Port Efficiency and Brazilian Exports

A Quantitative Assessment of the Impact of Turnaround Time

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Outline

Trade Facilitation and Port Efficiency

- Trade obstacles, such as the efficiency of port procedures, have grown rapidly in importance as far as the final cost of traded goods is concerned.
- Port infrastructure, as well as the efficiency of customs procedures, is among the most important for determining the final cost of an exported good.
- According to data from the Brazilian Ministry of Development, Industry, and Foreign Trade, between 2004 and 2013, approximately 83% of the total value and 96% of the total weight of Brazilian exports were conducted through ports
- According to the World Economic Forum indicator "Quality of Port Infrastructure," in 2013 Brazil ranked 130th among 148 countries in port quality and efficiency

Objective

- Time to complete port procedures is directly related to port efficiency;
- The purpose of this paper is to estimate the impacts of turnaround time on both the volume of Brazilian exports and on the number of categories of exported products;
- The decision to use Brazil for this study is justified by its geographic characteristics.
  - In fact, Brazil is a country of continental dimensions and has a large number of ports with significant trade volumes.
  - This ensures a data variability in terms of products and trade partners that cannot be found in many other countries.

Contribution

- We adopt an innovative identification strategy inspired by Djankov et al. (2010) to a unique database that enables us to control for several unobservable factors that can affect export flows at the local level.
  - The idea of this approach is to estimate a gravity in difference model where we use geographically close cities to build restricted ratios such that common trade facilitation components for a given group of cities, product and destination country can be controlled in the estimated equation
  - This approach may also reduce problems arising from the possible endogeneity between time measures and exported volume

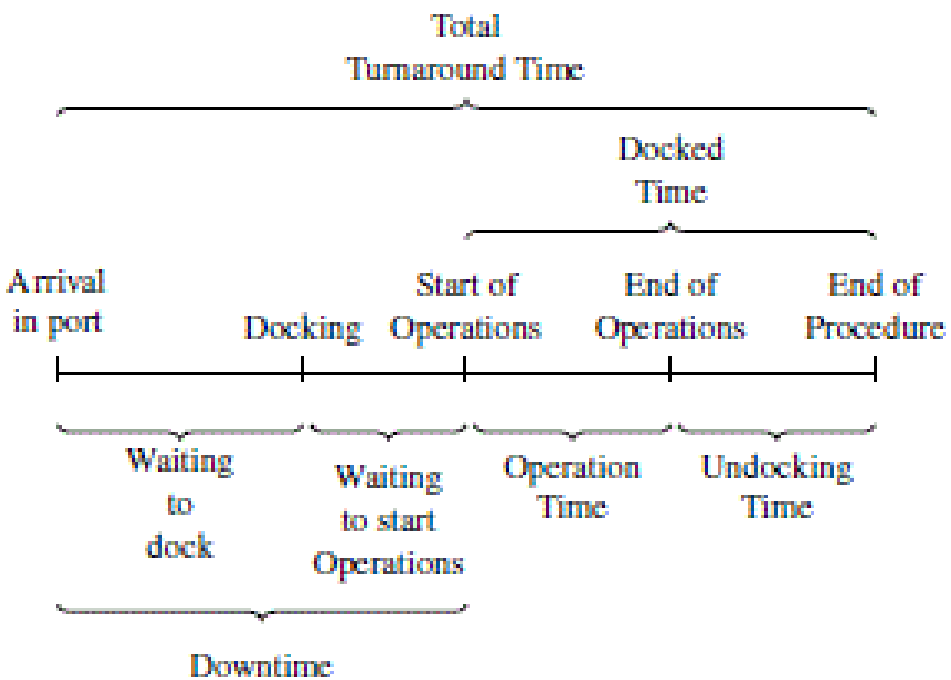
Data

- Database built of local exports, taking into consideration the port used, the country of destination, and products aggregated at the four-digit HS for the period between 2010 and 2012;
  - Brazilian export data were obtained from the Alice Web System;
    - The information was collected from 2010 to 2012 according to product category (at the four-digit and eight-digit HS) and to the 503 cities of origin of the goods
  - Data from 16 Brazilian ports responsible for approximately 78% of total Brazilian exports, and approximately 93% of exports by sea;
  - The Gross Domestic Product data for Brazilian cities - IBGE.
  - Average income of workers from auxiliary activities in the waterway transport sector in the cities where ports operate - RAIS (Annual Report on Social Information) labor force records

