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Do short food supply chains go hand in hand with environment-friendly practices?

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Abstract.

This article deals with the presumed relationship between environment-friendly practices, such as organic farming, and the adoption of short food supply chains (SFSC) at farm level because they meet the consumers' expectations in terms of quality and proximity. Calling on the literature, we formulate hypotheses about the close link between the environmental quality of production and vertical integration. They are tested using an econometric model with simultaneous equations considering the 2010 census of French farms which provides a full overview of strategies implemented by producers. We focus the analysis on wine-growing and arboriculture which correspond to farms most concerned by organic farming. The results show that when a farmer practices organic farming, the farm becomes integrated and conversely when a farm is integrated, the farmer is likely to adopt organic farming. This complementarity of producers' choices offers certain perspectives for the improvement of SFSC while considering environment-friendly practices.

Keywords: Organic farming, Short food supply chains, FADN, France
JEL codes: Q12, Q13, Q15

1. Introduction

The quality of agricultural production is a key concern for both producers and consumers. Since the early 1980s, an environmental awareness has emerged in response to intensive farming practices, such as the use of chemical inputs (Heckman, 2006). This renewed interest is characterized by the emergence and development of alternative food networks (AFNs). AFNs differ from traditional production and distribution channels while claiming to meet both producers' and consumers' requirements (Venn *et al.*, 2006). Their development has been encouraged at the European level through the second pillar of the Common Agricultural Policy (Goodman *et al.*, 2012) and at national level in France by the Ministry of Agriculture as part of the agricultural modernization policy.

There is a broad range of AFNs encompassing both organic farming (OF) and short food supply chains (Venn *et al.*, 2006). Each of these forms of AFN aims at providing responses to limitations encountered within the conventional food sector. For instance, organic farming offers a means of restoring consumer confidence that was shaken by food scandals, leading to the development of new quality standards by both the public authorities and the private sector (Giraud-Héraud *et al.*, 2006). These standards ensure consumers that production complies with environment constraints (Tuomisto *et al.*, 2012).

At the same time, the development of short food supply chains (SFSCs) has been encouraged because they are characterized by a relation of proximity, with no more than one intermediary involved in the exchange between the producer and the consumer (Renting *et al.*, 2003). Moreover, such distribution channels go hand in hand with rural development (Kneafsey *et al.*, 2013). SFSCs characterize the active involvement of farmers in the food market beyond production. In economic terms, thanks to the absence of intermediaries, producers capture more of the added value generated by their production (Broderick *et al.*, 2011; Aubert and Enjolras, 2013) while consumers benefit from lower prices compared to purchases made through a long supply chain. Beyond the economic gains provided by SFSCs, consumers expect a higher level of quality in this kind of production. The current trend translates into greater value placed on production sold directly to the consumer who is expecting a higher-level quality and greater proximity in return.

The evolution of both quality requirements and marketing channels does not seem to be unrelated (Ilbery *et al.*, 2005; Kottila and Rönni, 2008). However, these two topics have mainly been studied separately in the literature: SFSCs are examined using the Transaction Cost theory (Grote and Grote, 2009; Burton *et al.*, 2003; McNamara *et al.*, 1991) while commitment to environmental quality (organic farming) is considered through the Resource-Based View theory (Sylvander and Schieb-Bienfait, 2006; Moustier and Thi Tan Loc, 2013). Few studies consider both the link between SFSCs and environment-friendly practices, instead focussing primarily on regional case studies in Austria (Penker, 2006), England (Ilbery and Maye, 2005) and France (Maréchal and Spanu, 2010). Even if Maréchal and Spanu (2010) mention a possible bilateral causality, all these studies consider only the unilateral causality which considers that SFSCs lead to more ecological practices.

Consequently, this study seeks to appreciate the joint determinants of these strategies, which concern both producers and consumers. More precisely, our goal is to measure the effective simultaneity of these two choices that can explain the recent evolutions in favour of SFSCs and OF. The in-depth analysis relies on the latest French agricultural census conducted in 2010, which provides an exhaustive view of French agriculture with all farms being surveyed. Within this census, we focus on farms specializing in permanent crops since these farms are most prominently involved in short food supply chains (Kneafsey *et al.*, 2013). More precisely, we differentiate wine-growing from arboriculture because of their specificities: wine-growing is a perennial production while this is not the case for arboriculture.

Our article is structured as follows. In the first section, we develop the theoretical framework of our analysis while in the second section we present the analytical framework. In the third section, we present a descriptive analysis and the results of the econometric model before concluding.

2. Theoretical and analytical framework

Our analysis relies on the principle that producers make simultaneous choices in terms of vertical integration (adoption of SFSCs) and the implementation of environment-friendly production practices (adoption of OF). Because few studies have been conducted on this subject, it appears necessary to consider the factors identified in the literature which can influence, either separately or together, the adoption of vertical integration and production practices.

In order to overcome this limitation and mirroring the existing literature, we assume that production practices are more dependent on farm and farmers' characteristics while vertical integration depends more on transaction characteristics and the need to reduce uncertainty. We therefore explain the quality implemented by farmers using the Resource-Based View theory while calling on the Transaction Cost theory to understand vertical integration.

