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Article

Sustainability Standards and the Reorganization of Private Label Supply Chains: A Transaction Cost Perspective

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Abstract: Private standards are among the main measures that can be implemented to differentiate food production. Retailers have been particularly active in setting food safety and quality systems for the development of their private labels. The purpose of this paper is to identify the effects of introducing measures that guarantee the environmental sustainability of food production on vertical dyadic relations. We focus our attention on the adoption of integrated pest management (IPM) systems that are designed by retailers to support private label products, with the aim of studying how these systems affect the governance structure of transactions between retailer and farmer/processor. Transaction cost analysis is used as theoretical framework to assess changes in vertical coordination after the adoption of an IPM system. Four case studies related to food retailers in Italy were analyzed to identify changes in transaction characteristics, costs, and governance that are related to the adoption of this system. The results show that the introduction of an IPM system leads to an increase of transaction asset specificity (*i.e.*, especially of human and material asset specificity) among the agents of the supply chain, and a decrease of the degree of transaction uncertainty. The variations in transaction characteristics determine changes in transaction costs. These changes lead to new hybrid forms of transaction governance, namely dyadic contracts, and a centralized organization of vertical relationships.

Keywords: sustainable food chains; transaction costs; case studies; IPM

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1. Introduction

The increasing consumer interest regarding the quality, safety, and sustainability characteristics of food products has led manufacturers and retailers to strongly differentiate their production in terms of intrinsic and extrinsic product attributes [1,2]. Private standards are among the main measures which can be implemented to differentiate production at the supply chain level; these standards involve all the stakeholders operating throughout the stages of the chain. Labels and certification systems can be used to provide information to consumers, so as to inform them of the food products' specific attributes [3–5]. In this way, manufacturers and retailers can differentiate their production.

Retailers have been particularly active in setting food safety, quality, and environmentally-friendly standards for the development of their private labels. For these products, retailers often adopt more complex systems that go beyond mandatory requirements in terms of standards and level of information disclosure [6,7]. Therefore, standards are becoming important instruments that can affect the governance of food chain relationships and the efficiency of vertical exchanges; these standards require a higher level of coordination among the different supply chain agents [8]. Moreover, the growth of multinational food retailers determines the spread of international standards in OECD countries, and this phenomenon strongly impacts the food system [9].

Retailers use specific standards related to private labels for several reasons: to provide quality and safety assurance to consumers; to improve the environmental sustainability of food production; to coordinate supply chain operations; to gain access to new segments of demand; to increase and defend their reputation; to complement their brands; to define niche products [9,10].

By focusing on retailer strategies designed to support private label products, this paper aims to identify the effects of measures that guarantee the environmental sustainability of food production on the vertical relations of supply chains. More precisely, we concentrate our attention on the adoption of integrated pest management (IPM) systems designed by retailers to support private label products, with the aim of studying how these standards affect the governance structure of transactions between dyads, namely the retailers-processors and retailers-farmers relationships.

Transaction cost analysis is used as a theoretical framework for analyzing changes in vertical coordination after the adoption of an IPM system. Four case studies related to important retailers operating in Italy are analyzed in order to identify variations in transaction characteristics and costs, and to highlight changes in transaction governance that are connected to the adoption of this system.

The paper is organized as follows: the legal framework and the economic issues of the IPM system are examined in Section 2; the transaction cost approach to the IPM system is presented in Section 3; methodological issues are examined in Section 4; results are described in Section 5; concluding evidence is presented in Section 6.

2. The Integrated Pest Management System: Legislation and Economic Issues

"Integrated Pest Management (IPM) is a long-standing, science-based, decision-making process that identifies and reduces risks from pests and pest management related strategies" [11]. IPM systems are among those measures used in the agricultural sector that reference the concept of sustainable development. The three perspectives of sustainability, related to economics, social justice, and

environmental friendliness, can be applied to the agricultural sector by introducing the concept of "sustainable agriculture" [12]. In this context, IPM is an environmentally-friendly approach used in crop and livestock production systems so as to efficiently control pests; the approach considers both economic and environmental dimensions [13–15]. The present paper makes reference to the economic aspects of the IPM system. Specifically, our attention is concentrated on the effects of IPM's introduction on the efficiency of vertical dyadic relationships.

