DETERMINANTS OF THE PERFORMANCE OF CONTAINER TERMINALS IN BRAZIL

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Abstract: The determinants of port performance in a region are crucial to understand how these companies compete on market share to survive. The purpose of this article is to analyse and identify the main determinants of the performance of container terminals in Brazil in relation to their traffic. Different from previous works, which focus on the efficiency of the ports, this paper contributes by focusing on performance in regard to the competition between ports. Container ports were analysed in Brazil from 2011 to 2016. Tests were performed by using linear regression with panel data. Evidence indicates that from the five main variables, three are related to the internal infrastructure, one related to external infrastructure and one related to the institutional aspect. 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.

Keywords Container terminals, Private terminals, Performance, Institutional theory, Emerging markets

1 INTRODUCTION

Ports play a leading role in affecting the national and regional economy, with the development of international trade (Acer and 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 and Suárez-Alemán, 2016) responsible for international trade, enabling imports, exports, globalization, development. That is, they play a key role in the evolution of countries.

When containerization was introduced, it was aimed at improving productivity in general cargo traffic (Mccalla, 1994). 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).

* A revisão gramatical, ortográfica, ABNT ou APA foi realizada pelos autores.

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).

In this perspective, Parola et al. (2015) have concluded that the window of opportunity for big business in the largest global ports may already have been closed, but that apparently the only markets where this type of strategic buying opportunity is still possible is in Latin America and Africa. This may be justified by recent harassment of ports in Brazil by these multinational ports, either by modernizing legislation, attracting new investments, making them private ports (TUPs), or by encouraging competition. In view of this, institutional theory is a constant and permanent presence in the evaluation of port performance.

In Brazil, in the last ten years, in addition to private leases, the entry of TUPs 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. Liu (2015) has found evidence that container terminal infrastructures play an important role in improving port performance, such as: (a) the terminal surface and, (b) number of operators. There are, however, other factors besides terminal infrastructure related to institutional theory that can impact the performance of a container terminal. So, among so many critical and important factors that involve and impact a port's success, what are the key determinants of performance?

Performance measurement is a crucial exercise in strengthening the competitiveness of a port, as the results provide a reference by which the terminal can be evaluated in relation to others (Song and Han, 2004). Although it is a broad concept, the vast majority of the research carried out to date assume the container traffic in TEU as the main performance benchmark in container terminals (Notteboom et al., 2000; Tongzon and Heng, 2005; Wanke and Barros, 2015; 2016).

This research is based on quantitative methodological current and the unit of analysis of this study is comprised of Brazilian container ports. Specifically, the analysis will be under the container traffic in TEU from these ports, in the period from 2011 to 2016, to determine 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 of new projects of container terminals or expansions of existing ports.

In addition to the above, although current models of the theme deal with traditional infrastructure variables, and there are also high-quality articles that deal with 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. With this innovation, 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 behaviour (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). In addition, such rules drive the functioning of markets, industrial relations, internal competition and associative behaviour (Gertler, 2004).

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, 2006). 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 fact, the private sector is concerned about bottlenecks in Brazil's logistics infrastructure. The lack of rail and waterway infrastructure forces companies to rely on a limited number of roads to transport goods from farms and mines to ships in port (Wilmsmeier and Monios, 2016).

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 and 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 (i.e., dredged channels, aids to navigation) as well as the actual terminal interface with gantry cranes, patio cranes and container storage areas (Mccalla, 1994).

Nations thrive when their rulers are guided by two fundamental concerns: (a) to ensure competition between enterprises and (b) to strengthen institutions (North, 1990). In relation to performance, North (1990) points out that increased productivity in an economy can be improved or limited depending on its institutional structure. Companies must adapt their strategies to the regulation of (Khanna and Palepu, 1997). Unlike developed economies, emerging markets suffer from weak institutions in all or most areas. Yet, when regulators set political goals above economic efficiency, they can distort markets. Given the many social and economic structural weaknesses in developing countries, achieving returns close to or above those of developed countries could be unrealistic in the short term (Fraser and Nottebom, 2015).