2.1. Determinants of environment-friendly practices

The adoption of environment-friendly agricultural practices has been widely studied in the literature using the Resource-Based View (Penrose, 1959). The most relevant determinants of the decision to adopt this type of practice are therefore clearly identified even if their impact on adoption may vary from one study to another.

Irrespective of the context or production considered, the literature unanimously highlights the importance of taking available resources into account. All studies converge towards a positive impact between the size of the farm and the implementation of environment-friendly practices (Dörr and Grote, 2009; Burton *et al.*, 2003; McNamara et *al.*, 1991; Aubert *et al.*, 2013; Aubert and Enjolras, 2013).

Independent of the physical size of the farm, the relative importance of workers in the adoption of environmental-friendly practices is widely highlighted (Galt, 2008; Aubert and Enjolras, 2013). Workers can come from the farmer's family or be external employees. All workers have to be considered because the weight of family workers is relatively more important on small farms.

Another element that is supposed to influence practices implemented by producers is the degree of specialization of the farm. The degree of specialization is measured by the share of the revenue that depends on the main crop. The more a farm is specialized, the more it is likely to implement practices that are environment-friendly (Dörr and Grote, 2009; Aubert *et al.*, 2013).

H_1: The more resources available, the more the farm is likely to implement environment-friendly practices

Beyond available resources, the Resources-Based View theory highlights the importance of skills. With regard to the farmer's characteristics, almost all studies dealing with SFSCs highlight the importance of the farmer's level of education and his age. The level of education can be considered in two ways, the first being the general level of education and the second being the agricultural level of education. The general result is that more educated farmers are more likely to implement such practices (McNamara *et al.*, 1991; Fernandez-Cornejo and Ferraioli, 1999; Dörr and Grote, 2009; Aubert *et al.*, 2013; Aubert and Enjolras, 2013). Additionally, it appears that more experienced farmers, *i.e.* older ones, are less likely to adopt environment-friendly practices (Fernandez-Cornejo, 1996, Dörr and Grote, 2009; Aubert *et al.*, 2013).

H_2: The more skills available, the more the farm is likely to implement environment-friendly practices

Moreover, we consider the eventuality that the farmer has another activity and thus another source of income. In that case, farmers may be less likely to implement environment-friendly practices due to a lack of available time (McNamara *et al.*, 1991; Fernandez *et al.*, 1994; Fernandez-Cornejo, 1996; Aubert and Enjolras, 2013; Aubert *et al.*, 2013). Indeed, such practices translate into more time spent on farms to observe the production.

In addition to the resources and skills available on farms, the commercial strategy is highlighted as having an impact on the implementation of environmental-friendly practices (Venn *et al.*, 2006). Selling through SFSCs helps reduce quality uncertainty. Environmental attributes are difficult to measure for consumers, thus making them non-observable. Hence, this commercial strategy limits product quality uncertainty (Prigent-Simonin and Hérault-Fournier, 2005; Moustier and Thi Tan Loc, 20013) and reduces the need to indicate product quality using labels.

H_3: Farms selling through short supply chains are less likely to implement environment-friendly practices

2.2. Determinants of vertical integration

Vertical integration involves integrating different stages of a single process. These stages can be either productive or commercial. The Transaction Costs theory (TCT) underlines the fact that vertical integration depends on frequency, uncertainty and specificity of assets (Williamson, 1987). Because our study is conducted at farm level and the TCT is by nature available at transaction level, we adopt the hypothesis that uncertainty and specificity of assets are the same for all transactions at farm level, since frequency cannot be defined at farm level.

The aim of this analysis is to understand why farmers choose to sell their production themselves instead of selling it through intermediaries. This vertical integrated strategy means that the farmer is willing to perform an additional commercial activity which is very different from production. The farmer is then responsible for all stages of the supply chain from production to selling, which means that only large farms are able to become integrated (Moustier and Thi Tan Loc, 2013).

H_4: The size of the farm is positively linked to the degree of integration

We assume that the degree of uncertainty has a positive impact on the strategy of selling directly to the consumer. The more a farm faces uncertainty, the less its income is subject to uncertainty and the greater its degree of vertical integration. To assess uncertainty, we assume that this parameter is constant within a given farm and reflects only the uncertain environment of the farm. Because this uncertainty is difficult to measure, several indicators capable of reducing it can be considered.

The first indicator is the degree of specialization. More precisely, we can differentiate intra- and inter-diversification. For instance, a farm may specialize in wine-growing and, within this specialization, cultivate different types of grape, a practice referred to as intra-diversification. The same farm could also cultivate additional crops such as fruits, which is called inter-diversification. Computing inter-diversification relies on the indicator defined by Aubert (2013), which is a counter of all types of productions based on the specialization items. A specialized farm is generally exposed to higher crop income volatility (Purdy *et al.*, 1997;

Enjolras *et al.*, 2014). Because of the increase in volatility, the uncertainty faced by the farmer is higher and is reflected in a higher degree of integration.

Conversely, subscribing to multi-peril crop insurance or contributing to a mutual fund reduces the uncertainty associated with crop yields (Enjolras and Sentis, 2011). Their adoption may reduce the financial uncertainty of the farm and lead to less vertical integration.