With regard to the legislation of IPM products, the adoption of such a system is mainly supported by private standards elaborated and administered by various subjects of food supply chains (*i.e.*, retailers, processors, and other agents), which are controlled by a certification body or collective standards. According to the World Trade Organization classification of private standards [16], which is based on who defines and codifies the standard, individual company standards are set down by individual firms (predominantly large food retailers) and adopted across their supply chains. These standards are frequently communicated to consumers as sub-brands on retailers' private label products. The collective international standards are developed collectively by private food retailers, either through industry organizations (for example, the British Retail Consortium—BRC) or by coalitions of companies that join together for the specific purpose of standard development (for example, the Global G.A.P. standard, which concerns integrated farm assurance, livestock transport, chain of custody, *etc.*). Collective private food safety and environmentally-friendly standards are generally linked to systems of third party certification, and they are designed to be adopted by organizations in different countries. This means that the organization that applies the standard has international relationships.

At the moment, the legal framework elaborated by public authorities for the adoption of the IPM system in the EU is just limited to general principles. There are not yet any specific mandatory rules for this system. All the private standards have to respect the European legislation on pesticides, which involves: Regulation 1107/2009, which concerns the placing of plant protection products on the market, and repeals Council Directives 79/117/EEC and 91/414/EEC; Directive 2009/128/EC, which establishes a framework for Community action to achieve the sustainable use of pesticides; Directive 2009/127/EC, which amends Directive 2006/42/EC with regard to machinery for pesticide application; Regulation 1185/2009, which concerns statistics on pesticides.

Specifically, the "pesticides package" involves several aspects. First, the legislation concerning the production and licensing of pesticides gives precise instructions banning toxic chemical ingredients (because of their negative environmental or safety impacts) and regulates the licensing of certain types of pesticides for use. Second, the Directive concerning the sustainable use of pesticides emphasizes the importance of using IPM in agricultural production as an alternative to the use of pesticides, wherever possible. Moreover, the new legal framework also considers the collection of statistics on pesticides, as well as new rules for adopting machinery involved in pesticide application.

With regard to IPM production, European legislation provides general principles of IPM, which involve instructions concerning the "prevention and/or suppression of harmful organisms" through various environmentally-friendly agricultural techniques, such as crop rotation, alternative cultivation techniques, the use of resistant/tolerant cultivars, a balanced fertilization, and the protection of important beneficial organisms (Directive 2009/128/EC—Annex III).

Monitoring procedures are also among the general principles applied during the implementation of an IPM system. The Directive stresses the importance of applying adequate monitoring tools to control

harmful organisms. These tools include: "observations in the field as well as scientifically sound warning, forecasting and early diagnosis systems, where feasible, as well as the use of advice from professionally qualified advisors. Based on the results of the monitoring the professional user has to decide whether and when to apply plant protection measures (…). For harmful organisms threshold levels defined for the region, specific areas, crops and particular climatic conditions must be taken into account before treatments, where feasible. Sustainable biological, physical and other non-chemical methods must be preferred to chemical methods if they provide satisfactory pest control" (Directive 2009/128/EC—Annex III).

With regard to the economic aspects of the IPM system, the main drivers that lead retailers to adopt these kinds of systems are connected to different factors. The first driver is connected to the high interest of consumers regarding the safety, quality, and environmentally-friendly attributes of food products [17–19]. Second, the context in which firms operate is characterized by increased competition and pressure (due to the globalization of food supply) [7,10,20]. Third, the increased role of vertical coordination in reaching a high level of competitiveness creates new challenges in chain coordination and control [21–23].

The adoption of IPM private standards leads to several benefits in terms of environmental, food safety, and economic dimensions. From an environmental point of view, the adoption of an IPM system introduces extensive practices in agricultural and livestock production, which have positive effects on the environment. Moreover, the link between IPM and food safety is related to the fact that this method reduces the use of chemical residues in food products and, consequently, reduces the risk of human diseases connected to the ingestion of these substances. The implementation of IPM systems leads also to several economic benefits, which are mainly connected to consumer preferences and supply chain efficiencies.

With regard to consumers, IPM labels can introduce more information concerning the characteristics of products, and can make consumers aware of some intrinsic attributes of food products. This increased information for consumers allows them to choose products on the basis of their preferences, thus reducing market inefficiencies connected to the information asymmetry between consumers and producers [24,25].

From a chain network point of view, the implementation of an IPM system strengthens vertical relations due to different aspects: the increased information transparency concerning the quality characteristics of food; the increase of liability among agents of the food supply chain; and the introduction of new contract incentives and safeguard conditions via supply chain agreements [21,26,27].

The adoption of such systems imply different costs for chain agents, which are mainly related to the investments necessary to implement the system, and the variation of costs associated with transactions within the supply chain. In the first case, the costs refer, for example, to: the IPM software and traceability system, as well as the activity of selecting and training subjects that are able to participate in the certified supply chain. In the second case, the variation of costs for the introduction of the IPM system should be associated with the negotiation of contractual conditions and the monitoring of the IPM system [28]. The description of the transaction cost variations resulting from system implementation will be analyzed in depth in the next section.

