Transaction Cost Index to agricultural export ports

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Abstract

The Brazilian port scenario has undergone several changes in recent decades, from the decentralization of activities to the new exploration and leasing criteria for the private initiative of cargo handling terminals in public ports. This study aims to identify the transaction costs in the port sector for the export of agricultural products (soybean and ethanol) and develop a transaction cost index (TCI). The results showed that ethanol was in the highest category of transaction costs reaching 66.2%. We concluded that the assets, which were evaluated for both products, present specificities ranging from medium to high that lead to the highest transaction costs in the port sector, thereby promoting the adoption of new strategies to mitigate the risk associated with transactions, such as long-term contracts and partnerships.

Keywords: New Institutional Economics. Logistics. Supply chain. Agribusiness. Trading.

1. Introduction

In agriculture economics theory, the aspects related to distribution and the spatialization of productive activities are constant study topics. In various theoretical approaches, the costs of transportation and exportation are the main factors for the decision of the location for the installation of certain productive activity, and they also determine the relationship between the specialization of production and interregional trade.

Brazil is one of the world's leaders in exporting agriculture and livestock products and remains in first place in the export ranking of products such as: soybean complex (grain, meal, and oil), corn, coffee, sugar cane, orange juice, and meat. The Brazilian Ministry of Agriculture foresees that, by 2030, one-third of the agricultural products traded will come from Brazil, due to the growing demand of Asian countries (Brasil, 2014). A large part of commodity exports is shipped through the port of Santos, which is the largest port in Latin America. In 2019, the movement of goods reached about 134 million tons, with a strong influence of agricultural product shipments (51.5% of movement) with an emphasis on soybean complex, sugar cane, corn, citrus juices, and ethanol. The movement of agricultural products reached 69.1 million tons (CODESP, 2020).

Despite the intensity of export activities in the port of Santos, the shipping process has structural and planning failures that have caused the congestion of trucks and a long waiting time for ships to dock. According to the Global Competitiveness Report 2016-2017, Brazil holds the 114th position, among 138 countries, in port infrastructure (SCHWAB, 2016). This shows that, despite significant participation in world trade, investment is needed to overcome bottlenecks.

According to Hilsdorf and Nogueira Neto (2016), trucks loaded with sugar take about 12 hours to unload; ideally, this operation should be carried out between three and four hours. In addition, the unloading delay results in truck congestion and a long waiting time for ships to dock in Santos. In 2012, congestion lasted 16 hours, which is almost three times the time spent in 2003 (six hours), whereas the total stay time of vessels at the port increased from 26 to 35 hours during the same period.

The theoretical justifications of the research are associated with the importance of international trade for agricultural products that depend on the port system for trading. In order to contribute to the task of finding elements that assist in guiding more efficient export logistics arrangements, it is necessary to analyze the transaction costs of the port sector. By assessing the transaction costs inherent in port activities, it is possible to check what the best contractual arrangements for a given transaction are, thereby reducing costs.

Furthermore, the evaluation of the transaction costs in the port sector can contribute to investment interest in the port sector, which has had its configuration changed since 2003, when the Port Modernization Act (BRASIL, 1993) was enacted, followed by the new regulatory framework (BRASIL, 2013) allowing for new models of contractual arrangements.

The theoretical basis for studies on Transaction Costs is fairly rich, starting from Coase, (1937) in The Theory of The Firm, where he presented the subject of institutions

within the context of economic theory. Coase (1937) noted that sometimes the cost of managing economic transactions through markets is higher than the cost of managing the economic transactions within organizations. Years after the publication by Coase (1937), Williamson (1979) gave continuation to the studies on transaction costs.

The transaction is the transformation process of a given product through separable technological interfaces (WILLIAMSON, 1985). Having as an objective the reduction of transaction costs, agents can use mechanisms to regulate a transaction, which are referred to as modes of governance (WILLIAMSON, 1985).

