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INFORMATION AND PROPERTY RIGHTS: INFLUENCES OF MEASUREMENT ON STRATEGIES IN DAIRY AGRO-INDUSTRIAL SYSTEM

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Summary

Objective: To understand the effect of information on property rights protection and its consequences for the dairy agro-industrial system in Paraná-BR and Midi-Pyrénées-FR.
Methodology/approach: Descriptive qualitative cross-sectional study. Semi-structured interviews carried out with producers, processors, and key agents in the surveyed regions (Paraná-BR and the former region of Midi-Pyrénées-FR). The information was analyzed using the qualitative content analysis method, supported by the NvivoPro software.
Originality/relevance: With primary data collected in two countries (Brazil and France), and the empirical exploration of Measurement Costs Economics (MCE), the article advances the discussion on the possession of information and protection of property rights in the dairy agro-industrial system and the generation of positive effects in the system.
Main results: In regions where reliable information is shared between agents (Central-Eastern and Western Paraná, formerly Midi-Pyrénées), with contracts and differentiated payment according to the milk dimensions and its quality, efficiency was found by lower transaction and measurement costs, and investments in production by producers. In regions where information is unreliable and differences in product dimensions do not guide payment (North and West of Paraná), inefficiencies were identified, as well as a lack of investment in production.
Theoretical/methodological contributions: Based on the empirical exploration of MCE, a methodological orientation is proposed for the theory application, in the understanding of the organizational dynamics, in productive chains, when considering property rights guarantee, through measurement. This allows similar works to be replicated in other regions, and may support future studies aimed at formatting appropriate public regulations to avoid the observed discrepancies.

Keywords: Property rights protection; Measurement Costs Economics; Strategies; Information; Dairy Agroindustrial System.

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INFORMAÇÃO E DIREITOS DE PROPRIEDADE: INFLUÊNCIAS DA MENSURAÇÃO NAS ESTRATÉGIAS NO SISTEMA AGROINDUSTRIAL DO LEITE

Resumo

Objetivo: Compreender os efeitos do acesso à informação na proteção dos direitos de propriedade e nas consequências para o SAG do leite no Paraná-BR e na antiga Midi-Pyrénées-FR.
Metodologia/abordagem: Estudo qualitativo descritivo com corte transversal. Entrevistas semiestruturadas realizadas com produtores, processadores e agentes chave nas regiões pesquisadas (Paraná-BR e antiga região de Midi-Pyrénées-FR). Os dados foram analisados pela análise de conteúdo qualitativa com auxílio do *software* NvivoPro. Originalidade/relevância: Com dados primários coletados em dois países (Brasil e França), e a exploração empírica da Economia dos Custos de Mensuração (ECM), o artigo avança na discussão sobre a posse da informação e proteção dos direitos de propriedade no SAG do leite e a geração de efeitos positivos no sistema.
Principais resultados: Nas regiões em que informações confiáveis são compartilhadas entre os agentes (Centro-Oriental e Oeste do Paraná, antiga Midi-Pyrénées), com contratos e pagamento diferenciado pelas dimensões do leite e sua qualidade, foi constatada eficiência pelos menores custos de transação e mensuração, e investimentos na produção por parte dos produtores. Nas regiões em que as informações não são confiáveis e o pagamento não é diferenciado pelas dimensões do produto (Norte e Oeste do Paraná), ineficiências foram identificadas, bem como falta de investimentos na produção.
Contribuições teóricas /metodológicas: Com a exploração empírica da ECM, é proposta uma orientação metodológica para a aplicação da teoria, no entendimento da dinâmica organizacional, em cadeias produtivas, quando se considera a garantia de direito de propriedade, pela mensuração. Isso permite que trabalhos similares sejam replicados em outras regiões, e possam embasar futuros estudos para a formatação de regramentos públicos adequados para evitar as discrepâncias observadas.

Palavras-chave: Proteção dos direitos de propriedade; Economia dos Custos de Mensuração; Estratégias; Informação; SAG do leite.

INFORMACIÓN Y DERECHOS DE PROPIEDAD: INFLUENCIAS DE LA MEDICIÓN EN LAS ESTRATEGIAS EN EL SISTEMA AGROINDUSTRIAL DE LA LECHE

Resumen

Objetivo: Comprender los efectos de la posesión de la información sobre la protección de los derechos de propiedad y las consecuencias para el SAG de la leche en Paraná-BR y la antigua Midi-Pyrénées-FR.
Metodología/enfoque: Estudio transversal descriptivo cualitativo. Se realizaron entrevistas semiestructuradas con productores, procesadores y agentes clave en las regiones investigadas (Paraná-BR y antigua región de Midi-Pyrénées-FR). Los datos se analizaron mediante análisis de contenido cualitativa y el software NvivoPro.
Originalidad/relevancia: Con datos primarios colectados en dos países (Brasil y Francia), y la exploración empírica de la Economía de los Costos de Medición (ECM), el artículo avanza la discusión sobre la posesión de la información y la protección de los derechos de propiedad en el SAG de la leche y la generación de efectos positivos en el sistema.
Principales resultados: En las regiones donde se comparte información confiable entre agentes (Centro-Oriental y Oeste de Paraná, antígua Midi-Pyrénées), con contratos y pago diferenciado según las dimensiones de la leche y su calidad, se encontró eficiencia debido a los menores costos de transacción y medición, así como inversiones en la producción por parte de los productores. En las regiones donde la información no es confiable y el pago no varía según las dimensiones del producto (Norte y Oeste de Paraná), se identificaron ineficiencias, así como falta de inversión en la producción.
Aportes teóricos/metodológicos: Con la exploración empírica de la ECM, se propone una orientación metodológica para la aplicación de la teoría, en la comprensión de la dinámica organizacional, en cadenas productivas, al considerar la garantía de los derechos de propiedad, mediante la medición. Esto permite replicar trabajos similares en otras regiones y puede apoyar estudios futuros para la formulación de normativas públicas apropiadas para evitar las discrepancias observadas.