3. IPM System and Transaction Cost Analysis

From the perspective of neo-institutional economics, IPM standards can be viewed as a set of rules that can change the governance of transactions in supply chain dyadic relations. Therefore, IPM leads to a redesign of the supply chain's vertical organization. According to North [29,30], this system can be considered as an institution that may have a significant impact on transaction characteristics and costs [27]. North conceives of an institution as a set of "humanly devised constraints that structure political, economic and social interaction. They consist of both informal constraints and formal rules".

When applying North and the theoretical framework of Transaction Cost Economics (TCE) [31,32], a change in governance structure within a supply chain after the implementation of IPM is seen as a consequence of variations in both transaction characteristics (*i.e.*, the level of asset specificity, the degree of uncertainty, and the level of frequency) and the related costs (*i.e.*, information, negotiation, and monitoring costs).

Asset specificity occurs when both the supplier and the buyer are closely bound to the transaction (as a result of facing irrecoverable specific investment costs). More precisely, the two transacting parts are linked by a strong bilateral dependency, even if the part that made the higher investment remains locked into the transaction.

The hypothesis we test concerns the reorganization of the supply chain for the application of an IPM system. We predict that such reorganization should lead to a growth of asset specificity that is connected to the higher level of bilateral dependency between dyads of the supply chain.

The degree of uncertainty stems from the inability of the participants to identify all relevant features of the exchange in order to assess *ex ante* the value of the transaction, and from the difficulty of drafting clauses that allow for redefinition *ex post*. The transaction uncertainty may derive from several factors, such as the information asymmetry between buyer and seller, the stochastic nature of some events or the bounded rationality of individuals [21]. The implementation of an IPM system should provide a decrease in the degree of transaction uncertainty because of the greater amount of information exchanged within the supply chain [27]. This transparency can be connected to: a reduction in the number of agents involved in the system; more direct relationships between farmers or manufacturers with retailers; and the increase of information exchanges along the supply chain. Moreover, a higher level of transparency tends to increase trust among the agents of the supply chain.

The frequency of transaction is related to the number of repetitions of a transaction in a given period of time. The frequency of transactions should not be affected by the implementation of an IPM system.

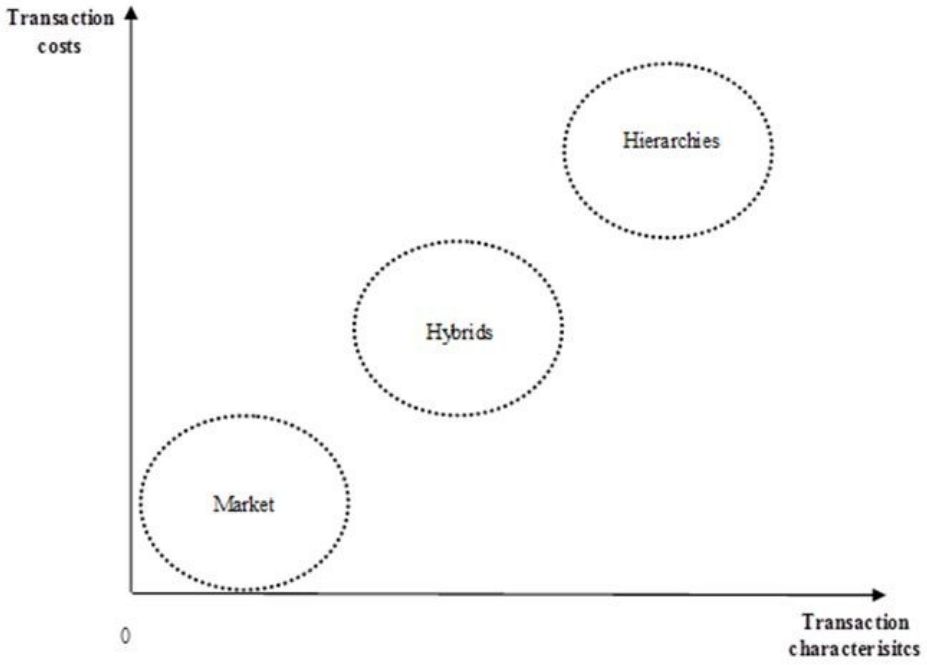
The changes in transaction characteristics should determine the variation of transaction costs, such as information, negotiation, and monitoring costs. According to Furubotn and Richter [33], "transaction costs include the costs of resources utilized for the creation, maintenance, use, change of institutions and organizations (...). When considered in relation the transfer of existing property rights and establishment or transfer of contract rights between individuals (or legal entities), transaction costs include the costs of information, negotiation and enforcement".