H_5: The more the farm faces uncertainty, the more it is likely to be vertically integrated

Echoing, Moustier and Thi Tan Loc (2013), we consider the specificity of assets through the implementation of environment-friendly practices, e.g. the adoption of the "organic farming" label. Labelled farms should respect precise specifications aimed at reducing asymmetric information effects regarding product quality (Akerlof, 1970). Producers involved in SFSCs are "building trust" when they adopt labels (Vincq *et al.*, 2010). This point explains why integrated farms are more often boast the "organic farming" label than others (Aubert, 2013; Redlingshofer, 2008).

H_6: The more assets are specific, the more the farm is integrated

These research hypotheses are tested within the empirical framework presented hereafter.

3. Empirical framework

3.1. Dataset

To take the individual and structural characteristics of the farms and the strategies adopted by farmers into account simultaneously, we use data from the exhaustive census of French farms (tables 1a and 1b). By doing so, we can evaluate the determinants of both the implementation of organic farming and the adoption of an integrated marketing channel.

The survey was conducted in 2010 and includes 514,186 farms encompassing all agricultural sectors, sizes and specializations[1], regardless of their production, location and legal status. The richness of this database allows us to assess the strategies adopted by producers correctly.

Our study focuses on farms specializing in wine-growing and arboriculture because they are relatively more likely to sell their produce directly to consumers (Aubert, 2013). The database accounts for 60,174 and 11,714 farms respectively.

Table 1a. List of main variables – Determinants of environment-friendly practices

Table 1b. List of main variables – Determinants of vertical integration

Because our study focuses both on environmental quality and the distribution channels adopted by producers, we present a definition of these concepts below.

3.2. Environment-friendly practices

In this paper we focus specifically on environmental quality, which can be measured both through the quality declared to consumers and through the quality implemented in practice by producers. One contribution of our study is to put these two measures into perspective in order to validate their consistency. Barzel (1982) highlights the fact that the difficulty farmers face when communicating about quality leads to increased integration. The use of labels provides an answer to this concern (Darby and Karni, 1973). Some of them are reliable as they are validated by a third party while others are commercial and provide a relatively stable quality (Gonzalez *et al.*, 2007). These two kinds of label refer to different ways of signalling and enforcing quality. Since our database lets us assess both of them, comparing their consistency is a way to confirm that the quality declared to consumers corresponds to the quality implemented by producers.

One of the most acknowledged quality signs is "organic farming" (OF) which is assumed to be associated with environment-friendly practices. The data at our disposal identify farmers who have adopted the OF label, considering both farmers who are currently committed to OF and farmers who plan to adopt it within 5 years. We aggregate these two configurations

[1] Farms specialize in a produce when 2/3 of their standard gross output is derived from this production.

because we assume that the adoption of such a label is based on stable characteristics over a long period.

The salient question is to verify in practice whether OF is effectively associated with effective protection of the environment. Several indicators can be used to ensure farms comply with quality standards. Both Galt (2008) and Aubert and Enjolras (2013) underlined the importance of using a recent sprayer to reduce the quantity of chemical inputs used. Furthermore, Fernandez-Cornejo (1996) and Galt (2008) insisted on the importance of performing an internal control of treatments applied to plots. Following this rationale, we first take account of the age of the sprayer and whether or not it is controlled. We then differentiate farms depending on whether they perform an internal control or if they delegate this control to a third party. We also consider the share of farmed area which is not treated using phytosanitary products.

We can therefore examine the relationship between declared and effective quality by comparing the OF label to the efforts effectively made by producers to implement environmentally-sound practices. For each economic and technical orientation (ETO), we computed Chi2 and correlation tests according to the nature of the variable considered. The results globally confirm that OF is more likely to be associated with environment-friendly practices (Table 2).

Table 2. Correspondence between quality declared to consumers and quality implemented in practice by producers

Organic farmers use more recent sprayers, which are on average 8.6 years old while sprayers used by other farmers are on average 10 years old. Moreover, organic farmers do not to perform phytosanitary treatments on 16.59% of their cultivated area while this percentage represents less than 11.13% for other farmers. The link identified between observed quality and implemented quality is also confirmed with regard to sprayer controls as they are performed by 33.26% of organic farmers and 28.95% of other farmers. Among these, we observe that 91.64% and 80.28% of organic farmers and other farmers respectively call on external control.

All these elements highlight the fact that quality declared to consumers goes hand in hand with practices effectively implemented by producers. Consequently, OF appears to be a good indicator of quality declared to consumers.

3.3. Vertical integration

Vertical integration cannot be simply defined as it refers to a multitude of cases. Thanks the database, we are able to assess the three degrees of integration that are usually considered: the integrated, hybrid and non-integrated forms (Williamson, 1987).

By definition, farms that are not vertically integrated do not perform any integrated transaction. These producers, who have no contact with their consumers, can therefore be easily identified in the database. Indeed, these farms declare that their turnover does not depend on SFSCs.

Once non-integrated farms are identified, differentiating integrated farms means the distribution channel must be considered. Echoing Moustier (2013), short supply chains can be a means of detecting integration. We adopt the hypothesis that selling all or part of production through SFSCs differentiates non-integrated farms from other farms. More precisely, we consider both direct and indirect selling to be short channels[2]. In this context, distinguishing hybrid and integrated forms requires the economic impact of short channels on farm income to be considered. Farms will be qualified as integrated if they sell a part of their production corresponding at least to 50% of their turnover through short channels. In that case, we assume that almost all transactions are conducted in short channels between the producer and the consumer. Hybrid forms then correspond to farms that sell part of their production via short channels but whose turnover does not depend primarily on this activity.

