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DETERMINANTS OF PERFORMANCE ON CONTAINER TERMINALS

DETERMINANTES DO DESEMPENHO DE TERMINAIS DE CONTAINER

DETERMINANTES DEL DESEMPEÑO DE TERMINALES DE CONTENEDORES

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ABSTRACT

Port performance determinants in a region are crucial to understand how these companies compete and survive. This article analyses and identifies the main performance determinants on container terminals in Brazil, regarding their traffic. This study contributes with a focus on performance in relation to competition between ports. Container ports in Brazil were analyzed from 2011 to 2016. Tests were performed by using linear regression with panel data. Evidence indicates that out of the five most relevant variables, three are related to the internal infrastructure, one related to external infrastructure and one related to the institutional aspect.

Keywords: Container terminals; Performance; Institutional theory.

RESUMO

Os determinantes do desempenho de portos em uma região são cruciais para entender como essas empresas competem e sobrevivem. Este artigo analisa e identifica os principais determinantes de desempenho dos terminais de contêineres no Brasil, em relação ao seu tráfego. Este estudo contribui com foco no desempenho em relação à competição entre portos. Os portos de contêineres no Brasil foram analisados de 2011 a 2016. Os testes foram realizados usando regressão linear com dados em painel. As evidências indicam que, das cinco variáveis mais relevantes, três estão relacionadas à infraestrutura interna, uma relacionada à infraestrutura externa e outra relacionada ao aspecto institucional.

Palavras-chave: Terminais de contêineres; Desempenho; Teoria institucional.

RESUMEN

Los determinantes del desempeño portuario en una región son cruciales para entender cómo estas compañías compiten y sobreviven. Este artículo analiza e identifica los principales determinantes del desempeño en las terminales de contenedores en Brasil, en relación con su tráfico. Este estudio contribuye al centrarse en el desempeño en relación a la competencia entre puertos. Los puertos de contenedores en Brasil se analizaron del 2011 al 2016. Las pruebas se realizaron mediante regresión lineal con datos de panel. La evidencia indica que, de las cinco variables más relevantes, tres están relacionadas con la infraestructura interna, una relacionada con la infraestructura externa y otra relacionada con el aspecto institucional.

Palabras clave: Terminales de contenedores; Desempeño; Teoría institucional.

1 INTRODUCTION

Ports play a leading role in affecting the national and regional economy, with the development of international trade (ACER; YANGINLAR, 2017). Over 80% of the world's cargoes are transported by sea (XIAO et al., 2012) and more than 70% of the value of global trade passes through ports (DAPPE; SUÁREZ-ALEMÁN, 2016) responsible for international trade, enabling imports, exports, globalization and development. That is, they play a key role in the evolution of countries.

The port industry is constantly under pressure to develop strategies and capacity to accommodate growing cargo volumes (MAGUIRE et al., 2010). In addition to infrastructure and heavy machinery, institutional theory is the source of multiple variables that reflect port development. The institutional change of the 1990s in port sectors around the world was accompanied by the emergence of transnational port operators. It is hard to imagine an industry that has internationalized as quickly as the container terminal industry. (OLIVIER et al., 2007). Especially, the growth of container shipping has typically been seen in terms of technological advances, increased ship capacity, traffic growth, financial performance and competitiveness, as well as organizational transformations (SLACK, 2009).

In this perspective, Parola et al. (2015) have concluded that the window of opportunity for major acquisitions and implementation in the largest global ports may have already been closed, but apparently the only markets where such strategic opportunity is still possible is in Latin America and Africa. This may explain the recent pursue of ports in Brazil by major international players, either due to modernized legislation, attract new investments, becoming private ports (TUPs), or encouraging competition. Institutional theory is therefore a constant and permanent presence in the evaluation of port performance.

In Brazil, during the last ten years, in addition to private concessions, the entry of 100% private terminals (TUPs) UPs into the container segment has changed the port reality of some states in the country. This development has also contributed to a lower logistics cost for shipowners, exporters and importers, encouraging and contributing to the country's growth. There are, however, other factors besides terminal infrastructure related to institutional theory that can impact the performance of a container terminal. Therefore, this paper intends

to answer the following research question: among many relevant aspects that lead to a port's success, what are the key determinants of performance?