Information costs take place during *ex ante* bargaining and include, for example, expenditures related to the time needed for identifying the most suitable suppliers, or for collecting information concerning the price of the product/object of the exchange, as well as its features, *etc.* Negotiating costs occur during negotiation; the size of these costs depends on the degree of difficulty associated

with defining contractual conditions, such as payments, shipping, price, quality of goods or services, and so forth. Monitoring costs also arise subsequent to transaction formalization, and include all the activities aimed at verifying the maintenance of commitments made in an agreement. The monitoring costs are intended to prevent opportunistic behavior by individuals.

The modifications of both transaction characteristics and costs affect the governance of transactions in supply chains (Figure 1). In other words, the choice of organizational governance form is seen as a way of managing the costs of information, monitoring, and negotiation, and is affected by transaction characteristics. According to Barney and Lee [34], there are different criteria in making governance choices, which can also be analyzed through other complementary theories, such as real option logic and knowledge-based theories. Moreover, Leiblein [35] builds up a conceptual framework for studying organizational governance decisions; the framework is based on the assumption that the choice of governance for transactions affects both the creation and the appropriation of economic value.

Figure 1. The governance structure of supply chains.



Williamson [36] pinpoints three main modes of transactional organization: market, hybrid forms (contracts), and hierarchy (vertical integration).

The market relies on price and competition to coordinate transactions, whereas hierarchical contracts refer to administrative controls that coordinate transactions [37]. Generally, TCE assumes that the market provides a more efficient mechanism for managing transactions than hierarchical solutions, even if certain situations increase the costs of market exchange and make it necessary to move toward more integrated forms of transaction governance. These situations are mainly connected to the risk of opportunistic behavior of economic agents that, in a context of bounded individual rationality, is affected by the level of transaction asset specificity (*i.e.*, with respect to the site, physical, human, temporal, and brand name asset specificity) or uncertainty (e.g., uncertainties concerning the market, suppliers or technology) [35].

Focusing on asset specificity, empirical research has provided strong and consistent support for the theorized relationships between transaction asset specificity and the governance of vertical relationships [38–41]. When no asset specificity exists among economic agents, the high transaction costs connected to hierarchy place the hierarchical approach at a disadvantage compared to the market approach. However, the cost differences between markets and hierarchy narrow as asset specificity builds up. Moreover, hybrid forms are viewed as contracting modes of organization that are used when asset specificity among the economic agents exists, but transaction costs are not high enough to justify the cost of hierarchies. In this case, specific provisions are set up in order to control the opportunistic behavior of economic agents.

The literature has differentiated different types of hybrid forms of transacting, depending on the transaction characteristics, as either formal contracts or verbal agreements [36]. In the food chains, it is possible to distinguish a variety of hybrid forms of transacting with different levels of vertical coordination. According to Fischer *et al.* [42], these forms include: relational contracts, written contracts, and cross-sharing holding arrangements. Another form is represented by inter-professional agreements.

Relational contracts are based on repeated exchanges between economic agents; trust and reputation play an important role in this organizational form. In the written contracts, the conditions of the agreement are formalized with a precision level depending on the information available and the contract life; this agreement has legal effects. In cross-sharing arrangements, the economic agents involved in the exchanges are independent but they share ownership rights [42,43]. Moreover, inter-professional agreements refer to framework agreements, signed by producer organizations and industry confederations, aimed at establishing the general conditions of economic exchange in a specific sector.

According to the literature, the choice of governance structure for vertical relationships and quality labels are inter-related. Avezedo and Santos Silva [44] investigated the variation of vertical coordination after the introduction of a private brand supported by franchising. Moreover, Gonzalez-Diaz *et al.* [45] and Raynaud *et al.* [43] study the relations between the governance of vertical chains and the introduction of different quality labels. Raynaud *et al.* find in their empirical results that the supply chain governance structure is influenced by the type of quality label chosen. More precisely, quality labels based on reputational capital are more likely to be associated with hybrid forms or vertical integration, whereas those based on public certifications (like PDO, for example) look to market-like institutions as possible solutions for coordinating vertical relationships.