Palabras clave: Protección de derechos de propiedad; Economía de los Costos de Medición; Estrategia; Información; SAG de la leche.

1 INTRODUCTION

The central idea that runs through this study concerns the possession of information for the protection of property rights in dairy agro-industrial system (AGS). Given that the *locus* of the transaction under consideration is the sale of milk from the rural producer to the processor, this study focuses on the vertical relationships between members of the chain (different technological interfaces), where measurement is established as necessary to enable transactions, and the Measurement Cost Economics (MCE) is presented as adequate theoretical support.

Zylbersztajn (2017) draws attention to agricultural product transactions as they contain asymmetric information about the dimensions of products and processes, highlighting gaps for opportunism and value capture strategies, a rationale that is presented for the entire agro-industrial system. According to the author, studies on agricultural management from the standpoint of protecting property rights have thus been increased. Furthermore, according to Zylbersztajn (2018), there is a limited number of research that address MCE, which should be explored.

In dealing with information in this AGS, the aim is to compare two different systems, which are the object of study: the dairy AGS in Paraná-BR; the dairy AGS in the former Midi-Pyrénées-FR (later called Occitanie). In this case, two distinct competitive conditions are confronted. In 2020, Brazil was the fourth milk-producing country, with the collection of 26.4 million tons of milk, followed by France in fifth position, having collected 24.6 million tons of milk. Brazil has historically improved in terms of output and productivity, with a 2016 production of 23.9 million tons of milk and a productivity of 1,774 kg/cow/year. Despite high milk output, Brazil lacks development to enhance productivity, which in 2020 was 2,353 kg/year/cow, while the French herd productivity was 7,273 kg/year/cow (CNIEL, 2022).

Thus, the countries under study were chosen based on the French reference in milk production, which stands out not only in rural production but is also recognized as one of the main reference centers in the development of dairy technologies and the exploration of dairy differentiation strategies (CNIEL, 2022). In Brazil, the probable causes of low productivity are the use of animals with no aptitude for dairy production or with inappropriate genetic potential; the low level of education of producers; the lack of improvements in food, production, and health management (Brasil, 2014). These conditions in dairy Brazilian AGS reinforce the importance of studies for development and improvement, focusing on the production chain.

In 2018, Paraná was the second largest milk producer in Brazil, with the production of 4.4 billion liters of milk, in addition, the state has one of the largest dairy basins in the country

(Central-Eastern region), with the use of state-of-the-art technology, high productivity rates and advanced genetics (DERAL, 2020). Despite this progress, according to this source, Paraná has diversity in production systems and professionalization of farmers, while only 5.9% of producers are responsible for 41.8% of the state's total milk production. Furthermore, most producers employ crossbred animals, and the industry is being phased out due to a lack of modernization and low output.

As a result, the research in two nations with distinct systems in terms of organizational, institutional, and operational capacity strives to develop guidelines that provide direction and instructions in the quest for system improvements from efficiency generation. According to Zylbersztajn (2017), the diversity of empirical mechanisms in AGSs is common, and identifies the need to understand these phenomena. Following the guidelines of Barzel (1982), improvements can occur in this orientation to the extent that exchange interactions and the partition of property among traders consider product information to limit opportunism, creating and protecting value that generates system improvements.

Thus, the consideration of information and its relationship with property rights indicate MCE as a relevant theoretical basis. When analyzing this theoretical framework and the given context, the following issues arise: What are the milk properties required of producers, and how are they measured? Is the information disseminated among the agents and considered in the pricing of the product? Is the property right protected and does it generate positive results for producers? As a result, the present investigation addresses the following research question: How does access to information affect property rights protection in the dairy AGS in Paraná, Brazil and in the former Midi-Pyrénées, France?

Thus, the present study aims to understand the effects of access to information on the protection of property rights and the consequences for dairy AGS in Paraná-BR and in the former Midi-Pyrénées-FR. The proposition is that the measurement and sharing of information promote the protection of property rights, which generate efficiency in the system, and in turn, can minimize possible strategic bottlenecks to its growth. So, the present study seeks to contribute to MCE research by empirically investigating measurement, information ownership, and property rights protection, as well as the implications for the value system.

To this end, the research paper includes, in addition to the introduction, the theoretical foundation, which considers the principles of MCE; the methodology, which encompasses the methodological procedures used; the analysis of the results, which includes the presentation and discussion of the data; the conclusion of the investigation; and finally, the references used.

2 THEORETICAL FRAMEWORK

2.1 Measurement cost savings

MCE enables us to understand the development of efficiency by allocating resources to optimize value, from the reduction of transaction costs to the assurances of rights in transactions (Barzel, 1982). According to Williamson (1985, p.29), "the measurement branch of transaction costs economics is concerned with performance or attribute ambiguities that are associated with the supply of a good or service". According to Barzel (2001), it is the information on the transacted dimensions of assets that allows a clear definition of property rights. Thus, through measurement and shared information, agents can use strategies to protect the property rights of their assets (Barzel, 2005).