Specifically, the analysis will be under the container traffic in TEU (Twenty Foot Equivalent Unit) from Brazilian container ports, in the period from 2011 to 2016, to present which are the main determinants of performance in relation to the traffic of the container terminals in Brazil. It is believed that the results of this work will contribute to the strategic vision of the container ports in Brazil, in the indication of bottlenecks, opportunities, and may also collaborate in the premises and guidelines on projects of new container terminals or expansion of existing ports.

In addition to the above, although current models of this subject use traditional operational infrastructure variables, and there are also high-quality articles that study performance comparing public and private terminals to date, no scientific research has been identified containing these infrastructure variables correlated with institutional environment in the same research model. It is believed that this model can also be useful and be replicated in researches in countries other than Brazil.

2 LITERATURE REVIEW

2.1 INSTITUTIONAL THEORY

Institutional conditions determine which strategic choices are possible (OLIVIER et al., 2007). Institutions, such as the formal and informal rules of a society, are the humanly invented constraints that shape such human choices and interactions, as well as conduct economic and political behavior (NORTH, 1990). Given that organizations are not institutions, such as banks, which are organizations, since the banking system is shaped by the institutional system (ROLAND, 2004; BUTTON, 2005), but they refer to such things as property rights, conventions, contract types, and authority, when discussing institutional environments, we are thinking of formal rules - international agreements, laws, regulations, property rights (BUTTON, 2005).

Moreover, institutional theory addresses the institutional rules that can stimulate or diminish economic activities in societies, which is why institutions can be defined as

established systems and with dominant social rules that structure social interactions (HODGSON, 2007). The institutional constraints facing maritime lines can be divided into two types: a) regulations and b) operations. Regulations include sovereign laws affecting shipping; and operations refer to customs procedures, such as the licensing and integration of intermodal transport with other modes of transport. Institutional constraints are most negatively felt in container companies because they adopt a universal land strategy for their container traffic. (MCCALLA et al., 2004).

The evolution of privatization has introduced many complexities. In potential antitrust scenarios, therefore, the regulator needs to be concerned not only with port authority fees but also with the many private operators that provide basic services, dramatically increasing the potentially regulated population (WORLD BANK, 2007). Under the port of public operation, ports assessed tariffs for only two parties - shipping lines and shippers. Under a privatized port arrangement, the port authority applies charges to operators, lines and shippers.

In general, the port sector is generally well regulated worldwide. Institutions are key to securing property rights, as entrepreneurs will invest only when they have guarantees on return on investment (NORTH, 1990; 2005). The operation of a range of formal institutions, including property rights, regulation, transparency of information and accountability, is important in attracting foreign direct investment mainly to developing and emerging countries (GLOBERMAN; SHAPIRO, 2003). Not providing infrastructure and not responding to customer needs means the doom of any port. The necessary infrastructure consists of on-site installations (i.e., roads, railways) and water (e.g., dredged channels, aids to navigation) as well as the actual terminal interface with gantry cranes, yard cranes and container storage areas (MCCALLA, 1994).

2.2 PORT PERFORMANCE

Port performance depends to a large extent on the efficient combination of the engineering part of the port and logistics construction, completing the measurement by examining and classifying a set of performance indicators according to the interests of the respective stakeholders (BALLIERE et al., 2016). Performance evaluation researches are aimed

at the operational efficiency of seaports. However, evaluation criteria do not address the performance of all agents that play a role in the port environment, and the evaluation tools used do not show evidence of how to intervene to improve measured performance (DUTRA et al., 2015). Moreover, management practices that are overlooked by port managers may even threaten the organization's performance (SOMENSI et al., 2017).

Individual performance indicators that measure the economic objective of the port are the benchmarks. One advantage to port management in having individual performance indicators to assess performance over time is that it can assess the performance of various service areas. This allows you to detect areas where performance is improving or decreasing. However, a disadvantage is how to assess correlation when changes in some indicators improve performance and changes in other indicators negatively affect performance. (TALLEY, 2006).