Based on this theoretical conceptualization of transaction organization, we expect that the introduction of an IPM system should lead to the reorganization of dyadic relations from market forms to hybrid forms of exchange. These hybrid forms involve the adoption of contracts between farmers or manufactures with retailers. The new organization of dyadic relations appears more efficient and allows long-term interactions. According to Gulati and Singh [46], this governance form represents a sort of contractual, strategic alliance that embodies a certain degree of hierarchy; the form is characterized by a greater extent of control and coordination (compared to market forms).

Nevertheless, the study presents some limitations connected to the theoretical framework used for analysis. Transaction cost economics mostly focuses on interdependencies within dyads, whereas those across dyads are not considered [47]. This means that the descriptive analysis is mainly focused on the interpretation of organizational behaviors between supplier (*i.e.*, the farmer or processor) and the supply chain leader (as represented by retailers).

4. Method

4.1. The Research Design

As we mentioned before, the study is focused on the analysis of the effects of environmental sustainability standards, namely those incident to IPM, on the vertical organization between dyads within food supply chains. Specifically, we consider the dyadic relations between retailers and farmers, and between retailers and processors. We choose TCE as our theoretical approach for understanding and explaining changes in supply chain organization.

The main hypothesis we test in the empirical analysis concerns the idea that the introduction of sustainability standards leads to a modification of transaction characteristics and costs in dyadic relations. The empirical investigation is concentrated on the identification of variables that can be associated with the variation of transaction characteristics and costs (after the introduction of said sustainability standards).

We expect an increase of transaction asset specificity. This is connected to the fact that for the implementation of IPM systems, the suppliers (*i.e.*, farmers or processors) have to make specific investments to implement both the pest management system and, often, the traceability system connected to the application of IPM standards. Specific adjustments in the production process are required, especially at farm level (e.g., with respect to chemical input reduction, crop rotation, alternative cultivation techniques, the use of resistant/tolerant cultivars, balanced fertilization, *etc.*). Also, new procedures must be applied in order to collect and process information concerning processes and products. Moreover, new skills are required for suppliers, and training activities are necessary to implement the system. On the other side, the retailers are involved in the selection of suppliers able to guarantee the correct execution of IPM standards. These elements lead to an increase of bilateral dependency between the agents of the supply chain (in our case between farmers/processors and retailers). Consequently, the retailers experience increased switching costs that reflect the greater difficulty of finding substitute suppliers. The implementation of these standards should also lead to a growth in the level of collaboration and trust in the dyadic relations.

With regard to transaction uncertainty variation, the implementation of IPM standards should lead to a higher level of transparency in dyadic relations. This is due to the increase of information exchanged in transactions (*i.e.*, information asymmetry would be reduced).

Concerning transaction costs, the implementation of an IPM system should bring about variations in transaction costs. These costs include information costs (for example, the time needed to select suppliers), negotiating costs (for example, the time needed to negotiate new contract conditions), and monitoring costs (for example, the costs needed to control the compliance of processes with the rules established).

The increase of bilateral dependency, and the changes of transaction costs, should determine a variation in transaction governance incident to the application of IPM standards. Consequently, new forms of transaction governance would be introduced to reduce transaction costs (namely hybrid forms). These forms are generally written contracts concerning dyadic relations between retailers and farmers, or retailers and processors.

Our analysis is focused on retailers' private labels. We utilized case study research in order to investigate the main changes related to vertical coordination that result from the introduction of an IPM system. The exploratory nature of our analysis justifies the small number of cases studied. We selected four case studies, which represent different typologies of retailers, and which all play important roles in the Italian market. Two of the cases involve national retailers (cases A and B), and the other two involve multinational firms, one of which is a discount business (cases C and D).

In our analysis, we involved the product managers of the chosen retailers. To conduct the analysis, we selected those private labels that are oriented toward the adoption of an IPM system. The choice of concentrating our attention only on private labels is twofold. First, private labels represent an important part of the products present on the market. In 2010, their market share was around 24% for fresh and frozen products, and 18% for packaged food [48]. Second, the adoption of an environmentally-friendly system for private labels means that retailers will engage in a reorganization of vertical relationships within the supply chain; such reorganization should determine important variations in vertical coordination.

We conducted face-to-face interviews to study the dyadic relations in the supply chain of private label fresh products. The questionnaire was structured with open answers in order to capture the variables that better describe the variations related to transaction characteristics and costs, as well as the organizational adjustments in the partners of the supply chain that resulted from the introduction of an IPM system. With the interviews, we tried to capture similarities and differences among the retailers in relation to the effects on governance forms incident to implementing an IPM system.

