COLLECTIVE ACTION AND ALLOCATION OF DECISION RIGHTS IN PESTICIDE SAFETY RISK MANAGEMENT: THE CASE OF TOMATO PRODUCER ORGANIZATIONS IN FRANCE

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Abstract

Pesticide safety management at the production/shipping level is a costly transaction between a farmer and a buyer. Within the safety-demanding global market, a frequent solution adopted to comply with end customer requirements is to allocate monitoring and decision rights to the shipper. Our paper aims to explain how and why farmers who are members of Producer Organizations (POs) allocate monitoring and decision rights to their managers to manage pesticide safety risks. It also distinguishes the two types of control rights (over the product and over the production process) which define a safety management strategy. Drawing on the scant empirical literature on the transfer of property rights within incomplete contracts (Arrunada et al, 2001; Hu and Hendrikse, 2009), it tests for the predictions of the theory, putting forward as main independent variables group size, reputation, customer safety demands and asset specificity. To this end, twenty POs accounting for more than 95% of French tomato production with market organization have been surveyed. Our results confirm most of the predictions, namely that the allocation of control rights increases with commercial reputation, customer safety demands and IPM technical assistance (asset specificity). Moreover, we show that the two types of control are substitutes and complementary. On the one hand, POs focus either on product control or process control while on the other hand, both controls are necessary for POs with a good reputation and demanding customers.

Key words: *incomplete contracts, property rights, allocation of property rights, safety, product control, process control, tomato, Producer Organizations or marketing groups, France.*

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1. Introduction

The stringent demands of customers in terms of pesticide safety lead suppliers to intervene more decisively in managing the safety risk at the production level. Nowadays, such involvement is not only required by European regulations which make in-house control obligatory at every level of the chain, is also highly motivated by the commercial risk of failing to comply with buyers' individual requirements (Bignebat and Codron, 2006).

A crucial level of managing the safety risk is at the production/shipping level. While the former level is broadly documented in empirical literature, the latter remains an emerging issue (Aubert et al, 2013). Empirically, buyers facing stringent safety requirements do not limit their control to the product itself (pesticide residue analysis at the platform level) but are also involved in controlling the production process (monitoring and often taking decisions with regard to certain production practices). While buyers' management practices usually combine both kinds of control, there is no easy hierarchy that may be established between buyers who prefer to focus control over the product and those who prefer to focus control over the production process (Bouhsina et al, 2009; Bonnaud et al, 2012a, b).

The aim of this paper is to offer an insight into how buyers manage safety with their suppliers and how buyers' characteristics may influence this organization. We maintain that buyers may choose to focus their control more on the product or more on the production process. To explain such a strategic choice of control, we will draw on the transactional and "contract design" literature and focus on the main variables usually identified as a major factor of influence on vertical integration, namely asset specificity, the level of customer safety requirements and – since our buyer is a marketing group – the size of the group and the collective commercial reputation at stake. As we are dealing with the management or governance of the safety risk, vertical integration will be approximated by the nature and the intensity of buyer control.

Our paper is organized as follows. Section 2 develops our theoretical framework, based mainly on a Transaction Cost approach to contract design and the allocation of property rights. Section 3 sets the stage, describes the groups and their main characteristics and presents both our methodology and the data collected while throwing light on the choice of variables allowing both types of control to be represented together with their contribution to the management of safety risk. Section 4 tests for the hypotheses based on the theory that allows both types of control and their interaction to be explained and comments on the findings. Section 5 concludes by emphasizing how both types of control are influenced by the factors put forward in the literature (reputation, safety objectives, asset specificity and group size) and how they combine to determine a strategy for managing the safety risk.

2. Analytical framework

2. 2.1 The grower-PO relationship and the nature of transaction costs

Transaction costs are central to the choice of control strategy. They basically derive from an agency issue where the goals of the farmer (maximizing yield and quality) may conflict with the goals of the buyer (compliance with the safety rules) and where deviant behavior is difficult to detect given the strong exogenous hazards. Farmers may thus be reluctant to reveal information or to produce information that may be useful to the buyer with regard to safety management. For instance, a farmer may prefer to use a forbidden pesticide which is cheaper and may have a stronger impact on the pest but which is not accepted by the buyer for regulatory or customer-related reasons. To reduce such agency costs, buyers may choose to focus their control on the product or the production process.

Controlling the product generates measurement costs which may prove prohibitive if applied to all products delivered by the growers. This leads buyers to use sampling and penalties to enforce compliance with safety requirements. However, given the complex production function and the high level of environmental uncertainty, it is difficult to distinguish between a grower's effort and hazard and thus to draft a complete contract and determine the optimal sanction which could lead a grower to make the "utmost effort" required by the buyer (Soubeyran et al.). Consequently, most buyers are encouraged to draft incomplete contracts and to monitor growers' efforts in the production process.