Brazilian Ports

Data

- Information on turnaround time from the Brazilian National Agency for Waterway Transportation (ANTAQ).
  - Average time (hours) necessary for a port to handle a complete import or export procedure for a standard container ship, from docking to undocking.



Descriptive Statistics

Variable	Obs	Mean	Median	Std. Dev.	Min	Max
Port Time	48	28.2	25.5	13.6	10.3	70.3
Docked Time	48	15.7	12.7	9.7	5.7	48.9
Downtime	48	13.6	11.8	11.8	0	60.2
Waiting to dock	48	12.5	11.4	11.9	0	57.6
Waiting to Start Operations	48	1.1	0.8	1.6	0	10.6
Operation time	48	12.5	9.6	8.2	4.4	44.1
Undocking time	48	2.1	1.3	3.5	0	24.4

Source: ANTAQ (2015)

Figure: Time Measures

Descriptive Statistics

Port	2010	2011	2012
Rio de Janeiro	16.80%	14.56%	3.47%
Belém	8.59%	8.70%	4.76%
Vila do Conde	5.88%	11.81%	8.95%
Santarém	8.37%	0.00%	21.68%
Itaqui	32.31%	35.47%	27.30%
Itaguaí (Sepetiba)	47.60%	47.98%	42.24%
Imbituba	37.95%	58.25%	47.57%
Suape	62.95%	46.04%	47.78%
Fortaleza	26.56%	37.55%	52.45%
Vitória	60.79%	59.93%	56.75%
Itajaí	71.58%	60.00%	57.64%
Santos	63.44%	50.54%	58.00%
Rio Grande	72.65%	75.11%	62.64%
Paranaguá	66.67%	56.90%	72.35%
Salvador	56.67%	58.44%	73.48%
São Francisco do Sul	59.52%	80.91%	85.63%
Mean	43.65%	43.89%	45.17%

Source: ANTAQ (2015)

Figure: Waiting time as a percentage of total time of stay

Gravity Model

- Gravity models have been widely used in the literature to estimate aggregate effects of tariff and non-tariff measures and costs reductions associated with trade facilitation;

$$X_{m,i,t}^{k} = \frac{Y_{i,t}^{k} Y_{m,t}^{k}}{Y_{t}^{k}} \left(\frac{\phi_{m,i,t}^{k}}{Q_{i}^{k} Q_{m}^{k}} \right)^{1-\sigma_{k}}$$

$X_{m,i,t}^{k}$ is exports from city m to country i in product sector k in year t;
$Y_{i,t}^{k}$ is country i's production in sector k in year t; and $Y_{m,t}^{k}$ is the exporting capacity of city m in sector k in year t, Y_{t}^{k} is the global production of industry k.
$\phi_{m,i,t}^{k}$ is a factor that represents all trade costs between city m and country i for a particular category of products k in year t,
σ_{k} is the elasticity of substitution between products from the same category k.
Q_{i}^{k} and Q_{m}^{k} represent multilateral resistance.