Having the notion of performance-related factors, Yeo (2010) summarizes that terminal facilities and service levels are associated with port performance, because service variables are also significant, as the simple fact that they are large container terminals does not guarantee a systematic performance improvement. Pallis et al. (2011) conclude that access to a railway line has a major impact on the performance of ports. The same way that Edwards and Alves (2006) who found that access to good rail infrastructure is an important determinant of the performance of manufactured exports. Lastly, Pallis et al. (2011) and Cullinane et al. (2002) concluded that a low level of regulation in the market is a variable with a relevant impact and exerts a positive influence on the performance of the ports. On the other hand, Notteboom et al. (2000) and Yeo (2010) argue that not necessarily the largest terminals are the most efficient.

2.3 PRIVATE TERMINALS (TUPS)

Not only in Brazil, but also container terminals in Asia suffered greatly from inefficiency, insufficient operational capacity, inefficient management, bureaucratic management, and possibly this was because most ports in this region were controlled and operated by public entities (CULLINANE; SONG, 1998). To address these problems port authorities in some countries have launched programs to attract private capital to improve

existing ports and create new ports. The consequence of this initiative was a real revolution that initiated a port competition and a significant improvement in the provision of services and prices practiced. The perception of this port restructuring, including privatization, was no longer simply wanted but needed. (CULLINANE et al., 2002).

On the one hand, privately owned seaports have obligations different from those of the public. Their opportunities for financing and use of public services are limited. The primary obligation of private ports is to maximize stakeholder value. Port managers maintain an obligation to their constituent owners (YEO, 2015). Enables terminal operators to conduct business with full authority and offer professional services with fast decision-making procedures (HUANG et al., 2012).

Privatization reflects a more efficient port operation (CULLINANE et al., 2002; QUANSAH, 2008). In opposition, Tongzon and Heng (2005) suggest that a totally private terminal (TUP) is not the most efficient, as it is better for the port authority to place limits on this privatization while maintaining regulatory functions. In other words, the port authority should encourage private financing, operation and management while public authorities remain in the role of regulators. According Notteboom et al. (2000) and Yeo (2015), did not identify clear evidence that private terminals were more efficient than public ones. However, Cullinane et al. (2002) concluded that a low level of market regulation is a variable that has a relevant impact and has a positive influence on the performance of ports. As private investors and operators seek to maximize profit, they can abandon facilities and services that offer more long-term rewards and establish a broader social context (LIU, 1995).

Divergent paths travelled through North Korea and South Korea, also East and West Germany, where one part of the country stagnated under central planning and collective ownership, while the other prospered with private property and the market economy (ACEMOGLU et al., 2001). The port authority needed to take on new roles and to create a competitive advantage in its ports, going beyond the simple port structure, thinking of logistics as a whole, infrastructure, road and rail transport, warehouses, among others (NOTTEBOOM; WINKELMANS, 2001).

2.4 HYPOTHESES DEVELOPMENT

The vast majority of the researches carried out to this date assume the container traffic in TEU as the main reference of performance. From the perspective of the determinants of this performance, Tongzon (2001) contributes that the main reasons for port inefficiency are: (a) bottlenecks in the terminal quay, (b) the terminal surface and (c) high port labor costs. In contrast, Wiegmans et al. (2001) present the critical success factors in maritime container terminals: (a) have strong backing from international shipping companies, (b) shipowners, (c) have good container transshipment services, and (d) a commitment to information management. That is, they also report that the terminals are focused on containers traffic at their terminals. From the institutional point of view, Cullinane et al. (2002) maintain that the level of deregulation is a variable that can also exert a positive influence, indicating that the simplifications of the rules are important for the development of the port segment. Therefore, based on the theoretical support presented, it is intended to find out which factors are related to the performance of the ports.

H1 Institutional factors such as: being a Private Terminal (TUP), having a shipping line as partner in ownership, being the only port in the state, and high state GDP, are related to higher port performance.

A review of the extant literature shows that the TUPs have become one of the main responsible for the development of the port sector, not only by the flow of the national production or the imports, but also through the generation of jobs, of income and of taxes, besides promote the socio-economic development of the regions where they are located. The success of these terminals is evident each year that their cargo movement becomes larger, when compared to the public ports (FRANCISCO; BOTTER, 2017).