The MCE's main author is Yoram Barzel, with guidance for efficiency in an *ex ante* perspective. The logic of efficiency is the allocation of resources to maximize value, that is, the objective of organizations is to create, protect and avoid value dissipation (Barzel, 2005). As a result, it is necessary to understand how the properties of a product and their associated information may be used to establish trading relationships, as well as how the property can be divided among traders (Barzel, 1982).

The MCE unit of analysis is transactions broken down into measurable dimensions that influence the protection of property rights (Zylbersztajn, 2018). Measurement is the quantification of information on the dimensions of assets that influence the strategy for protecting property rights (Barzel, 1982, Monteiro & Zylbersztajn, 2013). According to Saes (2009), an important implication of this approach is the possibility of strategies that seek to capture attributes that are not measured or difficult to measure. Thus, it should be considered that the measurement is costly and imperfect, which directs the way agents transact.

Thus, the theory's testable hypothesis is that transactions are advantageous to markets when measuring is simple and low-cost, whereas when measurement is difficult, costly, and subjective, vertical integration should be preferred (Barzel, 2005). Hybrid forms are favorable when the measurement is subjective, and it is chosen not to measure with the use of multiple enforcers such as the agreement, rules, or long-term relationships (Barzel, 2005).

Thus, each dimension of the transaction implies an exchange of rights, and the guarantee of these rights occurs through the possession of information on the attributes and their dimensions through measurement (Barzel, 2005). Thus, from the MCE perspective, transaction costs are defined by Barzel (1997, p. 2) as “[...] costs associated with the transfer, capture, and

protection of rights" . For Barzel (2001), transaction costs include the resources used to protect and capture property rights plus any costs that result in actual or potential protection and capture.

2.2 Information

In the view of MCE, information is an essential element in transactions, as agents need it for decision making when estimating or distributing results (Barzel, 2002). Thus, every transaction requires information on what each party agrees to give to the other (Barzel, 2001). According to Barzel (2005), it is the information that gives meaning to the property and exerts influence in two relevant aspects: 1) How the ownership of the product and the information for the transaction are established; 2) How the property is divided between the agents. These aspects ratify Alchian and Demsetz (1972, p.778) who state: "Meter means to measure and also to apportion".

Thus, the more information, the more attractive the transaction becomes (Barzel, 1982). Barzel (2002) states that individuals are expected to cooperate when sharing information, as it is useful to the agents involved in the transaction. Thus, information sharing agreements are established to reduce uncertainty in transactions and to save costs, as measurement required to gather trustworthy information is costly. It is noted that information has two roles in the transaction: to minimize uncertainty and to reduce *ex post* costs (Barzel, 2002).

Another important aspect is the fact that, since generating information is pricey, agents only have partial information on the products when conducting the transaction (Barzel, 2005). Furthermore, measurement errors are unavoidable, and when combined with insufficient information, it reflects on property rights that are not clearly defined, allowing for value captures (Barzel, 2005). When the costs of measurement are exceptionally high, or the measurement is subjective, the author believes the long-term relationship or vertical integration to be the control mechanisms advised for reducing measurement costs and ensuring property rights. It is noteworthy that Alchian and Demsetz (1972) emphasized the distributive view of measurement when they stated that it has the job of distributing value in addition to measuring.

According to Barzel (2004), one strategy for lowering measuring costs is standardization, which ensures that products are always assessed in the same way, resulting in economies of scale. Furthermore, standardization promotes the protection of rights by identifying pricing impacts in advance.

2.3 Property rights

The study of property rights is a major topic in MCE, associated with information costs, with a focus on defining approaches to construct mechanisms to safeguard property rights related to transaction dimensions (Zylbersztajn, 2018). According to Barzel (1994), the main issue of property rights is not the legal ability that players have, but what they can actually do with the qualities of their assets, not just the items themselves. According to Foss and Foss (2001), this occurs because most assets have several attributes that cannot be stated, and the concept of asset ownership is ambiguous. According to Barzel (1994), property rights are never fully delineated because the transaction is costly and it is difficult to collect accurate information on the dimensions of the assets. As a result of the high cost of measuring these characteristics, the potential for income capture exists in exchanges.

