fruit | 29.26 | 24.71 | 8.97 | 37.06 | 100 | Fruit | 13.94 | 5.25 | 0.39 | 80.43 | 100 | - | 15.32 | -19.46 | -8.58 | 43.37 |
| Honey | 19.37 | 12.67 | 7.74 | 60.22 | 100 | Honey | 6.29 | s | s<3 | 93.71 | 100 | - | 13.08 | | | 33.49 |
| Others | 32.83 | 20.53 | 8.09 | 38.55 | 100 | Cereals and oleo-proteaginous | 30.88 | 13.19 | 0.5 | 55.43 | 100 | | | | | |
| | | | | | | Olive oil | 3.87 | s | s<3 | 96.13 | 100 | | | | | |
| | | | | | | Other | 5.99 | 4.21 | 0.26 | 89.53 | 100 | | | | | |

Table 11 Distribution of farms according the share of sales of a given category of products that is made in SFSC (in percentage of farms selling the category in SFSC) in 2010 (all farms selling in SFSC and in 2020 (subset of 15528 farms surveyed).

In the surveyed subset of 2020 census, more than 75% of farms selling categories “other product”, ”olive oil”, “eggs and poultry” or “honey” make 100% of their sales of those categories in SFSC (Table 12).. For the sales of dairy product, fruits, vegetables and other animal products it concerns at least 50% of farms selling those categories in SFSC. For cereals and oleoproteaginous products, it concerns at least 25% of farms selling this category in SFSC. The average share of sales in SFSC per categories is given by the 4th line of Table 12. We notice that it is the highest for categories ‘honey’, ‘olive oil’ and the lowest for ‘dairy product’ and ‘eggs and poultry’ but still quite high even for the latter categories. However we cannot know in 2020 if the sales of these categories represent a large share of the total sales of the farm (probably for specialized farms, we don’t know for more versatile ones).

| | Min | 1st Qu | Median | Mean | 3rd Qu. | Max. |
|-----------------------|------|--------|--------|-------|---------|--------|
| Dairy | 1.00 | 40.00 | 100.00 | 74.09 | 100.00 | 100.00 |
| Eggs and poultry | 1.00 | 100.00 | 100.00 | 84.11 | 100.00 | 100.00 |
| Other animal products | 1.00 | 23.00 | 100.00 | 68.05 | 100.00 | 100.00 |
| Vegetables | 1.00 | 95.00 | 100.00 | 83.55 | 100.00 | 100.00 |
| Fruits | 1.00 | 80.00 | 100.00 | 80.75 | 100.00 | 100.00 |
| Honey | 1.00 | 100.00 | 100.00 | 91.92 | 100.00 | 100.00 |

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| | | | | | | |
|----------------------------|------|--------|--------|-------|--------|--------|
| Cereals, oleo-proteaginous | 1.00 | 20.00 | 70.00 | 61.19 | 100.00 | 100.00 |
| Olive oil | 2.00 | 100.00 | 100.00 | 95.13 | 100.00 | 100.00 |
| Others | 1.00 | 100.00 | 100.00 | 90.75 | 100.00 | 100.00 |

Table 12 Descriptive statistics of the share of sales of the category that is made in SFSC for surveyed farms selling the category in SFSCs in 2020.

3.5. Categories of products sold in SFSCs and types of commercialization in SFSCs

As showed in Table 13, on-farm sales is the most frequent type of MC whatever the category sold, except, in 2010, among farms selling vegetable or fruits (for which the most common types is direct off-farm sales). The share of farms using intermediated sales in SFSC is always the lowest whatever the categories sold (26 to 42 % in 2010, 35 to 60 % in 2020). Largest increases (>10%) are observed for the use of intermediated selling (among farms selling honey, dairy, fruits, eggs and poultry, vegetables). The largest decreases are observed for the use off-farm direct sales among farms selling vegetables and the use of on-farm sales among farms selling honey.