The basic proposition is that each form of governance, that is, of the market, whether integrated or mixed, must be supported by a particular type of contract. The firms choose the most appropriate form of coordination from the three transaction parameters analysis: the specificity of the assets involved in the transaction, frequency, and uncertainty (BELIK, et al. 2007; FERNANDES, 2009).

Given how significant agribusiness is in Brazilian exporting and the importance of ports in this process, evaluating the existence and extent of the transaction costs in the port sector presents itself as a strategic element to promote gains in competitiveness.

The aim of this study was to evaluate the occurrence of transaction costs in the port environment. In addition, the creation of a Transaction Cost Index (TCI) is proposed with the key element being the specificity of the assets involved in the export of soy and ethanol. This index can be used to help the decision making of export agents in the design of the most appropriate form of governance.

In this context, this research is intended to evaluate the occurrence of the transaction costs in the port and their impact on the logistics planning of soybean and ethanol exports. In addition, the aim of this work was to create a TCI, developed based on the analysis of the levels of specificity from the assets of soybean and ethanol export activities in the port sector. This index can be used to assist in the decision-making of exporting agents in the design of the most suitable form of governance.

Studies proposed by Fernandes (2009), Oliveira, (2011), Traversac et al. (2011), and Woldie and Nuppenau (2011) followed the same lines. Fernandes (2019) evaluated transaction costs in the swine breeding. Oliveira (2011) evaluated transaction costs in the railway sector for the transportation of four agricultural products (soybean, non-transgenic soybean meal, sugar and ethanol). Traversac et al. (2011) used Resource-Based Perspective and Transaction Cost Economics to create a suitable framework for analyzing vertical integration and describe the features of the French wine supply chain organization. Woldie

and Nuppenau (2011) proposed a quantitative analysis of transaction costs and the presence of institutions for supervising a formal exchange in the Ethiopian fruit sector.

In the port sector, Saeed et. al. (2018) used transaction cost analysis to examine port congestion and describe governance strategies for port congestion mitigation. The authors reveal that three characteristics of transaction cost analysis prevail in the maritime sector: asset specificity; frequency; and, uncertainty.

The hypothesis of this research is that the more specific the product or activity developed in export activities is, the higher the transaction costs involved in exports, leading to the need for more elaborate long-term contracts.

The Brazilian port scenario has undergone several changes over the past few decades, especially after the Port Modernization Act (BRASIL, 1993) and the new regulatory framework (BRASIL, 2013b) with the new criteria for exploration and lease (through the transfer of right to use) for the private initiative of cargo handling terminals in public ports. In addition, the new rules facilitate the installation of new private port terminals. For Farranha, et al. (2015), one of the main objectives of Law No. 12.815/2013 was to provide a faster process and to modernize the sector, thereby reducing the transaction costs.

The main contribution of our research is to develop a transaction cost index (TCI) for agricultural products supported by the TCT. This contribution is theoretically and practically relevant because our modeling approach is rather universal and allows for simulating the impact of transactions in the port sector, providing valuable insight to inform the discussion among stakeholders.

The present paper is structured as follows. First, a theoretical background about New Institutional Economics, focusing on the description in the Transaction Costs Theory, highlights the related literature, and helps at the better positioning our contribution. This is followed by the presentation of the methodology. Next, the results and discussions and finally the conclusions and contributions are presented.

2. Theoretical Framework

The New Institutional Economics (NIE) aims to explain the different forms of interactions of individuals in the allocation of resources (COASE, 1998), through the assumptions of limited rationality, asymmetry of information, and opportunistic behavior. The NIE consists of two complementary analytical strands. The first can be understood as macro-institutional, worked by Douglass North, which focuses on the origin, structuring, and

changes of institutions, which are seen as the rules that guide the behavior of society. The second is of a micro-institutional represented by the economy of organizations, which studies the different institutional arrangements. This aspect has contributions from several authors, such as Ronald Coase, Oliver Williamson, and Claude Ménard (ZYLBERSTAJN, 2005).

