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Organizational tolerance in agro-industrial systems: an empirical application for the meat sector

Tolerância organizacional em sistemas agroindustriais: uma aplicação empírica para o setor de carnes

Tolerancia organizacional en sistemas agroindustriales: una aplicación empírica para el sector de carnes

Silvia Morales de Queiroz Caleman [a,*], Decio Zylbersztajn [b], Matheus Wemerson Gomes Pereira [a], Gustavo Magalhães de Oliveira [b]

[a] *Universidade Federal de Mato Grosso do Sul, Campo Grande, MS, Brazil*
[b] *Universidade de São Paulo, Faculdade de Economia, Administração e Contabilidade, São Paulo, SP, Brazil*

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Abstract

Based on the Measurement Cost Theory, this study focuses on the coexistence of institutional arrangements in coordinating complex agribusiness systems. Under the rationale of "Organizational Tolerance", the existence of plural forms is investigated in the acquisition of cattle, poultry, and swine by the meatpacking industry in the State of Mato Grosso do Sul. In general terms, the degree of organizational tolerance and its determinants are assessed in this study. To this end, 98 farmers were interviewed and the data analyzed by applying an Ordered Logit model. The main hypothesis is that Organizational Tolerance is related to the difficulty of measuring attributes of the transacted products. The findings show that the difficulty of measuring the animal condition is statistically significant (5%) for the existence of a higher Organizational Tolerance. Other variables such as tradition (5%), cooperation (10%), and adoption of contracts (1%) also explain the degree of Organizational Tolerance in agro-productive systems. Understanding the determinants of organizational choice is essential to the identification of efficient solutions for the coordination of productive systems in agribusiness, and for the establishment of public and private strategies for the sector.

Keywords: Agribusiness; Institutional arrangements; Coordination; Diversity

Resumo

A partir da ótica da Teoria dos Custos de Mensuração esta pesquisa focaliza a coexistência de arranjos institucionais na coordenação de sistemas agroindustriais complexos. Com base no argumento da Tolerância Organizacional, investiga-se a coexistência de formas de contratação na aquisição de animal para abate nos sistemas agroindustriais de frango, suínos e bovinos em Mato Grosso do Sul. De modo geral, avaliam-se o grau de tolerância organizacional destes sistemas produtivos e seus determinantes. Para tanto, 98 produtores rurais dos referidos sistemas foram entrevistados, sendo os dados analisados por meio da aplicação de um modelo Logit Ordenado. A hipótese central é que a Tolerância Organizacional é relacionada ao grau de dificuldade de mensuração de atributos do produto transacionado. Os resultados da pesquisa apontam que a dificuldade de mensuração do atributo "conformidade do animal" é estatisticamente significativa para a existência de maior tolerância organizacional ao nível de 5%. Outras variáveis como tradição (5%), cooperação (10%) e adoção de contratos (1%) também explicam o grau de Tolerância Organizacional observados nos

* Corresponding author at: Avenida Senador Filinto Muller, Unidade 10, Caixa-postal: 549, CEP 79070-900, Campo Grande, MS, Brazil.
E-mail: silviacaleman@gmail.com (S.M. Caleman).
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sistemas investigados. A compreensão dos determinantes das escolhas organizacionais é fundamental para a identificação das soluções eficientes para a coordenação de sistemas produtivos no agronegócio e para o estabelecimento de estratégias publicas e privadas para o setor.

Palavras-chave: Agronegócio; Arranjos institucionais; Coordenação; Diversidade

Resumen

Con base en la Teoría de Estimación de Costos, se analiza en este estudio la coexistencia de arreglos institucionales en la coordinación de sistemas agroindustriales complejos. A partir del razonamiento de la Tolerancia Organizacional, se investiga la existencia de diversas formas de contrato en la adquisición de ganado, aves y cerdos en la industria empacadora de carne en el Estado de Mato Grosso do Sul. En términos generales, se evalúan el grado de tolerancia organizacional de estos sistemas productivos y sus determinantes. Para ello, se entrevistaron a 98 productores y se analizaron los datos por medio de un modelo logit ordenado. La hipótesis principal es que la Tolerancia Organizacional se relaciona con el nivel de dificultad para medir los atributos de los productos negociados. Los resultados muestran que la dificultad de medir el atributo adecuación del animal es estadísticamente significativa (5%) para la existencia de una mayor tolerancia organizacional. Otras variables como la tradición (5%), la cooperación (10%) y la adopción de contratos (1%) también explican el grado de tolerancia organizacional en los sistemas productivos estudiados. La comprensión de los factores que determinan la elección de la organización es esencial en la identificación de soluciones eficientes para la coordinación de los sistemas productivos de la agroindustria y para que se establezcan estrategias públicas y privadas para el sector.

Palabras clave: Agroindustria; Arreglos institucionales; Coordinación; Diversidad

Introduction

The efficiency of an Agro-Industrial System[1] (AgS) is based on its ability to create, sustain, and distribute value. For this, the *coordination* mechanisms are indispensable. Value creation is associated with innovation; sustaining is related to the way in which agents can design mechanisms to protect the value created (Monteiro & Zylbersztajn, 2012); and the value distribution results from the solution of distributional problems in transactions. From the sustaining and distributing efforts can emerge potential conflicts, leading to a possible destruction of the value created in the AgS.

Value creation can be associated with investment in specific assets that, subject to an environment of uncertainties, informational asymmetry, and limited rationality of the agents, leads to the occurrence of transaction costs. Finding institutional arrangements[2] that minimize such costs and prevent the occurrence of opportunistic behavior and contractual breaches is imperative for an efficient coordination that results in creation and value protection (Monteiro & Zylbersztajn, 2012; Zylbersztajn & Caleman, 2012).