Among farms selling on-farm, the most frequent are those selling “other animal products”. Among those using off-farm direct sales and intermediated sales, the most frequent are those selling vegetables or “other animal products”. Besides, we observe a noticeable increase of the share of farms selling “other animal products” among those using off-farm direct sales and of the share of farms selling vegetables among those using intermediated selling from 2010 and 2020. Further analyses (appendix 9) reveal weakest links between the fact of selling a given category and using a given Type of MC in 2020 than in 2010. This also concerns the positive link between the use of Off farm direct sales and the fact of selling vegetables and the negative link between the use Off farm direct sales and the fact of selling other animal products (that were among the strongest in 2010). The groups of farms using off farm direct sales is always the most specialized (and the groups of farming using Intermediated selling is the lowest) in terms of category sold (but all Isards coefficients are lower in 2020 than in 2010).

The groups of farms selling dairy or eggs and poultry are among the most specialized in terms of type of MC use in both year. The groups of farms selling vegetables was the most specialized in terms of type of MC in 2010 but is the most diversified in this respect in 2020.

| | 2010 | | | 2020 | | | Difference % 2020 - % 2010 | | |
|-----------------------|-------|-------|-------|-------|-------|-------|----------------------------|--------|-------|
| | ON | OFF | IS | ON | OFF | IS | ON | OFF | IS |
| Dairy | 72.94 | 59.23 | 42.40 | 75.92 | 53.94 | 60.37 | 2.98 | -5.29 | 17.97 |
| Eggs and poultry | 78.76 | 57.87 | 20.37 | 73.18 | 58.27 | 35.56 | -5.58 | 0.40 | 15.19 |
| Other animal products | 64.68 | 31.13 | 34.59 | 55.28 | 38.95 | 41.88 | -9.40 | 7.82 | 7.29 |
| Vegetables | 54.59 | 68.83 | 27.25 | 58.61 | 52.88 | 42.27 | 4.02 | -15.95 | 15.02 |

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| | | | | | | | | | |
|--------|-------|-------|-------|-------|-------|-------|--------|-------|-------|
| Fruits | 60.83 | 62.94 | 30.86 | 64.13 | 53.42 | 48.49 | 3.30 | -9.52 | 17.63 |
| Honey | 77.08 | 51.61 | 28.29 | 64.95 | 55.05 | 54.51 | -12.13 | 3.44 | 26.22 |
| Others | 76.77 | 48.41 | 25.96 | 66.97 | 49.61 | 35.92 | -9.80 | 1.19 | 9.96 |

Table 13 Distribution of farm according the category of products sold and the type of marketing channel in SFSC used in 2010 and 2020 (in % of the number of farms selling the category in SFSCs). Sum of percentages in a row for a given year exceed 100% as a farm can use several types of MC. Columns percentages, person phi coefficients and specificity and Isard indexes are presented in appendix 9 as well as equivalent with MCs instead of types of MCs (appendix 10)

In terms of combinations of types of MCs in SFSCs (Table 13), using on farm only and off farm alone is the most frequent chosen “combination” in 2010, concerning more that 20% of farms whatever the category of product considered. The only exception is for farms selling other animal products (ISO is the second most frequent) and for farms selling vegetables (OFFO is the most frequent followed by ON+OFF). Many changes can be observe in the distribution of farms according to category sold and combination of types of MC from 2010 to 2020. The decrease in the use of combination ONO and ON+OFF and OFF+IS concern almost all groups of farms, the increase in the use of combination ISO, ON+IS and ON+OFF +IS concern all groups of farms. The use of OFF increase for some category decreases for others. Given the number of modality of the 2 variables, we cross here it is hard to synthetize the analysis of specificity specialization and association measures but generally goes along observation made for the association between the use of a type of MC and the fact of selling given category (Details can be found in appendix 11)