3.4. The model: simultaneous equations

Our study focuses both on environment-friendly practices and vertical integration of the supply chain. Because these two behaviours are long-term management strategies within alternative food networks, they are assumed to be chosen simultaneously. Therefore, farmers

[2] The French Ministry of Agriculture defines indirect selling as a situation in which there is no more than one intermediary between the producer and the consumer.

who adopt the OF label are more likely to sell their production through a short circuit and conversely, farmers who sell their production through this channel are more likely to adopt such a label. This means that the way farmers implement quality has an impact on the integration of the supply chain and vice versa.

This model can be estimated thanks to the size of our sample. We can then go beyond existing studies (Penker, 2006; Ilbery and Maye, 2005; Maréchal and Spanu, 2010) in which the analyses faced a lack of data.

Figure 1. Adoption of the OF label and vertical integration by farms

Given the joint adoption of environment-friendly practices and vertical integration, we estimate an econometric model based on simultaneous equations. Because of the possible feedback effect, considering each equation independently would ignore the fact that farmers who sell through SFSCs may be more likely to adopt the OF label and conversely, farmers who adopt this label may be more likely to sell through SFSCs.

Maréchal and Spanu (2010) showed that different kinds of relationship exist between the adoption of the OF label and selling through SFSCs. While some farmers first adopt the label before selling through short channels, others decide to go the opposite way while others adopt both strategies simultaneously. Based on a survey of farmers, our model examines the possible simultaneity of these two strategies considering that each strategy can have an impact on the other. Such a consideration is translated into the equations given below:

$$Organic\ Farming = \beta_0 + \beta_1 \times Structural\ Characteristics + \beta_2 \times Individual\ Characteristics + \beta_3 \times Vertical\ integration + \varepsilon$$

$$Vertical\ integration = \gamma_0 + \gamma_1 \times Size + \gamma_2 \times Uncertainty + \gamma_3 \times Organic\ Farming + \mu$$

Where β_0 and γ_0 represent the constant of the first and second models respectively; β_1, β_2, β_3 are the coefficients associated with each group of variables that explain the adoption of the organic farming label; γ_1, γ_2, γ_3 are the coefficients associated with each group of variables that explain vertical integration; ε and μ are the residues of the first and second models respectively.

As our database corresponds to a census conducted for a given year, we are able to observe these two strategies but not to identify the date of their implementation. Because these strategies are conducted in the long run, we assume that an “organic farming” label is adopted at the same time as the decision to implement environment-friendly practices. A panel approach might have provided more information about the nature of the causality: one-way versus mutual causality.

These strategies are defined using qualitative variables. While the adoption of “organic farming” can only be a dichotomous variable, vertical integration should be a quantitative variable. With the data at our disposal, we are only able to measure this integration by an ordered variable from no-integration to integration. Such definition corroborates the definition usually adopted by the Transaction Costs theory differentiating integrated, non-integrated and hybrid forms (Williamson, 1971).

Considering a model with simultaneous equations, we assume that the adoption of the farmer’s strategies depends on unobserved quantitative variables. For instance, the farmer chooses to adopt the “organic farming” label if he considers that this practice will provide him with increased utility. For this strategy, the unobserved quantitative model and the observed qualitative model described below are as follows:

$$Y^* = X' \beta + \varrho$$

$$Y = 1 \; if \; Y^* > 0 \; ; 0 \; otherwise$$

Where β is the vector of coefficient associated with factors affecting the latent variable and thus the dichotomous choice observed; ϱ is the error term of the equation

The relevance of the simultaneous model is validated since the correlation of the error terms is significantly different from 0 (Berndt, 1991).

4. Results

In this section, we present the results of summary statistics, complemented by econometric modelling based on simultaneous equations.

4.1. Summary statistics

The adoption of organic farming (OF) differs according to the specialization considered. The label has been adopted by 8.78% of farms specializing in wine-growing and 13.02% of farms specializing in arboriculture. Because of this difference, we consider each of these specializations separately.

Farmers who have adopted the OF label are younger and more educated both in terms of agricultural and general education (tables 3a and 3b). Otherwise, they claim to work more on their farms: more than 75% of organic farmers spend more than 3/4 of their work time on their farm while this percentage is less than 60% for other farmers. These results appear to be independent of farm specialization.

Table 3a. Individual characteristics of farmers specializing in wine-growing
Table 3b. Individual characteristics of farmers specializing in arboriculture

Organic farmers also present similar specificities independent of their specialization (tables 4a and 4b). A salient result is that OF farms correspond to larger farms on which labour is less intensive. In addition, we observe that the labour force is more predominantly made up of employees rather than family members, and more precisely by permanent employees.

Farms specializing in wine-growing which adopt OF present a higher degree of diversification both in terms of intra- and inter-diversification. OF therefore goes hand in hand with a need to provide a more diversified production and to offer a larger wine production range. Farms specializing in arboriculture do not exhibit such similarities.