It is assumed that value creation in a given institutional environment, based on the proposal of efficient alignment proposed by Williamson (1996), would result in some degree of convergence of the observed arrangements. That is, agents observe and replicate organizational solutions that demonstrate positive results. However, analyzing the arrangements adopted in AgS reveals a great diversity in the forms of contracting. It is worth noting that this diversity is observed even in transactions that are similar in terms of asset specificity and institutional environment rules. Nevertheless, transactions are coordinated differently, with arrangements that persist over time, suggesting their stability (Zylbersztajn & Nogueira, 2002). This finding motivated the effort to understand the coexistence of arrangements in a single institutional environment.

In contrast to the alignment proposal of institutional arrangements offered by Transaction Cost Economics (TCE), one can ask: would not the diversity of arrangements be a kind of regularity? In addition, agro-industrial systems present different rates of adoption of specific arrangements (Zylbersztajn & Nogueira, 2002). Faced with the diverse reality of arrangements, a set of questions may be presented: How can the different adoption rates of specific arrangements among AgS be explained, considering specificity and similar institutional environments? If there is an efficient and therefore superior arrangement, why is there no convergence to a single governance mechanism?

Different explanations for the diversity of institutional arrangements coexist in the literature. In general, this coexistence is explained as resulting from variables such as path dependence, distinct institutional environments, changes in the transaction pattern (leading to situations of imbalance), and specific non-transferable routines (Zylbersztajn & Nogueira, 2002). Such explanations explore an aspect which is largely absent from the theory developed by Williamson (1996), which generated the hypothesis of efficient alignment, that is, the non-diversity of institutional arrangements.

The coexistence of efficient institutional arrangements in agribusiness has not been well addressed in the literature. In addition to the reasons traditionally referred to, such as agents'

[1] The concept of Agro-Industrial Systems AgSincorporates the institutional environment aspects to the productive chain approach, such as support and regulation institutions, not exclusively focused on sequential product transformation (Zylbersztajn, 2000).

[2] Institutional arrangements are governance mechanisms designed to generate incentives for cooperation among economic agents. Thus, contracts, partnerships, and strategic alliances are examples of hybrid forms of coordination that represent institutional arrangements under the logic of Transaction Cost Economics (TCE). The terminology "institutional arrangements" is used based on free translation of *institutional arrangements*, a term adopted by Williamson (1996) to treat the same phenomenon.

power structure, time needed for the diffusion of efficient models (informational asymmetries), differences in institutional environment and coordination failures (Caleman, 2010), the diversity of coordination forms in a given AgS could signal the existence of the system's own characteristics, this feature called "Organizational Tolerance" (Zylbersztajn & Caleman, 2012). "Organizational Tolerance" is defined as the degree of variety of institutional arrangements observed in similar transactions, and its analysis is developed from the theoretical framework proposed by Barzel (1997) in the Measurement Cost Theory (MCT), which accounts for a little-explored line of study in Transaction Cost Economics (TCE).

The present study focuses on the AgS of swine, poultry, and cattle, characterized by different organizational tolerance patterns, with the poultry sector presenting the highest rates of formal contracts adoption (less diversity of institutional arrangements types); and the beef cattle sector presenting the greatest diversity of arrangements, including coordination through the market, formal contracts, agreements, partnerships, marketing alliances, and vertical integration. The choice of productive animal protein systems to perform this research allows the analysis and comparison of organizational solutions in similar institutional environments,[3] exemplified by the sanitary requirements for animal production, which despite the existence of diseases specific to each animal, follow similar parameters defined by national and international agencies.

When analyzing the coordination pattern in agro-industrial systems, Macdonald (2006) points out that contracted production of cattle, swine, and chickens/eggs in 2003 in the United States accounted for respectively 28.9%, 57.3%, and 88.2% of the total. For Brazil, Zylbersztajn (2005) estimates that in poultry, at least 59.5% of the production was organized by contracts, while in swine production the rates reach 30–40%. Various authors have observed, in the case of beef cattle, the low adoption rate of contracts between suppliers and the meatpacking industry in Brazil (Pitelli & Moraes, 2006; Silveira, Carrer, Carvalho, Foscaches, & Saes, 2014), in the range of 0–25%, with the highest rate being for animals which are traced in a specific exporting firm. In addition to the existence or not of contracts, there are variations in the contractual terms. That is, institutional arrangements, in the form of formal contracts, are characterized by significant differences, which include the use of various mechanisms of guarantees, deadlines, and ways of measuring the transacted attributes.

The motivation of the present study is the investigation of the coexistence of institutional arrangements in complex agro-industrial systems. Having as its object the transactions between farmers and the slaughtering and processing industry in the chicken, swine, and cattle agribusiness systems in Mato Grosso do Sul, it aims to evaluate the organizational tolerance of these productive systems. Specifically, it seeks to: (i) identify the diversity of institutional arrangements in these productive systems; (ii) analyze the variability of the transacted attributes and its degree of measurability; and (iii) evaluate the relationship between measurement costs and the diversity of arrangements.

Theoretical foundation

The co-existence of institutional arrangements for the coordination of transactions in the same institutional environment and involving similar transactional characteristics is a current theme. A theoretical branch that investigates the diversity of coordination forms, called "plural forms" of coordination, is inspired by a vast literature on franchises (Bradach & Eccles, 1989; Lafontaine & Slade, 2007; Silva & Azevedo, 2007). According to these authors, there is a plurality of coordination forms of the relationship between franchisee and franchisor, co-existing product distribution structures through its own stores (vertical integration), and franchised stores (coordinated by contracts). Moreover, in the argument of "plural forms", but advancing the proposition of other variables for the transaction analysis (ambiguity, complexity, and strategic behavior), Menard (2013) develops a model that is empirically tested in the agricultural sector by Menard, Saes, Silva, and Raynaud (2014). Furthermore, Monteverde and Teece (1982) investigated the occurrence of hierarchical solutions simultaneous to contracts in the automobile industry, and Zylbersztajn and Nogueira (2002) analyzed the coexistence of contractual arrangements in the Brazilian poultry industry, arguing that the phenomenon occurs due to situations of imbalance, barriers for the adoption of the new contractual arrangement, and effects of the institutional environment. However, these studies all dialog to some extent with the theoretical assumptions of Transaction Cost Economics, whose analysis variables are strongly related to asset specificity and transaction frequency.

