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Effect of privatization and inland infrastructural development on India's container port selection dynamics

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ABSTRACT

In this study, we present insights on how the privatization of Indian ports is altering the market share of containerized shipments across two key Industrial corridors of India. Using bill of lading dataset, we implement a binary multi-level discrete port choice model that measures the multidimensional attributes that inform the systematic differences in container shipment transport characteristics between the major government ports and private ports in India. The analysis shows that the private port of Mundra has non-trivial effects on the hinterlands of other state-owned ports. This research offers important markers of port selection in developing economies such as India.

1. Introduction

In this article, we offer insights into the changing contours of port privatization in India through an empirical analysis of the modalities of shippers' selection of India's largest and growing private container port – Mundra. The business and logistical effect of privatization is a dynamic and extended process in any economy. We inform this process within the context of a rapidly developing economy like India by capturing a snapshot of its early-stage privatization in its maritime sector.

Strong and sustained economic growth of India between 1990 and 2010 and its continuance have made the country's export sector regionally and globally prominent. As a natural consequence, the operations of existing ports and the development of new ones have taken a sharper trajectory in the last decade. Two important aspects of India's maritime evolution are the increased containerization of shipments, and the development of private ports and a deeper involvement of private players in the shipping and freight transportation industries. By 2013, there were 58 port projects with active private investment, along with another 83 projects with private investment under consideration or in the early stages (Dappe and Suarez-Aleman, World Bank 2016). According to the Indian Port Association (IPA) report in 2007, container shipments accounted for about 22 per cent of India's total export cargo volume. 'Towards the end of 2007, the Indian seaborne container trade had increased by nearly 14 per cent to 5 million TEUs, while Indian seaports were forecasted to handle 18 million TEUs

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by 2014 (Ng and Gujar, 2009).

Successive central governments of India have provided support to this evolution of the Indian maritime industry along three dimensions: 1) reshaping policies to foster greater competition among ports; 2) creating entrepreneurial opportunities for private entities in order to reduce fiscal burden and increase commercial activity; 3) planning and delivering major inland infrastructure for better hinterland connectivity and market access. This research situates itself at the intersection of policymaking and infrastructural development and of the competitive economic activity surrounding inland transportation of containerized export shipments in Indian ports. Specifically, we study whether and how development of private ports has impacted the selection of container ports along two major industrial corridors that have been aided with significant freight-oriented infrastructural development.

The development of private ports has been a relatively recent phenomenon in the Indian shipping industry. Most major ports are controlled by the government through the Shipping Corporation of India. Several minor ports are owned/operated by private enterprises but, of the major ports, Mundra and Pipavav in the state of Gujarat have had significant success in attracting containerized shipment traffic. Of the two, the port of Mundra has been emerging as a rival to the dominant public port – Jawaharlal Nehru Port Trust (JNPT) near Mumbai. In this context, we focus our empirical study on these two close competitors and investigate the important parameters of choice governing the selection between private and state-owned ports, for exporting containerized shipments. This study is further contextualized on India's recent infrastructural development, the 'golden quadrilateral' (GQ), a new network of semi-access controlled express highways developed with a strong emphasis on road-based freight transportation. We analyze containerized shipments originating from the captive zone of two important industrial corridors - Delhi to Mumbai and Mumbai to Chennai - served by the GQ and study the factors leading to the selection of the private port of Mundra against any of the public ports in India, especially JNPT.

The goals and contributions of the study are multiple and are as follows. First, we expand the extremely limited literature on Indian ports. Access to micro-level shipping data of India has historically been an obstacle in quantitative studies. We overcome this challenge in this study by using bill of lading data that allow analyses of port selection at individual shipper and carrier levels. Second, our focus on a major emerging private port puts the spotlight on key issues concerning broader impacts of privatization in the maritime industry of India specifically, and also of other countries that are in the process of reevaluating the role of the public section in port and maritime activities. Third, this research also extends the work by Thill and Venkitasubramanian (2015) by proposing an alternative methodology to model port selection that incorporates a multilevel modeling framework to accommodate unobserved carrier/service provider level factors that affect shippers' selection process.

In the following section, we review the context and literature relevant to each of the contributions mentioned above.

2. Literature Review

Port privatization has long been linked to port competitiveness (Tongzon and Heng, 2005) and adaptability to customer demand. The argument for privatization of ports in developing countries such as India has been consistent – the need and benefits of operational and commercial flexibility that would allow private entities that are served by maritime sector on both sides to increase efficiency and market discipline. Literature on the process, outcomes and prominence of port privatization (Bassett, 1993; Fernandez et al., 1999; AJ Baird, 2002; Cullinane and Song, 2002; Gaviria, 1999) have largely revolved around efficiency and growth of specific cases of private ports. The literature is of consensus that private ports offer positive economic effects to the industry as well as to regional commerce.