Among the main Brazilian ports, not only those of containers, the results also indicate a strong positive influence due to the public-private partnerships in the efficiency of the ports, that is, those in operation by concession agreements for the private initiative. These also proved to be more efficient in traffic costs and vessel waiting times. (WANKE; BARROS, 2016). Finally, several studies have argued that privatization is a positive phenomenon in ports and is generally related to performance gains (CULLINANE et al., 2002; PALLIS et al., 2011; TONGZON; HENG, 2005).

H2 In the competition between Private Terminals (TUPs) and Public Ports with private operators, TUPs perform better.

3 METHODOLOGY

This study used quantitative method. By its nature, it is classified as hypothetic-deductive, as it seeks to test the hypotheses raised from the literature review. The study is of the predictive type, which generates a possible explanation of the event after it has happened. Further, this type of study is determined from the desired capacity to predict the event and in what situations it will occur. The unit of analysis on this study is comprised of Brazilian container ports. Specifically, the analysis will be under the container traffic from these ports, in the period from 2011 to 2016. The container traffic data were extracted from the ANTAQ (National Waterway Transport Agency) yearbook. Terminals with traffic below 200 TEUs/year were not considered in this research.

3.1 DEPENDENT VARIABLE

The variables chosen to answer the research question refer to the characteristics of the containerization processes of the sample ports. The theoretical basis served to identify the variables investigated, following works similar to this study, besides an innovative variable proposed by the author. The variables are divided into two groups: dependent and independent.

The dependent variable of this study refers to the port performance in container terminals, shown in Table 1.

Table 1 - Descriptive of the dependent variable

Variable	Metric	Source
Container traffic (performance)	Twenty Foot Equivalent Unit (TEU)	Bernardo (2017), Cullinane et al. (2002), Jiang and Li (2009), Notteboom et al. (2000), Pires (2017), Tongzon (2001), Tongzon and Heng (2005), Wanke and Barros (2016), and Yeo (2010).

Source: Authors (2020).

According to Notteboom et al. (2000), a terminal is efficient if it produces the maximum output (container traffic in TEU) compared to certain inputs (terminal superstructure). This concept is understood as a maxim in the container terminal performance

researches performed to date, and the container traffic in TEUs is the output used in the sources.

3.2 INDEPENDENT VARIABLES

In order to observe the variation in the dependent variable, the independent variables are presented below with the metric used and the respective supporting source. The independent variables are divided into two major groups:

a institutional factor variables

b infrastructure factor variables (internal and external)

The infrastructure factor is further subdivided into internal infrastructure and external infrastructure. To do so, these variables, also called moderators, are illustrated in Table 2.

Table 2 - Descriptive of independent variables

Variable	Metrics	Source
Institutional		
Private port (TUP)	Yes, or Not	Cullinane et al. (2002), Quansah (2008), and Tongzon and Heng (2005).
State GDP	R$ (Brazilian real)	Jiang and Li (2009).
Partner shipowner	Yes, or Not	Zenzerović and Mrnjavac (2000).
Only port in the State	Yes, or Not	De Langen and Pallis (2006).
Internal infrastructure		
Terminal quay length	Every 100m (meters)	Jiang and Li (2009), Notteboom et al. (2000), Pires (2017), Wanke and Barros (2016) and Yeo (2010).
Container gantry cranes	Every 1 (number)	Balliere et al. (2016), Jiang and Li (2009), Notteboom et al. (2000), Pires (2017) and Yeo (2010).
The terminal area	Every 10,000m2 (square meters)	Notteboom et al. (2000), Pires (2017), Wanke and Barros (2016) andYeo (2010).
External Infrastructure		
Draft of the ship	Every 1m (meters)	Bernardo (2017), Pires (2017) and Wanke and Barros (2016).
Direct rail access	Yes, or Not	Wank and Barros (2015, 2016) and Yeo (2010).
Ship size	Every 10m (meters)	Baird (2002).

Source: Authors (2020).

The traditional infrastructure variables, internal and external, were presented in the theoretical basis and widely studied with great quality by several authors, therefore they will not be deepened in this study. It can be argued that external infrastructure variables are also related to institutional theory, mainly because the government is responsible for the

execution of these works in most cases. However, in order to preserve standard comparison with several other papers, it was preferred to keep these variables in a separate group, classified as external infrastructure. Also, on this group, the determinant 'maximum allowed size of vessel, not commonly used in performance surveys, will also be considered in this assessment, as well as the four variables related to institutional theory.