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). In this meaning, performance indicators can be classified into five main families (Balliere et al., 2016):

- production (traffic)
- productivity (traffic per unit time)
- use of resources (equipment and labor)
- punctuality (according to schedule)
- efficiency (proportion of valuable container traffic)

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).

Marine container terminals need to keep the traffic equipment efficient and technologically advanced. Managers need to develop and optimize different aspects, such as the design of cribs and patios, as well as choosing the most suitable traffic systems for the specific characteristics of the terminals themselves (Contu et al., 2011). In terminals in Asia, it was found that port performance is significantly influenced by the use of the crib. Also, other factors, independent of port control, such as the frequency with which shipping companies care about the geographical location of a port and the economic activities of the port interior (Song and Han, 2004).

Port efficiency is an important factor for transport costs (Clark et al., 2001). Likewise, efficiency is an important port performance indicator; the more efficient the port, the lower the costs involved and the greater the ease of importing and exporting a particular country (Merk and Dang, 2012). In general, a container terminal is considered efficient or highly productive if it is able to produce the maximum outputs for certain inputs, or use the minimum of inputs to produce a given output (Pallis et al. 2011). Notteboom et al. (2000) indicate that the outputs are the container traffic performed by this terminal, so a terminal is efficient if it produces the maximum container traffic in Twenty Foot Equivalent Unit (TEU) for certain inputs, usually related to the terminal superstructure. This search for the highest possible efficiency and the largest possible number of container traffic results in competition between port terminals (Tongzon and Heng, 2005). A continuous assessment of port performance and productivity is the activity that will sustain a competitive advantage in global markets (Cheon et al., 2009).

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. The terminal quay and facility optimization can also produce significant improvements in inefficiency and efficiency of port performance (Huang et al., 2012). In the same sense, congestion at the gate of a terminal generates various problems, such as pollution and long waiting periods for truck drivers (Gracia et al., 2017).

Lastly, Pallis et al. (2011) and Cullinane et al. (2002) concluded that larger container terminals are more efficient than smaller terminals, and 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 and Song, 1998). To address these problems port authorities in some countries have launched programs to attract private capital to improve existing ports and also 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).

On the other hand, 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, but 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). Contemporary economic development has ensured that port performance has become an important part of the supply chain. Factors such as property forms, the presence of competition between ports and possible externalities of port operation would be achieved, being private or government ports (Xiao et al., 2012). This led to two more significant conclusions:

- 1 All being equal, private investors would compromise less capacity than governments, who are more concerned with regional economic benefits and the well-being of port users
- 2 Competition between ports plays an important role in determining port capacity and price investments. Private investors would invest in port capacity beyond the optimal social level, while local authorities would commit even more. Investments in port capacity may be influenced by the ownership structure

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 and Winkelmans, 2001). Governments should consider implementing a complementary set of regulations describing how the concession law will be applied in practice. As there are other ways beyond granting private participation in port activities, the national legal framework for public-private partnerships must also incorporate these elements, or at least establish which entity will be responsible for monitoring them. (World Bank, 2007).

2.4 Hypotheses development

The great majority of the researches carried out to 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, Wiegman 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. In the Brazilian context, Pires (2017) concluded that the ports of Itapoá and Paranaguá were those that had efficiency. From another perspective, Francisco and Botter (2017) concluded that the terminals of Navegantes and Itapoá were the main responsible for the development of the sector in the state and indicate that waterway, road and rail infrastructure are still bottlenecks and limit the growth of ports. 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 TUP, having a partner shipowner, being the only port in the state, and 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 and 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 boat waiting times. (Wanke and 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 and Heng, 2005).

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

3 METHODOLOGY

This study used quantitative methodological current. 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 of 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 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, according to 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 dissertation refers to the port performance in container terminals, shown in Table 1.