Table 4a. Structural characteristics of farms specializing in wine-growing
Table 4b. Structural characteristics of farms specializing in arboriculture

Considering integration leads to a substantial differentiation between specializations. While organic farmers specializing in wine-growing are more likely to be integrated, those specializing in arboriculture are more likely to correspond to the hybrid form. Irrespective of their specialization, all organic farmers considered are less likely to be non-integrated (tables 5a and 5b).

Table 5a. Adoption of the OF label and integration on farms specializing in wine-growing

Table 5b. Adoption of the OF label and integration on farms specializing in arboriculture

When considering the determinants of integration, we observe that there are several differences between specializations (tables 6a and 6b). Integrated farms specializing in wine-growing are larger than hybrid and non-integrated concerns, while integrated farms specializing in arboriculture are the smallest. Similarly, while the former are less specialized in their dominant crop, the opposite is true for the latter. Nevertheless, a common element to both specializations is their degree of diversification: integrated farms are clearly more diversified than other ones.

In the wine-growing sector, crop insurance and mutual funds are not adopted at all by integrated farmers. The reason may be the cost of the inefficiency of these products in this configuration. The less a wine-grower is integrated, the more he selects financial risk management instruments. The trend is similar for farms specializing in arboriculture, even if integrated farmers are more interested in risk management tools.

Table 6a. Characteristics of farms specializing in wine-growing according to their degree of integration

Table 6b. Characteristics of farms specializing in arboriculture according to their degree of integration

4.2. Econometric models

The results of the econometric models are provided in table 7.

Table 7. Econometric models

We must first mention the relevance of considering a model with simultaneous equations instead of separate estimations for each strategy: indeed, we observe a correlation between error terms. We can then confirm that there is mutual causality between strategies adopted by farmers: farmers who adopt organic farming are more likely to be integrated and conversely, farmers whose farm is integrated are more likely to adopt environment-friendly practices.

4.2.1. Determinants of environment-friendly practices

The results highlight that, in accordance with the literature, resources and skills as well as the degree of integration have a positive influence on the adoption of organic farming.

We confirm the importance of labour as a strategic resource for implementing environment-friendly practices. Farms that adopt the organic farming (OF) label have fewer salaried employees per hectare but these employees are more permanent, which indicates extensive production. When fulfilling the OF label requirements, farmers must design their agricultural practices by paying more attention to the monitoring of the production, which cannot be done by “mechanical” means but with more permanent employees.

We also observe that the more a farm is diversified in its wine-growing production, the more it is likely to adopt organic farming while the opposite effect is observed for arboriculture. Moreover, for farms specializing in wine-growing production, the more the standard gross margin depends on this specific activity, the more the farmer is likely to adopt the “organic farming” label.

The smallest farms are more likely to adopt organic farming when their economic and technical orientation (ETO) is wine-growing while the opposite is true for farms whose ETO is arboriculture. These two results point to structural differences between these two sectors, the former being less extensive than the latter. H_1 is therefore partially validated.

Focusing on individual characteristics, organic farming is adopted by farmers who are more educated, younger and more present on their farm than other farmers. This result, which confirms H_2, is in line with the need for careful monitoring of production which cannot use traditional production patterns such as the application of phytosanitary products.

Whatever the ETO, vertical integration appears to be an essential element in differentiating farms regarding the adoption of organic farming. The more the farm is integrated, selling through short supply chains, the more it is likely to implement environment-friendly practices, which validates H_3. By doing so, the farm seeks to enhance the quality and the value-added of its production which can be considered a specific asset.

4.2.2. Determinants of vertical integration

Based on the Transaction Costs theory, three main hypotheses have been formulated regarding the determinants of vertical integration.

The results confirm that the size of the farm is strongly linked to the degree of integration, even if we observe a sectorial effect. The most integrated farms whose ETO is wine-growing correspond to the biggest ones, while the contrary applies to farms whose ETO is arboriculture. H_4 is thus partially validated. This result may be in line with the fact that the former perform more regular transactions (grapes and above all bottles) compared to the latter whose production is more seasonal.

Considering uncertainty and its supposed positive impact on vertical integration, we observe differentiated behaviour between farmers according to their main production. The more wine-growing farms are diversified and insured, the less likely they are to sell their production through short channels, which validates H_5. This result is the opposite for arboriculture. In this sector, farms that sell through short supply chains are probably willing to meet consumer requirements in terms of product diversity because they offer consumers a wider variety of products.

Finally, we notice a very strong and positive link between the practice of organic farming and vertical integration, which validates H_6. Because they comply with strong environmental constraints, farmers involved in organic farms are encouraged to sell their produce themselves using short supply chains. They can then benefit directly from a high quality image.

5. Conclusion

In recent years, consumers have been looking for more quality produce. This expectation has been satisfied by producers through changes in production processes and the development of short food supply chains. Selling using short channels can be seen as an alternative to other more traditional channels.

Conceptually speaking, improving the quality of produce through environment-friendly practices and integrated supply chains appear to be closely linked. This is particularly true when considering the growth of organic farming which requires the adoption of and compliance with technical specifications. These increasing requirements are important issues for producers and adaptation depends on both individual and structural characteristics. Nevertheless, the choice to sell through short food supply chains refers to the conditions of the transactions.