Under a distinct theoretical approach, aligned with the assumptions of the Measurement Costs Theory (Barzel, 1997), the Organizational Tolerance argument for the study of the diversity of institutional arrangements is proposed in this study (Zylbersztajn & Caleman, 2012). The term Organizational Tolerance was inspired by the concept of Technological Tolerance treated by Farina, Azevedo, and Saes (1997), based on the reference points developed by Hirschman (1958) in Industrial Organization theory. For the author, there is a differentiation of the productive systems due to greater or lesser technological tolerance. Thus, in less tolerant systems, there is a low diversity of technologies adopted in the productive process: the same technological standard is adopted by most of the productive agents.

In general, these standards represent higher technological sophistication, not observed in high tolerance systems that allow the coexistence of different technology standards. Waak (2000) suggests that the soybean AgS exemplifies a system of low

[3] The discussion about the limits of the institutional environment and the parameter to be set in each agro-industrial system, or in other words the degree of similarity and/or difference among institutional environments and their respective AgS, is a relevant question for an analysis that is willing to understand organizational solutions in agricultural-based production systems. In order to delimit the institutional environment in this study, it focuses on health issues for animal production, considering that there is a common scope in health legislation for the meat sector in Brazil (formal institution) and in the region (Mato Grosso do Sul). Still, in the case of productive systems operating in the same region (MS), there is a greater similarity regarding cultural and tradition issues in livestock production (informal institution).

technological tolerance, while the beef AgS presents a high tolerance system, in which "there are vaccines of different quality standards, varied production and handling systems and [] the beef we consume can be found with different quality standards" (Waak, 2000, 344). Thus, just as productive systems present greater or lesser tolerance of technological diversity, would these same production systems be subject to greater or lesser tolerance toward the diversity of institutional arrangements?

The concept of Organizational Tolerance (Zylbersztajn & Caleman, 2012), developed on the basis of the theoretical assumptions of Measurement Costs Theory (MCT) (Barzel, 1997), is defined as the variety of institutional arrangements observed in similar transactions in the same institutional environment. This concept is applied to the study of complex institutional arrangements in which the coexistence of coordination forms adopted by the economic agents is observed, having as a variable of analysis the measuring cost of the transacted attributes.

Convergent with the diversity hypothesis, the MCT is a theoretical part that contributes to the explanation of the diversity of institutional arrangements, counting on the argument of the variability of the transactional attributes and of their measurement costs. For Barzel (1997), the strategic variable is not asset specificity (Williamson, 1996), but the degree of attribute measurability. It is on the basis of this argument that the hypothesis that productive systems may present particular characteristics which make them more or less tolerant to the institutional arrangements diversity, that is, with higher or smaller tolerance to the coexistence of different arrangements.

The Measurement Cost Theory (Barzel, 1997) is considered a branch of Transaction Cost Economics (Williamson, 1985; Zylbersztajn, 2005); however other authors emphasize its roots in the Property Rights Theory (Allan & Luek, 1998; Caleman, 2010; Monteiro & Zylbersztajn, 2012; Zylbersztajn, 2005).

According to Barzel (1997) property rights may be legal and/or economic. Legal rights are guaranteed by the State, while economic rights are guaranteed by private mechanisms such as a company's equity and reputation. The rights that individuals actually have over a given asset result from efforts to protect them, from efforts to capture its value, and from the protection offered by the State. The central issue is the cost of defining and of guaranteeing these rights,[4] so the rights are not perfectly delineated while being subject to capture. The difficulty in defining rights is related to their multidimensional character,[5] and to the variability of the transacted attribute, which therefore creates space for the value capture.

To illustrate this argument, the acquisition of livestock by the slaughter and processing industry should be analyzed. The animal for slaughter is not a one-dimensional asset. In addition to the gender (male or female), as well as its weight and age, dimensions traditionally recognized by the industry, a set of other attributes and by-products are inserted in this product generically denominated "finished animal for slaughter". Attributes of quality, sanitary condition, and traceability are also transacted at the time of sale. Thus, the slaughter animal is a classic example of a multidimensional product, where each dimension differs in the degree of measurement difficulty.

The animal for slaughter presents a set of margins—age, weight, gender, sanitary conditions, traceability, fat finishing, viscera, and leather, among others—and part of these margins may not be contracted at the moment of the animal's commercialization. As a result, there is a set of margins in the transaction that, when not effectively contracted, fall into the public domain, becoming susceptible to capture by the economic agents, in this case the meatpacking industry. There is thus room for conflict in the transaction of different natures: discussion of carcass yields, non-remuneration of quality attributes, discounts due to animal non-compliance, non-remuneration for leather, among others.

Barzel (1997) advances in relation to the Property Law Theory *mainstream* when identifying and characterizing its different dimensions: legal right, economic right, and right in public domain, the last being a dimension in which one of the parties is capable of appropriating the value even if it is protected (imperfectly) by law or by private mechanisms. According to this present study's author, the existence of rights in the public domain leads to dissipation of the transaction value, and this value can be captured by economic agents. For Monteiro and Zylbersztajn (2012), the risk of value capture may occur not only in the public domain but also in those domains protected by legal and economic rights, since these also have protection costs in the face of value appropriation.

Thus, for Barzel (1997), the key variable for the efficient coordination analysis would not be asset specificity as proposed by Williamson (1985, 1996), but the measurability of the transacted attributes. It is understood that this theoretical branch also allows foreseeing the possibility of co-existent institutional arrangements, since the assets are considered multidimensional and, depending on the measurability of each dimension of the transaction, there will be a more efficient coordination mechanism. The focus is the transaction value and not its costs minimization (Zylbersztajn, 2005).

