ARTICLES

MUTUAL COMMITMENTS IN TRANSACTIONS OF HORTICULTURAL PRODUCTS IN THE SERRA FLUMINENSE

Compromissos mútuos nas transações de hortícolas na serra fluminense

Compromisos mutuos en las transacciones de productos hortícolas en la Sierra Fluminense

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ABSTRACT

This article aims to identify the factors that explain the establishment of mutual commitments between the small farmers growing horticultural products and their buyers in the Brazilian region of Serra Fluminense. It uses the theoretical framework of transaction cost economics to analyze 567 transactions performed by a sample of small farmers in seven Brazilian municipalities. The empirical study starts from previous research to construct a variable that captures two types of transactions; in the first type, the buyer provides inputs or technical assistance to the farmer, whereas no such commitment exists in the second. The descriptive statistics and a logit model show that transactions "with mutual commitment" are associated with a higher level of asset specificity and a broad set of coordination routines. Further, the building of trust emerges as a fundamental coordination mechanism even in transactions that are "without mutual commitment."

KEYWORDS | Economic organization, coordination of transactions, family farming, horticultural products, hybrid forms.

RESUMO

O objetivo deste artigo é identificar os fatores que explicam o estabelecimento de compromissos mútuos entre os agricultores familiares e compradores de produtos hortícolas na Região Serrana do Rio de Janeiro. Para tanto, analisa 567 transações referentes a uma amostra de agricultores familiares baseados em sete municípios. A Economia dos Custos de Transação (ECT) é usada como marco teórico. O estudo empírico parte da construção de uma variável que divide as transações em dois grupos. No primeiro grupo, intitulado "com compromisso", o comprador fornece insumos ou assistência técnica ao produtor. Já no segundo grupo, intitulado "sem compromisso" inexiste tal comprometimento de conhecimento e recursos. Estatísticas descritivas e um modelo logístico (logit) binário mostram que transações "sem compromisso" se caracterizam por um maior nível de especificidade do ativo e um amplo conjunto de rotinas de coordenação. Por sua vez, a construção de confiança emerge como um mecanismo de coordenação fundamental mesmo naquelas transações "sem compromisso."

PALAVRAS-CHAVE | Organização econômica, coordenação de transações, agricultura familiar, produtos hortícolas, formas híbridas.

RESUMEN

El objetivo de este artículo es identificar los factores que explican el establecimiento de compromisos mutuos entre agricultores familiares y compradores de la región serrana de Río de Janeiro. Para ello, se analizaron 567 transacciones referentes a una muestra de agricultores familiares de siete municipios de la región. La Economía de los Costos de Transacción fue el marco teórico utilizado. El estudio empírico usó una variable capaz de identificar dos grupos de transacciones: mientras en el primer grupo el comprador ofrece insumos o asistencia técnica a los productores, en el segundo grupo tal compromiso no existe. El análisis estadístico muestra que transacciones "con compromisos mutuos" poseen un nivel más alto de especificidad del activo, además de un conjunto más amplio de rutinas de coordinación. Por su parte, la construcción de la confianza es un mecanismo de coordinación fundamental tanto para transacciones "con compromisos mutuos" como para transacciones "sin compromisos mutuos."

PALABRAS CLAVE | Organización económica, coordinación de transacciones, agricultura familiar, hortalizas, formas híbridas.

INTRODUCTION

Since 1970s, a modernization process has transformed the agribusiness chains of several developing countries (Reardon & Timmer, 2012). The progressive diffusion of contractual arrangements has supported the exchange of technologies used in production, as well as the sharing of management approaches and risk (Zylbersztajn, 2005). Specialized staff members – either in-house or outsourced – transfer technologies and monitor the activities of suppliers. To some extent, these changes replicate the diffusion patterns of contractual arrangements that are found, for example, in the United States and Western European countries (James, Klein, & Sykuta, 2011). However, it is clear that the ability to replicate a similar organizational architecture in diverse societies is possible only if supported by the institutional framework or adopted by farmers who are fully capable of using such arrangements (Henson & Reardon, 2005; Humphrey, 2007; Miranda & Chaddad, 2014). In this sense, the emergence of novel organizational arrangements between buyers and producers is tantamount to the establishment of particular patterns of relationship. Arms-length transactions, such as those carried out in the spot market that are therefore devoid of long-term commitments, have been replaced by creative solutions that enable the sharing of resources and an economic relationship over extended periods of time (Bijman, 2008; Otsuka, Nakano, & Takahashi, 2016).

In the Brazilian market of horticultural products, the typical relationship between family farmers and buyers has been embedded through strong ties that support the diffusion of relatively strict patterns of coordination (Carvalho, Costa, & Souza, 2014). Given the bilateral dependence between farmers and buyers, which is often asymmetric, the relationship is characterized by the building of trust. Both sides establish a series of routines, such as the sharing of production and management techniques, determining how to monitor quality, setting the price, devising rules for the delivery of products, and so on (Souza Filho & Bonfim, 2013; Souza & Scur, 2011). To achieve these common goals, family farmers and buyers often design hybrid forms in which participants address the fundamental challenge of sharing resources while maintaining some degree of independence from others (Ménard, 1996; Williamson, 1991).