| | | ONO | OFFO | ON+OFF | ISO | ON+IS | OFF+IS | ON+OFF+IS | |
|------------|-----------------------|---------------|-------|--------------|-------------|-------------|--------|-------------|--------|
| 2010 | Dairy | 20.51 | 12.80 | 24.29 | 6.62 | 13.64 | 7.64 | 14.50 | 100.00 |
| | Eggs and poultry | 32.41 | 13.86 | 33.36 | 3.66 | 6.07 | 3.72 | 6.92 | 100.00 |
| | Other animal products | 40.68 | 11.25 | 13.48 | 21.03 | 7.16 | 3.04 | 3.35 | 100.00 |
| | Vegetables | 17.61 | 31.16 | 23.98 | 6.81 | 6.74 | 7.43 | 6.25 | 100.00 |
| | Fruits | 20.67 | 24.92 | 23.55 | 7.67 | 8.72 | 6.58 | 7.89 | 100.00 |
| | Honey | 35.03 | 13.43 | 23.25 | 3.15 | 10.22 | 6.34 | 8.58 | 100.00 |
| | Others | 36.91 | 13.75 | 23.39 | 5.32 | 9.35 | 4.17 | 7.12 | 100.00 |
| 2020 | Dairy | 13.58 | 10.31 | 15.74 | 9.00 | 23.49 | 4.78 | 23.11 | 100.00 |
| | Eggs and poultry | 23.32 | 17.45 | 23.66 | 5.71 | 12.70 | 3.66 | 13.50 | 100.00 |
| | Other animal products | 28.12 | 19.12 | 10.88 | 23.56 | 9.37 | 2.04 | 6.90 | 100.00 |
| | Vegetables | 17.70 | 23.79 | 16.24 | 13.97 | 15.45 | 3.63 | 9.22 | 100.00 |
| | Fruits | 16.33 | 19.05 | 16.13 | 12.59 | 17.66 | 4.23 | 14.01 | 100.00 |
| | Honey | 15.62 | 15.55 | 14.31 | 12.47 | 16.86 | 7.03 | 18.15 | 100.00 |
| | Others | 28.80 | 18.96 | 16.31 | 10.65 | 10.94 | 3.42 | 10.90 | 100.00 |
| %2020-2010 | Dairy | -6.93 | -2.49 | -8.55 | <u>2.38</u> | 9.84 | -2.87 | <u>8.61</u> | |
| | Eggs and poultry | -9.09 | 3.60 | -9.70 | <u>2.05</u> | <u>6.63</u> | -0.06 | <u>6.57</u> | |
| | Other animal products | -12.56 | 7.87 | -2.60 | <u>2.53</u> | <u>2.21</u> | -1.00 | <u>3.55</u> | |

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| | | | | | | | |
|------------|----------------------|--------------|--------------|-------------|-------------|--------------|-------------|
| Vegetables | <i>0.09</i> | <i>-7.37</i> | <i>-7.75</i> | <u>7.16</u> | <u>8.70</u> | <i>-3.80</i> | <u>2.97</u> |
| Fruits | <i>-4.33</i> | <i>-5.88</i> | <i>-7.42</i> | <u>4.92</u> | <u>8.94</u> | <i>-2.34</i> | <u>6.12</u> |
| Honey | <i>-19.40</i> | <i>2.12</i> | <i>-8.94</i> | <u>9.32</u> | <u>6.64</u> | <i>0.69</i> | <u>9.57</u> |
| Others | <i>-8.11</i> | <i>5.22</i> | <i>-7.07</i> | <u>5.33</u> | <u>1.59</u> | <i>-0.74</i> | <u>3.79</u> |

Table 14 Distribution of farms according the category of product sold and the combination of type of MC in SFSC in 2010 and 2020 (in % of the number of farms selling the category in SFCS). . Columns percentages, person phi coefficients and specificity and Isard indexes are presented in appendix.