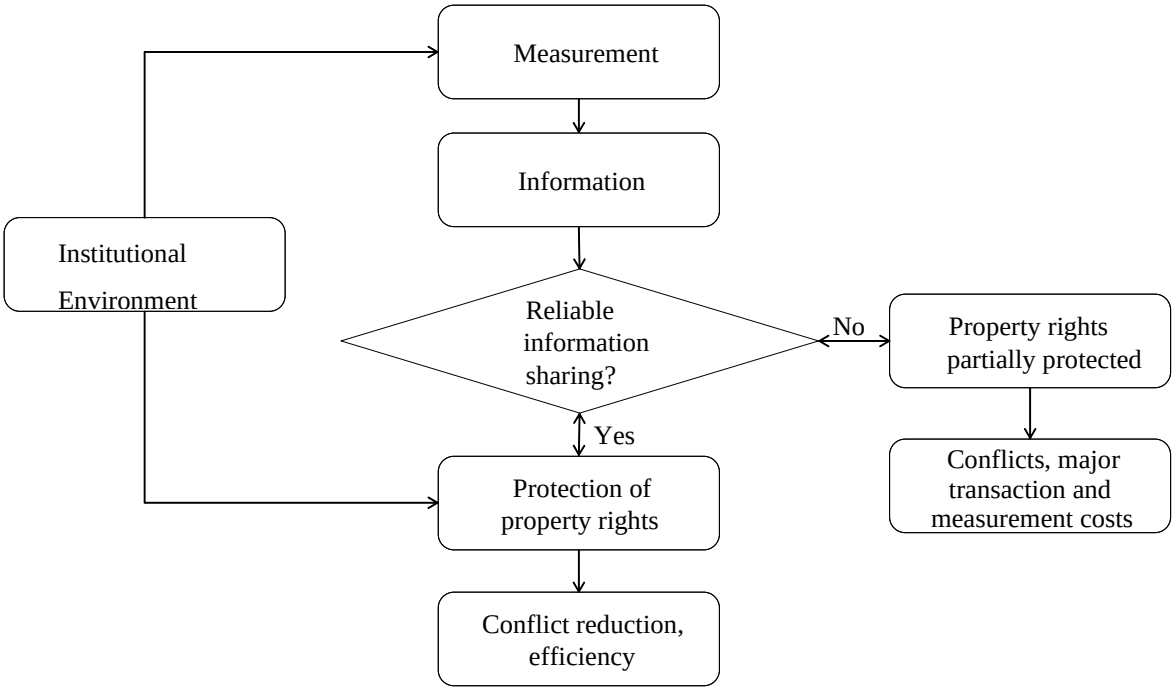
According to Auerbach and Azariadis (2015), the better the guarantee of property rights, the more agents make productive choices, becoming more efficient. This is due to the fact that when property rights are restricted, people are drawn to unproductive activities that provide lower earnings than total potential (Auerbach & Azariadis, 2015). Furthermore, the authors believe that the limitation of property rights affects the expectation of return on all forms of investments and leads to resource misallocation. On the other hand, without the assurance of property rights, agents may engage in treason, fraud, and other undesirable behaviors (Leite, Silva & Afonso, 2014). In this sense, the value generated in the transaction can be dissipated if property rights are not properly defined (Zylbersztajn, 2018).

It should be highlighted that the macro-institutional environment, through official norms (constitutions, laws) and informal constraints (sanctions, taboos, customs, traditions, and standards of conduct), also plays a role in safeguarding property rights. These recommendations aim to provide order and eliminate uncertainty in exchanges by creating incentives and disincentives in economic, political, and social behavior (North, 2003).

Thus, based on the MCE elements, the current study proposes that sharing of reliable information between agents while carrying out transactions (generated by measurement) along with institutional environment favors the protection of property rights, generating efficiency in the system by lowering transaction costs and allowing agents to dissipate value in the exchange. The analysis scheme is presented in Figure 1.

Figure 1

Analysis scheme



Source: Prepared by the authors from Barzel (2001; 2005).

3 METHODOLOGY

The study is qualitative, descriptive, and cross-sectional. Primary data were collected personally through semi-structured interviews with dairy AGS producers, processors, and key agents in Paraná-BR (November 2016 to September 2017) and in the former Midi-Pyrénées, France (April to August 2016). The respondents were chosen based on their availability and convenience, observing the region researched, as well as their willingness to participate in the survey.

In Paraná, the interviews took place in the Central-Eastern, West and North regions, and in France, in the former Midi-Pyrénées region, Southwest of the country. To carry out the interviews, a pilot or pre-test of the script was carried out to evaluate the understanding, repetitiveness, and effectiveness of the answers. The contacts of the first interviewed producers were provided by organizations that support milk production (in Paraná and in the former Midi-Pyrénées), and the other contacts were indicated by the interviewed producers themselves. Interviews with producers were carried out on rural properties, and interviews with processors took place in factories or cooperatives. The regions in Paraná were chosen due to differences in

output in the activities, with the goal of understanding the most advanced ones in terms of productivity, technology, and management (Central-Eastern and West), and presenting a triangulation with the least developed region (North). The characteristics of the interviewed producers and processors are presented in Tables 1 and 2.

Table 1

Characteristics of producers interviewed

Country	Producer	Time in milk production (years)	Number of cows	Total production (liters/day)	Average production per animal (liters/day)	Processor Relationship	Buyer
BR	1	5	85	940	15	Verbal agreement	Industry
	2	5	17	250	20	Verbal Agreement & Vertical integration	Industry
	3	8	40	700	18	Agreement	Cooperative
	4	20	160	3,200	21	Agreement	Cooperative
	5	5	98	1,800	19	Agreement	Cooperative
	6	25	140	4,340	31	Agreement	Cooperative
	7	17	180	4,000	22	Agreement	Cooperative
	8	25	40	800	20	Agreement	Cooperative
	9	10	39	850	24	Agreement	Cooperative
	10	40	70	1.400	20	Verbal agreement	Cooperative
	11	30	46	950	22	Verbal agreement	Cooperative
FR	12	35	50	1,200	24	Contract and Vertical integration	Cooperative
	13	38	110	2,600	25	Agreement	Cooperative
	14	10	44	800	25	Verbal Agreement & Vertical integration	Cooperative
	15	21	80	2,160	27	Verbal agreement	Industry
	16	30	75	2,100	30	Agreement	Cooperative
	17	17	50	700	23	Agreement	Industry
	18	41	120	2,100	23	Agreement	Industry
	19	7	70	2.00	27	Agreement	Industry

Source: Research data.