After a brief description of the general aspects of the retailers, and of the private labels adopted by them, the case study analysis focuses on changes in transaction characteristics due to the introduction of IPM, in terms of asset specificity and uncertainty. With regard to asset specificity, questions investigate changes in human, geographical, and material asset specificity (*i.e.*, supplier selection activity, training personnel, difficulty in supplier substitution, changes in collaboration and trust degree in vertical relations, implementation of traceability, and implementation of IPM standards). Concerning the transaction uncertainty, questions refer to the increase of information flow in the dyadic relations of a supply chain (*i.e.*, the reduction of information asymmetry). Afterwards, the analysis investigates the variations in transaction costs, in terms of information (for example, the time needed to select suppliers), negotiating (for example, the time need to accomplish negotiation), and monitoring costs (for example, the costs needed to verify supplier production process, and the cost needed to monitor the system). The last part regards the changes in the governance structure of the supply chain due to the adoption of the IPM system.

4.2. The Case Studies

Case A concerns one of the largest Italian retailers. It was founded at the end of the fifties, and it has more than a hundred different stores in Italy, which are subdivided into supermarkets and superstores. The retailer's main strategy is to offer a variety of high-quality food products and to promote the sustainability of food production. This retailer has four different private labels. One label specifically refers to conventionally processed food. Another label sorts products with specific sensorial features and renown within the Italian culinary tradition; examples include fresh pasta, olive

oil, fish, jam, butter, pizza, chocolate, and other products of the confectionery industry. The third label relates to organic farming, and provides both fresh and processed food products. Finally, the last private label sets a specific quality and environmentally-friendly scheme, and implements an IPM system for products such as beef and chicken, fruits and vegetables, fish, and eggs. The diverse private label product lines have different quality assurance schemes. Case A referred to the last private label described.

Case B concerns a retailer that aims to create a strong collaboration between food producers/processors and consumers. The retailer has different products with private labels, which represent more than 25% of the total food turnover. The private labels include several quality attributes of products. One identifies those Italian products with a special gastronomic heritage. Another one refers to those products that use fair trade as a distribution channel. The third refers to organic products, whereas the fourth comprehends those food products that can have healthy effects. The fifth identifies products characterized by a low price range, and the sixth one refers to products for babies. There is also another label which has been present on the market since the end of the eighties, and represents all the products of the retailer that have been produced with an IPM system. To implement this system, all the products are traced through voluntary certification, which assures specific controls concerning all supply chain agents and the safety attributes of their food products. This private label is applied to the following products: fresh fruit and vegetables, fresh meat (*i.e.*, chicken and red meat), and eggs. For fresh fruit and vegetables, this private label refers to those products with an environmentally-friendly production process, which saves until the 70% of chemical matters. For meat and eggs, the standard and label scheme assures safe feeding rules. For example, the scheme assures that the food is GMO free, lacks animal protein and fats, is free of coloring, and that any meat comes from animals that are extensively reared.

Case C refers to a multinational retailer operating in Italy. The retailer has different private labels. The first identifies the label for organic products. The second one comprehends specialties, which have specific flavors and higher price ranges (compared to the average price of similar products). The third identifies basic food with the lowest price. The fourth refers to local products, and the fifth, to those products that use fair trade principles for production and distribution. The sixth identifies products for babies. In addition to these private labels, there is one which has been created to guarantee the highest degree of food safety and quality, and implements an environmentally-friendly scheme. The products which have this private label are fresh products (e.g., fresh meat, fruit, and vegetables). The IPM system is adopted for producing and processing these products; all the steps of the supply chain are characterized by a sophisticated traceability system. For meat, this label assures specific feeding rules and extensive breeding. For fruit and vegetables the production is based on procedures that guarantee environmental sustainability and a high level of food safety.

The last case study (case D) refers to a discount operation within Italian territory. The retailer has many private labels, one of which concerns organic products, while others concern healthy food, and products that use the fair trade principles in production and distribution. No private labels are connected to products that make use of the IPM system during production. However, the retailer is certified by GLOBALG.A.P, which is a certification aimed at conforming producers to standards of food safety, sustainable production, responsible use of water, worker health and safety, and animal welfare. GLOBALG.A.P requires, among other things, an approach to farming aimed at building good practices in production to preserve the environment for generations to come. This approach includes

the most responsible use of chemicals in food production. It also means careful pest control management through techniques that involve IPM standards.

In all cases analyzed, the IPM system is applied to undifferentiated and fresh products (e.g., fruits and vegetables, meat, *etc.*). The main reason for this strategy is to enable the retailer to differentiate products in terms of sustainability, safety, and quality assurance.

5. Results

The interviews revealed some interesting aspects related to the effects of IPM system introduction on vertical relationships within supply chains (Table 1).