In this research it is, therefore, proposed to include this independent variable, not common in efficiency and performance surveys, which is the maximum size of ships that can operate in those ports. Baird (2002) already pointed to the need for container terminals to adapt to the new generation of larger ships. In addition to the independent variables of infrastructure, internal or external, there are also other critical factors related to institutional theory that are believed to have a significant influence on the performance of port terminals, including the public or private port issue.

Considering that the results of the GDP of 2016 were not yet available by the state at the time of the simulations, it was decided to consider the same result of 2015 in 2016, in order to make the interpretations feasible, without any significant prejudice in the analysis. This opens an opportunity for the regressions to be carried out again soon once official data is available.

3.3 RESEARCH DESIGN AND FINAL MODEL

Although the indicators commonly used to measure port efficiency focus on operational aspects (ENSSLIN et al., 2017), there are some other statistical techniques that have already been used to analyze the performance of port terminals (YEO, 2010). Given that efficiency is the comparison between what has been achieved (products) and the maximum value that could be achieved from the resources used (inputs) (RIOS; MAÇADA, 2006), this study is a performance research, measured through the movement of TEUs. That is why it is understood that the multivariate linear regression technique is more appropriate than the DEA and SFA models, which are more commonly used to measure the efficiency of container terminals (PALLIS et al., 2011). Used panel data regression, unbalanced, was used because there is a few missing data inputs by observation over time. Essentially, this is due to the many

changes during the period studied, where some ports started their operations, others stopped operating ships.

Two regression models were evaluated in order to deepen and deplete the possibilities of tests in different ways, and to certify that the results found are consistent, not exclusive to any specific model: (a) It was decided to start with an OLS estimator model. 'Controlled' OLS were also used, where the ports with movement below 16,500 TEUs/year were excluded; (b) The second regression model selected was the GLS estimator data panel. In this model, the tests were also performed with the 'total' data group and the 'controlled' group, excluding ports with a movement of less than 16,500 TEUs/year.

The regression estimation procedure with OLS estimator establishes the statistical regression weights to minimize residuals (HAIR et al., 2019). The GLS estimators are more efficient than the OLS estimate, leading to smaller standard errors, narrower confidence intervals. (CAMERON; TRIVEDI, 2009). In addition, while the model with OLS estimators was robustly controlled for heteroskedasticity problems, in the model with GLS estimators, the choice between RE or FE was given by the Hausman test. According to section 2.4, two hypotheses were defined, so the general equation of the model is presented below:

$$Performance_{it} = \beta 0 + \alpha i + \beta 1 * Institutional_{it} + \beta 2 * Infrastructure_{it} + \Sigma \beta n * Controls_{it} + \varepsilon it$$

Where:

$Performance_{it}$: Number of containers trafficked, measured in TEUs

β0: Intercept;

β1*Institutionalit: Represents the variables related to institutional factor

β2*Infrastructureit: Represents the variables related to the infrastructure factor

Σβn*Controlsit: Represents the control (independents) variables of the model and its parameters;

εit: Component of residual error.

3.4 ANALYSIS

Table 3 demonstrates the data obtained from the descriptive analysis of the dependent variable and the control variables. Terminals with traffic below 200 TEUs/year were not considered in this research. It is possible to observe the minimum and maximum values and the means of the variables. As the main variable, the container traffic in TEU registers an average of 323,000 movements, with a maximum of more than 1,800,000 TEUs. Another important point is the number of cranes, which has a value of at least 1, on the other hand, the highest recorded value is the quantity of fourteen container gantry cranes. In addition to the already mentioned, it is also presented the metric used in each variable, to provide the correct understanding of the results. In this sense, the variables 'railroad', 'TUP', 'shipowner' and 'single port' are dummy variables, that is, whether there is (value 1) or not (value 0) the presence of this characteristic in the sample port.