The precursor study for understanding transaction costs was conducted by Ronald Coase in 1937. In this study, the author describes the firm as an instrument to act in the markets with the purpose of reducing transaction and contract costs (COASE, 1937).

Half a century later, Oliver Williamson's studies advanced in the analysis of transaction costs, considered by Williamson (1979) as fundamental for the study of economics, where the Theory of Transaction Costs (TCT) identify the critical dimensions to characterize transactions and, from then on, the most appropriate modes of governance or forms of trade. Williamson (1996) associates the concept of institutions with that of governance for micro analyses of the individual transaction.

Two assumptions are important to understand the limitations of contracts as a form of trading. Limited rationality is the assumption that the agent does not have all the necessary information for the transaction. For practical purposes of TCT, the key to limited rationality is that all contracts are inevitably incomplete (WILLIAMSON, 2007). The second assumption is opportunism wherein, within the search for their self-interest, economic agents do not always conduct themselves in a transparent and honest manner. Therefore, the possibilities for economic agents to deliberately induce a breach of contract and engage in other forms of strategic behavior are admitted (WILLIAMSON, 1993).

In order to reduce transaction costs through a form of trade, companies can choose from three types of forms: via markets; hybrid forms (medium and long-term contracts); hierarchy (vertical integration) (OLIVEIRA; SILVEIRA, 2013) (Figure 1). In general, the transaction costs depend on asset specificity, transaction uncertainty, and transaction frequency (WILLIAMSON, 1979). The stronger the asset specificity is, the higher the degree of uncertainty it will be in the transaction. The higher the transaction frequency is, the higher the transaction costs will be (DENG; ZHANG, 2020) (Figure 1).

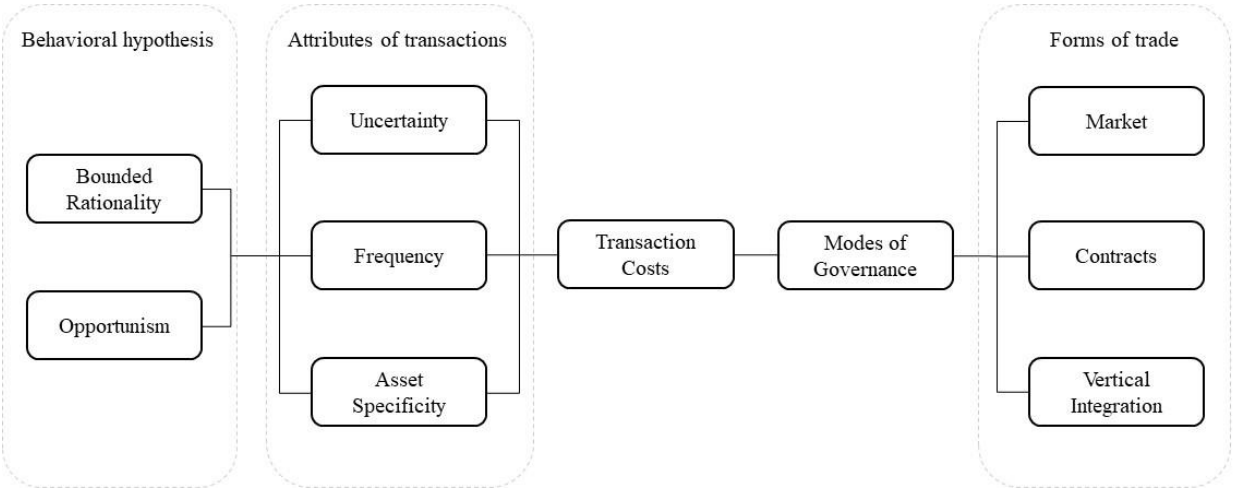

Figure 1: Theoretical framework about transaction costs

Fonte: Belik et al. (2007, p. 117).