Table 1 Descriptive of the dependent variable

<i>Variable</i>	<i>Metric</i>	<i>Source</i>
Container traffic (performance)	Twenty Foot Equivalent Unit (TEU)	Bernardo (2017), Cullinane et al. (2002), Itoh (2002), Jiang and Li (2009), Notteboom et al. (2000), Pires (2017), Tongzon (2001), Tongzon and Heng (2005), Wanke and Barros (2015; 2016), Wilmsmeier and Monios (2016), Yeo (2010)

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 variable

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

- a variables of the institutional factor
- b variables of the infrastructure factor (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

<i>Variable</i>	<i>Metrics</i>	<i>Source</i>
<i>Institutional</i>		
Private port (TUP)	Yes or Not	Cullinane et al. (2002), Quansah (2008), 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)
<i>Internal infrastructure</i>		
Terminal quay length	Every 100m (meters)	Jiang and Li (2009), Notteboom et al. (2000), Pires (2017), Wanke and Barros (2015; 2016), Yeo (2010)
Container gantry cranes	Every 1 (number)	Balliere et al. (2016), Jiang and Li (2009), Notteboom et al. (2000), Pires (2017), Yeo (2010).
The terminal surface	Every 10,000m ² (square meters)	Notteboom et al. (2000), Pires (2017), Wanke and Barros (2015; 2016), Yeo (2010).
<i>External Infrastructure</i>		
Draft of the ship	Every 1m (meters)	Bernardo (2017), Pires (2017), Wanke and Barros (2015, 2016)
Direct rail access	Yes or Not	Wank and Barros (2015, 2016), Yeo (2010)
Ship size	Every 10m (meters)	Baird (2002)

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 the vast majority of cases. However, in order to maintain the comparative advantage in relation to international research already done, it was preferred to keep these variables in a separate group classified as external infrastructure. Also, on this group, the determinant 'maximum allowable size of vessel for operation', not commonly used in performance surveys, will also be considered in this assessment and therefore making this somewhat more elaborate, as well as the four variables related to institutional theory.

In this research among container terminals in Brazil we propose, therefore, to include this independent variable, which has not been used until now in efficiency and performance surveys, mainly in Brazil, 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 up an opportunity for the regressions to be carried out again in the near future once official data are available.

3.3 Research Design and final model

There are some techniques that have already been used when analysing the performance of port terminals (Yeo, 2010). In this study, if it is a performance research, measured through the movement of TEUs, it is understood that the multivariate linear regression technique is more adequate than the DEA and SFA models, which are most commonly used to measure efficiency of container terminals (Pallis et al., 2011). In view of this, we will use the regression test with panel data, unbalanced, because there are missing data 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 appropriate when there are one or more indications of heteroskedasticity and the correlation of regression errors fail. It is a richer model and correctly specified for the error. More efficient than the OLS estimate, leading to smaller standard errors, narrower confidence intervals. (Cameron and 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:

$$\text{Performance}_{it} = \beta_0 + \alpha_i + \beta_1 * \text{Institutional}_{it} + \beta_2 * \text{Infrastructure}_{it} + \sum \beta_n * \text{Controls}_{it} + \varepsilon_{it}$$

Where:

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

β₀: Intercept;

β₁*Institutional_{it}: Represents the variables related to institutional factor

β₂*Infrastructure_{it}: Represents the variables related to the infrastructure factor

Σβ_n*Controls_{it}: Represents the control (independents) variables of the model and its parameters;

ε_{it}: Component of residual error.

3.4 Analysis

First, 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 for 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, it should be pointed out that 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 surface'	Every 10,000m ²	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

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

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 ($\beta = 2.107$, $p < 0.01$), but in the final model did not hold the significance. The coefficient of determination, also called r-squared (R^2), 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*** (0.000493)			0.000805** (0.000327)
Container gantry cranes			0.0959 (0.119)			0.297*** (0.0656)
The terminal surface			2.65e-06 (1.86e-06)			-6.84e-07 (1.06e-06)
Partner shipowner	2.107*** (0.276)		0.376 (0.411)	0.669*** (0.186)		0.453* (0.249)
TUP		1.658*** (0.552)	0.534* (0.292)		0.840*** (0.196)	0.391* (0.207)
Draft of the ship			0.0988*** (0.0223)			0.0267** (0.0128)
Direct rail access			-0.239 (0.259)			-0.00683 (0.126)
Ship size			0.0191*** (0.00301)			0.00481*** (0.00174)
State GDP			8.00e-09 (3.66e-07)			-1.94e-07 (2.00e-07)
Only port in the State			1.315*** (0.425)			0.247 (0.256)

Constant	10.64*** (0.231)	10.79*** (0.217)	1.330 (0.909)	12.08*** (0.109)	12.10*** (0.103)	8.482*** (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.