Control over the production process means high transaction costs due mainly to uncertainty and asset specificity. Uncertainty derives from the complexity of the production function and the difficulty in evaluating the right decision (Codron et al, 2013) for some key pest and disease management activities. Decisions concerning activities such as chemical spreading or the introduction of biological auxiliaries are so complex and contingent on fluctuating parameters which have to be measured at the last moment, that they cannot be defined ex-ante and have to be taken at short notice. Such uncertainty is also observed in the literature as ease of measurement (Williamson, 1991), difficulty of measurement (Barzel, 1982), non-separability (Alchian and Demsetz, 1972) or task programmability (Eisenhardt, 1985). Allocation of monitoring and decision rights to the party best informed (Barzel, 1989) allows such uncertainty to be reduced but, at the same time, creates new transaction costs, referred to by Barzel (2005) as "errors of measurement" and related to the possible manipulation of information by the party which has been allocated control and decision rights.

Asset specificity is mainly embodied by the human resources that the buyer invests to perform his control over the production process. Most buyers recruit technicians with some knowledge of IPM to recommend or impose actions to be taken by the grower. Given the exogenous uncertainty and the difficulty in monitoring the grower, there is potential for grower opportunism and a risk of poor efficiency of the technician. Drawing on the literature on the allocation of property rights (Barzel, 1989; Arrunada et al, 2003) and asset specificity (Williamson, 1991), the risk of maladaptation or abusive appropriation of the quasi-organizational rent created in the grower-buyer transaction increases with uncertainty or measuring difficulty, asset specificity and the level of safety that is targeted by the buyer.

A third class of transaction costs exists in our case study. They derive from the nature of the buyers who are marketing groups of growers who delegate authority to managers (Bijman, 2007; Ménard, 2012). The transfer of decision rights is primarily concerned with product commercialization but may extend to the production process in order to improve product commercialization and help build a group reputation or a collective brand. In this paper, we limit the scope of our analysis to the governance mechanisms and their application for safety purposes. First, although marketing groups may differ considerably in their governance structure (Sykuta and Cook, 2001; Chaddad and Iliopoulos, 2013), we consider that, with regard to safety management, differences in governance mechanisms are much greater than differences in governance structures. A major reason behind this is that most of the groups[1] are of the cooperative type (17/20), were created to benefit from EU subsidies and demonstrate few differences in decision-making processes concerning internal safety rules; however they differ considerably in the content or intensity of their control over the product or the production process.

Second, we consider that the delegation of authority for safety purposes is representative of the general delegation of authority and captures most of the transaction costs linked to the marketing of the product on behalf of the growers. In particular, while commercial quality (size, taste, packaging, etc.) may be easily measured and rewarded at the platform level where growers deliver their products, it is more difficult to measure safety along the customer requirements, either on the product or in the process of production. Consequently, except for the penalties that may punish a safety-deviant grower, there is no other incentive that may reward safety performance. Products eligible to be sold to safety-demanding customers are not given a premium while products with residue excesses due to exogenous hazards are not punished and receive the same price as compliant products.

In addition to the control costs previously mentioned, safety-specific transaction costs generated by collective action within the marketing group include exclusion costs or costs to protect the collective good from free riding. In the case of a marketing group, the dominant collective good is the collective brand or the commercial reputation of the group. Of course, traceability helps identify the defaulting grower and alleviate the responsibility of the group. However, it does not totally exonerate the group which is deemed responsible for grower control, must justify such a flaw and may suffer damage to its commercial reputation. Consequently, we can expect that the delegation of authority, which helps reduce transaction costs, will increase with the size of the group and the commercial reputation. This is in line with the emerging literature on contract design focusing on the allocation of control/decision rights (Arrunada et al, 2003; Hu and Hendrikse, 2009; Aubert et al, 2013).

2.3 Hypothesis

Within this framework, we can predict that the delegation of safety control in the marketing group will increase with the level of safety targeted by the group (Raynaud et al, 2009), commercial reputation, asset specificity and group size (Hu and Hendrikse, 2009). We therefore expect PO managers to be allocated more rights to decide and monitor the behavior of farmers in larger groups, in groups with a high commercial reputation, in groups targeting safety-demanding customers and in groups with high safety-specific investments. The four variables impacting the transfer of property rights are highly concerned with safety management and are the result of strategic choices made by the group. Our empirical work aims to explain the two observed types of control implemented by the groups as a consequence of these strategic choices.