The census of French farms performed in 2010 provided a comprehensive overview of strategies implemented by producers with regard to their specialization. Since farms specializing in wine-growing and arboriculture are more concerned with the adoption of organic farming and short food supply chains, we focused our study on these farms.

Using an econometric model with simultaneous equations, we were able to demonstrate that farmers who adopt organic farming label are more likely to sell their produce through short food supply chains. Conversely, farmers who sell their production using this channel are more likely to implement environment-friendly practices. Such results highlight the fact that proximity can be associated with quality, irrespective of the production considered. Moreover, our study confirms that environment-friendly practices are more likely to be implemented by younger producers who are furthermore better educated and claim to work more on their farm. Such practices require increased labour. Despite some differences depending on farm specialization, these results and their interdependency tend to prove that the quality of agricultural products and processes can be enhanced in several ways, either through the commercial channel or the adoption of environmental labels.

Two limitations on our study can be identified. The first is the lack of historical data to assess the stability of choices observed for producers. The second is that our study focuses only on permanent crops. A future work would be to conduct a similar study on other kinds of production. The objective would be to test the link between the quality of production and the vertical integration of supply chains, thus extending the scope of our results to non-perennial plants.

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Table 1a. List of main variables – Determinants of environment-friendly practices

Variable		Unit	Definition	Expected influence
H1: Resources				
Area		Hectare	Cultivated area	+
Employees / cultivated area		-	Number of salaried employees per hectare	+
% permanent employees		%	% of permanent salaried employees in total workforce	
% employees / total employment		%	% of salaried employees in total workforce	
Degree of specialization in wine-growing		%	% of the standard gross output derived from wine-growing	+
Degree of specialization in arboriculture		%	% of the standard gross output derived from arboriculture	
H2: Skills				
Agricultural education	**No**	-	The farmer has no agricultural education	+
	Primary	-	The farmer has a primary level of agricultural education	
	Secondary	-	The farmer has a secondary level of agricultural education	
	Higher	-	The farmer has a higher level of agricultural education	
General education	**No**	-	The farmer has no general education	
	Primary	-	The farmer has a primary level of general education	
	Secondary	-	The farmer has a secondary level of general education	
	Higher	-	The farmer has a higher level of general education	
Age		Year	Farmer's age	-
Time worked on farm	**< 25%**	-	The farmer spends less than 25% of his working time on the farm	+
	25%-50%	-	The farmer spends between 25% and 50% of his working time on the farm	
	50%-75%	-	The farmer spends between 50% and 75% of his working time on the farm	
	> 75%	-	The farmer spends more than 75% of his working time on the farm	
H3: Adoption of the "organic farming" label				
Integration	**Integrated form**	-	The farm sells through short food supply chains and this activity represents more than 50% of its turnover	-
	Hybrid-form	-	The farm sells through short food supply chains and this activity represents less than 50% of its turnover	
	Non-integrated form	-	The farm does not sell through short food supply chains	

Table 1b. List of main variables – Determinants of vertical integration

Variable	Unit	Definition	Expected influence
H4: Size effect			
Area	Hectare	Cultivated area	+
H5: Uncertainty			
Degree of specialization in wine-growing	%	% of the standard gross output issued from wine-growing	+
Degree of specialization in arboriculture	%	% of the standard gross output issued from arboriculture	
Inter-diversification	Counter	Number of different productions	-
Intra-diversification in wine-growing	Counter	Number of different productions within wine-growing	-
Intra-diversification in arboriculture	Counter	Number of different productions within arboriculture	
Multi-peril crop insurance	Yes/No	The farmer subscribes to a multi-peril crop insurance	-
Participation in a mutual fund	Yes/No	The farmer is involved in a mutual fund devoted to covering sanitary or environmental risks	-
H6: Specificity			
Organic farming	Yes/No	The farm has adopted an organic farming label or is going to within 5 years	+

Table 2. Correspondence between quality declared to consumers and quality implemented in practice by producers

	Organic Farming			Correlation test Chi2 test
	No	**Yes**	**All farms**	
Age of the sprayer	10.23	8.60	10.06	***
% of the area without phytosanitary treatments	11.13%	16.59%	11.72%	***
% of farms benefitting from external control	80.28%	91.64%	81.35%	***
% of farms whose sprayers are controlled	28.95%	33.26%	30.41%	***

Keys:
- Correlation tests: H_0 = There is no difference between OF and non-OF. ***, ** and * indicate that this hypothesis is accepted at the 1%, 5% and 10% levels respectively.
- Chi2 tests: ***, ** and * denote a significant relation at the 1%, 5% and 10% respectively between being an OF and other qualitative variables.