Table 3 - Descriptive analysis

Variables	Metric	Obs.	Mean	Std. Dev.	Min.	Max.
TEU's	Every 1 (num.)	158	323000	342000	470	1811358
Terminal quay length	Every 100m	158	770.665	286.907	298	1420
Container gantry cranes	Every 1 (num.)	157	4.688	2.946	1	14
The terminal area'	Every 10,000m2	157	211000	142000	29000	596000
Draft of the ship	Every 1m	158	13.511	4.758	6.8	35
Ship size	Every 10m	158	283.278	44.252	180	340
State GDP	R$ (real)	136	555000	638000	41002	1939890
Direct rail access	Yes, or Not	162	.494	.502	0	1
TUP	Yes, or Not	162	.136	.344	0	1
Partner shipowner	Yes, or Not	162	.204	.404	0	1
Only port in the State	Yes, or Not	162	.247	.433	0	1

Source: Authors (2020).

4 RESULTS AND DISCUSSION

For the proposed analysis, there are two groups of data: 1) the 'total' and 2) the 'controlled' data, in the latter were excluded the ports that had a sporadic movement of containers in the period evaluated and little significant volume compared to the other ports, that is, the ports that moved between 10,000 and 16,500 TEUs in their best year were excluded, since the total average of other ports is 323,000 TEUs/year. The results show, in the models initially presented (Table 4), that the variables are significant: 'terminal quay length'

(β = 0.00316, p <0.01), 'TUP' (β = 0.534, p <0.10), 'draft of the ship' (β = 0.0988, p <0.01), 'ship size' (β = 0.0191, p <0.01), and 'only port in the State' (β = 1.315, p <0.01).

On the other hand, the variables such as 'container gantry cranes', 'the terminal surface' and 'partner shipowner', were significant during the tests performed, but as more variables were added, they were no longer significant, as can be observed in the Model 3 of the total tested. Specifically, the variable 'partner shipowner' showed to be significant when there was no interaction with the other independent variables (β = 2.107, p <0.01), but in the final model did not hold the significance. The coefficient of determination, also called r-squared (R2), which indicates in percentage, how much the model can explain the observed values, was 69%.

Table 4 - OLS regression models

Variables	**VD: Number of TEU's**					
	Total			**Controlled**		
	Model 1.1	Model 1.2	Model 1.3	Model 1.4	Model 1.5	Model 1.6
Terminal quay length			0.00316***			0.000805**
			(0.000493)			(0.000327)
Container gantry cranes			0.0959			0.297***
			(0.119)			(0.0656)
The terminal area			2.65e-06			-6.84e-07
			(1.86e-06)			(1.06e-06)
Partner shipowner	2.107***		0.376	0.669***		0.453*
	(0.276)		(0.411)	(0.186)		(0.249)
TUP		1.658***	0.534*		0.840***	0.391*
		(0.552)	(0.292)		(0.196)	(0.207)
Draft of the ship			0.0988***			0.0267**
			(0.0223)			(0.0128)
Direct rail access			-0.239			-0.00683
			(0.259)			(0.126)
Ship size			0.0191***			0.00481***
			(0.00301)			(0.00174)
State GDP			8.00e-09			-1.94e-07
			(3.66e-07)			(2.00e-07)
Only port in the State			1.315***			0.247
			(0.425)			(0.256)
Constant	10.64***	10.79***	1.330	12.08***	12.10***	8.482***
	(0.231)	(0.217)	(0.909)	(0.109)	(0.103)	(0.632)
Estimator	OLS	OLS	OLS	OLS	OLS	OLS
Number of obs.	190	190	179	149	149	149
R-squared	0.073	0.031	0.691	0.053	0.056	0.649

Note. Robust standard errors in parentheses. ***p<0.01, **p<0.05, *p<0.10.
Source: Authors (2020).

In this regression with OLS estimators and more specifically in the models with total data, of the ten variables studied, five have significance and relevance, especially the variable "TUP" (β = 0.534, p <0.10) that is related to total moves on average 53.4% higher than a conventional terminal. Also, for the variable 'only port in the State' (β = 0.391, p <0.10) that is related to an average total moves 131.5% higher than the other terminals that do not have this condition, according to the 'Model 1.3'. If the 'partner shipowner' variable is considered without interaction of the others, the significance is high (β = 2.107, p <0.01), in the same way, in 'Model 1.2' where the variable 'TUP' is presented individually in moderation for performance (β = 1.658, p <0.01).