Trade Costs

- We decompose the trade costs, $\phi^k_{m,p,i,t}$, in a following way:

$$ln(\phi^k_{m,p,i,t}) = ln(\mu^k_{m,p,t}) + ln(\omega_{p,t}) + ln(\psi^k_{p,i})$$

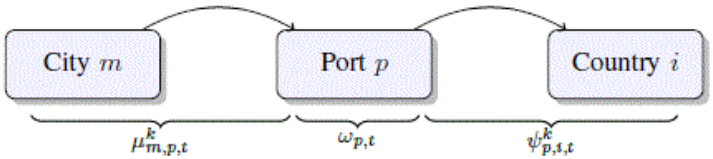


Figure: Trade Costs

$\mu^k_{m,p,t}$: set of variables that denote any cost factor between exporting city m and port p - "behind borders" elements;
$\omega_{p,t}$: set of variables that reflect the characteristics of the port used for export, such as the quality and efficiency of customs procedures - "frontier" elements;
$\psi^k_{p,i}$: set of variables that represent the costs during the trading process between port p and country of destination i in year t - "beyond-the-border" elements.

Identification Strategy

- Difference gravity models - Djankov et al. (2010)
  - The ratio of two observations regarding the exports of two cities located in the same geographic region
- Definition of clusters of close municipalities
  - hierarchical cluster analysis, with geographic distance as the dissimilarity variable between cities - 143 clusters
- A second identifying assumption: given two cities belonging to the same cluster, the components of $\mu^k_{m,p,t}$,that differ for two distinct ports are invariant in the short term.
  - With the estimation of a fixed-effects model, the term "behind-the-border" trade facilitation, $\mu^k_{m,p,t}$, can be eliminated from the equation
- To control for the elements of "beyond-the-border" trade facilitation, we calculated the ratios only with observations whose country of destination is the same.

Econometric Model

- By constructing ratios of local observations for the same region, and by using the fixed-effects model, we obtain the following equation:

$$ln\left(\frac{X^k_{m_1,p_1,i_1,t}}{X^k_{m_2,p_2,i_2,t}}\right) =$$

$$\alpha^k_{m_1,m_2,p_1,p_2,i} + \alpha_t + \beta_1 ln\left(\frac{Coef.Exp^k_{m_1,t}}{Coef.Exp^k_{m_2,t}}\right) + \beta_2 ln\left(\frac{Cost_{p_1,t}}{Cost_{p_2,t}}\right) +$$

$$\beta_3 ln\left(\frac{Time_{p_1,t}}{Time_{p_2,t}}\right) + \beta_4 ln\left(\frac{Nro.Docking_{p_1,t}}{Nro.Docking_{p_2,t}}\right) + \varepsilon^k_{m_1,m_2,p_1,p_2,i_1,i_2,t}$$

$Time_{p,t}$ refers to turnaround time variables in port p and year t.

Results - Export Volume

Dependent variable: ln(Ratio Exported Value FOB)				
	Fixed-Effects Models			
	(1)	(2)	(3)	(4)
ln(Ratio Export Coefficient) $_{-1}$	0.170***	0.174***	0.171***	0.176***
	(0.054)	(0.054)	(0.054)	(0.054)
ln(Ratio Number of Dockings)	1.170***	1.167***	0.757***	0.904***
	(0.209)	(0.210)	(0.199)	(0.195)
ln(Ratio Port Cost)	-1.098***	-1.202***	-1.229***	-1.335***
	(0.233)	(0.267)	(0.241)	(0.227)
ln(Ratio Turnaround time)	-0.514***			
	(0.136)			
ln(Ratio Operation Time)		-0.050		
		(0.147)		
ln(Ratio Waiting Time + Undock)		-0.353***		
		(0.086)		
ln(Ratio Waiting to Dock)			-0.100***	
			(0.020)	
ln(Ratio Docked Time)			-0.029	
			(0.167)	
ln(Ratio Waiting Time Rate)				-0.266***
				(0.070)
Constant	-0.554***	-0.563***	-0.426***	-0.470***
	(0.106)	(0.109)	(0.104)	(0.101)
Observations	11,377	11,377	11,377	11,365
Year Dummies	Yes	Yes	Yes	Yes
R-squared	0.040	0.040	0.041	0.038

Source: Data compiled by the authors.
Note: Standard errors robust to heteroscedasticity are in parentheses.
*, **, and *** denote statistical significance at 10%, 5%, and 1%, respectively.