With regard to the changes in transaction characteristics, in the systems implemented to guarantee a sustainable production (*i.e.*, cases A, B, C) the analysis has shown an increase in asset specificity and a decrease in transaction uncertainty. The positive relationship with asset specificity is due to the higher bilateral dependency among supply chains agents. The increase of bilateral dependency among the agents of the chain is mainly due to:

- the activity of supplier selection;
- the training of selected suppliers;
- the investment needed for IPM implementation.

The retailer has two main tasks for the supplier's selection. On one hand, the retailer has to select those suppliers that can guarantee established quality and quantity levels [49]. On the other hand, the retailer must be sure that the supplier puts the effort required to produce on the basis of IPM standards. Indeed, important factors that affect supplier selection are firm size and entrepreneurial capability. Supplier selection and the process of adaptation to a new standard can take a long time (e.g., between 6 and 12 months). If the retailer judgment is positive, the retailer may actively support the supplier in the adjustment process, so as to help the supplier implement pest management rules by providing specific training.

Once the suppliers are selected, the agents invest in instruments, which allow them to manage and control IPM products. The adoption of an IPM system necessitates the implementation of software that is able to manage the rules related to IPM production, as well as a traceability system that would allow for a precise management of the batches along the supply chains. These adjustments allow the retailer to better monitor the activities of the supply chain agents. The respondents stated an increase of collaboration between retailer and suppliers, a growth of trust, and a higher difficulty in supplier substitution.

With respect to transaction uncertainty, the respondents stated that the implementation of the IPM system leads to a lower degree of uncertainty (as a result of the new rules in the production processes and the consequent higher flows of information exchanged).

Table 1. The effects of an integrated pest management (IPM) system on transaction characteristics, costs, and vertical coordination.

IPM products		Variation of transaction characteristics		Variation of transaction costs			Variation of vertical coordination	
		Asset specificity (+)	*Transaction uncertainty (-)*	*Information*	*Negotiating*	*Monitoring*	*Coordination variation*	*New hybrid forms*
A	Fruits and vegetables; fresh meat; processed pork meat; fish; cheese (Grana Padano, Bufala campana)	Selection of suppliers; training personnel; increase of collaboration; implementation of traceability; implementation of pest management system	Reduction of information asymmetry	Time to select suppliers	Time to accomplish negotiation between retailer and suppliers	Cost to verify supplier production process; cost to monitor the system	Centralisation of vertical relationships; increase of supplier liability; product rule enforcement for suppliers; price incentives	Dyadic contracts
B	Fruits and vegetables; fresh meat; eggs	Increase of collaboration; increase of trust; difficulty in supplier substitution; implementation of traceability; implementation of pest management system	Reduction of information asymmetry; more efficiency in product recalls	Time to select suppliers	Time to accomplish negotiation between retailer and suppliers	Cost to verify supplier production process; cost to monitor the system	Centralisation of vertical relationships; increase of supplier liability; incentives connected to longer contractual terms; price incentives	Dyadic contracts
C	Fruits and vegetables; fresh meat; fish	Selection of suppliers; implementation of traceability; implementation of pest management system	Reduction of information asymmetry	Time to select suppliers	Time to accomplish negotiation between retailer and suppliers	Cost to verify supplier production process; cost to monitor the system (ex-ante, during processing, on final product)	Rule enforcement; price incentives	Dyadic contracts
D	Fruits and vegetables; milk; chocolate; tea; orange juice; sugar		Higher transparency along the supply chain			Cost to verify supplier production process		

An increase in transaction asset specificity increases the transaction costs between a retailer and its selected suppliers. The interviews highlighted the increase in information, negotiation, and monitoring costs. With regard to information costs, the retailers make reference to the time spent for the suppliers' selection. Negotiating costs arise in connection with the time spent to negotiate the new production conditions, such as the quantity to be produced and the price of "sustainable products". Monitoring costs relate to the expenditure faced by the retailer for implementing IPM system controls. The implementation of an IPM system necessitates a considerable amount of monitoring activity by the retailer, both *ex-ante* and *ex-post*. The *ex-ante* monitoring refers to all activities carried out by the retailer in order to assess the firms' ability to perform the contract. The *ex-post* monitoring considers all controls the retailer plans in order to verify the accuracy of the procedures.

With regard to the governance structure of transactions along the supply chains, the implementation of the IPM system leads to a variation in dyadic relations, mainly with respect to:

(a). new hybrid forms (*i.e.*, namely dyadic contracts);
(b). centralized organization of vertical relationships.