In the model with 'controlled' data, with the OLS estimators, the 'container gantry cranes' (β = 0.297, p <0.01) and 'partner shipowner' variables (β = 0.453, p <0.10) were significant in the model contemplating all the variables in the first model, now appear as significant. The coefficients of performance determination were high in both models, 'total' (69.1%) and 'controlled' (64.9%). The highlight is the "TUP" and "partner shipowner" variables, which, in the controlled model, presented total moves of 39.1% and 45.3% higher, respectively, than the terminals that do not have these characteristics.

The variable 'partner shipowner' has a significant impact (p <0.10) on the container movement in Brazil, being a determinant of performance. Shipowners are the main customers of the ports, so having a global shipowner, as a partner, translates into a certain "guaranteed" annual movement, where naturally the owner of the vessel will try to operate in its port, contributing to a larger, more stable and predictable, and therefore more sustainable (WIEGMANS et al., 2001).

Table 5 - GLS models regression panel data

Variables	**VD: Number of TEU's**					
	Total			**Controlled**		
	Model 2.1	**Model 2.2**	**Model 2.3**	**Model 2.4**	**Model 2.5**	**Model 2.6**
Terminal quay length			0.00298***			0.000918**
			(0.000761)			(0.000447)
Container gantry cranes			0.00868			0.121*
			(0.137)			(0.0657)
The terminal area			4.25e-06*			2.48e-06**
			(2.24e-06)			(1.24e-06)

Variables	VD: Number of TEU's					
	Total			Controlled		
	Model 2.1	**Model 2.2**	**Model 2.3**	**Model 2.4**	**Model 2.5**	**Model 2.6**
Partner shipowner	1.261*		-0.165	0.421		-0.129
	(0.702)		(0.592)	(0.294)		(0.322)
TUP		-0.316	0.639*		0.535***	0.463***
		(1.135)	(0.326)		(0.176)	(0.142)
Draft of the ship			0.0954**			0.0304
			(0.0373)			(0.0211)
Direct rail access			-0.505			-0.455
			(0.392)			(0.301)
Ship size			0.0199***			0.00914**
			(0.00403)			(0.00438)
State GDP			-7.69e-09			9.41e-09
			(4.97e-07)			(2.65e-07)
Only port in the State			1.285***			0.453
			(0.489)			(0.371)
Constant	10.62***	10.84***	1.564	11.97***	11.98***	7.377***
	(0.496)	(0.441)	(1.630)	(0.244)	(0.222)	(1.333)
Estimator	GLS	GLS	GLS	GLS	GLS	GLS
Effect	RE	RE	RE	RE	RE	RE
Number of obs.	190	190	179	149	149	149
Groups	35	35	32	29	29	29
R2 within	0.00	0.01	0.00	0.00	0.00	0.04
R2 between	0.10	0.03	0.81	0.09	0.08	0.70

Note. Robust standard errors in parentheses. ***p<0.01, **p<0.05, *p<0.10.
Source: Authors (2020).

In the regression models with GLS estimator, the tests were also maintained for the 'total' sample group of the sample and for the 'controlled' data. In the second group tests, the results show that the 'partner shipowner' is only a determinant of performance if there are no other control variables in the model (β = 1.261, p <0.10). Likewise, the 'TUP' variable in the 'controlled' data model presented significance when this is the only control variable (β = 0.535, p <0.01). However, remained significant (p <0.01) when in interaction with all other control variables (β = 0.463). The results of the research show that being a TUP is not only among the main determinants of performance, it is the most responsible variable for performance, where a TUP is related to moving on average 46.3% more than terminals that are not TUPs.

When it comes to 'Model 2.3' and 'Model 2.6', those with all control variables in interaction to create effect on the dependent variable, five variables present a significant relationship in the container traffic in TEUs. While in the 'total' data group the 'draft of the ship' variable has significance (β = 0.0954, p <0.05), in the 'controlled' group this does not

occur. Likewise, with the variable 'only port in the State' (β = 1.285, p <0.01). On the other hand, in the group of 'controlled' data the 'container gantry cranes' are performance determinants (β = 0.121, p <0.10), which were not for the 'total' group.

In this way, hypothesis 1 is partially accepted. Since it is sought to determine the relation of the determinants of the institutional factor, only the factors 'TUP' and 'partner shipowner' are related to better performance. Being the 'only port in the state' and the 'State GDP', are not necessarily related to a better performance of the port terminals in Brazil.