The specificity of the assets involved is one of the most important parameters, being considered as a key variable for the determination of the governance structure. The more specific an asset is, the more it is assumed that the transaction costs involved will be higher and, according to Azevedo (2000), the assets are specific when the return related to them depends on the continuity of a transaction.

Neves et al. (2001) points out that the specificity of the assets can be considered in six different types: local specificity; physical specificity; human specificity; technological specificity; brand specificity; and temporal specificity.

If the asset specificity is zero, the transaction costs will be negligible and there is no need to control the transaction. In this case, the most efficient organizational form would be the market (Figure 1). If, on the contrary, the asset specificity is high, the costs associated with the breach of contract will be high. In this case, it is interesting to have more control over the transactions, even at the expense of less motivation. Therefore, the vertical integration is chosen (AZEVEDO, 2000).

Despite the importance of transaction costs by organizations and economic agents, the efforts of current studies focus on the application of TCT in the business environment in order to identify, analyze, and compose bases for the decision making of organizations. Some more recent works have involved the proposition of analytical models for agroindustrial systems under the TCT light, allowing testing hypotheses regarding the organization of systems such as Deng and Zhang (2020) and Nuintin et al. (2012).

Nuintin et al. (2012) characterized and analyzed the contracts and forms of governance relating to transactions resulting from the employment of labor in coffee activity from the perspective of transaction cost economics.

Casali and Marion Filho (2013) contributed to research that aimed to evaluate the transaction costs, especially asset specificity, and sunk costs in dairy farming. They concluded that the uncertainty, frequency, and specificity of the assets involved in milk transactions are low, which generates negligible transaction costs. However, there are sunk costs, such as investments in specific equipment and infrastructure works that are not negligible.

TCT was also applied in order to understand its influence on the choice of the most appropriate marketing mechanism in Leme and Zylbersztain (2008), Oliveira (2011), Fragoso (2013), and Weseen et al. (2014). However, the literature still needs more studies to be conducted on applications that seek the creation of comparative parameters, as this is one of the motivations for the development of the present research.

3. Methodology

The methodology employed in this research was based on the model developed by Neves, Zuurbier, and Campomar, (2001) for the planning of distribution channels for food and drinks, and by Oliveira (2011), who evaluated the transaction costs of agricultural products in the railway sector. Figure 2 illustrates the construction of the analysis base for this study.