We consider that our prediction is true whatever the type of control (over the product or over the production process) and whatever the tools implemented to organize the control over the product (pressure of analysis, sampling methods and sanctions). However, it remains

[1] Let us note, however, a significant difference in governance structure which exists for groups having entered a superstructure to benefit from economies of scale, in particular regarding marketing, commercialisation and technical services. While the existence of such a superstructure tends to rule and homogeneize the decision-making processes of the elementary marketing groups and thus the elementary governance structures, there are still significant differences in the safety control mechanisms. This is particularly true of the production process which is mostly regulated by the elementary marketing groups, even though the superstructure offers some technical strategic orientation.

unclear what exactly determines the trade-off between the two controls. We will test for complementarity and substitutability of the two controls, echoing Arrunada et al (2003). In line with the theoretical predictions, we have identified and documented, for each PO, the following proxies for each of the four categories of explanatory variables: group size, group reputation, safety demand and asset specificity. Group size is measured by the number of tomato growers in the PO while the reputation of the group is approximated by three variables: the existence of an association of POs with a collective brand, the average value per kilo obtained by a PO during the year (total value/total production), and the level of segmentation measured by the percentage of "non-standard" tomatoes (small tomatoes, old varieties). Quality/safety targeted by the group is approximated by three variables: the existence of customers in the UK, market share of the fast food industry and the existence of specific safety requirements in terms of pesticide residues. Two proxies were finally selected to represent asset specificity: the quality manager's profile and the IPM technician's profile: the former was defined by the level of professional education and the number of years' experience in this activity while the latter was characterized by his level of IPM implication: strong involvement for technicians hired by the PO and fully dedicated to IPM, medium involvement for technicians hired by the PO and sharing their time between IPM and general technical assistance, low involvement when no technician has been hired.

3. Data and methodology

Twenty POs (out of twenty two POs existing in France in 2010) were surveyed, accounting for more than 95% of tomato production with market organization and more than 70% of total French production (not including production for self consumption). Data were collected through closed questionnaires and qualitative face-to-face interviews. The questionnaires considered three series of PO items : i) structures and marketing; ii) pesticide residue controls and penalties in case of non-compliance with PO rules; and iii) grower production practices and how the latter are managed/monitored by the PO. Face-to-face interviews were conducted with the PO Director, the Quality Manager and the IPM Technician, if existing.

Table 1: Structures and marketing characteristics of Tomato Producer Organizations (2010)

	Minimum	Maximum	Average
Producers	1	94	21,5
Tomato Surface Area (ha)	2	191	38,3
Tomato Production (tons)	186	72000	14180
Tomato Turnover (10^3 €)	340	124000	16700
Export (%)	0	20	3

Source: our survey

A data base of 113 variables (90 from the closed questionnaire and 23 from the face-to-face interviews) was established. 22 variables out of the 113 were considered of potential interest for the analysis. After testing for non-dependency/correlation, 19 variables (9 independent variables and 10 dependent variables) were finally retained for analysis. From table 1, we can see that an average profile of the POs under scrutiny at the time of our survey could be characterized as follows: 21 farmers with a total greenhouse area of 38 ha (that is more or less 2 ha per grower) and producing 14,200 tons of tomatoes. The figures in table 1 also show a wide dispersion of those characteristics. For instance the ratio between the size of the smallest PO and the biggest is 1 to 94 for the number of producers, 1 to 100 for the greenhouse area and 1 to 360 for tomato production, while the marketing ratios range from 70% to 100% for tomato diversification (cherries and cocktail tomatoes, old varieties), from 0 % to 20 % for the share of total volume exported and from 0% to about 25 % for the share of total volume sold to the fast food industry.

Table 2: Statistics concerning the independent variables

Group Size	Number of tomato producers within the group	Min: 1 Max: 94 Mean: 21.5
Level of customer safety requirements	Existence of customer specific requirements	Yes: 6 POs No: 14 POs
	Export to UK customers	Yes: 4 POs No: 16 POs
	Share of the fast food industry (%)	Min: 0 Max: 23 Mean: 2
Commercial Reputation	Membership in a commercial superstructure with collective brand	Yes: 11 POs No: 9 POs
	Level of tomato valuation (€/kg)	Min: 0.70 Max: 2.32 Mean: 1.47
	Tomato segmentation (% of cherries, cocktail tomatoes and old varieties in total volume)	Min: 0 Max: 68 Mean: 13
Specific Assets	Type of technician: contractual status and degree of concern for IPM	Independent with grower contract: 3 Independent with PO contract: 2 Employee with partial IPM dedication: 8 Employee with full IPM dedication: 7
	Type of quality manager (QM): specialized education background and experience	No employee with full dedication to quality management: 4 Low skills: no specialized education and low experience: 4 High skills: specialized education and/or high experience: 12