Hybrid forms can take the form of diverse configurations (Ménard, 2018; Martins, Trienekens, & Omta, 2017; Ménard, 2004). In the case of horticultural products, arrangements enable the provision of inputs and technical assistance from buyers – even in the case of middlemen – or a more complex pattern of coordination under the leadership of supermarket chains or processing companies (Bignebat, Koç, & Lemeilleur, 2009; Bonfim, Souza Filho, & Silva, 2003; Carvalho et al., 2014). It is true that most of these arrangements have features that resemble the organizational forms typically found in the spot market. Nevertheless, the consolidation of bilateral dependence ties and commitments to particular transactions have motivated the construction of more complex organizational forms (Ménard et al., 2014). Hence, the research question that inspires this paper is: *what are the factors that explain the adoption of hybrid organizational forms in the transactions between small horticultural producers and buyers?*

This article aims to identify the factors that determine the characteristics of the hybrid forms used in transactions between family farmers from the *Serra Fluminense* region and their buyers. In this sense, this study builds on several recent efforts that allow a better understanding of the organizational complexity that exists in the Brazilian agricultural sector (Chaddad, 2017; Ménard et al., 2014). In the next few pages, we share the conclusions from the analysis of a sample comprising 576 transactions carried out by family farmers from the *Serra Fluminense* region in the Brazilian state of Rio de Janeiro. The *Serra Fluminense* region surrounds one of the largest metropolitan areas in Brazil, and has a population of approximately 12 million people. Descriptive statistics and a logistic model (*logit*) show that transactions "with commitment," that is, transactions in which the buyer provides inputs or technical assistance to the farmer, are characterized by a higher level of asset specificity and a broad set of coordination routines. At the same time, trust building emerges as a fundamental coordination mechanism, even for those transactions that are "without commitment."

THEORETICAL FRAMEWORK

Transaction cost economics (TCE) is the approach traditionally used to explain the configuration of diverse organizational forms in agribusiness systems (Zylbersztajn, 2017; Cook, Klein, & Iliopoulos, 2008; Masten, 2000). According to Williamson (1991), economic agents choose governance structures that are aligned with the features of the transaction to be carried out. Three dimensions are considered: the level of specificity of the assets used in the transaction, the frequency, and the level of uncertainty. The same contribution describes three basic forms of coordination, which are supported by particular governance structures. These are as follows:

- spot market: option used for transactions without specific assets, in which agents have no intention of maintaining the relationship over time. In spot market transactions, the identity of the parties is irrelevant – therefore, the selection of new partners can occur without major costs. Buyers and sellers do not have a bilateral dependence, adjustments in the terms of the transaction ensue from the powerful incentives furnished by the price mechanism and monetary rewards and the contractual relationship tends to be strictly interpreted according to legal principles;

- vertical integration or hierarchy: this form is used in transactions with highly specific assets. In this case, the transactions are carried out within the boundaries of the firm. Vertical integration provides a flexible alternative for the attenuation of disturbances. The implicit contract that characterizes a hierarchy is that of forbearance: disputes are settled within the boundaries of the firm, since the firm has mechanisms that are analogous to an appeals court;

- hybrid forms: represent a heterogeneous set of arrangements, established to allow the common use of resources that belong to independent individuals or firms (Ménard, 2004). In the hybrid forms, cooperation through the establishment of a contract does not eliminate competition among the parties. For example, farmers might create a hybrid form to support a certification scheme and simultaneously compete in the market (Ménard, 1996). According to Williamson (1991), neoclassical contracts are typically found in a hybrid form, given the growing importance of the identity of the parties. Neoclassical contracts favor the continuity of the relationship and adaptability in case of unanticipated disturbances, thereby enabling ex-post adjustments.

In fact, a central issue in the literature is the role of hybrid forms in the promotion of a coordination action between independent individuals and firms that own diverse bundles of knowledge and resources (Ménard, 2004). The autonomy of the parties requires the establishment of an explicit form of coordination, the authority – that is, the explicit delegation of decision rights to the parties with a greater ability to determine a particular course of action (Ménard, 1996). In this sense, the influence of the price mechanism on the decision-making process in a hybrid form tends to be slower than that of price incentives on a typical spot market transaction. In a hybrid form, choices depend on a complex network of mutual commitments that lead to the distribution of decision rights within the hybrid form.

Contracts in a hybrid form can be formal. In this case, controversies can be evaluated by appeals courts. Nevertheless, hybrid forms can also be embedded in informal agreements, such as tradition and the progressive building of reputation, factors that may reduce the possibility of an opportunistic action (Uzzi, 1997). Although contracts may be based on consolidated legal principles, Williamson (1991) contends that formal agreements are necessarily incomplete. This is because the clauses of a contract cannot anticipate all potential consequences resulting from the establishment of an economic relationship. Together with the pervasiveness of uncertainty, the threat that the parties in a contract might seek short-term interests increases the importance of coordination mechanisms. In this sense, coordination implies the definition and operation of mechanisms – economic, regulatory, and contractual incentives – that efficiently reduce conflicts and contradictions. In other words, the parties should aim to establish governance structures that reinforce the incentives of agents to act in accordance with common strategic goals. At the same time, the maintenance of structures should not imply an excessive burden; that is, governance costs should be minimized.