4. Conclusion, methodological discussion and perspectives

4.1. Summary of main results

We observed an increase in the number and share of farms selling in SFSC and of the share of sale of each category of product that is made in SFSC from 2010 to 2020. This trend goes along a diversification of in term marketing channels and marketing’s type. The diversification in terms of category of product seem to be less important that the diversification in terms of MC or MC types but we have no information about the change in number of products sold among a given category (intra-category diversification). These phenomemons are accompanied with a decrease in the number and share of farms using on-farm direct-to-consumers sales (alone or with other MC) and increase in the number and share of farm using others MC an MC TYPES. Moreover, the link between types of MC and category of product sold over time became weaker. Concerning share of total farm sales that is made in SFSC in 2010, we observe a polarisation with about 30% of that made 10% max of their sales in SFSC and about 40% that made more than 75% of their sales in SFSC. We also observe such a polarization for shares of sales per category of products in 2010 and 2020. In 2010, we observe a positive relationships between the use of off-farm-direct-to consumers sales (especially when combined with the use one or two types of MC) and high share of total farm sales in SFSC and a positive link between the use of on-farm-direct-to-consumers sales and low share of total farm sales in SFSC. We also observe apposite relationships between the share of total farm sales and the number of MC in SFSC.

Last, some category of product are more associated with highest share of sales (total in 2010 or for both years per category) in SFSC such vegetable and honey.

These statistics should be however considered with caution for two main reasons. On the one hand, it was the first time in 2010 that farmers were questioned about their sales in short food supply chain and some fields experts acknowledge some inaccuracy of the data. On the other hand, if farms and surveyors were certainly more familiar with SFSCs ten years latter, the census refers to the farm situation in 2020, a very specific years during witch a lot of consumers

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wanted to buy in SFSCs both because they wanted to avoid crowded supermarkets and because they have more time to cook gross products. (ref.) However, it is possible some farmers that began to sell or made high share of sales in 2020, stopped selling or sell less in SFSC afterward.

The share of farms involved in SFSC (14% in 2010, 19% in 2020) in France contrast markedly with those obtained from the data of the American Agricultural censuses according to which sales in short circuits only concerned 6.2% percent of farms in 2017 and 7.8% in 2012.. According to the 2008 AMRS survey, the average number of marketing methods per farm selling in a short circuit was 1.5 (Low and Vogel, 2011). Based on a sample from the same survey, Uematsu and Mishra (2011) observed that 58% of farms selling in SFSCs do so through a single mode, 23% via 2 modes and 13% via 3 modes, which is quite close to what can be observed in France in 2010-

Concerning marketing channels, our observations are in line with Low and Vogel (2011)'s ones as they observed that in the United States the sale at the farm and the sale on the markets as the most frequent modes of marketing in SFSC.

According to the 2007 American agricultural census, 70% of farms selling in SFSCs, used only direct selling for their sales in SFSCs, the others using either indirect sale only (16%), or both (14%) (Low and al. 2015), i.e. proportions similar to those observed in France in 2010. Based on a 2015 national survey of farms selling in SFSCs (Local Food Marketing Practices Survey - "LMRS 2015" in the following), Plakias et al. (2020) observed that direct sales to consumers concerned 69% of farms, which is less than in the French Censuses (88,61% in 2010, 83,34% in 2020) and in the ARMS 2008 (according to which these proportions amounted to around 90%). Direct sales to retailers, supermarkets and restaurants (=considered as "retailers" in ARMS 2008) and "(regional) food-hubs³" (= "intermediaries") concerned 36% of farms, and direct sales to institutions (schools, hospitals, prisons) concerned 14% of farms. Indirect sale in SFSCs therefore concerned a higher proportion of holdings selling trough SFSCs than in France. However, these comparisons should be considered with caution, as which is considered as indirect sale in SFSCs according to the FAC and as "intermediate local food sale " according to the aforementioned American surveys can be significantly different (these differences being probably more marked than for the notion of direct sales to the consumer). Finally, according to the Piedmontese agricultural census (Italy) of 2010 (Corsi et al., 2018) , on-farm selling was practiced by 14.0% of the 58,304 farms analyzed and off-farm (direct??) selling by 8.1 % . 3,5% practiced both direct and off-farm sales.