Figure: Impacts of turnaround time on volume of exports in Brazilian

Results - Export diversification

Dependent variable: ln(Ratio Number of Exported Products)				
	Fixed-Effects Models			
	(1)	(2)	(3)	(4)
ln(Ratio Export Coefficient) $_{-1}$	0.071***	0.072***	0.073***	0.073***
	(0.019)	(0.019)	(0.019)	(0.018)
ln(Ratio Number of Dockings)	0.340***	0.327***	0.248***	0.276***
	(0.078)	(0.078)	(0.076)	(0.075)
ln(Ratio Port Cost)	-0.093	-0.054	-0.090	-0.132
	(0.097)	(0.107)	(0.098)	(0.093)
ln(Ratio Turnaround time)	-0.099**			
	(0.047)			
ln(Ratio Operation Time)		-0.075		
		(0.052)		
ln(Ratio Waiting Time + Undock)		-0.071**		
		(0.030)		
ln(Ratio Waiting to Dock)			-0.012	
			(0.009)	
ln(Ratio Docked Time)			-0.082	
			(0.052)	
ln(Ratio Waiting Time Rate)				-0.051
				(0.036)
Constant	-0.235***	-0.228***	-0.187***	-0.210***
	(0.048)	(0.048)	(0.045)	(0.045)
Observations	16,062	16,062	16,062	16,047
Year Dummies	Yes	Yes	Yes	Yes
R-squared	0.004	0.004	0.004	0.004

Source: Data compiled by the authors.
Note: Standard errors robust to heteroscedasticity are in parentheses.
*, **, and *** denote statistical significance at 10%, 5%, and 1%, respectively.

Figure: Impacts of turnaround time on export diversification

Sensitivity Analysis

- Although the empirical strategy adopted controls for many unobserved variables, there might still exist some endogeneity with respect to the time measures:
  - Estimates only with observations in which the two ports considered in the ratio are in the same geographical region: strengthens the assumption made to control for "behind-the-border" trade facilitation
  - Estimates without the largest and smallest ports: she size of the port might be correlated with other port characteristics that affect the efficiency of the port, specially the time variables
  - Estimates without the top 20 products (2-digit HS) exported : to reduce possible endogeneity that may exist between the exported amount of specific goods and the time for each step of the port procedure

Sensitivity Analysis

- 10% decrease in relative turnaround time is reflected in an increase of 6.37% to 14.94% in local exports.
- Reductions of 10% in waiting or in time to undock are associated with increases of 4.13% to 10.34% in relative export volume
- Regarding the models estimated with the ratio of the number of products as a dependent variable, the coefficients of the control variables maintain the same general pattern in terms of signals and statistical significance;
  - the undocking time is the only measure with significant impacts on the number of products.
  - 10% reduction in total turnaround time would increase the number of exported goods by approximately 1%.
  - 10% reduction in downtime or in undocking time would increase the number of exported products by 0.96%.

Summary

- Brazilian ports presented in the sample an average downtime (time waiting to dock and time to the beginning of operations) of 45.17% in 2012.
  - The results show that Downtime is the main bottleneck to port efficiency in Brazilian ports.
- The results suggest that the reduction in turnaround time can provide Brazilian exporters with better access to the international market.
  - 10% reduction in total turnaround time may increase local exports by approximately 5.1 %
  - For each additional hour of a ship's stay in the average port is equivalent to a reduction of approximately 2% in local exports
- We also provide evidence that turnaround time also affects the variety of products that can be exported by a city.
  - 10% reduction in the relative time a ship stays in port can increase the number of product categories by approximately 1%.
  - For each hour of delay in time to dock in the average port, ceteris paribus, is equivalent to a reduction of 0.88% in local exports