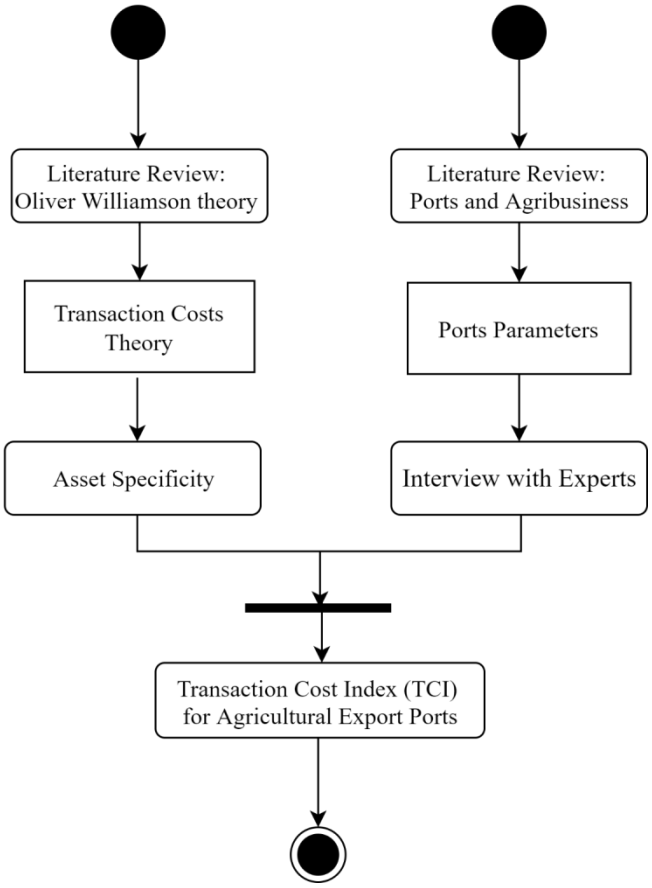

Figure 2: Methodology structure

The activity diagram (Figure 2) begins with the literature review regarding New Institutional Economics and Transaction Costs based on works by Oliver Williamson. Additionally, a literature review on port the port system main challenges and the implications for agricultural commodities was also analyzed. From these two approaches, Asset Specificity involved in the process of exporting agricultural products were defined. This specificity was also validated through interviews with sector experts. Thus, it was possible to systematize a sequence of operations and procedures related to the different dimensions of the assets (physical assets, human assets, technological, locational and temporal) which subsidized the construction of a Transaction Cost Index (TCI) N for the port sector. The approach presented in this research seeks to help exporters making strategic decisions and allowing for simulating the impact of transactions in the port sector, providing valuable insight to inform the discussion among stakeholders.

In this research, the products selected were soybean and ethanol. The choice for these products was due to them being significantly marketed and exported items as well as due to their physical differences, which could allow for a more comprehensive analysis.

Interviews were conducted with key players in the grain and biofuels chain. This methodological approach, which is known as rapid assessment, is used by Ellman, (1981), Kumar, (1993), Dunn, (1994) ,and Beebe, (1995), in which they use data from secondary sources together with non-random samples and semi-structured interviews wherein the key players can be applied in research that is necessary to obtain data and/or more detailed information to understand the dynamics of the sector.

Rapid appraisal is a data collection method aimed at supplying the needed information in a timely and cost-effective manner. The method provides the views and feedback of beneficiaries and other stakeholders in order to respond to decision-makers' needs for information.

In July 2016, we interviewed 20 stakeholders from trading companies that operate in the export activities of soybean and ethanol in the Port of Santos, for which structured forms were sent to identify, interpret, and analyze transaction costs, specifically regarding the specificity of the assets employed in such activities. The stakeholders interviewed were representatives of large companies like Petrobras (Brazilian Petroleum Corporation is a semi-public Brazilian multinational corporation in the petroleum industry) and Caramuru Group (leading Brazilian Company in processing soybean, corn, sunflower, and canola) as well as university centers. The Caramuru Group also stands out for its products and grain transport logistics, with large investments in the Port of Santos.

The forms employed in this research were structured with questions about the transaction dimension, namely asset specificity. The level of specificity was classified as low, medium, or high. Subsequently, the scale was transformed into values ranging from 1 to a classification for a "low", 3, for a "high" rating in unit intervals.

For the analyses to be conducted, the calculation methodology of transaction cost index proposed by (Oliveira, 2011) was adopted. This index involves the transformation of the five dimensions contemplated by it with regard to specificities (physical assets, temporal, human assets, technological, and locational). The total number of attributes, that is, the items evaluated among the different specificities, totaled 34 attributes. Of these, four of them apply only to soybean or ethanol.

Consider the following parameters: k = {1, ..., 34} - set of the number of evaluated attributes, |k| = 34 is the cardinality of the attributes set, and e x_i - value assigned to the specificity attribute i. Let S - the sum of specificity attributes and TCI - transaction cost index, which is determined by:

$$S = \sum_{i=1}^{k} x_i \quad (1)$$

$$TCI = 100 * \frac{S-|k|}{2|k|} \quad (2)$$

In equation (1), considering the value assigned to each specificity attribute *i*, the total sum of specificity attributes is determined. Equation (2) calculates the TCI relating the value of the sum of specificity attributes with the number of specificity attributes considered.

The TCI is the percentage of the final cost of the transaction, spent and immobilized with the attributes of the specifics considered. This index can range from 0% to 100%.

In order to better position the TCI obtained for each product and to support the decision-making of export agents in the design of the most appropriate modes of governance/form of trade, the index was classified into three categories (Table 1).