Table 3: Statistics of the dependent variables

Control over the product	Pressure of analysis (tons/analysis)		Min: 141 Max: 5,500 Mean: 842
	Sanctions	Type of penalty	No sanction: 1 (a) Cost of additional analysis paid by the grower: 1 (b) Downgrading or no commercialization under PO brand: 11 (c) = (a) + (b) : 4 (d) = (c) + payment of a fine: 3
		Incentives for grower transparency concerning deviant practices (lower penalty)	No: 15 Yes: 5
		Communication of individual residues analysis results at the collective level	No: 7 Yes: 13
	Control procedures	Grower sampling for residue analysis	At random: 3 Targeting suspicious ones: 17
		At least one analysis per grower per year	Yes: 12 No: 8
		Information on the results of the residue analysis and/or association of the IPM technician to control planning adjustments	No information: 11 Information: 5 Information and association: 4
Control over the practices	Crop sheets management (*)	Type of control	No control: 1 Control to verify adequation of pesticide use to the rules: 9 Control with the additional aim of improving IPM practices: 3 Control with the additional aim of improving IPM practices based on observation sheets data: 7

		Centralization at the PO level	Yes: 10 No: 10
	Consultation between the Quality Manager and the IPM Technician over residue management and prevention		Yes: 16 No: 4
	High frequency of greenhouses visits (more than once a month) by the Quality Manager		Yes: 12 No: 8

(*) In the analysis, "Crop sheets management" is a combination of the variables "Crop sheets type of control" and "Centralization of crop sheets at the PO level" with the respective weightings (4 and 1).

Selecting and aggregating the dependent and independent variables

The variables highlighted by the theory as having an influence on the allocation of monitoring/decision rights for safety management purposes have been documented by our survey and validated by experts. After eliminating the items with no variation or very low occurrence and testing for dependence/correlation between the remaining variables, we were left with 1 variable for group size, 3 variables for customer safety requirements, 3 variables for commercial reputation and 2 variables for asset specificity.

The same procedure was conducted for the dependent variables. The two types of control (over the product and over the process) were assessed using a list of relevant data collected during the survey. Twelve items were likely to be representative of a strategy of control. After eliminating the items with no variation and testing for dependence/correlation between the remaining variables, we were left with 7 variables for product control and 3 variables for process control.

The following OLS regressions were then run for each of the 10 variables of control over the 9 independent variables (see table in appendix).

$$\textit{Decision/monitoring right allocation}_{\,i=1\ \grave{a}\ 10} = \beta_0 + \beta_1\,\textit{Size} + \beta_{2\text{-}4}\,\textit{Quality targeted}_{2\text{-}4} + \beta_{5\text{-}7}\,\textit{Reputation}_{5\text{-}7} + \beta_8\,\textit{QM}_8 + \beta_9\,\textit{Technician}_9 + \varepsilon_i$$

Theoretical and empirical considerations led us to identify four categories for the rights that are transferred to the marketing group for safety management purposes: control over grower practices, pressure of analysis, level of sanctions and procedures of control, the last three latter relating to control over the product. After testing the influence of each of the 9 independent variables on the 10 dependent variables, we tried to give a more synthetic view by using the aggregated variables previously identified. Given the differences in nature of the variables, we used a series of combinatorial tests to assign a weight to each elementary variable within a given category of dependent or independent variables. All elementary variables had previously been normalized at 10 as a maximum. Resulting weightings (tables 4 and 5) were validated by experts. Every major variable is thus represented by the weighted sum of its basic variables.

Table 4: Weighting of the independent variables

Aggregated	Elementary variable	coefficient

variable		
Group Size	Number of tomato producers within the group	No aggregation
Level of customer safety requirements	Existence of customer specific requirements	20
	Export to UK customers	1
	Share of the fast food industry (%)	20
Commercial Reputation	Membership in a commercial superstructure with collective brand	4
	Level of tomato valuation (€/kg)	4
	Tomato segmentation (% of cherries, cocktail tomatoes and old varieties in total volume)	1
Specific Assets	Type of technician: contractual status and degree of concern for IPM	No aggregation
	Type of quality manager (QM): specialized education background and experience	No aggregation

Table 5: Weighting of the dependent variables

Aggregated variable	Elementary variable	Coefficient
Pressure of Analysis	Number of tons per residue analysis	No aggregation
Sanctions	Type of penalty	5
	Incentives for grower transparency	2
	Communication of individual results at the collective level	1
Control procedures	Grower sampling for residue analysis	1
	At least one analysis per grower per year	1
	Information/Association of the IPM technician	2
Control over practices	Crop sheets management	4
	Consultation between the QM and the IPM Technician	2
	Frequency of greenhouse visits by the QM	1