In general, coordination through the market arises from transactions with easily measurable attributes, whose rights guarantee is exercised by the legal system (judiciary). Hierarchical coordination results from the transaction of attributes of difficult (or extremely costly) measurement, with the firm's assets being the guarantee for the transaction. Hybrid forms of coordination would involve relational contracts, with reputation being the source of transaction guarantee. Thus, the transaction of greater value results from the adequate form of guarantee offered by the agents, depending on the variability and measurement of the transacted attributes. Based on these arguments, the coexistence of institutional arrangements is explained.

[4] For the author, transaction costs are the costs associated with the transfer, capture, and property rights protection (Barzel, 1997, p.2).

[5] For Barzel (1997), transacted assets should be analyzed as a set of attributes, hence the transaction's multidimensional nature. Thus, each dimension is related to the definition and guarantee of a property right. Acquiring a fruit represents acquiring a weight, a shape, a color, a variety, a flavor, a sanitary condition, an origin, etc.

In order to analyze the diversity of institutional arrangements linked to measurement costs, two basic assumptions are made:

Assumption 1: "The diversity of institutional arrangements arises from the proportion of easily-measured attributes that provide incentives for convergence, and difficult-to-measure attributes that imply diverse arrangements."

Assumption 2: "The higher the proportion of easily-measured attributes with rights protected by formal institutions, the smaller the variability of institutional arrangements in a given hybrid form of coordination."

In summary, in the presence of mechanisms that define and properly protect property rights, transactions are carried out at low cost. If property rights are not adequately defined and protected, some value will be subject to capture, either because of imperfections in the protection of legal and economic rights, or because they fall into the public domain. Thus, the institutional arrangement results from a combination of formal institutional protections, related to legal rights, and informal institutional protections related to economic rights.

Methodology

The object of this study is the transaction that involves the acquisition of animals for slaughter by the slaughter and processing industry. The analysis unit is the transaction between producers (poultry farmers, swine farmers, and cattle ranchers) and the processing industry. It seeks to identify the governance pattern in these transactions through analysis of the acquisition of animals under the *commodity* standard. A *commodity* standard is a product that does not have a brand, seal, or certification audited by third parties, and is therefore not intended for specific and differentiated market niches. As an example, differentiated products from organic production, production systems focusing on precocity and quality (early calf, golden piglet), among others, will not be part of this study. Products destined to the international markets which do not present specific stamps, brands, and certifications are considered as *commodities* in this research.

The study was developed through the collection of primary and secondary data. Secondary data collection (documentary and bibliographic research) was carried out to achieve a general understanding of the respective AgS in Mato Grosso do Sul. Semi-structured interviews were previously conducted with AgS' sector leaders in poultry, swine, and cattle (rural producers, slaughter and processing industry) in Mato Grosso do Sul. The aim of these interviews was to characterize and identify the standard(s) of animal contracting for slaughter, the variables considered in the transaction, measurement aspects and guarantees of transacted attributes, as well as the main conflicts involved. From these exploratory interviews it was possible to elaborate a semi-structured questionnaire that was later applied to rural producers (poultry producers, swine farmers, and cattle ranchers).

Table 1
Standard of transaction of animals for slaughter.

	Contracts	Agreements[a]	Market	Others
Poultry	100%	0.0%	0.0%	0.0%
Swine	66.7%	15.2%	0.0%	0.0%
Cattle	3.0%	42.4%	63.6%	9.1%

Source: Research data.

[a] For the data tabulation, "contracts" were understood as formal written contracts, duly signed. The "agreements" category involves a set of informal solutions such as unsigned contracts between the parties, verbal agreements based on the reputation of the agents—cattle ranchers and industries. In the case of "agreements", reputation is a guarantee of the transaction, not the courts.

The sample consists of 98 observations,[6] divided into 33 poultry farmers, 25 swine farmers, and 40 cattle ranchers. Depending on the interviewees' availability, the questionnaire was applied either personally (60% of the questionnaires about swine, 100% about poultry, and 30% about cattle) or by telephone (40% swine, 0% poultry, and 70% cattle). A producers register provided by the State Agency for Animal and Plant Protection (IAGRO/MS) was used to identify cattle ranchers. As far as poultry farmers and swine farmers were concerned, producer associations and cooperatives provided producer contacts. In this way a convenient and non-probabilistic sample was obtained.[7]

In order to guarantee a comparison standard between the different productive systems surveyed, the questionnaire presented similar questions for the transaction pattern evaluation, respecting particularities regarding the transacted attributes.

Analytical model

The analytical model chosen for this study development is the Ordered Logit. According to Wooldridge (2002), such a model allows the variable response to have more than two ordered or hierarchical categories. The empirical application considered the degree of organizational tolerance (*TD*) of the agro-industrial systems of poultry, swine, and cattle as a dependent variable such as:

$$TD = \begin{cases} 1 & \text{Low Organizational Tolerance} \\ 2 & \text{Average Organizational Tolerance} \\ 3 & \text{High Organizational Tolerance} \end{cases} \quad (1)$$

The organizational tolerance degree (*TD*), categorized as high/average/low, arises from the diversity of the transaction pattern between suppliers and slaughter and processing industries. According to Table 1, presented in the results discussion, beef cattle showed greater diversity in the transaction pattern, and thus high organizational tolerance, followed by swine and poul-

[6] As one of the respondents did not answer some questions, the final model has 97 observations.