In relation to private terminals, the result is in line with the theoretical findings. The TUP variable presented significance in all the models, thus accepting hypothesis 2. In the competition between TUPs and Public Ports with private operators, TUPs perform better (CULLINANE et al., 2002; TONGZON; HENG, 2005; PALLIS et al., 2011).

The synthesis of the four regressions is shown in Table 6, which presents the consistency of the tested variables in different models.

Table 6 - Regressions results summary

	OLS total	OLS controlled	GLS total	GLS controlled
Terminal quay length	***(+)	**(+)	***(+)	**(+)
Container gantry cranes		***(+)		*(+)
The terminal area			*(+)	**(+)
Partner shipowner		*(+)		
Private port (TUP)	*(+)	*(+)	*(+)	***(+)
Draft of the ship	***(+)	**(+)	**(+)	
Railroad				
Ship size	***(+)	***(+)	***(+)	**(+)
State GDP				
Only port in the State	***(+)		***(+)	

Note. ***p<0.01, **p<0.05, *p<0.10.
Source: Authors (2020).

Among the OLS and GLS estimators, and the 'total' and 'controlled' groups, it is believed that the most appropriate regression to validate this research is the controlled GLS regression. Since it uses panel data, and to exclude minor distortions that may detract from the analysis. In this way, it is inferred that the relevance of the significant variables will be based on Model 2.6, of controlled GLS.

There are five main determinants, three are internal infrastructure variables: "Terminal quay length", "Container gantry cranes" and "The terminal area", corroborating with several international surveys already performed previously. The results also show that of the ten analyzed variables, nine have significance and, therefore, can be considered determinants of the performance of the ports in Brazil.

5 CONCLUSIONS

We´ve investigated among many important factors involved in the success of a container terminal, which are the main determinants related to the greater total moves. The conclusion of this study is that, of the ten variables studied, eight are among the main determinants of performance, excluding only the variables: 'direct access to the railroad', different from the studies by Edwards and Alves (2006) and Pallis et al. (2011), and 'state GDP', contrary to the findings of Jiang and Li (2009). Among the eight main ones, taking into account the main regression model used, GLS 'controlled', the five main determinants of performance are: To be a 'TUP', 'the terminal quay length', 'container gantry cranes', 'the terminal area' and 'ship size'. Of these five main variables, three are related to internal infrastructure, one related to external infrastructure and on related to the institutional aspect. This last one with such relevance that TUPs are related to an average movement of 46.3% higher than traditional terminals.

Being a TUP is clearly related to higher performance. Owning a 'partner shipowner' and being the 'only port in the state' are also related to better performance but did not present the same consistency as the TUP. Hypothesis 2 was accepted in this research, among container terminals in Brazil, during the period studied.

The results found in this research can help answer the question about why there was a drastic cargo migration between the main container ports in Brazil. These results can also contribute to the theme of performance in the port sector, with a strategic view of the ports in Brazil, possibly in the indication of trends, bottlenecks and opportunities. Finally, they will also be able to contribute to the premises of new container terminal designs and/or expansions of existing terminals.

Among the limitations of the research are the fact that different types of cranes are not considered, some more productive and modern than others. In relation to the group of determinants, there are other variables that could also be studied in an extended research. The period evaluated was between 2011 and 2016, so a longer evaluation can lead to different results. In addition, corporate strategies, business performance and terminal management performance could be considered in future studies, as well as the interest and strategy of the customers and stakeholders involved, as an example of strategic alliances of shipowners. Therefore, there are limitations that have been evaluated, but haven´t been possible to find an adequate way to include these aspects aligned with the proposed methodology.

Finally, there is an extensive line of research that can still be explored in this segment, corroborating with the presented model. Among these possibilities, evaluate the ports of Brazil in general, not only those of containers. Or, apply a similar model in different segments, such as bulk terminals, liquids, break bulk cargo, among others. Another opportunity would be to extend the time of research, to evaluate if the results found represent a history or tendency of short, medium or long term. It would still be relevant to run this same model in other markets, terminals of the Americas, Asia, developed countries, in order to be able to compare the reality of Brazil with other ports in the world.

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