Several studies analyze the adoption of hybrid structures in horticultural transactions in Brazil. Faulim and Azevedo (2003) identify the broad use of informal contracts between buyers and horticultural famers in São Carlos (São Paulo). The perishable nature of horticultural products, which leads to investments in specific assets by farmers and a high uncertainty level, also demands the building of trust over time for the stability of commercial relationships (see also Carvalho et al., 2014). Given the growing influence of certification on the measurement of the attributes of horticultural products, Cunha, Saes, and Mainville (2015) argue that the features of the institutional framework play a fundamental role in the widespread use of informal contracts in the sector. In an analysis on the exchange of organic iceberg lettuce, Saes, Schneider, and Souza (2014) describe the coexistence of diverse contractual models in the supply chain. The study shows that although a formal contract is rare in the organic iceberg lettuce sector, commitments, such as the promise of purchase, are offered to a set of exclusive suppliers. As a result, buyers aim to increase the predictability in the organic iceberg lettuce market, facilitating the equilibrium of supply and demand.

METHODS

Sample and data collection

The empirical research of this paper adopts a positivistic approach (Saccol, 2009) based on the collection of information through a survey. The analysis uses descriptive statistics and an econometric model with a qualitative dependent variable. Primary data were collected between May and July of 2015 from family farmers living in seven municipalities of the *Serra Fluminense* region. We use the definition of "family farmer" found in Law n. 11,326/2006, which relies on four elements: the area of the farm should not exceed four fiscal modules; the labor force must be provided mainly by family members; the family income must derive mostly from agricultural activities on the family farm; and the farm must be run by the farmer or other family members. The probabilistic sample comprises 262 family farms, which were randomly selected from a list of family farmers provided by farmers' associations in each of the seven municipalities. We used the criteria of regional stratification to define the probabilistic sample. Table 1 presents the distribution of the sample and the population of the family farmers from each city, according to the Agricultural Census of 2006 (IBGE, 2006). The sample's error is 6.07% if an infinite population is considered, and 5.98% for a finite population.

Table 1. **Number of family farms according to the Agricultural Census of 2006 and sample**

Municipalities	Population*	Sample
Cachoeiras de Macacu - RJ	1,049	31
Nova Friburgo - RJ	1,348	40
São José do Vale do Rio Preto - RJ	329	10
Sapucaia - RJ	486	14
Sumidouro - RJ	2,346	69
Teresópolis - RJ	2,569	76
Trajano de Moraes - RJ	739	22
Total	8,866	262

* Data from the Agricultural Census (Brazilian Institute of Geography and Statistics, 2006).

A structured survey was applied to the probabilistic sample of farmers. On-site interviews resulted in the collection of information regarding transactions, buyers, farmers, and the rural establishment. We began with the assumption that farmers could sell the products of their harvest to more than one buyer. Likewise, we assumed that transactions with the same buyer could have diverse features or involve different products. Obviously, such scenarios would imply the collection of a considerable amount of data. For example, a farmer who sells four diverse products to three buyers could have carried out as many as 12 transactions. Given the time constraints for the interviews, we decided to simplify the data collection process. Two decisions were made in this regard:

- For each family farmer, only the information on the two main buyers was collected – considering the period between May 2014 and April 2015. Each farmer identified the type of buyer, the number of years in which the farmer negotiated with the same buyer, the motivations for establishing the negotiation, and the advantages and primary problems of the relationship.

- Only the information on the two most representative products sold to each of the buyers was collected. Hence, a farmer provided information on four transactions at most – two for each buyer. For each transaction, the farmer identified the horticultural product, the percentage of the harvest acquired by the buyer, consignment sales, the timing of the negotiation, the timing of pricing, the payment deadline, and the nature of the contractual agreement – i.e. a formal contract or an informal agreement.

The total number of transactions in the sample is 576, which corresponds to 18,867 transactions in expanded value for the population, according to the weights adopted in the sample design (see Table 2). The sample contains 44 horticultural products, with 11 products representing 70% of the transactions. The most representative products in the sample are lettuce (17.5%), tomato (10.3%), and broccoli (9.7%).

Table 2. **Number of transactions according to type of commitment and respective groups**

		Groups		
		Without commitment	With commitment	Total
Upfront payments	Expanded	17,448	1,419	18,867
	Sample	525	42	567
Inputs	Expanded	0	1,153	1,153
	Sample	0	34	34
Technical assistance	Expanded	0	499	499
	Sample	0	15	15
Inputs and technical assistance	Expanded	0	233	233
	Sample	0	7	7
Inputs and/or technical assistance	Expanded	0	1,419	1,419
	Sample	0	42	42

Analysis variables

To carry out the empirical analysis, we constructed a dependent variable to identify two groups of transactions. The first group contains transactions in which some degree of bilateral dependence between the farmer and the buyer exists. We assumed that this dependence reflects mutual commitments based on the sharing of resources to carry out the transaction. It is true that every farmer invests resources – land, capital, or labor – with diverse specificity levels in a transaction. In this sense, the establishment of a significant bilateral commitment occurs whenever the buyer allocates specific resources – in particular, knowledge – before the materialization of the transaction.