[7] The state of Mato Grosso do Sul accounts for 3% of total poultry slaughter in Brazil, 15% of cattle, and 4% of swine, occupying respectively, the 8th, 2nd, and 8th position in the national ranking regarding the production of animal protein for poultry, cattle, and swine (Ministry of Agriculture, Livestock and Supply [MAPA], 2016). The sample of companies surveyed accounted for 3% of the total slaughter of poultry in Mato Grosso do Sul, 6% of cattle, and 6% of swine.

try respectively, with the poultry sector being the least diverse in the transaction pattern, and thus low organizational tolerance.

In ordering organizational tolerance, the maximum likelihood ratio test is used, based on the comparison of the likelihood function of the restricted model (i.e. the ordered model)[8] with the unrestricted model function (i.e., the unordered model),[9] defined by Johnston and Dinardo (2001):

$$\lambda = \frac{L_*}{L}, \tag{2}$$

where L_* is the value of the likelihood function of the restricted (ordered) model; L, the value of the likelihood function of the unrestricted (unordered) model, and $0 \leq \lambda \leq 1$.[10] The test statistic, which is the logarithm of the likelihood ratio, is equivalent to:

$$LR = 2(\ln\ L - \ln\ L_*) \sim \chi^2_m, \tag{3}$$

where the variable LR is characterized by the distribution of chi-square (χ^2), with m degrees of freedom.[11] The null hypothesis to be tested is that the ordered model is equal to the estimated non-ordered model, or, in other words,

$$\begin{aligned} &H_0 : Ordered \bmod el = Unordered \bmod el. \\ &H_1 : Ordered \bmod el \neq Unordered \bmod el. \end{aligned} \tag{4}$$

If the null hypothesis is rejected, the ordered model will be chosen, and the producer will face three levels of organizational tolerance. In case the null hypothesis is not rejected, only high organizational tolerance will be used, or not.

According to Capéau, Decoster, and Vermeulen (2003), the Ordered Logit model is constructed from a linear relationship between an unobserved continuous latent variable Y_i^* and a vector of regressors X_i ($kx1$), such that:

$$Y_t^* = X_i\beta + \varepsilon_i, \quad \text{with } i = 1, \ldots, n. \tag{5}$$

where β is a parameter vector ($kx1$) and ε_t is the random error term. Consider that the variable ε_t has a logistic distribution, the error distribution function is given by:

$$F(\varepsilon_i) = \frac{1}{1 + e^{-\varepsilon_i}}. \tag{6}$$

The relationship between the unobserved latent variable Y_t^* and the observed results of the individual satisfaction levels i, can be represented by the following observations:

$$\begin{aligned} &Y_i = 1 \quad \text{if} \quad Y_i^* \leq \mu_1, \\ &Y_i = 2 \quad \text{if} \quad \mu_1 \leq Y_i^* \leq \mu_2, \\ &Y_i = 3 \quad \text{if} \quad \mu_2 \leq Y_i^*. \end{aligned} \tag{7}$$

where the μ_k ($1 \leq k \leq 2$) are the unknown limits of the intervals (*cut points*) that will be estimated together with the vector β, as mentioned by Parente (2000). In addition, the μ's must meet the following conditions $\mu_1 < \mu_2$. Assuming that the error term is logistically distributed, then the model's probabilities can be written as:

$$\begin{aligned} Pr(Y_i = 1) &= Pr(X_i\beta + \varepsilon_i \leq \mu_1) = \frac{1}{1 + \exp(X_i\beta - \mu_1)}, \\ Pr(Y_i = 2) &= Pr(X_i\beta + \varepsilon_i \leq \mu_2) - Pr(X_i\beta + \varepsilon_i \leq \mu_1) \\ &= \frac{1}{1 + \exp(X_i\beta - \mu_2)} - \frac{1}{1 + \exp(X_i\beta - \mu_1)}, \\ Pr(Y_i = 3) &= Pr(\mu_2 \leq X_i\beta + \varepsilon_i) \\ &= 1 - \frac{1}{1 + \exp(X_i\beta - \mu_2)}. \end{aligned} \tag{8}$$

The estimation of the unknown coefficients β and μ is obtained by the maximum likelihood method. Wooldridge (2002) states that for every i, the log-likelihood function is given by:

$$\begin{aligned} l_i(\mu, \beta) = {} & 1[Y_i = 1] \log[\Lambda(\mu_1 - X_i\beta)] + 1[Y_i = 2] \\ & \log[\Lambda(\mu_2 - X_i\beta) - L(\mu_1 - X_i\beta)] + 1[Y_i = 3] \\ & \log[1 - \Lambda(\mu_2 - X_i\beta)] \end{aligned} \tag{9}$$

where Λ represents the logistic function.

According to Capéau et al. (2003), the marginal effect of the Ordered Logit model is calculated through the derivative of the cumulative probability, if $\Pr(Y_i \leq k)$,that is:

$$\frac{\partial Pr(Y_i \leq k)}{\partial X_i^j} = -\beta_j \frac{\exp(X_i\beta - \mu_k)}{(1 + \exp(X_i\beta - \mu_k))^2}, \tag{10}$$

where $Pr(Y_i \leq k) = \frac{1}{1+(X_i\beta - \mu_k)}$. This confirms that the probability decreases with an increase in the explanatory variable if β_j is positive, and the opposite occurs if $\beta_j \leq 0$.

The marginal effect associated with the probability of the kth satisfaction stage is given by:

$$\begin{aligned} \frac{\partial Pr(Y_i = k)}{\partial X_i^j} = -\beta_j \Bigg(& \frac{\exp(X_i\beta - \mu_k)}{(1 + \exp(X_i\beta - \mu_k))^2} \\ & - \frac{\exp(X_i\beta - \mu_{k-1})}{(1 + \exp(X_i\beta - \mu_{k-1}))^2} \Bigg) \end{aligned} \tag{11}$$

where X_i represents the vector of the explanatory variables and β their respective parameters.

The model was estimated using the specialized statistical package of Data Analysis and Statistical Software 10 (STATA, 2007).