Table 3a. Individual characteristics of farmers specializing in wine-growing

		Organic Farming								
		Population			Percentage (line)			Percentage (column)		
		No	**Yes**	**All farms**	**No**	**Yes**	**All farms**	**No**	**Yes**	**All farms**
Agricultural education	**No**	26,766	1,777	28,543	93.77%	6.23%	100.00%	48.76%	33.64%	47.43%
	Primary	15,321	1,209	16,530	92.69%	7.31%	100.00%	27.91%	22.88%	27.47%
	Secondary	6,690	907	7,597	88.06%	11.94%	100.00%	12.19%	17.17%	12.63%
	Higher	6,114	1,390	7,504	81.48%	18.52%	100.00%	11.14%	26.31%	12.47%
General education	**No**	4,604	241	4,845	95.03%	4.97%	100.00%	8.39%	4.56%	8.05%
	Primary	24,827	1,318	26,145	94.96%	5.04%	100.00%	45.23%	24.95%	43.45%
	Secondary	11,283	1,362	12,645	89.23%	10.77%	100.00%	20.56%	25.78%	21.01%
	Higher	14,177	2,362	16,539	85.72%	14.28%	100.00%	25.83%	44.71%	27.49%
Time worked on farm	**< 25%**	21,885	995	22,880	95.65%	4.35%	100.00%	39.87%	18.83%	38.02%
	25%-50%	2,986	277	3,263	91.51%	8.49%	100.00%	5.44%	5.24%	5.42%
	50%-75%	1,788	186	1,974	90.58%	9.42%	100.00%	3.26%	3.52%	3.28%
	> 75%	28,232	3,825	32,057	88.07%	11.93%	100.00%	51.43%	72.40%	53,27%
All farms		54,891	5,283	60,174	91.22%	8.78%	100.00%	91.22%	8.78%	100.00%

Source: Agreste – Exhaustive census of French farms 2010

	Organic Farming		
	No	**Yes**	**All farms**
Age (average)	51.68	47.19	51.29

Source: Agreste – Exhaustive census of French farms (2010)

Table 3b. Individual characteristics of farmers specializing in arboriculture

		Organic Farming								
		Population			Percentage (lines)			Percentage (columns)		
		No	Yes	All farms	No	Yes	All farms	No	Yes	All farms
Agricultural education	**No**	5,311	510	5,821	91.24%	8.76%	100.00%	52.12%	33.44%	49.69%
	Primary	2,745	411	3,156	86.98%	13.02%	100.00%	26.94%	26.95%	26.94%
	Secondary	1,082	265	1,347	80.33%	19.67%	100.00%	10.62%	17.38%	11.50%
	Higher	1,051	339	1,390	75.61%	24.39%	100.00%	10.32%	22.23%	11.87%
General education	**No**	1,134	86	1,220	92.95%	7.05%	100.00%	11.13%	5.64%	10.41%
	Primary	4,566	440	5,006	91.21%	8.79%	100.00%	44.81%	28.85%	42.74%
	Secondary	2,157	405	2,562	84.19%	15.81%	100.00%	21.17%	26.56%	21.87%
	Higher	2,332	594	2,926	79.70%	20.30%	100.00%	22.89%	38.95%	24.98%
Time worked on farm	**< 25%**	3,480	289	3,769	92.95%	7.05%	100.00%	34.15%	18.95%	32.18%
	25%-50%	667	96	763	91.21%	8.79%	100.00%	6.55%	6.30%	6.51%
	50%-75%	420	69	489	84.19%	15.81%	100.00%	4.12%	4.52%	4.17%
	> 75%	5,622	1,071	6,693	79.70%	20.30%	100.00%	55.18%	70.23%	57.14%
All farms		10,189	1,525	11,714	86.98%	13.02%	100.00%	100.00%	100.00%	100.00%

Source: Agreste – Exhaustive census of French farms 2010

	Organic Farming		
	No	Yes	All farms
Age (average)	53.36	48.00	52.66

Source: Agreste – Exhaustive census of French farms (2010)

Table 4a. Structural characteristics of farms specializing in wine-growing

	Organic Farming		
	No	**Yes**	**All farms**
Cultivated area	16.49	24.67	17.21
Employees / cultivated area	0.41	0.24	0.39
% permanent employees	15.38	27.75	16.47
% employees / total employment	0.13	0.23	0.13
Degree of specialization in wine-growing	97.06	96.75	97.03
Degree of specialization in arboriculture	0.65	1.19	0.70
Inter-diversification	1.32	1.44	1.33
Intra-diversification in wine-growing	1.25	1.40	1.27
Intra-diversification in arboriculture	0.08	0.20	0.09

Source: Agreste – Exhaustive census of French farms 2010

Table 4b. Structural characteristics of farms specializing in arboriculture

	Organic Farming		
	No	**Yes**	**All farms**
Cultivated area	19.87	28.31	20.97
Employees / cultivated area	0.30	0.21	0.29
% permanent employees	10.26	16.76	11.11
% employees / total employment	0.09	0.14	0.10
Degree of specialization in wine-growing	7.16	9.24	7.43
Degree of specialization in arboriculture	87.00	84.07	86.62
Inter-diversification	1.76	1.95	1.79
Intra-diversification in wine-growing	0.28	0.36	0.29
Intra-diversification in arboriculture	1.81	2.22	1.86

Source: Agreste – Exhaustive census of French farms 2010

Table 5a. Adoption of OF label and integration on farms specializing in wine-growing

		Organic Farming								
		Population			Percentage (lines)			Percentage (columns)		
		No	Yes	All	No	Yes	All	No	Yes	All
Integration	Integrated	238	50	288	82.64%	17.36%	100.00%	0.43%	0.95%	0.48%
	Hybrid	14,270	2,804	17,074	83.58%	16.42%	100.00%	26.00%	53.08%	28.37%
	Non-integrated	40,383	2,429	42,812	94.33%	5.67%	100.00%	73.57%	45.98%	71.15%
	All	54,891	5,283	60,174	91.22%	8.78%	100.00%	100.00%	100.00%	100.00%