For each main dependent variable, we thus run the following OLS regressions:

$$\textit{Pressure of analysis} = \beta_0 + \beta_1 \textit{Size} + \beta_2 \textit{Quality targeted} + \beta_3 \textit{Reputation} + \beta_4 \textit{QM} + \beta_5 \textit{Technician} + \varepsilon$$

$$\textit{Level of Sanction} = \beta_0 + \beta_1 \textit{Size} + \beta_2 \textit{Quality targeted} + \beta_3 \textit{Reputation} + \beta_4 \textit{QM} + \beta_5 \textit{Technician} + \varepsilon$$

$$\textit{Control procedure} = \beta_0 + \beta_1 \textit{Size} + \beta_2 \textit{Quality targeted} + \beta_3 \textit{Reputation} + \beta_4 \textit{QM} + \beta_5 \textit{Technician} + \varepsilon$$

$$\textit{Control over the practices} = \beta_0 + \beta_1 \textit{Size} + \beta_2 \textit{Quality targeted} + \beta_3 \textit{Reputation} + \beta_4 \textit{QM} + \beta_5 \textit{Technician} + \varepsilon$$

4. Results

In this section, we comment on the tests relating to the theoretical predictions concerning the allocation of rights, distinguishing between rights to control over the grower practices and rights to control over the product. The latter include the intensity of control (number of residue analyses per ton), the level of sanctions and the control procedures. We then go on to study the interactions between the two types of control.

Most factors demonstrate a significant impact on control variables with the exception of the procedures of control over the product (Fisher test non validated). Despite a high level of significance, our hypothesis are only partially confirmed (table 6). The theoretical predictions are fully verified regarding the role of reputation and the IPM technician (first asset specificity), while those regarding the quality manager (second asset specificity) run the other way (reverse impact on control) and the predictions regarding group size and customer safety demand have an ambiguous impact on control. Let us comment on these findings

Table 6: Marketing group discretion

Type of control	Dependent Variables	Independent Variables					Intercept	R^2	Prob > F
		Group Size	Customer safety demand	Commercial Reputation	IPM Technician	Quality Manager			
Process control	Process control	0.113	-0.055**	0.413***	1.896**	-1.117 (10.9%)	36.362***	0.635	0.008
Product Control	Analysis Pressure	-0.451***	0.010***	0.061***	0.100	-0.457***	4.234***	0.840	0.000
	Sanctions	-3.477**	-0.014	0.513***	3.012***	-3.677***	55.218***	0.699	0.002
	Procedures	-0.465	0.001	0.087	1.364*	-0.597	11.953	0.251	0.487

Significant at 1% (***), 5% (**); 10% (*)

Commercial reputation

From an empirical point of view, the positive influence of commercial reputation is easy to understand. The level of control increases with the level of commercial reputation that is under exposure and this is true whatever the type of control. The stronger the brand or the commercial reputation, the higher the pressure of analysis and the level of sanctions and the more intensive the control over grower practices.

Customer safety demand

More ambiguous is the influence of customer safety demands, which is positive regarding product control but negative regarding process control. While the first result is in line with the theoretical prediction (more control rights over the product will be allocated to the marketing group with an increase in customer safety demands), the second result is more surprising and leads us to review the elementary variables that were used to define customer safety demands. Actually, by far the strongest component of such demands is the existence of customer-specific requirements. Thirty per cent of POs claimed to respond to specific requirements relative to pesticide residues. Global GAP (Good Agricultural Practices) which applies to grower practices, is not considered a specific requirement since it tends to be a standard requirement when exporting to Northern Europe. This is not the case of the private standards relative to pesticide residues imposed by some European supermarkets. Those standards are much more stringent than the public standards on pesticide residues implemented by the European Union. They place a true burden on the marketing groups working with such customers. To comply with such safety demands, strict control over the product is unavoidable while long-term actions taken to improve grower IPM practices are less useful.

Group size

Group size does not have the expected impact suggested by Olson's collective action theory which predicts an increase in group control over potential member free-riding when the size of the group increases. This is true whatever the type of control. On the one hand, the non-significance of the influence of group size over process control most likely highlights the double and contradictory impact of the size of a group, the expansion of which requires more severe control of potential member free-riding but at the same time allows for economies of scale, in particular to achieve better control over the production process. On the other hand, the impact on product control is significant but contradictory: it increases with the pressure of analysis but decreases with the level of sanctions. Consequently, it is impossible to say whether the incentives not to free ride will increase or decrease with group size. Indeed, a good proxy of these incentives is the likelihood of a sanction which can be assessed by multiplying the probability of a grower being controlled (the pressure of analysis per grower) by the level of sanctions that will be applied in the event of fraudulent deviation (Soubeyran et al, 2009).

What can be hypothesized, however, is the impact on a strategy of control. Given that POs' strategies of control may be represented as a trade-off between control over the product and control over the process, we can anticipate that the impact of group size will depend on the level of control over the product relative to control over the production process. Indeed, when the ratio is in favor of process control, there is more transparency with regard to grower practices, higher costs for fraudulent grower deviation which should lead to less free riding and a smaller impact of group size on the level of control. Conversely, when control over practices is low, growers have more opportunity to deviate from the safety rules imposed by the group and those opportunities should increase with the size of the group, leading to an increase in product control (pressure of analysis and sanctions).