According to the ARMS survey (Agricultural Resource Management Survey) of 2008, "local food sales ⁴" represented at least 75% of sales volumes (" total gross farm sales") for almost

³ Regional *food hubs* are companies that bring together locally sourced food to meet wholesale, retail, institutional and even individual demand, cf. Low et al, 2015)

⁴ In US censuses and surveys mentioned here, "local food farms" refer to farms earning revenue from the sale of food for human consumption through any local food marketing channel, classified into 2 types: direct marketing to consumer (roadside stalls, farmers markets, picking, farm shops and community supported agriculture...) and intermediate marketing channels which generally include all marketing opportunities in the local supply chain that are not transactions between farmers and consumers, including farmers selling to grocers, restaurants, regional food hubs, school catering, universities, hospitals and other institutions. This definition of intermediary marketing channels is very broad and data on them has only recently begun to be collected (Low et al. 2015).

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2/3 of farms involved in short circuits and less than 25% of sales volume for 22 % of farms (Low and Vogel 2011)

The comparison with the work carried out using American data (in particular Uematsu and Mishra (2011) and Park et al, 2014) on the impact of the number of MC on farm gross cash income is not directly possible here since the 2010 FAC provides information on the share of the sales made in SFCS but not on the value of those sales. In this perspective, the standard gross product could be used as a proxy for the total sales. On the other hand, the positive relationship between share of sales and the number of MCs in SFSCs corroborates the intuition that leads Uematsu and MiShra (2011) to use the number of MCs as an instrument to estimate the impact of intensity of adoption of SFSCs on farm income

The differences with the French observations can come both from the context (country, cultures, habits and different productions), from the data (exhaustive census VS survey) and from the definition of the object of study (meaning of SFSCs and “local food sales”, inclusion of viticulture in the United States)

4.2. Methodological discussion and perspectives

The in-depth analysis of variables likely to characterize the involvement of farms in the short circuit also made it possible to highlight the advantages and limits of the various tools used. Thus, such an approach could not have been conceived without the analysis of the frequencies of various modalities and the intersections of modalities. However, since the notion of association between variables cannot be limited to frequency analysis, indicators such as Pearson's Phi coefficient of association between modalities and indices of specificity and concentration/specialization of Isard have been used. Specificity indices have both the advantage and in a way the limit of overcoming the “size effect”. They effectively make it possible to identify concentrations/specializations (or, on the contrary, their absence) which could not have been identified by frequency analysis alone. On the other hand, the risk is to focus on concentrations/specializations, which if they exist and are strong, sometimes concern a very limited number of observations. Pearson 's Phi coefficient (or, if applicable, Kendall's tau c) by its calculation, and according to the results obtained, finally seems to be an “intermediate” between the frequencies and the specificity indices. It thus highlights associations between modalities, and not simply frequencies of co-occurrence, but the intensity of the associations is not totally independent of these frequencies.

The use of the Isard index associated with specificity indices makes it possible to establish classifications in terms of degree of specialization or concentration, an equivalent approach not being permitted by an existing indicator, to our knowledge, based on the Phi coefficients. However, unlike the specificity and Isard indices, the use of the phi coefficient makes it possible to know the significance of the association measure, which is necessary, like the frequency of co-occurrence, for a relevant analysis of the observed relationships.

Finally, if these analyzes are complementary, they are relatively time-consuming, and a choice (towards Pearson's Phi or for ordinal variables of Kendall's tau c) has to be made if we want to

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extend it to a large number of variables, for example from the perspective of the analysis of probable determinants of involvement in short circuits.

From this last point of view (or from the perspective of analyzing the impact of involvement in the circuit on the activity of exploitation), the question also arises of the characterization of this involvement. Indeed, econometric approaches in particular leave few possibilities for a fine characterization of this, in particular when this implication is the phenomenon to be explained and must be reduced to one or to a limited number of endogenous variables.

We can for instance consider modeling from the CA carried out in SFSCs and the choice of combinations of types (rather than modes, so as not to have an endogenous variable with too many modalities) through a logit a simultaneous equations (following the example of calavrezo and Rémy, 2017 or Gaudry and vernier 1999) or a logit with selection equation (following the example of Park 2014). The results of the statistical analysis combined with knowledge from the literature review will be particularly useful in guiding the choice of explanatory variables. Last, the link between share of SFSC's sale among total sales and share of SFSC sales among a product category should sales should be further explored if we want to conduct the analyse on 2020's data.

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