Source: Agreste – Exhaustive census of French farms 2010

Table 5b. Adoption of OF label and integration on farms specializing in arboriculture

		Organic Farming								
		Population			Percentage (lines)			Percentage (columns)		
		No	Yes	All	No	Yes	All	No	Yes	All
Integration	Integrated	1,878	365	2,243	83.73%	16.27%	100.00%	18.43%	23.93%	19.15%
	Hybrid	1,596	415	2,011	79.36%	20.64%	100.00%	15.66%	27.21%	17.17%
	Non-integrated	6,715	745	7,460	90.01%	9.99%	100.00%	65.90%	48.85%	63.68%
	All	10,189	1525	11,714	86.98%	13.02%	100.00%	100.00%	100.00%	100.00%

Source: Agreste – Exhaustive census of French farms 2010

Table 6a. Characteristics of farms specializing in wine-growing according to their degree of integration

	Integration			
	Integrated	**Hybrid**	**Non-integrated**	**All farms**
Cultivated area	27.28	23.35	14.69	17.21
Degree of specialization in wine-growing	87.41	97.33	96.98	97.03
Degree of specialization in arboriculture	5.79	0.65	0.69	0.70
Inter-diversification	2.10	1.34	1.32	1.33
Intra-diversification in wine-growing	1.74	1.31	1.25	1.27
Intra-diversification in arboriculture	0.61	0.10	0.08	0.09

		Integration			
		Integrated	**Hybrid**	**Non-integrated**	**All farms**
Multi-peril crop insurance	**Yes**	0.47%	28.34%	71.20%	100.00%
	No	0.55%	28.58%	70.87%	100.00%
Participation in a mutual fund	**Yes**	0.47%	28.17%	71.36%	100.00%
	No	0.93%	36.89%	62.18%	100.00%
All farms		0,48%	29.37%	71.15%	100.00%

Source: Agreste – Exhaustive census of French farms 2010

Table 6b. Characteristics of farms specializing in arboriculture according to their degree of integration

	Integration			
	Integrated	**Hybrid**	**Non-integrated**	**All farms**
Cultivated area	12.89	27.52	21.64	20.97
Degree of specialization in wine-growing	3.60	10.58	7.72	7.43
Degree of specialization in arboriculture	89.92	81.19	87.08	86.62
Inter-diversification	1.72	2.15	1.71	1.79
Intra-diversification in wine-growing	0.18	0.44	0.29	0.29
Intra-diversification in arboriculture	2.34	2.45	1.56	1.86

		Integration			
		Integrated	**Hybrid**	**Non-integrated**	**All farms**
Multi-peril crop insurance	**Yes**	19.81%	16.81%	63.38%	100.00%
	No	13.27%	20.37%	66.36%	100.00%
Participation in a mutual fund	**Yes**	19.53%	16.68%	63.79%	100.00%
	No	14.09%	23.65%	62.25%	100.00%
All farms		19.15%	17.17%	63.68%	100.00%

Source: Agreste – Exhaustive census of French farms 2010

Table 7. Econometric models

		Farms specializing in wine-growing	Farms specializing in arboriculture
Determinants of Organic Farming			
Intercept		4.602***	2.456***
Integration		2.143***	1.152***
Cultivated area		-0.005***	0.002***
Employees / cultivated area		-0.182***	-0.111***
% employees / total employment		0.041***	0.147***
Specialization in wine-growing		0.001	
Specialization in arboriculture			-0.003***
Activity	**Farmer**	*Reference*	
	Farmer in another farm	-0.014	0.018
	Employee	-0.106***	0.0005
	Retired	-0.326***	-0.246***
Time on farm	**< 25%**	*Reference*	
	25%-50%	0.165***	0.176***
	50%-75%	0.181***	0.175***
	> 75%	0.172***	0.146***
Agricultural education	**No**	*Reference*	
	Primary	0.008	0.064***
	Secondary	0.152	0.119***
	Higher	0.017	0.134***
General education	**No**	*Reference*	
	Primary	0.032	0.069
	Secondary	0.215***	0.202***
	Higher	0.226***	0.268***
Farmer's age		-0.001***	-0.004***
Inter-diversification		0.006	-0.104***
Intra-diversification in wine-growing		0.054***	
Intra-diversification in arboriculture			-0.061***
Determinants of integration			
Intercept		-2.881***	-1.720***
Organic farming		2.145***	1.536***
Cultivated area		0.005***	-0.004***
Specialization in wine-growing		0.001	
Specialization in arboriculture			0.004***
Inter-diversification		-0.053***	0.138***
Intra-diversification in wine-growing		0.001	
Intra-diversification in arboriculture			0.096***
Multi-peril crop insurance		-0.021***	0.076***
Participation in a mutual fund		0.023	-0.105***

Source: Agreste – Exhaustive census of French farms 2010
Keys: Estimates significant at the 10 % (*), 5 % (**) and 1 % (***) thresholds.

Figure 1. Adoption of the OF label and vertical integration by farms