IPM technician

Investments in technical assistance for IPM monitoring and management have, on the one hand and as expected, a positive influence on the control over grower practices. In particular, the higher the investments, the more cooperation there will be between the technician and the quality manager and the more frequently the latter will make field visits (see table in the appendix). The impact of such investments differs, on the other hand, between the three components of product control. While no impact can be detected on the pressure of analysis, significant influence is found for the procedure of control and even more for the level of sanctions. More precisely, the items most impacted by such asset specificity are, on the one hand, the information of the technician concerning residue analysis and his contribution together with the quality manager to adjusting residue control planning and, on the other hand, the incentives given to growers to reveal ex-ante possible misconduct in using pesticides.

We can explain such a contrast first by pointing out that the IPM technician has above all a role of education and guidance regarding IPM. Consequently, his participation in control will be all the more understood and accepted by growers if he has good IPM skills and his conduct is transparent and consistent. A second reason for his participation in control is his position of front-line observer, which gives him a true advantage over the quality manager regarding ex-post adjustments of product control. In particular, he is the most capable of differentiating between technical or economical hazard and grower opportunism in the event of detected deviation. Since penalties may have a high impact on grower incomes, a fair evaluation of grower responsibility is required. The application of a sanction will be all the easier as POs have made consistent investments in IPM technical assistance.

Quality manager

The significant negative coefficient characterizing the influence of the quality manager (QM) on product control (pressure of analysis and level of sanctions) and, to a lesser extent, on process control is intriguing. We had expected a positive relationship assuming that the quality manager might be considered as a specific asset. Unexpectedly, the results show that the higher the QM's skills and experience, the lower the allocation of rights for product safety control. The negative impact on product control can be interpreted as follows: first, we have to stress that the main task of a QM is to control for commercial quality and to arrange for disputes that may arise with customers who claim to be dissatisfied upon reception of the product (Bonnaud et al, 2012). So far, most disputes concern quality, packaging, delays or quantities while there are very few claims for non-compliance with safety requirements. Moreover, there may be a conflict of compliance between shipping orders and safety requirements, as soon as demand outstrips the quantities available supplied by PO's growers. Thus, much less priority is often given to safety control than to commercial control. Consequently, we may consider that investments in managing quality are often barely specific to safety.

Second, we may assume that a senior QM with a good knowledge of growers' practices may relieve the pressure of residue analysis by concentrating sampling on the more suspicious growers. Our hypothesis of a positive correlation between QM seniority and good knowledge of growers' practices is confirmed by our analysis which demonstrates a strong positive impact of QM seniority on frequent QM field visits. It is worth mentioning, however, that despite this positive relationship, the impact of QM seniority and educational skills shows up as a significant negative impact on process control due to the fact that formal cooperation with the IPM technician is less necessary than with new QMs and also due to the weighting used for aggregation (process control = 4 crop sheets management + 2 QM-technician cooperation + 1 QM field visits frequency).

Complementarities between variables of control

In line with Arunada & al. approach (2001), we also assume that safety risk management is a system of interdependent choices, in which the two types of strategy – those based on control over products and those based on control over practices – can be complementary or substitutes. To verify this hypothesis, we examined the conditional correlations between each pair of strategic variables: "Pressure of residue analysis", "Sanctions", "Procedures of control over products" and "Control over practices" (Table 7).

Table 7 – Complementarities: conditional correlations

	Pressure of residue analyses	Level of sanctions	Procedures of control over	Control over practices

			products	
Pressure of residue analysis	1.0000			
Level of sanctions	0.1255	1.0000		
Product control procedures	0.1004	-0.0352	1.0000	
Control over practices	-0.4805*	-0.0274	-0.1761	1.0000

* Significant at 5% level

Globally speaking, even though only one correlation is significant (between pressure of analysis and control over practices), results are clear cut between the two types of strategy, that based on control over the product and that based on control over practices. Indeed all correlations between the three variables of product control and the variable of process control are negative, leading us to conclude that there is substitutability between the two strategies. This is particularly true between "Pressure of residue analysis" and "Control over practices": this relationship suggests that strong investment in control over practices may facilitate a reduction in the pressure of analysis. Such complementarity has to be highlighted by considering the long-term/short-term effects of the two types of management. While sustainable control over practices focuses more on learning than on punishing and needs to be embedded in a long-term quality management system, successful control over the product can be obtained with less preparation and more reactivity. The more embedded the former control, the more information asymmetries may be reduced between growers and the PO and the less sanctions are needed for control over the product. However, grower opportunism or free riding cannot be totally dismissed when adopting a long-term strategy, thus causing the product control lever to be kept operational. This is all the more important as safety-demanding customers are targeted by the PO marketing strategy.