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" ($\beta = 0.534$, $p < 0.10$) that is related to a movement on average 53.4% higher than a conventional terminal. Also, for the variable 'only port in the State' ($\beta = 0.391$, $p < 0.10$) that is related to an average movement 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 ($\beta = 2.107$, $p < 0.01$), in the same way, in 'Model 1.2' where the variable 'TUP' is presented individually in moderation for performance ($\beta = 1.658$, $p < 0.01$). The latter requires two degrees of significance, but remains a determinant of performance.

In the model with 'controlled' data, with the OLS estimators, the 'container gantry cranes' ($\beta = 0.297$, $p < 0.01$) and 'partner shipowner' variables ($\beta = 0.453$, $p < 0.10$) 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 a movement 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 (Wiegman 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*** (0.000761)			0.000918** (0.000447)
Container gantry cranes			0.00868 (0.137)			0.121* (0.0657)
The terminal surface			4.25e-06* (2.24e-06)			2.48e-06** (1.24e-06)
Partner shipowner	1.261* (0.702)		-0.165 (0.592)	0.421 (0.294)		-0.129 (0.322)

TUP	-0.316 (1.135)	0.639* (0.326)		0.535*** (0.176)	0.463*** (0.142)	
Draft of the ship		0.0954** (0.0373)			0.0304 (0.0211)	
Direct rail access		-0.505 (0.392)			-0.455 (0.301)	
Ship size		0.0199*** (0.00403)			0.00914** (0.00438)	
State GDP		-7.69e-09 (4.97e-07)			9.41e-09 (2.65e-07)	
Only port in the State		1.285*** (0.489)			0.453 (0.371)	
Constant	10.62*** (0.496)	10.84*** (0.441)	1.564 (1.630)	11.97*** (0.244)	11.98*** (0.222)	7.377*** (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
R ² within	0.00	0.01	0.00	0.00	0.00	0.04
R ² 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.

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 ($\beta = 1.261$, $p < 0.10$). Likewise, the 'TUP' variable in the 'controlled' data model presented significance when this is the only control variable ($\beta = 0.535$, $p < 0.01$). However, the latter remained significant ($p < 0.01$) when in interaction with all other control variables ($\beta = 0.463$). 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 provoke 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 ($\beta = 0.0954$, $p < 0.05$), in the 'controlled' group this does not occur. Likewise, with the variable 'only port in the State' ($\beta = 1.285$, $p < 0.01$). On the other hand, in the group of 'controlled' data the 'container gantry cranes' are performance determinants ($\beta = 0.121$, $p < 0.10$), 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 (Tongzon and Heng, 2005; Cullinane et al., 2002; Pallis et al., 2011).

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

Table 6 Regressions results summary

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

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. This is due to the fact that it uses panel data, and also 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.

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

5 CONCLUSIONS AND IMPLICATIONS

We investigate, among so many important factors involved in the success of a container terminal, which are the main determinants related to the greater movement. 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., 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 surface' and 'ship size'. Of these five main variables, three are related to internal infrastructure, one related to external infrastructure and one related to the institutional aspect. The latter 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 main 'TUP'. On the other hand, 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 taken into account, 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 taken into account, as well as the interest and strategy of the customers and stakeholders involved, as an example of strategic alliances of shipowners. Therefore, there are conscious limitations that have been evaluated, but it has not been possible to find an adequate way to include these aspects in harmony 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, to 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, loose 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 short, to be able to compare the reality of Brazil with other ports in the world.

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