Restricting for ports located in the same region

	Restriction: Same-region ports							
	ln(Ratio Exported value FOB)				ln(Ratio Number of Exported Products)			
ln(Ratio Turnaround time)	-0.994***				-0.087			
	(0.172)				(0.060)			
ln(Ratio Operation Time)		-0.074				-0.096		
		(0.204)				(0.082)		
ln(Ratio Waiting Time + Undock)		-0.733***				-0.069*		
		(0.123)				(0.039)		
ln(Ratio Waiting Time for Docking)			-0.115***				-0.014	
			(0.021)				(0.009)	
ln(Ratio Docked Time)			-0.446*				-0.174*	
			(0.245)				(0.099)	
ln(Ratio Waiting Time Rate)				-0.304***				-0.043
				(0.073)				(0.038)
Constant	1.353***	1.359***	0.716***	0.862***	0.113***	0.107**	0.051	0.065
	(0.150)	(0.154)	(0.129)	(0.127)	(0.042)	(0.043)	(0.045)	(0.043)
Observations	4,408	4,408	4,408	4,396	6,087	6,087	6,087	6,074
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.099	0.104	0.088	0.077	0.004	0.005	0.005	0.004

Source: Data compiled by the authors.
Note: Standard errors robust to heteroscedasticity are in parentheses.
*, **, and *** denote statistical significance at 10%, 5%, and 1%, respectively.

Figure: Results restricting ratios for ports located in the same region

Sample by eliminating the most-traded products

	Without most-traded goods							
	ln(Ratio Exported value FOB)				ln(Ratio Number of Exported Products)			
ln(Ratio Operation Time)		-0.210 (0.158)				-0.040 (0.057)		
ln(Ratio Waiting Time + Undock)		-0.413*** (0.091)				-0.096*** (0.031)		
ln(Ratio Waiting Time for Docking)			-0.113*** (0.021)				-0.010 (0.008)	
ln(Ratio Docked Time)			-0.193 (0.185)				-0.089 (0.064)	
ln(Ratio Waiting Time Rate)				-0.275*** (0.073)				-0.053** (0.026)
Constant	-0.460*** (0.105)	-0.433*** (0.110)	-0.291** (0.115)	-0.363*** (0.108)	-0.214*** (0.045)	-0.224*** (0.045)	-0.173*** (0.043)	-0.197*** (0.042)
Observations	8,104	8,104	8,104	8,092	9,978	9,978	9,978	9,963
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.060	0.061	0.063	0.057	0.006	0.006	0.006	0.006

Source: Data compiled by the authors.
Note: Standard errors robust to heteroscedasticity are in parentheses.
*, **, and *** denote statistical significance at 10%, 5%, and 1%, respectively.

Figure: Results restricting sample by eliminating the most-traded products

Sample by eliminating the largest and smallest ports

	Without the largest and smallest ports							
	ln(Ratio Exported value FOB)				ln(Ratio Number of Exported Products)			
ln(Ratio Turnaround time)	-1.494***				-0.108			
	(0.209)				(0.068)			
ln(Ratio Operation Time)		-0.367				-0.204*		
		(0.273)				(0.106)		
ln(Ratio Waiting Time + Undock)		-1.034***				-0.042		
		(0.145)				(0.048)		
ln(Ratio Waiting Time for Docking)			-0.138***				-0.012	
			(0.031)				(0.009)	
ln(Ratio Docked Time)			-0.471				-0.182*	
			(0.303)				(0.103)	
ln(Ratio Waiting Time Rate)				-0.431***				-0.048
				(0.134)				(0.037)
Constant	0.608***	0.583***	0.276**	0.196**	-0.035	-0.003	-0.026	-0.060**
	(0.097)	(0.110)	(0.110)	(0.090)	(0.026)	(0.031)	(0.029)	(0.025)
Observations	4,117	4,117	4,117	4,117	5,362	5,362	5,362	5,362
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.113	0.113	0.081	0.065	0.006	0.007	0.007	0.006

Source: Data compiled by the authors.
Note: Standard errors robust to heteroscedasticity are in parentheses.
*, **, and *** denote statistical significance at 10%, 5%, and 1%, respectively.

Figure: Results restricting the sample by eliminating the largest and smallest ports