Result and discussion

This research is conducted based on the central hypothesis that Organizational Tolerance is related to the degree of difficulty in measuring the transacted product attributes (Zylbersztajn & Caleman, 2012). For the purpose of the study, the following hypotheses were defined:

[8] Estimated by the Ordered Logit, where the producer faces three levels (degrees) of organizational tolerance.

[9] Estimated by the Logit model, where it considers 1 if the producer adopts a high degree of organizational tolerance, and 0 otherwise. For more details on the Logit model, see Johnston and Dinardo (2001).

[10] The term λ is known as the likelihood ratio.

[11] Wherein m is the number of restrictions imposed by the null hypothesis.

Classification	General hypotheses	Variable description	Detailed hypotheses	Type of variable	Expected signal
Producer profile	Variables of control	Tradition in activity	Having tradition in the activity implies less organizational tolerance / less diversity of institutional arrangements (*path dependence*)	*Dummy*	–
		Time in activity (years)	Longer time in the activity implies lower organizational tolerance / lower diversity of institutional arrangements (*path dependence*).	*Continuous*	–
		Cooperation	Being part of an association and / or cooperative implies adopting several negotiating models (more options for members), thus, a greater diversity of institutional arrangements.		+
Transaction Attributes	H1a; H1b	Difficulty in measuring the attribute "weight" of the animal (high, average, and low)	H1a/ H1b –The higher / lower the difficulty of measuring the animal's weight, the lower / higher the Organizational Tolerance.	*Dummy*	+
		Difficulty of measuring the attribute "age" of the animal (high, average, and low)	H1a/ H1b –The higher / lower the difficulty of measuring the animal's age, the lower / higher the Organizational Tolerance.	*Dummy*	+
		Difficulty of measuring the attribute "quality" of the animal (high, average, and low)	H1a/ H1b – The higher / lower the difficulty of measuring the animal's quality, the lower / higher the Organizational Tolerance.	*Dummy*	+
		Difficulty of measuring the attribute "compliance" of the animal (high, average, and low)	H1a/ H1b –The higher / lower the difficulty of measuring the animal's compliance, the lower / higher the Organizational Tolerance.	*Dummy*	+
Transaction Standard		Adoption of formal contracts for the transaction	H1a –The smaller the measurement difficulty, the higher the possibility of adopting formal contracts and the smaller the Organizational Tolerance.	*Dummy*	–
Organizational Tolerance	Dependent Variable	Governance mode of the transaction	Based on the observed diversity of forms of contracting animals for slaughter, there are: High Organizational Tolerance (Cattle); Average Organizational Tolerance (Swine), and Low Organizational Tolerance (Poultry).	*Dummy*	

Chart 1. Variables of the econometric model.

H1a: The higher the proportion of easily-measured attributes, the lower the Organizational Tolerance (OT);

H1b: The higher the proportion of less easily-measured attributes, the higher the Organizational Tolerance (OT).

The research was developed from three groups of variables: (i) the producer profile; (ii) transacted attributes; and (iii) transaction pattern. To set the producer's profile, the following points were analyzed: the developed activity (cattle, swine, and poultry), time in activity (years), tradition (1st generation, 2nd, 3rd, > 3rd) and participation in associations or cooperatives (yes/no). Regarding the transacted attributes, the degree of difficulty (high, average, or low) in measuring the attributes of weight, age, quality, and animal compliance were analyzed. In particular, in the quality requirement, the quality of the leather and the percentage of fat cover were considered to be attributes

Table 2
Descriptive statistics of independent variables, OT.

Variable	Description	Measured in	General	
			Average	Standard deviation
Time (temp)	Time in the activity	Years	16.41	11.17
Tradition (trad)	Tradition in the activity	1st generation = 1 2nd generation = 2 3rd generation = 3 >3rd generation = 4	1.82	0.912
Cooperativism (coop)	Participation of producers in some association or cooperatives	(Yes = 1, No = 0)	0.806	0.3973
Transaction standard (trans_cont)	If the transaction standard occurs via formal contract	(Yes = 1, No = 0)	0.5714	0.4974
Difficulty in measuring compliance (dif_conf)	Producer difficulty in measuring product compliance	(Average/high = 1, low = 0)	0.2857	0.454

Source: Research data.

for the cattle transaction. The transaction pattern was evaluated based on the governance mode of the transaction: contracts, agreements, market, or other modality.

Considering the transaction pattern of animals for slaughter, it is observed that for poultry 100% of the transactions are carried out by contract, while for swine this indicator is 66.7%, and for cattle it is 3%. For cattle, 63.6% of respondents report that the sale of animals is carried out in the spot market and 42.4% through an informal agreement with the meatpacker (Table 1).

Based on the observed contracting methods diversity, it is assumed that "Cattle" presents "High Organizational Tolerance"; "Swine" presents "Average Organizational Tolerance"; and "Poultry" presents "Low Organizational Tolerance".

These results indicate that out of the 97 interviewees, 32 (or 32.98%) are characterized by high organizational tolerance and are associated with cattle production; 25 (or 25.77%) have an average organizational tolerance; and 40 (or 41.23%) have low organizational tolerance.

Chart 1 shows the variables considered in the econometric model.

Empirical results

Regardless of activity type (cattle, swine, or poultry), it is observed that the average time of producers in the activity is of 16.41 years. Thus, on average, the producer is close to the second generation (1.82). The average participation of producers in associations or cooperatives is quite high, 80.6%.

On average, 57.14% of producers transact their goods having a pre-arranged formal contract before sale. Regarding the difficulty of measuring the product compliance, only 28.57% of the producers think that this difficulty is average or high.

Table 2 describes the independent variables, besides the means and their standard deviations. In order to make the model more parsimonious, attributes of weight, age, and quality and their respective aspects of measurement were not considered in the final model because they do not present statistical significance.

Table 3
Likelihood ratio test for ordered model.