Data collected in the on-site interviews showed that a set of farmers received inputs or technical assistance from buyers. Hence, a variable that indicates the commitment of resources by buyers was created. We assumed that farmers who received at least one of these types of resources established a commitment with a particular buyer; that is, they deployed other resources, such as capital, land, and labor, to carry out a specific transaction. Consequently, we observe the establishment of arrangements

based on mutual commitments, a necessary condition for the emergence of a hybrid form between parties that, although independent, share an intermediate level of interdependence (Ménard, 2004; Williamson, 1991). In turn, the second group encompasses transactions in which the buyers did not furnish inputs or technical assistance. In this case, the assumption was that transactions without a mutual commitment of resources have features that are typical of a spot market exchange.

The dependent variable defined above is used to identify the existence of a hybrid form of governance. This dependent variable is called "with commitment" and assumes a value of 1 if the transaction was carried out with a buyer who provided inputs or technical assistance and a value of 0 in cases characterized by the inexistence of resources or knowledge shared with family farmers. A binary logit model is used to analyze the pattern of adoption of mutual commitments, considering the level of asset specificity observed in each transaction and the socioeconomic data from respondents. The group of transactions without the sharing of specific resources is called "without commitment." Out of a total of 576 transactions, 42 belong to the "with commitment" group; that is, the buyer furnished inputs or technical assistance.

Descriptive statistics and the binary logit model

The two groups of transactions are compared with the goal of identifying their main peculiarities. Descriptive statistics (frequencies, averages, and hypotheses testing) and a binary logit model are used. Binary logit models are commonly used to explain the probability of a given decision or the occurrence of an event. For instance, several papers that study the organization of transactions in the South American agricultural sector use the same method to explain the adoption of different contractual arrangements, including hybrid forms (Mello & Paulillo, 2009; Souza Filho & Paulillo, 2005; Vinholis et al., 2014). In this case, the choice of an individual, or the probability of occurrence, is explained by a set of factors and the following function (Greene, 2003):

| *Probability (event j occurs) = Probability (Y = j) = f [determinants, parameters]* | (1) |

Since the decision parameters are not observable in many cases, one potential approach is to define a latent variable y_i^* for each transaction i, as in:

| $y_i^* = \beta'Xi + u_i \quad i = 1, \dots, N$ | (2) |

where X denotes a set of potential determinants or variables to be tested. The observed pattern of choice can be described with a dummy variable, y, in which $y_i = 1$ if the transaction i is within the "with commitment" group and $y_i = 0$ if it is not. The observed values of y are related to y^* as follows:

| $y_i = 1 \; se \; y_i^* \rangle 0$
 $y_i = 0, \; if \; not$ | (3) |

and

| $PR \; (y_i = 1) = Pr(y_i^* \rangle 0) = PR \; (u_i \rangle -\beta'X_i) = 1 - F(\beta'X_i) = F(\beta'X_i)$ | (4) |

where F is a function of the cumulative distribution for u and a symmetric distribution is assumed. The estimates for the parameters β can be obtained with the use of a maximum likelihood approach. In a logit model, the cumulative distribution function is assumed as:

| $PR \; (y_i = 1) = \dfrac{e^{\beta X}}{1 + e^{\beta X}} = \Lambda(\beta X)$ | (5) |

where Λ denotes the logistic cumulative distribution function.

RESULTS

Characteristics of farms and farmers

Table 3 presents the average area of land managed by the family farmers in the sample. The information includes both the area owned by the farmer and that owned by others, which is rented or managed in partnership. From a statistical perspective, we can identify significant differences between the average total area managed by farmers from the "with commitment" and those from the "without commitment" groups. Three key points warrant attention here. First, the farms in the sample are small and have a small standard deviation, reflecting the fact that the research has focused on family farms. Moreover, it is important to emphasize that the "with commitment" group encapsulates farmers managing smaller areas, whether it is the owned or total area. Finally, the "with commitment" group is characterized by a higher dependency on land from other owners – in particular, plots that are managed in partnership with others. There is strong evidence that farmers from the "with commitment" group use these arrangements more frequently.

Table 3. **Average area managed by farmers (in hectares)**

	Without commitment		With commitment		
	Average (ha)	Deviation	Average (ha)	Deviation	T-Test
A - Area owned by the farmer	6.53	0.56	2.95	0.39	0.000
B - Owned area rented to others	0.19	0.05	0.02	0.01	0.006
C - Owned area managed in partnership	0.61	0.09	0.55	0.15	0.686
D - Area owned by others	1.63	0.20	1.12	0.23	0.038
E - Rented area	0.94	0.16	0.49	0.17	0.030
F - Area owned by others managed in partnership	0.69	0.13	0.64	0.19	0.615
G - Total area managed by the farmer (A + D)	8.16	0.58	4.07	0.40	0.000

Table 4 presents the levels of adoption for irrigation and harvesting technologies. Irrigation is largely used in horticultural production. Therefore, we do not observe a significant difference between the two groups regarding the adoption of these technologies. In turn, protected cultivation is less common. However, we observe a higher level of investment in technology-intensive assets in the "with commitment" group, such as hydroponics and protected cultivation systems, which may result in differentiation and value aggregation. These assets suggest the existence of investment in assets with an intermediate specificity level, which are an important driver in the adoption of a hybrid form (Ménard, 1996; Williamson, 1991).