Table 1: Classification of the Transaction Cost Index Categories

Classification	Value of TCI
Low	[0%-33%]
Medium	(33%-66%]
High	(66%-100%]

Maximum TCI: 100%; Minimum TCI: 0%.

4. Results and Discussion

The highest TCI was the ethanol, which indicates that the transaction cost associated with the export process of this product via the Port of Santos is higher and demands more elaborate governance structures, such as long-term contracts and partnership models for equalizing such transaction costs.

The more unique and specialized a good or service is, and the less substitutable this good or service is, the higher the transaction costs. Assets are specific when they cannot be employed again for another use without incurring in value loss. The transaction cost index obtained for soybean and ethanol are shown in Table 2. The indicator was developed based on the various dimensions of assets specificities, thus indicating which product provides a higher transaction cost.

The 45.6% rate reached by soybean falls in the classification of medium TCI while for ethanol the index was 66.2%, being in the category of high TCI, based on Table 1.

Table 2: Transaction Costs Index (TCI) by asset specificity for soybean and ethanol

Asset specificity	Soybean	Ethanol
Temporal Specificity	4	2
Specificity of Human Assets	8	11
Locational Specificity	12	14
Specificity of Physical Assets	11	20
Technological Specificity	30	32
S = Sum of Attributes	65	79
TCI = Transaction Cost Index	**45.6% = Medium**	**66.2% = High**

The transaction costs related to locational specificity (Table 3), although at the same level of specificity, have more relevance with respect to ethanol export activities due to the need for this product to be stored and handled near the port and the pier, whereas soybean does not require this specific location.

Table 3: Locational Specificity of Assets

Type of Asset Investments	Level of Specificity	
	Soybean	Ethanol
Need for proximity to pier	1	2
Need for proximity to port	1	2
Need for proximity to railway	3	2
Need for proximity to production center	2	3
Energy supply	3	3
Water supply	2	2
Total	12	14

According to Williamson, (1985), locational specificity refers to the geographical space necessary for asset use, i.e. for the use of a particular asset there are corresponding locational restrictions.

The specificity of physical assets is pointed out by Belik, et al. (2007) as referring to the assets involved during the production of a particular product to be transacted. The asset has use limitations, such as machinery and specific equipment for a particular production process (Table 4).

Table 4: Specificity of Physical Assets

Type of Asset Investments	Level of Specificity	
	Soybean	Ethanol
Physical Facilities		
Storage (Silo/Warehouse/Tankage)	1	3
Ease of storage	2	2
Service and repair center	3	3
Storage yard	1	3
Dump truck	1	0
Conveyor	1	0
Scale and Hopper	1	0
Pumping system	0	2
Duct for loading/unloading	0	3
Flow meter	0	1
Mobile Facilities/Equipment		
(Un)loader for ships	1	3
Total	11	20

Ethanol is stored in tanks that must be used exclusively for this purpose. Ethanol also requires pipeline pumping and loading systems, and unloaders for specific ships. These characteristics contribute to the level of specificity of physical assets during export activities of ethanol to be high as well as for the TCI related to specificity of physical assets from soy to be lower compared to ethanol.

This is unlike what happens for soybeans, since the infrastructure and investments in the port and in the pier to export this product can be easily relocated to another export bulk product.

Another specificity of assets identified by Azevedo (2000) refers to the human resources required to conduct a specific activity. In general, the specificity of human assets (Table 5) is an important component of the transaction. This result is due to the fact that people who work with agricultural export activities require specific technical training, operational, product, and trading knowledge as well as being under constant professional improvement.

Table 5: Specificity of Human Assets

Type of Asset Investments	Level of Specificity	
	Soybean	Ethanol
Training of technical manpower	1	3
Need for knowledge on the operation process	2	3
Need for knowledge on the product	2	3
Need for knowledge on trading	3	2
Total	8	11

Considering a high level of specificity, the risks of lacking full-time workers in activities and difficulty of knowledge management must be analyzed, as they lead to higher transaction costs that could raise TCI even more.