Log $L^{\bullet} = -31.50$	$\chi^2_{tab}{}^{\bullet\bullet\bullet} = 3.84$
Log $L_*{}^{\bullet\bullet} = -42.76$	$LR > \chi^2_{tab}$
$LR = 22.52$	Rejects *Ho* at the level of 1% of significance.

Source: Research data.
Note: $^{\bullet}$ Log L is the logarithm value of the unrestricted model's likelihood function.
$^{\bullet\bullet}$ Log L_* is the logarithm of the restricted model's likelihood function.
$^{\bullet\bullet\bullet}$ Value of the χ^2_{tab} at the level of 0.01 of significance, with 1 degree of freedom.

Table 3 presents the likelihood ratio test, described in (3), in which the hypothesis of ordering the organizational tolerance degree is tested. Statistically, this is done by testing the hypothesis that the estimated ordered model is equal to the estimated model in an unordered way.

The test result strongly rejects the hypothesis of equality between the models, which indicates that the organizational tolerance degree is done in an ordered way, or in other words is more accurately estimated if the Ordered Logit model is used.

It is also verified that the estimated model is globally significant, since by the Likelihood Ratio (*LR*) test, it is possible to reject the null hypothesis that all coefficients associated with the explanatory variables are null.

Tests were performed to detect heteroscedasticity and serial autocorrelation, since the presence of these problems invalidates the use of the t and F tests for inference purposes and the estimators are no longer efficient (Greene, 2012). The tests of White to detect heteroscedasticity, and the Durbin-Watson test for autocorrelation were performed, which did not indicate the presence of either, giving greater confidence in the presented results.

Multicollinearity was tested for all variables and a significant relationship was found between time and tradition, since the longer the activity duration, the higher its family tradition will be. The problem was solved by excluding the variable time in the regression of the Ordered Logit model.

Table 4 presents the estimates results of the Ordered Logit model parameters for organizational tolerance of the poultry,

Table 4
Ordered Logit model result of the organizational tolerance degree.

Explanatory variables	Coefficient	Standard deviation
Trad	−0.93006**	0.3824
Coop	1.6215***	0.87627
trans_cont	6.1547*	1.2399
dif_conf	1.6765**	0.6783
(*cut point 1*) μ_1	2.0476	1.179
(*cut point 2*) μ_2	65,908	1.6327
Pseudo R^2	0.5962	

Source: Prepared by the authors.
* Significant at 1%.
** Significant at 5%.
*** Significant at 10%; ns not-significant.

swine, and cattle of the agro-industrial systems, calculated by STATA 10.[12]

By the results analysis it is verified that the regression as a whole presented good predictive power, with a Pseudo R2 of 0.6. The "Transaction Standard" variable (*trans_cont*) was significant at 1%, while the "Tradition" (*trad*) and Difficulty in measuring compliance (*dif_conf*) variables were significant at the 5% level, while the variable "cooperation" (*coop*) was significant at the 10% level.

The variable (*trans_cont*) showed a sign opposite to the expected, that is, the adoption of contracts correlated positively to the degree of organizational tolerance. The argument that the adoption of contracts presupposes the existence of attributes of low cost of measurement, which would result in a lower organizational tolerance degree in the transaction, was not confirmed. However, it is a fact that a contract involves a set of negotiated attributes, possibly with varying measurement difficulties. The detailing of the contracts between the parties was not analyzed in this research. The lack of this analysis is, perhaps, an opportunity for improvement, as well as a possible explanation for the opposite sign of this variable in the statistical model.

As expected, the variable (*coop*) showed a positive sign; to be part of an association or cooperative would provide members with various business options, increasing the organizational tolerance. The (*trad*) variable presented a negative sign, indicating that the higher the tradition the smaller the degree of organizational tolerance, possibly due to *path dependence* or perhaps also suggesting that variables associated with learning, establishment of relationships within the AgS, and previous experience, are associated with less flexible choice patterns. Also, the variable (*dif_conf*) presented a positive sign, indicating that the higher the difficulty of measurement, the higher the organizational tolerance, corroborating the theory. Thus, the study's central hypothesis is confirmed, relating the difficulty of measuring the attribute "animal compliance" with the existence of organizational tolerance.

The calculated cut points (*cut points*) were: $\mu_1 = 2.0476 < \mu_2 = 6.5908$, and indicate the intervals where change occurs at the organizational tolerance level.

[12] For more details on the estimation of the Ordered Logit model in STATA, see STATA (2007).

Table 5
Probabilities of occurrence of degrees of organizational tolerance.

OT	Probability
Pr ($Y_i = 1$) Low Organizational tolerance	0.45373
Pr ($Y_i = 2$) Average Organizational tolerance	0.32125
Pr ($Y_i = 3$) High Organizational tolerance	0.2250

Source: Prepared by the authors.

Table 6
Marginal effects for the different levels of organizational tolerance.

	Variable	Coef.	Standard deviation
$\frac{\partial Pr(yi=1)}{\partial x_i^j}$	*Trad*	0.13499***	0.07410
	Coop	−0.30327NS	0.2024
	trans_cont	−0.86081*	0.07240
	dif_conf	−0.19283**	0.09838
$\frac{\partial Pr(yi=2)}{\partial x_i^j}$	*Trad*	−0.0876NS	0.05933
	Coop	0.25165NS	0.18676
	trans_cont	0.44632*	0.1100
	dif_conf	0.07904NS	0.08055
$\frac{\partial Pr(yi=3)}{\partial x_i^j}$	*Trad*	−0.04733NS	0.02899
	Coop	0.05161NS	0.03224
	trans_cont	0.41449*	0.0861
	dif_conf	0.1137 NS	0.08543

Source: Research results.
* Significant at 1%.
** Significant at 5%.
*** Significant at 10%; ns not-significant.