Table 4. **Adoption of irrigation and cultivation technologies (in %)**

	Without commitment	With commitment	Total	T-test
Uses irrigation	90.4	82.0	89.8	0.153
Uses hydroponics	5.3	6.9	5.4	0.662
Protected cultivation	14.9	28.9	16.0	0.009

Table 5 shows how family farmers gather information that can be used to determine what will be cultivated. In both groups, the absolute majority of farmers make decisions based on their own experience, a result that is consistent with other studies highlighting the importance of tacit knowledge for agricultural activities (see Curry & Kirwan, 2014). Other sources of information were also cited, such as conversations with technical staff and other farmers. However, the use of these alternative sources of information was much lower than the influence of personal experience on decisions. Regardless, we identified a statistically significant difference between the "with commitment" and "without commitment" groups regarding the use of alternative sources of information for decision-making purposes

Table 5. **Sources of information that guide farmer decisions (em %)**

	Without commitment	With commitment	Total	T-test
Websites on the Internet	1.19	0.0	1.1	0.486
Reads newspapers or magazines	2.58	0.0	2.4	0.302
Conversations with technical staff	20.7	22.0	20.8	0.824
Conversations with other farmers	25.9	47.5	27.5	0.004
Conversations with the buyer	15.6	34.3	17.0	0.002
Personal experience	96.6	95.9	96.5	0.652

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The data reveal aspects that help us differentiate the two groups of transactions. First, we observe a more diversified use of information sources by the family farmers who share a commitment with the buyers of their harvest. More specifically, both the personal experience and a higher level of interactions with other farmers and buyers influence the decisions of this group of farmers. Indeed, the "with commitment" group is characterized by the more frequent use of the buyer as a source of information, which is a potential consequence of the provision of technical assistance. In this sense, the sharing of knowledge is part of an arrangement in which joint decisions determine both the adoption of production methods and the choice of the horticultural products to be cultivated. Mutual commitments suggest the existence of an intermediate level of interdependence, which does not imply the end of independence on either side of the exchange.

Relationship with buyers

Considering the full sample, 86% of the buyers are intermediaries, with no significant difference between the two groups (Table 6). The considerable participation of intermediaries in the exchange of horticultural products is related to the features of this system of production, that is, short cycle, sequential, and diversified production, an intensive use of working capital, and a semi-continuous production and commercialization flow. Hence, family farmers become more dependent on an agent that provides services, such as the aggregation of volume, transformation, and the sale of products, with a frequency of deliveries and sales that is higher than that observed in other temporary crops.

Table 6. Main types of buyers (in %)

	Without commitment	With commitment	Total	T-test
Intermediary	85.9	87.6	86.0	0.670
Industry	0.9	0.0	0.8	0.525
Street market	3.2	0.0	2.9	0.236
Retail	7.0	2.6	6.7	0.245
Another farmer	1.2	5.4	1.5	0.056
PAA/PNAE	0.2	0.0	0.2	0.777
Hotel and Restaurant	0.2	0.0	0.2	0.777
Other	1.5	4.5	1.7	0.125

Given the price risk and potential occurrence of opportunistic behavior (Williamson, 1993), the family farmer likely represents the more fragile of the two relationship partners. In response, horticultural producers tend to privilege trustworthy partners. In rare cases, the establishment of prices in advance is possible. In our sample, farmers carried out transactions with the main buyers for an average period of 7.6 years. Both the "with commitment" and the "without commitment" groups are characterized by similar average periods – 7.6 and 7.5 years, respectively – without a significant difference at the 11 percent level.

Additional evidence is found once we analyze the main motivations behind farmers' commercialization decisions (Table 7). By definition, the main reason behind the materialization of a spot market transaction is the price. However, price was cited as one of the main motivations by only 18.1% of the interviewed farmers. For the "with commitment" group, higher prices are even less important (5.3%). In turn, it is noteworthy that the explanation "trust in the buyer" was cited as a motivation for 80.7% of the transactions in the sample, 91% of which were from the group of transactions "with commitment." The inexistence of a clear differentiation between the two groups shows the importance of the construction of one's reputation in the establishment of transactions in the *Serra Fluminense* region.

Table 7. Reasons for choice of buyer (in %)

	Without commitment	With commitment	Total	T-test
Pays a higher price	19.1	5.3	18.1	0.022
Trust	79.9	91.0	80.7	0.093
Has no other option	18.4	18.41	18.0	0.535
Other	9.0	7.7	8.9	0.663

Together with the importance of trust, the extended period of relationship between buyers and sellers indicates that the building of reputation ensues from the repetition of transactions. This process is marked by the consolidation of routines and the reduction of potential sources of disagreement. Hence, adjustments may be promoted more smoothly, restoring the arrangement's efficiency. Given the lack of differences between the "with commitment" and "without commitment" groups in Tables 6 and 7, it is important to stress that even those transactions with a limited level of bilateral dependence can be supported by hybrid forms. In other words, the transactions in the "with commitment" group have elements that reinforce bilateral commitments, such as the provision of inputs and technical assistance. Nevertheless, the transactions "without commitment" cannot be classified as pure spot market transactions either.