Table 2

Characteristics of processors interviewed

Country	Processor	Year of foundation	Number of producer suppliers	Type of Company
BR	1	1991	130	Industry
	2	1951	369	Cooperative
	3	1977	1,000	Cooperative
FR	4	1964	2,300	Cooperative
	5	1919	400	Industry

Source: Research data.

The interviews were documented using notes taken during the procedure and recordings with the consent of the participants, and the data were processed using naturalized transcription of the interviews. The interviews of the French agents were transcribed directly into Portuguese, and the NVivo Pro software was used to organize the source classification spreadsheets and codify the information following the pre-established analysis categories with the support of the theoretical framework. The categories used in the software for analysis were measurement, information, institutional environment, sharing of reliable information, protection of property rights, and efficiency, as shown in Figure 1. For data analysis and interpretation, qualitative content analysis was employed in accordance with Moraes (1999): information preparation; unitarization or transformation of content into units; categorization or classification of units into categories; description; interpretation.

To generate validity and reliability in the research, data triangulation was used with several sources of information, including primary data from producers, processors, and AGS key agents (a milk chain researcher and a moderator from the Livestock Institute in France) in the regions surveyed, as well as a theoretical review.

4 ANALYSIS OF RESULTS

4.1 Measurement and information ownership in Paraná

According to the interviews conducted, the measurable dimensions of milk in all regions investigated in Paraná are volume, fat, cryoscopy, and the presence of antibiotics. Other dimensions differ between regions, and the Central-Eastern region assesses milk more judiciously than the other regions since it has more dimensions. These dimensions in the

surveyed regions are presented in Table 3, as well as the dynamics of measurement, milk pricing and their effects.

Table 3

Measurable dimensions and pricing in Paraná

	Central-Eastern	West	North
Dimensions	Volume, bacteria, somatic cells, temperature, fat, protein, cryoscopy, storage capacity/flexibility in the property, accreditation of good practices on the farm (GPF), access to the property (toco truck, and three-axle trailer) and antibiotics or inhibitors.	Volume, fat, somatic cells, minimum level of bacterial count and antibiotic	Volume, fat, cryoscopy, antibiotic, acidity, distance from the processor.
Measurement	By the accredited laboratory (one sample per week) and the processor's laboratory (for all collection).	By the accredited laboratory (three samples per month) and by the processor's laboratory (for all collection).	By the accredited laboratory (three samples per month) and by the processor's laboratory (for all collection).
Information sharing	The information is reliable and sent at the same time to the buyer and producer by the laboratory.	Information shared, but not trusted by producers.	Information shared, but not trusted by producers.
Pricing according to dimensions	The dimensions are agreed in advance as well as their impact on the price, whether in bonuses or discounts. Differentiated payment for milk dimensions.	Differentiated payment for some of the dimensions of milk. There is mistrust as to the results of the measurement.	There is no differentiated payment for milk quality, only discounts if there is a negative result in the analyzes.
Agreements (*ex ante*)	Contract.	Contract and verbal agreement.	Verbal agreement.
Effect	Investments	- Investments (in case of agreement). - Higher transaction and measurement costs (in cases of verbal agreement). - Less investment (in cases of verbal agreement).	- Higher transaction and measurement costs. - Higher trading costs. - Less investment.

Source: Research data.

The measurable dimensions characterized by Barzel (2001, 2005), which exert variations in the definition of the milk price, are measured in the regions surveyed by processors as well as accredited third-party laboratories that test the dimensions agreed upon between the agents. According to Raynaud, Sauvée, and Valeschini (2009), third-party examination encourages quality assurance and reduces the possibility of opportunism in the relationship.

Regarding pricing, it differs between the regions studied. In the Central-Eastern and Western region, contracts are signed stipulating the necessary dimensions of the milk and its incidence on the price, which stimulates the production of quality milk. Reliable information is

shared between producers and processors in these locations by the laboratory responsible for the analyses, which decreases uncertainties regarding product payment and reduces *ex post* costs, as considered by Barzel (2002). Other situations in the West region involve verbal agreements between producers and processors, the effects of dimensions on pricing are unclear, and the results of analyses are seen untrustworthy by producers, as producer 10 observes:

> We always take it with a pinch of salt. We never know what it's like. I once did the analysis in a private laboratory, but it doesn't match the results here. I took the sample when the milkman took it, and it didn't match, it had to match. It didn't have to be exactly the same, but kind of similar, not too different.

In the North region, the dimension that positively influences the price is only volume. The other analyzes can generate penalties if the milk presents any negative result in these criteria, with no payment for the quality of the product, discouraging investments by producers. In addition, the producers interviewed do not trust laboratory analyses, as Producer 1 says: "In the current testing, we trust when everything is fine. When a problem occurs, we are suspicious and perform the counter-evidence".

Another way to protect property rights is through the institutional environment (North, 2003), and empirically, it was possible to identify the role of formal rules that seek to reduce uncertainties in exchanges. The rules observed in Paraná are Normative Instruction 62 (IN62) (later replaced by INs 76 and 77), environmental legislation, sanitary control, and contractual rules (Central-Eastern and West regions). Table 4 presents the highlights and analyzes of the interviews conducted in Paraná.