5. Conclusion

Our paper aims to explain the design of a pesticide safety control strategy in a marketing group by referring to the literature on incomplete contracts with transfer of property rights. It defines such a strategy of control as a combination of control over the product and control over growers' practices giving insights into the different nature of such controls. While the former may primarily be considered as a short-term management tool which basically aims to control residues in the products and to penalize fraudulent deviant behavior, the latter is more preventive and educational in nature and is implemented in a long-term perspective.

Our analysis confirmed most of the theoretical predictions and in particular demonstrated that the allocation of monitoring/decision rights increases with commercial reputation, customer safety demand and specific investments in IPM technical assistance. A more thorough analysis helps to differentiate the impacts of the nine independent variables on the ten dependent variables and in particular sheds light on the following aspects. First, it highlights the considerable sensitivity of the pressure of residue analysis to customer safety demand, in particular when compliance with private standards is required. Second, it invalidates the initial assumption of a strong specificity of the investment made by the marketing group in employing a quality manager, considering that the investment is primarily implemented to control commercial quality, which may conflict with safety quality. This finding is in line with the qualitative analysis made by Bonnaud et al (2012). Third, it emphasizes the role of the IPM technician who not only provides technical assistance and education, but also makes a decisive contribution to assessing the responsibility of a grower in the event of deviant residue analysis. Fourth, it does not help conclude about the effect of group size which remains ambiguous, most likely because of a trade-off between gains obtained by economies of scale and costs to protect from potential free riding. Fifth, product control and process control are substitutes, in particular regarding the pressure of residue analysis which may be reduced with increased control over growers' practices. Nonetheless, as soon as POs have a good commercial reputation and sell to demanding customers, both controls are necessary and cannot be exclusive.

It is worth mentioning some limitations to and perspectives of our analysis. A first limitation is the specificity of our case study which applies to pesticide safety issues and to hybrid forms of the cooperative type. Extension of the problem to other empirical domains nevertheless looks quite promising. We may, for instance, consider applications of the problem for other types of quality attribute which are difficult to measure or complex to produce (such as fair trade or environmental-friendly products) or to other types of buyer such as private shippers. In the latter case, some modifications in the analytical framework are necessary, in particular regarding commercial reputation which is no longer a collective good with potential free riding but a buyer-specific asset with potential hold-up from the suppliers. A second limitation is the size of our population which, although exhaustive, does not provide much robustness to testing. Given the crucial role of safety in food chain competitiveness, many industries or grower associations should be interested in such a topic offering numerous opportunities to apply the problem and contribute to the empirical literature on incomplete contracts with transfer of property rights.

6. Bibliography

Alchian, A.A. and H. Demsetz (1972). Production, Information Costs, and Economic Organization, *American Economic Review*, 62 (5), 777-795

Arrunada, B., Garicano, L. and Vazquez, L., 2001. Contractual allocation of decision rights and incentives: the case of automobile distribution, *Journal of Law, Economics and Organization*, 17(1), 257-284.

Aubert, M., Bouhsina, Z., Codron, J.-M. and Rousset, S. (2013), "Pesticides safety risk, food chain organization, and the adoption of sustainable farming practices. The case of Moroccan early tomatoes" *134th EAAE Seminar, Labels on sustainability: an issue for consumers, producers, policy makers, and NGOs, March 21-22, 2013, INRA, Paris, France*.

Baker, G., Gibbons, R., and Murphy, K.J. (2006) "Contracting for control". Working paper, MIT. May 2006 version

Barzel, Y.A. (1982). Measurement cost and the organization of markets, *Journal of Law and Economics*, Vol. XXV, n°1 : 27-48

Barzel, Y. (1989) Economic Analysis of Property Rights, Cambridge University Press, First Edition 1989, Second Edition 1997.

Barzel, Y.A. (2005). Organizational Forms and Measurement Costs. *Journal of Institutional and Theoretical Economics*. 161(3): 357-373.

Bignebat, C and Codron, J.M. (2006) – Organizational innovations and food safety monitoring in the fresh produce industry. *Research in Economics and Rural Sociology. INRA n° 5-6, November 2006, 4 p.*

Bijman, J. (2007) "The role of producer organisations in quality-oriented agrifood chains: an economic organisation perspective" In: R. Ruben, M. van Boekel, A. van Tilburg and J. Trienekes (eds) *Tropical food chains: governance regimes for quality management.* Wageningen, Wageningen Acad. Publ., 257-277.