As explained earlier in this paper, activities such as the provision of inputs and technical assistance allowed us to identify a higher level of bilateral commitment in the transactions in the sample. However, upfront payments are also found in the transactions of horticultural productions in the *Serra Fluminense* region. In 41.5% of the transactions from the "with commitment" group, we observe the existence of upfront payments (see Table 8). Although we may argue that upfront payments increase the level of bilateral dependence, we must acknowledge that the sharing of non-specific resources – e.g. financial resources – does not necessarily imply the establishment of a complex coordination pattern. More specifically, the influence of upfront payments on the decisions of family farmers is subtle. This scenario contrasts with the central role played by technical assistance and the provision of inputs in the determination of the horticultural products to be harvested. Therefore, we decided not to include the variable "upfront payments" among the practices that define the "with commitment" group.

Table 8. **Benefits and services offered by buyers (in %)**

	Without commitment	With commitment	Total	T-test
Money	6.9	41.5	9.5	0.000
Inputs	0.0	81.3	6.1	
Technical assistance	0.0	35.2	2.7	
Harvest and other services	5.2	19.5	6.3	0.000

Transaction features

Respondents shared their perception of the total percentage of sales to a given seller for each product. On average, 66% of the total sales were made to each of the informed sellers (see Table 9). The significant difference between the two groups is noteworthy. In general, we note that the transactions of horticultural producers belonging to the "with commitment" group are characterized by a higher dependence on the buyer.

Table 9. **Characteristics of transactions with the main buyers (in %)**

	Without commitment	With commitment	Total	T-test
Percentage of sales to a buyer (average)	64.9	86.6	66.6	0.000
Commissioned sales	15.4	30.9	16.5	0.010
Negotiation upon delivery	67.0	57.3	66.3	0.131
Negotiation before delivery	33.0	42.7	33.7	0.131
Price set upon harvest/delivery	46.3	39.9	45.8	0.328
Price set before harvest	20.4	17.7	20.2	0.748
Price set after delivery	33.9	42.4	34.6	0.220
Existence of verbal agreement	98.6	100.0	98.7	0.420
Establishment of contractual commitment	1.5	0.0	1.3	0.420

Consequently, commissioned sales occurred mainly between intermediaries and horticultural producers. In this type of transaction, the intermediary transports the horticultural product to another buyer, who is generally a wholesale distributor like Ceasa in Brazil, without striking a previous agreement on prices. Farmers also pay the full transportation costs. Hence, the farmer must address the price risk in the transaction. Commissioned sales occurred in 16.5% of the transactions and we identified a significant difference between the "with commitment" and "without commitment" groups in this regard.

The participation of commissioned sales in the transactions of horticultural products in the *Serra Fluminense* region can be more effectively analyzed if we consider how prices are determined and the risks that are shared. In the sample, the negotiation of the sale had occurred by the time the horticultural product was delivered in 66.3% of the transactions. In turn, in 33.7% of the observations, the negotiations took place before the delivery (see Table 9). The results suggest that most producers assumed – or had no choice other than to assume – the risk of not selling their harvest until the end of the production cycle. It is important to emphasize that the percentage of transactions carried out with a previous negotiator in the "with commitment" group is 43%, which is higher than that for the "without commitment" group. Thus, we observe a higher level of coordination among buyers and farmers within the "with commitment" group, a reality that reduces the risk assumed by producers. The price risk was also evaluated as follows: farmers assumed most of the price risk or assumed it altogether in 80% of the transactions, with no significant difference between the two groups.

Interestingly, the percentage of transactions with formal contracts accounts for only 1.3% of the observations in the sample. Therefore, 98.7% of the transactions were carried out according to a verbal agreement alone. Unsurprisingly, the building of trust is a fundamental coordination mechanism in the *Serra Fluminense* region. In the absence of formal agreements, farmers endeavor to choose buyers who are considered trustworthy. Given the constraints that preclude their access to public mechanisms for dispute settlement, trust ties and reciprocity at the community level are potential instruments that enhance the predictability of behaviors (Greif, 1993). In turn, cases of strict bilateral coordination are rare and are supported by a broad set of commitments and specific routines.

The binary logit model

The logit model allows the evaluation of the role played by three aspects in the adoption of the diverse hybrid forms in the sample:

(i) asset specificity; (ii) other commitments; and (iii) trust. The dependent variable is binary and aims to identify the factors that lead to the participation in the "with commitment" group, and is therefore characterized by a higher level of bilateral dependence. Eight independent variables are used (see Exhibit 1).

Table 10 shows the odds ratios for each of the independent variables. The empirical analysis uses the odds ratio (e^β) instead of the coefficient β. The results can be interpreted as follows: a positive change in one independent variable with an odds ratio higher than 1 increases the probability that a transaction is from the "with commitment" group. For an odds ratio lower than 1, the effect on the probability that a transaction is within the "with commitment" group is negative. The statistical F-test shows that the variables are jointly significant at the 1 percent level. Likewise, the analysis of the correlation matrix of the independent variables shows no signs of multicollinearity.