Regarding temporal specificity, Williamson (1985) and Neves, Zuurbier and Campomar (2001) describes that it is present when a product presents characteristics such as perishability or any other condition involving the need for consumption under a certain period of time.

In this case, soy TCI is higher since it is a perishable product, while ethanol is not (Table 6). Soybeans requires a higher frequency of loading and unloading, aside from a focus on the storage time of the product.

Table 6: Temporal Specificity

Type of Asset Investments	Level of Specificity	
	Soybean	Ethanol
Time of storage (perishability)	2	1
Constant boarding-landing/transit time	2	1
Total	4	2

For Williamson (1985), for the firm to conduct the transaction, it needs to invest in certain technological processes. Such as information technology (electronic exchange of data, inventory management, logistics planning).

In general, technological specificity is average in the activities related to the export of soybeans and ethanol (Table 7) because there is a need for tracking products via SISCOMEX (Brazilian Integrated Foreign Trade System) from the time of the entry into the port until the actual export. Starting from the Port Modernization Act, there was a need for integration between the exporting agents, the Federal Revenue and the Security Control of Ports,

coordinated by CODESP - the Dock Company of the State of São Paulo (in Portuguese *Companhia Docas do Estado de São Paulo*).

Table 7: Specificity of Assets related to Information Technology and Processes

Type of Asset Investments	Level of Specificity	
	Soybean	**Ethanol**
Investment in electronic data exchange		
With CODESP	2	2
With the Federal Revenue	3	3
With a Navigation Agency	2	2
With cargo owner	2	2
Management process according to product category		
Team	2	3
Separate warehouse	3	3
Different equipment	1	2
Client management process		
Fumigation process	2	-
Different tankage process	-	1
Information accompanied with the product	2	3
Joint logistics planning process		
With CODESP	1	1
With Shipping Carrier	2	3
With Cargo Owner	3	3
Quality programs (certifications)	2	1
Cargo tracking programs	3	3
Total	30	32

Furthermore, importers such as China have special requirements, such as registration with the competent authorities of the country, carried out through MAPA (Ministry of Agriculture, Livestock and Food Supply), whereas countries from the European Union require cargo tracking. Ethanol, in turn, must be registered via SISCOMEX together with the ANP (National Petroleum Agency). These systemic needs make the degree of specificity similar for both products.

Comparing ethanol and soybean, the results suggest that among the five dimensions of asset specificities, ethanol requires greater specification among the four of them (Table 2 and Figure 3). Technological specificity has a greater impact on the TCI for both assets. However, the main difference is in physical specificity, where ethanol requires 82% more dedicated infrastructure compared to the soybean's demand.