Bonnaud L., Bouhsina Z. and Codron J. M., (2012) -Le rôle du marché dans le contrôle des traitements phytosanitaires**.** *Terrains et Travaux, n° 20, 2012, 87-103*

Bonnaud L. ; Bouhsina Z. and Codron J.M. (2012). Tracer les tomates. In : Bonnaud, L. ; Joly, L. (éds) - L'alimentation sous contrôle : tracer, auditer, conseiller. – Paris (FRA) : Editions Quae, 2012. - P. 77-90 - (Sciences en partage)

Bouhsina, Z., Codron, J.M., Cordier, E. and Soubeyran, R. (2009). Les stratégies de contrôle de la qualité dans les Organisations de Producteurs de tomates [En ligne] **-** Montpellier (FRA) : UMR MOISA, 2009. - 36 p. – (Série Cahier de recherche ; 6) http://ideas.repec.org/b/umr/ecbook/200906.html

Chaddad, F.R. and C. Iliopoulos, (2013). Control Rights, Governance and the Costs of Ownership in Agricultural Cooperatives, *Agribusiness: An International Journal*, 29 (1), 3-22.

Codron, J.-M., E. Montaigne, and S. Rousset (2013). Quality management and contractual incompleteness: grape procurement for high-end wines in Argentina. *Journal of Chain and Network Science*, 2013, 13(1): 11-35

Eisenhardt, K.M. (1985). Control: Organizational and economic approaches, Management Science, Vol. 31, n°2 : 134-149

Hu, Y and G.W.J. Hendrikse (2009). Allocation of Decision Rights in Fruit and Vegetable Contracts in China. *International Studies of Management and Organization* 39(4): 8-30.

Ménard. C. (2012). Hybrid Modes of Organization. Alliances, Joint Ventures, Networks, and Other 'Strange' Animals. In: R. Gibbons and J. Roberts (eds.) The Handbook of Organizational Economics. Princeton University Press, Princeton, 1248 p.

Raynaud, E., L. Sauvée, and E. Valceschini (2009). Aligning branding strategies and governance of vertical transactions in agri-food chains. *Industrial and Corporate Change* 18(5): 835-868.

Sykuta, M. and Cook, M.L. (2001). A New Institutional Economics Approach to Contracts and Cooperatives, American Journal of Agricultural Economics, 83(5), 1273-1279.

Williamson, O.E. (1991). Comparative economic organization: the analysis of discrete structural alternatives. *Administrative Science Quarterly* 36(2): 269-296.

Appendix : OLS Models Results

Independant Variables	Dependant Variables	Pressure of Analysis	Control over the Products								Control over the Practices			
			Sanctions				Control procedures							
			Aggregate	Type of penalty	Incentives for grower transparency	Communication of individual residues analysis results at collective level	Aggregate	Grower sampling for residue analysis	At least one analysis per grower per year	Information on the results of analysis and/or association of the IPM technician to control planning adjustments	Aggregate	Crop sheets management	Consultation between Quality Manager and IPM Technician over residues management and prevention	Frequency of greenhouse visits by the QM
	Group Size	**-0.477*** **	**-3.477** **	0.874°	-0.993*	0.475	**-0.560**	-0.128	-1.186*	0.629	**1.099**	0.005	0.664°	-0.251
level of customer safety requirements	**Aggregate**	**0.010*** **	**-0.014**	0.005	-0.006	0.006	**0.001**	-0.100	0.017*	-0.003	**-0.055** **	-0.011	-0.005	-0.002
	Customers specific requirements	-0.200***	-0.344	0.097	-0.085	-0.007	-0.429	-0.634**	0.403°	-0.099	-1.490**	-0.273**	-0.229	-0.062
	Share of fast food industry	0.330***	1.178	0.351	-0.156	0.804**	-0.019	0.710*	0.504	-0.617°	-1.530°	-0.382**	-0.018	0.032
	Export to UK customers	0.003	-0.819	0.033	-0.101	-0.174	0.642	-0.135	-0.385	0.582*	0.452	0.175°	-0.030	-0.186
Reputation	**Aggregate**	**0.061*** **	**0.513*** **	0.184	0.050	0.122**	**0.087**	-0.048	0.100*	0.178	**0.413*** **	0.044	0.092**	**0.054**
	Membership in a commercial superstructure	0.346***	2.898***	0.196	0.210	0.825***	0.087	0.069	0.455°	-0.218	1.131*	0.051	0.309°	0.307°
	Level of tomato valuation	0.331°	3.615°	-0.691	0.567	0.735	0.912	0.599	-0.026	0.169	3.485°	0.152	-0.201	0.477
	Tomato segmentation	-0.166°	-0.514	0.105	-0-0.072	-0.129	0.481	0.119	0.740°	-0.189	0.925	0.245	0.119	-0.294
Type of Technician		**0.145***	**3.012*** **	-0.025	0.556*	0.198	**1.483**	-0.022	0.231	0.637*	**1.941** **	0.149	0.449°	0.447°
Type of Quality Manager		**-0.457*** **	**-3.677*** **	-0.274	-0.557**	-0.381	**-0.597**	0.037	-0.335	-0.307	**-1.765** **	-0.237°	0.767**	0.718**

Significant at 1% (***); 5% (**); 10% (*)
Significant at 20% (°)