Two proxy variables aim to identify the role of asset specificity in the establishment of bilateral commitments: investments in protected cultivation and the intensity of the investments in the inputs. The odds ratios for both variables are statistically significant, revealing a positive effect. Once a transaction involves a protected cultivation, the probability that this transaction is within the "with commitment" group is 155.8% higher than if the same practices were not adopted. Likewise, when a transaction involves higher investments in inputs per hectare, the probability that this transaction is within the "with commitment" group is higher; the probability is approximately 1% higher for each R$ 10,000 of investments. Investments in specific assets increase the potential quality of horticultural products, enabling differentiation strategies and value aggregation. Hence, these investments generally demand both the sharing of knowledge and resources between buyers and farmers and that of scarce resources by the farmer.

We use five variables to analyze the influence of other commitments on the establishment of a high level of bilateral dependency: upfront payments; dependence on a single buyer; partnership; commissioned sales; and shared decision-making. The inclusion of these variables allows us to evaluate the correlation of other routines that help determine the features of the transactions in our sample through the establishment of arrangements with a higher level of mutual commitment. The results show that the odds ratios for "Upfront payments" and "Dependence on a single buyer" are high and statistically significant at the 1 percent level. The odds ratios for "Commissioned sales" and "Shared decision-making," two important factors in the adoption of governance structures "with commitment," are also statistically significant. These results highlight the finding that transactions involving mutual commitments tend to be supported

by a broad set of routines. In turn, the odds ratio for the variable "Partnership," which is significant at the 5 percent level, denotes a positive effect on the adoption of governance structures with commitment. Many family farmers in the *Serra Fluminense* region face constraints in their ability to access land, depending on their cooperation with other members of the community to create value. The establishment of commitments between farmers and buyers may reflect this complex reality, which is marked by the identification of economic opportunities that lead to the establishment of cooperative arrangements among rural producers.

Exhibit 1. Description and measurement of variables in the *logit* model

| Variables	Description and measurement
Dependent variable	
Hybrid form	1, if the transaction involves the provision of inputs and/or technical assistance ("with commitment" group); 0, if not.
Independent variables	
Asset specificity	
Protected cultivation	1, if the farmer adopts protected cultivation (greenhouses, plasticulture, polytunnels, shading fabric; 0, if the farmer does not adopt them).
Intensity of investments	Total investments (R$ per hectare) with labor, inputs, investments, services, land lease, share of partners and other expenses, divided by the total area managed by the farmer.
Other bilateral commitments	
Upfront payments	1, if the buyer makes upfront payments; 0, if not.
Dependence on a single buyer	How the farmer perceives the percentage of the total harvest bought by the buyer who transacts; the variable has positive values and corresponds to 1 when the buyer acquires 100% of a farmer's production.
Partnership	1, if the farmer and the buyer work as partners in the transaction; 0, if not.
Commissioned sales	1, if the sale was commissioned; 0, if not.
Sharing of decision-making	1, if the farmer talks to the buyer before deciding on what to cultivate; 0, if not.
Trust	1, if trust is an important driver of a buyer's choice; 0, if not.

Table 10. Odds ratios in *logit* model

	Odds ratios	Standard error	P›t
Asset specificity			
Protected cultivation	2.55820	1.10328	0.030
Intensity of investments	1.00001	0.00000	0.000
Other bilateral commitments			
Upfront payments	7.32082	3.00915	0.000
Dependence on a single buyer	6.06764	4.42891	0.014
Partnership	2.31842	0.90150	0.031
Commissioned sales	3.61647	1.34628	0.001
Sharing of decision-making	2.05878	0.86105	0.085
Trust	2.33868	1.33317	0.137
Constant	0.00235	0.00244	0.000

Number of observations = 567; expansion for population = 18,867.874; F = 11.39; degrees of freedom of the sample = 560; Prob › F = 0,0000

Finally, trust is an extremely important factor for the family farmers in the sample. No significant difference is observed between the "with commitment" and "without commitment" groups. Trust emerges as a relevant governance mechanism in the whole spectrum of hybrid forms in the *Serra Fluminense* region, influencing both the transactions supported by governance structures with features that resemble a typical spot market exchange, and those with a high level of bilateral commitment. Hence, the odds ratio for this variable does not have statistical significance. The pervasiveness of trust in the coordination of transactions has also been identified in other stages of the Brazilian horticultural agribusiness chain (Carvalho et al., 2014; Faulim & Azevedo, 2003). Figure 1 presents a summary of the results discussed in this paper.