Table 4

Highlights and interview analyses in Paraná

Producer/region	Excerpt from the interview	Analysis
Producer 7/ Central-Eastern	Measurement is important to maintain quality. From the moment I don't have the differentiated measurement, and a differentiated payment, I'm in a mass grave, and then people stop striving for quality.	Measurement for quality milk production
Producer 7/ Central-Eastern	Measurement helps build trust, it's important. If you have any suspicions, there is a way to have a counter-evidence as well. They store the sample, and if we have any questions, they test it again.	Possibility of counter-evidence
Producer 7/ Central-Eastern	This information is accessible, direct to everyone, when it is available in the system, the producer has it *online* through the cooperative's website, and there is the application where he learns about it.	Information Sharing
Producer 8/West	Producers have access to information, every time the analysis is done, behind the note there is the report, and today you can access it online for the last 3 months [...] I trust the results of the analyses. Because it is a cooperative, I do trust it.	
Producer 2/North	I trust the lab, but the analysis is completely hazy. The guy who collects the sample ...he dispatches and does whatever he wants with this sample. If he wants to put antibiotics in there, he can. If he wants to tamper with the sample to harm me, he can. I have no guarantee that the milk tested there is the milk that left my house. Even if he correctly stored the sample, I don't know.	Mistrust of information

Source: Research data.

Observing the empirical data, based on Barzel's (2005) point of view, it is clear that the transaction between producers and buyers relies upon the milk product and its dimensions. *Ex ante* payment established according to dimensions prevents appropriations and the necessity for *ex post* negotiation. In addition, the contracts used favor the guarantee of property rights and minimize opportunistic attitudes.

Another observation is the high frequency and recurrence of transactions between agents, with collection occurring every day or every two days, and payment is done once a month, according to interviewees. It should be noted that the frequency is characteristic of the activity since the product does not allow stock to be kept for a prolonged period and follows the guidelines of IN62. Despite this, the high frequency can be seen as a result of the reputation created among the agents. According to Barzel (1982), past experiences serve to guarantee and reduce uncertainties, minimizing the possible conflicts that may arise.

Thus, in the Central-Eastern and Western regions, where there are contracts between producers and processors, property rights are maintained by the measurement mechanism and reliable information sharing. As a result, it is noted that producers make investments in

production, which may highlight the efficiency generated in the system, as considered by Auerbach and Azariadis (2015).

In the case of verbal agreements (West and North), where there is mistrust about measurement and differentiated payment based on product size is unclear (West) or non-existent (North), the interviewees' statements helped to identify higher transaction and measurement costs due to the need for counter-evidence, resulting in system inefficiency. This aspect confirms the position of the interviewed producers, by stating that they are not able to make investments in production. These factors also support Auerbach and Azariadis's (2015) claim that limiting property rights results in lesser profits for the agents involved.

4.2 Measurement and information ownership in the former Midi-Pyrénées

In France, the principle of paying milk according to bacterial quality (hygiene and health) and its composition were introduced in 1969. In 2015, a mandatory contract was established between producers and processors, and there is an aggregated document, called the Monthly Milk Payment Table *(Grille mensuelle de paiement du lait)*. The mandatory and optional measurable characteristics of milk composition and quality are outlined in this document, including the main ones: levels of fat/butyric matter (fat content utilized in butter manufacturing), protein, bacteria, cells, germs, antibiotic residues, and freezing point. The document also presents the measurement criterion and its impact on the price of the product. This evaluation is carried out by an independent laboratory authorized by the National Interprofessional Center for Milk Economy (CNIEL). This qualification was created in 1973, with the objective of assisting laboratories and controlling the standardization of analysis methods. According to Trouvé et al. (2014), the qualification of the laboratories was carried out to guarantee the neutrality of the milk quality analysis and the transparency of the product payment, which corroborates Raynaud et al. (2009).

Thus, the milk components demanded by the processors and which have an influence on the price definition are those determined by the Monthly Milk Payment Table, for all producers interviewed. As Producer 13 observes: “The items required are based on the table that has the characteristics of milk quality and variations in price” (authors' translation). The interviewed processors also stated that they require the characteristics determined by the Monthly Milk Payment Table from milk producers, and there may be variations according to the destination of the milk in production, as Processor 03 considers: "Specifically for producers

who supply raw milk, they have 5 additional criteria, which are pathogens, particular germs that cause problems related to raw milk" (authors' translation).

Thus, the measurement is made in all collections, and the payment is according to the quality of the product, following the guidelines of the Monthly Milk Payment Table. There is also the possibility of performing the counter-evidence, which generates confidence in the process, as Producer 01 considers: "The information is sent to us and to the buyer. When we do not agree with some analysis, we can ask the laboratory to repeat some analyzes. This can happen" (authors' translation). The dimensions, measurement dynamics, milk pricing and their effects are presented in Table 5.

Table 5
Measurable dimensions and pricing in the former Midi-Pyrénées

	Former Midi-Pyrénées
Dimensions	Levels of fat/butyric matter, protein, bacteria, cells, germs, antibiotic residues, and freezing point.
Measurement	By an independent laboratory authorized by the National Interprofessional Center for Milk Economy (CNIEL) in all collections.
Information sharing	The information is reliable and sent at the same time to the buyer and producer by the laboratory.
Pricing according to dimensions	The dimensions are agreed in advance as well as their impact on the price, whether in bonuses or discounts.
Agreements (ex ante)	Contract
Effect	Investments

Source: Research data.