The first one concerns the rules incident to implementing an IPM scheme, which guarantee the introduction of agricultural practices oriented toward protecting the environment. With these new organizational forms, new responsibilities for the supply chain agents and specific controls are established. Through dyadic contracts, a new formalization of all specific rules of IPM production and new contractual conditions that are related to the price and the suppliers' and retailers' liabilities are provided. Thanks to this new form of transacting, the uncertainty of transacting is reduced by an augmentation of the information formalized by the agreement.

The second refers to the purchasing strategy for private label products, which involves a centralized mode of supply chain relationship organization. The centralization of the IPM system results in retailers assuming a leadership role within the supply chain. This means that the retailer has to manage the activities of the other agents, design the dyadic contracts, coordinate the information, and arrange the controls [27].

6. Conclusions

IPM standards are one of the most important tools guaranteeing the sustainability of food production at the international level. Nevertheless, diverse schemes are available in different countries. In our analysis, IPM systems are private standards, and in most of the cases, are individual company standards that are set down by retailers for their private label products. The survey we conducted revealed in most of the cases that the implementation of an IPM system entails a reorganization of supply chains.

Through the case studies presented in this paper, it was possible to identify the main changes in transaction characteristics, costs, and vertical coordination that result from implementing an IPM system. Results show that the introduction of this system leads to a growth of the bilateral dependency due to an increase of asset specificity among supply chain agents and a reduction of the degree of transaction uncertainty, related to the increased transaction transparency. The bilateral dependency results in mainly two specificities: human asset specificity (*i.e.*, the activity of supplier selection, the training of selected suppliers, the difficulty in supplier substitution, the increase of collaboration and

trust in the dyadic relation between retailer and farmer/processor, *etc.*) and material asset specificity (*i.e.*, the investment needed to implement an IPM and traceability systems).

The variation in transaction characteristics leads to changes in transaction costs, such as information costs, which are primarily connected to the time needed to select suppliers for the IPM system. The retailer looks for suppliers that are able to respect the conditions imposed by the system and to comply with retailer's requirements.

The implementation of such a system also leads to higher negotiating costs that are related to the time spent to accomplish negotiations between retailers and suppliers, and for the elaboration of new contractual conditions. Moreover, introducing an IPM system entails monitoring costs. Such costs are related to controls that the retailers have to face both *ex ante*, *i.e.*, during the processing, and *ex post*, *i.e.*, on final products.

Therefore, the main hypothesis of the study is verified. The analysis has shown that the IPM system implemented by retailers for private labels modifies the governance structure of the dyadic relations in supply chains. The changes in transaction characteristics and costs lead to hybrid forms of transaction governance (namely dyadic contracts). As the degree of bilateral dependency between farmer/processor and retailer is quite high, the dyadic relations are based on written contracts, where the conditions of the agreement are expressed. According to the literature, dyadic contracts for the adoption of IPM standards are similar to the hybrid forms linked to private quality labeling schemes where reputational capital plays an important role.

The dyadic contracts involve organizational adjustments among partners and a centralized organizational form for vertical relationships. The retailer becomes the leader of the supply chain, and manages the IPM system by verifying that standards are properly applied.

Important implications of the results highlighted by our analysis concern the stability over time, the strong vertical coordination, and the efficient organization of the dyadic relations in supply chains designed to apply these kinds of environmental sustainability systems. These may generate advantages for the different agents of the supply chains, including farmers and small manufacturers. Nevertheless, a critical point can be the strong market power of the retailers that promote this system.

The benefits of long-run relationships involve both retailer and farmer/processor. The advantage for the retailer concerns the availability of a set of selected suppliers that guarantee compliance with IPM standards and multiple trading conditions, such as food safety and quality requirements, the established quantity of product, the certainty of price and cost, and so on. These features play a fundamental role for private label products, as the retailer particularly cares about the reputation of these kinds of products and their brand image.

On the other side, the benefits of long-run relations for the farmer and for the small processor can be connected to certainty of production trading, the knowledge of the marketing price, the efficiency of the production process, the innovative technology applied, and so on. Therefore, even though the dyadic relations between retailer and farmer/processor are characterized by an imbalance of market power due to the retailer's large size, a sort of economic balance can exist in the trading relations for both transacting agents; both can benefit from the advantages of long-term relations.

Future studies should verify these results on a larger sample of supply chains, and test the economic benefits for farmers and small processors (as revealed through empirical analyses). Moreover, future research may be focused on the study of the interdependencies across dyads in order to study

organization mechanisms at the chain level, and verify whether the results supported by transaction cost literature are confirmed through a wider set of interdependencies.

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Conflicts of Interest

The authors declare no conflict of interest.

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