From this model the probabilities of occurrence of the three levels of organizational tolerance are estimated: low, average, and high, calculated by the mean values of the independent variables (Table 5).

The probability that the degree of organizational tolerance is low is $Pr(Y_i = 1) = 0.45373$, or 45.37%; the probability that the degree of organizational tolerance is average is $Pr(Y_i = 2) = 0.32125$, or 32.13%; the probability that the degree of organizational tolerance is high is $Pr(Y_i = 3) = 0.2250$, or 22.5%. Therefore, the results allow one to state that the probability of agro-industrial systems being classified as having low or average organizational tolerance is 77.5%.

Table 6 shows the marginal effects of the three probabilities, calculated by the mean values of the independent variables.

In general, it is observed that the marginal effects for the probability $Pr(Y_i = 1)$ are negative, indicating that the increase in one unit in the explanatory variables decreases the probability of the agro-industrial systems having low organizational tolerance. However, it is observed that the Tradition variable (*trad*) presented a positive signal, indicating that the higher the producers' tradition, the more resistant they will be to adopt a system with higher organizational tolerance.

While marginal effects $Pr(Y_i = 2)$ and $Pr(Y_i = 3)$ are positive for the Transaction Pattern variable (*trans_cont*), indicating that the increase by one unit in the explanatory variables increases the likelihood of the agro-industrial systems having higher levels of organizational tolerance. The other variables were not significant, indicating that the change by one unit in *trad*, *coop*, and *dif_conf* do not have an impact on the probability change of

the agro-industrial systems being considered average and high. The results obtained with the statistical model corroborate the two hypotheses presented. The simpler and lower the cost of measuring attributes, the lower the observed tolerance degree. This results from the inductive role of formal institutions in the presence of legal property rights.

Conclusions

The observation of the governance modes of the institutional arrangements in complex agro-industrial systems demonstrates a diversity of possibilities. Formal and informal contracts, vertical integration, and markets are examples of the solutions found in the same agro-industrial system. In spite of the expected convergence to a model considered more efficient, from the perspective of Transaction Cost Economics, what is seen is the coexistence of arrangements under the same institutional context.

Moreover, it is observed that some agro-industrial systems demonstrate higher or lower tolerance to strict organizational models. Thus, the poultry AgS unambiguously shows a dominant pattern in the relationship with processing industries through integration contracts. In turn, beef cattle breeding present a greater diversity of arrangements with the slaughter and processing industry. Despite the importance of other theoretical explanations, this research investigates the "Organizational Tolerance" argument for understanding the coexistence of institutional arrangements. That is, based on the assumptions of the Measurement Costs Theory (Barzel, 1997), it is investigated whether the difficulty of measuring the transacted attributes impacts the existence of a diversity of institutional arrangements in the agro-industrial systems.

Considering the transaction pattern and the product attributes negotiated in the acquisition of the animals for slaughter in the beef, swine, and poultry agro-industrial systems of Mato Grosso do Sul, an Ordered Logit model is proposed to test the central hypothesis that the "Organizational Tolerance" is related to the degree of difficulty in measuring the transacted product attributes (Zylbersztajn & Caleman, 2012).

The research results indicate that the difficulty of measuring the attribute "animal compliance" is statistically significant for the existence of higher organizational tolerance at the level of 5%. Other variables such as tradition (5%), cooperation (10%), and contract adoption (1%) also explain the organizational tolerance degree observed in the systems investigated. However, "contract adoption" is in the opposite direction to what was expected. Therefore, it is understood that the central hypothesis of the research was validated, namely that the degree of organizational tolerance of a AgS depends on the degree of difficulty in measuring an attribute of the related product, in this case, the attribute "animal compliance".

In addition to the confirmation that the cost of measuring the transacted attributes may explain the higher or smaller diversity of institutional arrangements (respectively, smaller or higher organizational tolerance), this study contributes the identification of guidelines for public and private policies.

Thus, AgSs with a high diversity of institutional arrangements can mean higher difficulties in the transactional attributes measurement from which high transaction costs arise. Public policies aimed at reducing measurement costs, such as access to new technologies and/or programs that facilitate the measurement of attributes could reduce transaction costs and provide greater efficiency to the identified arrangements. For example, for the beef AgS, the adoption of programs for inspection and verification of scales in the slaughterhouses, standardization of the animals' hygiene and evaluation of carcasses, as well as animal and leather quality incentive programs, are initiatives that have long been demanded by the industry.

Within the scope of private policies, programs such as "Pesebem"[13] of the Federation of Agriculture and Livestock of Mato Grosso (FAMATO) and of Goiás (FAEG), and initiatives modeled on the Council of Producers of Sugar Cane, Sugar, and Ethanol of the State of São Paulo (CONSECANA-SP) (Belik, Paulillo, & Vian, 2012) could establish clear criteria for animal remuneration, based on income and compliance indexes previously agreed between the parties. However, according to Zylbersztajn and Nogueira (2002), the diversity of organizational solutions does not mean per se a condition of inefficiency.

There remains a clear need for complementary studies to gain a better understanding of the phenomenon. The sample's limited size, its non-probabilistic and intentional nature, and the investigation of a restricted set of attributes may facilitate and simplify data collection and analysis, but they also represent limitations. Such limitations should be understood as an incentive for further investigations, with deeper studies on the subject.

Understanding the organizational efficiency of agricultural-based systems is critical to the establishment of public and private strategies for the national agribusiness sector. This research innovates by bringing forward the "organizational tolerance" argument and by seeking to validate it through empirical research. It is certainly a first step in a broad research agenda to investigate the plural forms of coordination.

Conflicts of interest

The authors declare no conflicts of interest.

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[13] The Pesebem Program in Mato Grosso was financed by the Support Fund for the Beef Cattle Industry (FABOV) until 2010 and involved the weighing of cattle through the installation of producers' federation scales in the cold storage facilities.

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