As a result, the measurable dimensions, which influence the definition of the milk price, are measured by third-party laboratories and processors in accordance with the MCE assumptions set by Barzel (2001, 2005). Furthermore, the institutional environment influences the protection of property rights by creating regulations for milk quality and pricing throughout the entire country. The guarantee of rights enables productive choices, as Auerbach and Azariadis (2015) consider.

The frequency in transactions is recurrent, as stated by Processor 01: "Depending on the production, we have collections every day, every two or three days, no more than that. Classic production is every three days. When we have production using raw milk, we can have collection every two days and every day" (authors' translation). Payment is made once a month. As in Paraná, the high frequency of transactions in the former Midi-Pyrénées region may indicate a reflection of the reputation created among agents and the low incidence of conflicts, as stated by Barzel (1982).

In terms of the institutional environment, which also has an impact on property rights (North, 2003), the milk producers interviewed claimed that they follow the necessary contractual requirements with the processors as well as the Common Agricultural Policy (CAP), which focuses on animal welfare and environmental rules. CAP was established in 2013 with the objective of bringing competitiveness, sustainability, and social rooting. Furthermore, it aimed to improve the operation of the counseling and networking system for knowledge generation and dissemination (Trouvé et al, 2014).

As a result of this dynamic, it can be seen that producers invest in the production that generates the highest returns, as Producer 13 says: "The contract guarantees a return on investment to obtain quality milk [...]. We always invest a little" (authors' translation). Table 6 presents highlights and analyses of the interviews in the former Midi-Pyrénées region.

Table 6

Highlights and analyses of interviews in the former Midi-Pyrénées

Interviewee	Excerpt from the interview	Analysis
Processor 04	We collected samples in all collections. We have an interprofessional laboratory, which is neither owned by the producer nor by the companies, managed by all three (producer, cooperative and industry). In this laboratory, we deliver all the samples, they take three at random to make the payment for milk quality per month. The cost is divided, half for the producer and half for the cooperative. This gives us neutrality.	Measurement
Producer 12	The information is sent to us and to the buyer. When we do not agree with some analysis, we can ask the laboratory to retest some.	Information sharing
Producer 16	It has a base price that is set by the collecting company, depending on the market price. There are additional premiums added to this base price depending on quality.	Differentiated payment for milk dimensions.
Processor 04	We have a contract that is renewed every five years, and the cooperative is always engaged in this relationship with the producer. Except if they don't meet quality standards or purchasing standards and good practices. These are not cooperative regulations, they are environmental.	Institutional environment
Producer 12	A number of conditions are laid out in the agreement, including how the samples are to be collected, the criteria for paying for the tests, the minimum conditions and frequency of the tests, the methods of analysis, the instruments that can be used for the tests, the calculations of the results based on the tests, and the destination of the samples.	

Source: Research data translated by the authors

4.3 Measurement, information ownership, and property rights in the surveyed regions

By observing the dynamics of measurement, information sharing in the guarantee of property rights in the regions studied, it was possible to validate the proposition of the study. Table 7 presents a summary of the information identified.

Table 7

Measurement, property rights, and effects

Region		Measurement	Property Rights	Effect
Former Midi-Pyrénées|		Shared and reliable information.	Protected by contracts.	Investments.
Paraná	**Central-Eastern**	Shared and reliable information.	Protected by contracts.	Investments
	West	Shared but unreliable information.	Partially protected.	- Higher transaction and measurement costs. - Less investment.
	North	Shared but unreliable information.	Partially protected.	- Higher transaction and measurement costs. - Higher trading costs. - Less investment.

Source: Research data.

It can be seen that the most advanced milk productivity regions (Central-Eastern Paraná and former Midi-Pyrénées) have *ex ante* resource allocation that seeks to maximize value because the milk characteristics (dimensions) that favor the production of quality milk in the industry are established in the exchange and are also valued in pricing to the producers. Thus, in order to safeguard and avoid value dissipation, measurement is performed according to predetermined frequency and information is shared between the agents involved, as stipulated in the agreements, and as Barzel (2005) suggests. In these regions, it can be seen that property shared out between the parties allows agents to make investments, which benefits the regional chain.