Figure 1. Determinants of governance adopted
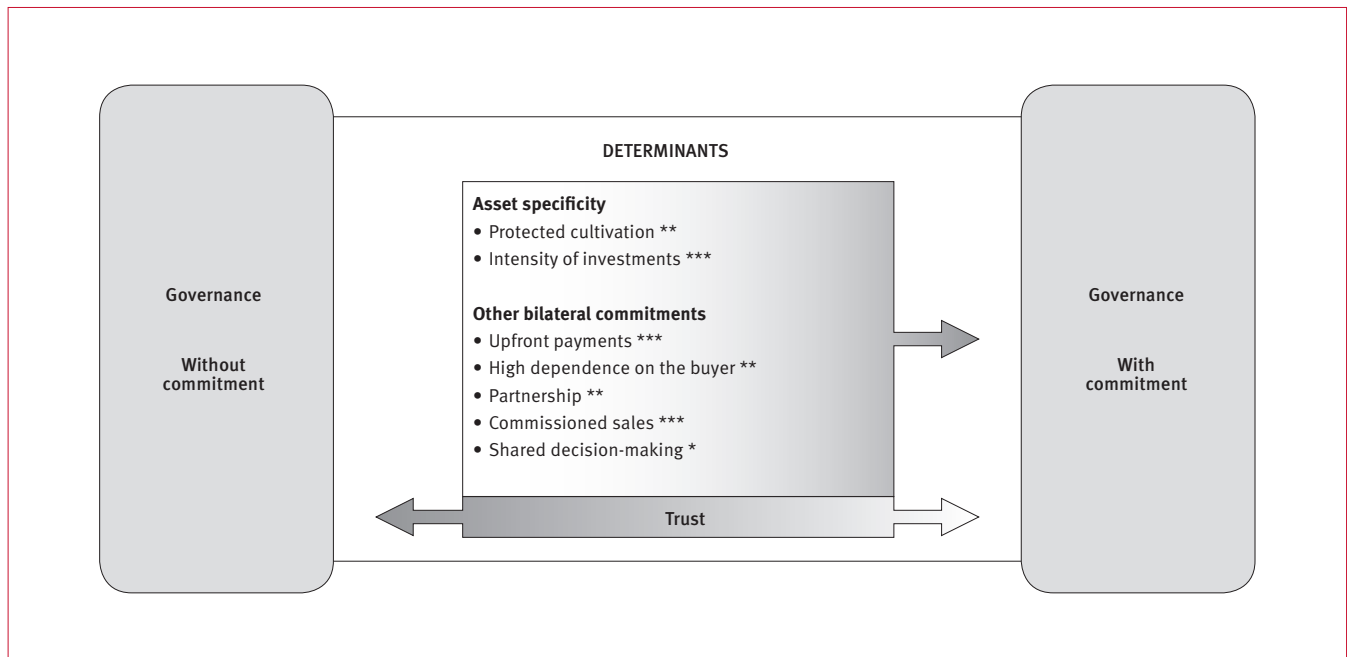
Note: The symbols (***), (**) and (*) represent a statistical significance at 1.5 and 10 percent levels, given the particular econometric model used.

FINAL REMARKS

This paper identifies the variables associated with the existence of bilateral commitments between horticultural family farmers from the *Serra Fluminense* region and buyers. To achieve this goal, we divide a sample of 567 transactions into two groups with bilateral commitments of different intensities. The results suggest the existence of some organizational diversity among the transactions in the sample. We show that the establishment of trust ties and reputation is an important component for most transactions. Given the limited role played by the identity of the parties in a typical spot market transaction, it is clear that even transactions with a limited level of coordination employ mechanisms found in hybrid forms. Amidst the diversity of governance structures, small subgroups are characterized by a stronger level of bilateral coordination, without a loss of independence on either side of the transaction. For example, in some transactions in

the sample, the buyer provides family farmers with inputs or technical assistance. Even in this group, we observe the adoption of different complementary mechanisms that support bilateral coordination – e.g. upfront payments, agreement on price in advance, the sharing of decision rights, and so on.

The empirical analysis also shows that investments in assets with a higher level of specificity play an important role in the establishment of bilateral commitments, a result that is consistent with TCE's theoretical principles. However, formal contracts govern only 1.3% of the transactions. Contracts tend to be used to govern only the more complex transactions in the sample, in which bilateral dependence manifests in a series of shared decisions, such as the frequency of delivery, the ex-ante definition of quality standards, particular price formulas, and the sharing of knowledge and resources. In turn, the transactions belonging to the "without commitment" group have attributes

that resemble a spot market transaction. Overall, the results show that the adoption of technologies to fulfill emerging consumer demands leads to the establishment of a higher intensity of coordination between family farmers and buyers. This tendency is observed even though the rate of adoption for these technologies is still low in the *Serra Fluminense* region.

Therefore, we infer that the relative importance of typical spot market transactions in the horticultural sector should diminish over the next few years, as new production techniques are adopted in the region. Both public policies and private strategies must consider the consequences of these transformations. Indeed, the number of private distribution centers in the fruit and vegetable market, which are generally created by wholesalers and retailers, has grown significantly since the turn of the twenty-first century. These centers are characterized by investments in physical assets with some specificity, thereby supporting the establishment of hybrid forms.

This research is part of a broader goal, that is, to better understand the heterogeneity of arrangements adopted by horticultural family farmers. In this sense, we must highlight the limitations of our work. First, we only collected information on the two main buyers and the two main products sold by each family farmer. Moreover, we limit our analysis to the comparison of two groups. Hence, important nuances may have been lost. Further research is needed to expand the data collection by adding new variables to the analysis or conducting a more extensive examination of the transactions conducted by each farmer. Finally, we recommend the publication of comparative studies that analyze diverse Brazilian regions or agribusiness sectors.

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