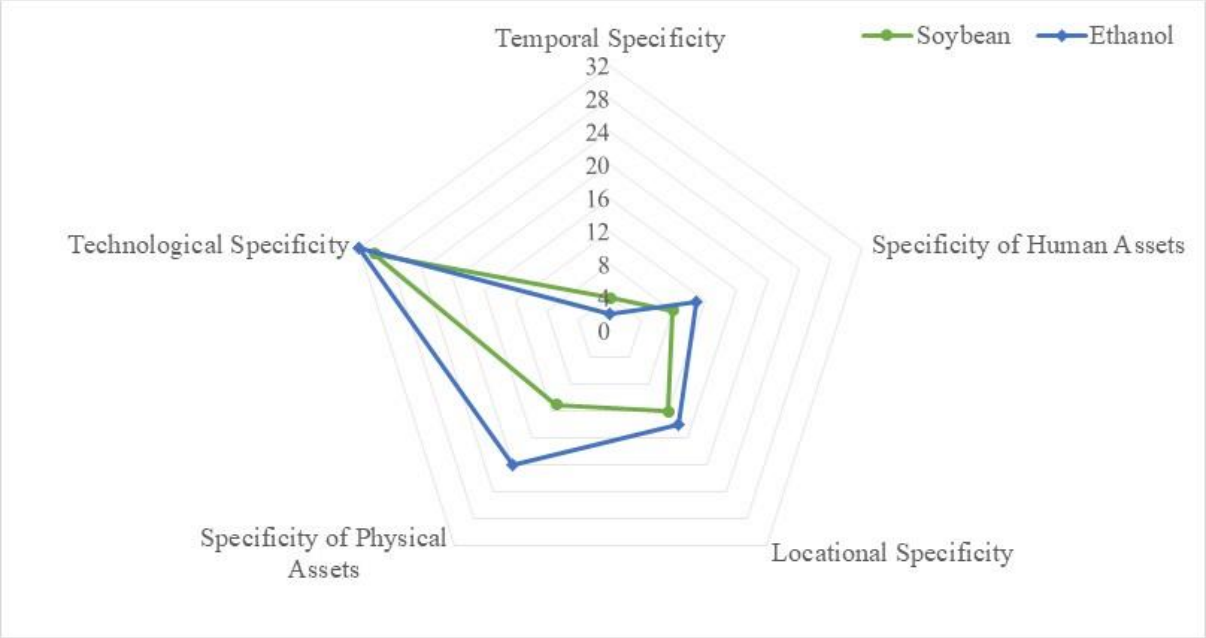

Figure 3: Comparative of assets specificities

Confirming the statement of Azevedo (2000), considering the different types of asset specificity, when thinking about transaction costs, the higher the specificity of assets, the greater the loss that is associated with an opportunistic action by another agent and, consequently, the higher the transaction costs will be.

5. Conclusions

The present study aimed to investigate the transaction costs in the port sector for export of agricultural products (soybeans and ethanol) and develop a transaction cost index (TCI). The Transaction Cost Theory is a thoroughly explored topic in the literature. The question that arises, however, is the need for these concepts, which are so important to the organizational management of firms, to be studied and analyzed in such a manner as to be applied in case studies, and, more importantly, to be used in a practical way by modern organizations.

This research investigates the transaction costs in international trading. In particular, the transaction costs from the port infrastructure, since most Brazilian agricultural products are exported by maritime transport. The main focus was the port of Santos, as the main Brazilian exportation port, which presents structural and planning failures in the shipping process, resulting in higher transaction costs, and thereby decreasing Brazil's competitiveness

in international trade.

To quantify the transaction costs, this study proposed a transaction cost index. The TCI is inherent to port activities to ethanol and soy, considering the specificity of each product.

The greater assets specificity was achieved by the ethanol that reached the highest TCI index. This indicates that the transaction cost associated with the export process of this product via the Port of Santos is higher and demands more elaborate governance structures, such as long-term contracts and partnership models to equalize such transaction costs.

Based on the calculated TCI, it is generally desirable to use medium- and long-term contracts on the organizational management of ethanol export activities. In this case, even if the transaction costs are higher initially, these more elaborate and complete contractual arrangements can mitigate opportunistic behavior and uncertainty in contractual relations, thereby regulating the TCI inherent to the management of these specific assets. For soybean export activities, short-term contracts become more attractive, since some items such as physical asset specificity have lower TCI indexes, and very elaborate, long-term contractual arrangements can be costly without the desired financial return.

The scientific contribution of the research is of particular interest and use for those researchers and professionals interested in effective international markets. In addition, the findings confirm the importance of logistics for the agricultural sector that affects every player in the global food system.

This study focused on studying the specificity of assets, which is one of the parameters of contractual transactions observed by the seminal studies of Oliver Williamson. Therefore, there is an opportunity to study the other two parameters of contractual transactions for the analysis of transaction costs, which are frequency and uncertainty of transactions. The adoption of New Institutional Economics to analyze the export activities of other agricultural products is also interesting to create a group of studies applied in Transaction Costs Theory.

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