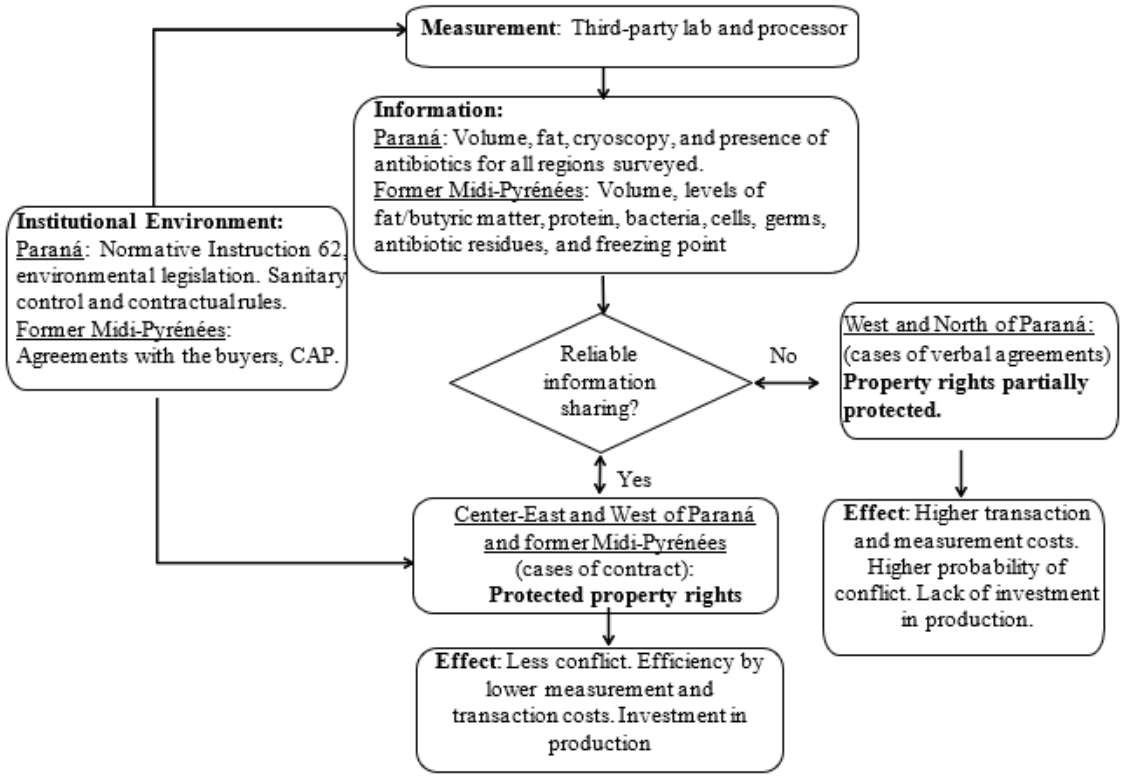
Contracts play a significant role in dealing with opportunistic attitudes since the dimensions and method of payment are stipulated ex ante, decreasing appropriation of these parameters and the necessity for ex post agreements. Contracts, according to Barzel (2005), are appropriate when the measurement is objective and verifiable, as identified in the research.

In the other regions (West and North of Paraná), it is noted that the milk characteristics agreed *ex ante* are not considered in the pricing (North) or the information is not reliable (West and North), which limits the guarantee of property rights, and favors the capture of attributes by buyers, as Saes (2009) considers. These constraints confirm the proposition of the study by noticing that the absence of property rights guarantees a reduction in gains between agents, with

ramifications for the entire chain. Based on the assumptions of Barzel (2001, 2005), some suggestions can be made to improve the system in these regions and reduce the identified inefficiencies, such as: (1) differentiated payment based on the quality of the milk and its dimensions to encourage producers (especially in the North); and (2) the establishment of contracts to protect the rights of the parties with reliable information. Figure 2 shows the main results according to the analysis scheme adopted.

Figure 2

Measurement, information, and protection of property rights



Source: Research data.

It is worth mentioning that, aside from the increased number of dimensions collected from the public domain, in the former Midi-Pyrénées-FR region, these are contracted ex ante, in addition to establishing their information sharing and dependability. When examining production in Paraná, the quality of the information, in addition to influencing its reliability, takes into account only one of the dimensions of the milk asset traded. This can have an effect on investment decisions and engagement in the transaction. In this case, these aspects can significantly make up the set of factors that contribute to a reduction in the level of investment in production, or even to a producer's decision to switch activities.

5 CONCLUSION

The present study aimed to understand the effects of access to information on the protection of property rights and the consequences for dairy AGS in Paraná-BR and in the former Midi-Pyrénées-FR. The proposition was that information measurement and sharing promotes the protection of property rights, which generates efficiency in the system and, as a result, can minimize potential barriers to its growth. For this, descriptive cross-sectional qualitative research was carried out, based on semi-structured interviews with AGS producers and processors.

The study's proposition was validated in the Central-Eastern regions of Paraná and in the former Midi-Pyrénées, where the measurement and sharing of reliable information favor the protection of property rights, generating efficiency with lower transaction and measurement costs, and impact on investment decisions. In regions where information was unclear (West) or unreliable (West and North), inefficiencies were observed and, therefore, less stimulus to investment was reported, which also validates the proposition of the study. Thus, to encourage the production of quality milk in the latter regions, the payment for milk dimensions, within a transparent and reliable measurement process and the availability of the information generated is fundamental. The reduction of uncertainty and other stimuli should increase investments in production by producers.

As demonstrated, the current study intended to progress in an attempt to better understand the interactions between agents contemplating property rights protection and the desire for efficiency, producing and safeguarding value through the empirical exploration of MCE. Thus, this study can serve as a reference for strengthening milk production in the country, guiding not only private strategic initiatives but also public policies. These initiatives aimed at

defining clear rules for identifying milk dimensions, measuring and sharing information are established as mechanisms to reduce uncertainty in the relationship and induce investments.

Despite meeting the proposed objective, the study has limitation of periods of data collection. In France, in 2016, the context was a low milk price, while in Brazil, in 2017, the price of milk was high. This difference in prices may have influenced some interviewees' responses, especially considering the possibilities of investment in production.

As suggestions for future research, studies in other regions of Brazil are indicated, as well as longitudinal research that considers the fluctuations in milk price and the investments made, as well as the growth of the macro-institutional environment in both nations. In addition, future research may offer guidelines for the elaboration of public policies that define clearer rules for producers and processors in an attempt to make information available, protect property rights, favor efficiency in the system, and provide conditions in these segments for the generation and implementation of sustainable growth strategies.

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