In the case of India, the efficiency advantages of privatized port terminals over publicly managed terminals have been unclear (Dasgupta and Sinha, 2016). In the case of Mumbai where partial privatization was attempted as early experiment, efficiency improvements in the order of 90% have been reported (Shashikumar, 1998). Over the last two decades, publicly owned ports in India have similarly offset specific parts of their operations to private players as joint ventures, leasing and public-private partnerships. Significantly different from this incremental privatization is the greenfield development of new major private ports and establishment of special economic zones to aid the entry and sustenance of private competition. Mundra and Pipavav – the ports that make the focus of this study, belong to this latter category. We lack empirical studies that investigate how the emergence of new private ports alters the existing hinterland structure – the key final outcome of the identified efficiency advantages of privatization. A developing country such as India, which is at an early to intermediate stage of economic liberalization and which has allowed privatization of ports, offers an appropriate time-phase to study how emerging private ports compete and contest a largely government-controlled maritime sector. The study year of 2007-2008 focuses on Mundra - the largest private port in India – on its tenth year of operation. The insights in our article hence offer a snapshot of the changing hinterland dynamics that may resonate with the experiences – past or future – of privatization in similar other developed countries who operate a tightly regulated shipping industry by policy. The outcomes of Mundra against a dominant public sector industry represents the challenges and opportunities of translating the studied efficiency advantages of privatization onto actual business outcomes – port selection by shippers and carriers. Previous studies (De Monie, 1995; Haralambides and Behrens, 2000; De and Ghosh, 2002; Paul, 2005; Panigrahi and Pradhan, 2012; Dappe and Suarez-Aleman, 2016) focus generally on productivity and efficiency of Indian ports. In this context, Thill and Venkitasubramanian (2016) stand out by making inroads into understanding port selection and hinterland dynamics of Indian ports with the development of a decision tree model that explains their respective market share on the basis of various characteristics of shippers, ports, regional economies, and shipping systems. Also, we contribute to the growing port selection literature previously studied from multiple perspectives, from shippers, to carriers, forwarders and vessel operators (Tiwari et al., 2003; Veldman and Buckmann, 2003; Malchow and Kanafani, 2004; Song and Yeo, 2004; Slack, 2006; Tongzon and Sawant, 2007; Magala and Sammons, 2008; Garcia-Alonso and Sanchez-Soriano, 2009; Hoshino, 2010; Veldman et al., 2011).

Sanchez et al. (2002) provide a detailed review on how service providers and carriers make shipping decisions based on port characteristics and attractiveness. Kashiha and Thill (2015) use a latent class approach to account for unobserved heterogeneity in port selection, while the same modeling approach is adopted by Arunotayanun and Polak (2011) for understanding freight shipping mode choices. As Halim et al. (2016) contend, the influence of port-hinterland logistics systems dominated by carriers on container port choice is rarely assessed in aggregate in empirical models. Carriers have emerged as the pivotal agents of logistics systems that connect the various players who facilitate movement from consignment sources to ports. The qualitative and quantitative factors involved in the decision making and the complexity of business ecosystems at the carrier level have been an empirical challenge in previous port selection models. Our approach addresses this issue by explicitly accounting for carrier-level heterogeneity in port selection – a model that may be easily scaled and updated to explore carrier variables and how they interact with individual shippers. This study also utilizes micro-level data of shipments that allow more granular understanding of the decision making and hinterland change due to the growth of private ports in the GQ corridors.

3. Data

This study The containerized shipment data used in this research are based on a complete, one-month (October, 2006) waterborne export database provided by PIERS Trade Intelligence. PIERS collects export declaration forms/bills of lading that are completed by shippers, carriers, or third party logistics operators, and these monthly data cover every shipment exported from ports in India to the United States. We observe that this study year is appropriate to collect cross-sectional data, as the global economic downturn after the year 2007 may have affected the container export patterns in unpredictable ways. Keeping in mind the longer-term macro-growth forecasts of India, we view that these results may be representative of the regular picture of containerized exports. We use the same dataset as in the study conducted by Thill and Venkitasubramanian (2016).

The PIERS data provide relevant attributes of shipments including shipper identification; commodity type based on the Harmonized System (HS) classification; quantity (weight, volume, TEU, estimated dollar value); carrier; forwarding port; destination American port; and the final American destination. We conducted substantial post-processing to ensure the validity of the data. Data preparation included implementing fuzzy matching algorithms to extract shipper origin locations from shipper business names and addresses, and manual validation of these locations. Furthermore, we geocoded the shipment locations at the city level in order to compute and map their spatial characteristics. Although the original data contained detailed commodity classifications (HS codes), we collapsed the six-digit codes into two-digit codes and developed a broader and more pertinent taxonomy based on the classification used by Export-Import Association of India (EXIM-India). IPA provided data on ports' operational statistics and aggregate information about port traffic. In addition to shipment and port information, we collected India's state boundaries and transportation network in GIS format from Europa Technologies' Global Insight database.

Based on the geocoded shipment data, figure 1 describes the market share of eleven major ports in India. JNPT dominates the container shipment traffic and has the most extensive hinterland while the hinterland of Mundra, the largest private port, is seen limited to Western and North-Western States. Chennai, the second largest container port, competes with JNPT in the Southern States. The exploration motivates further analysis of hinterland between JNPT and Mundra, both of which appear to have overlapping hinterland. Figure 2 shows the origin-destination map of JNPT and figure 3 shows the same for Mundra. The thickness of lines corresponds to the volume of container shipments from the origin city measured in TEUs. This further confirms the region where the growth of Mundra could impact the longstanding dominance of state-owned ports such as JNPT.

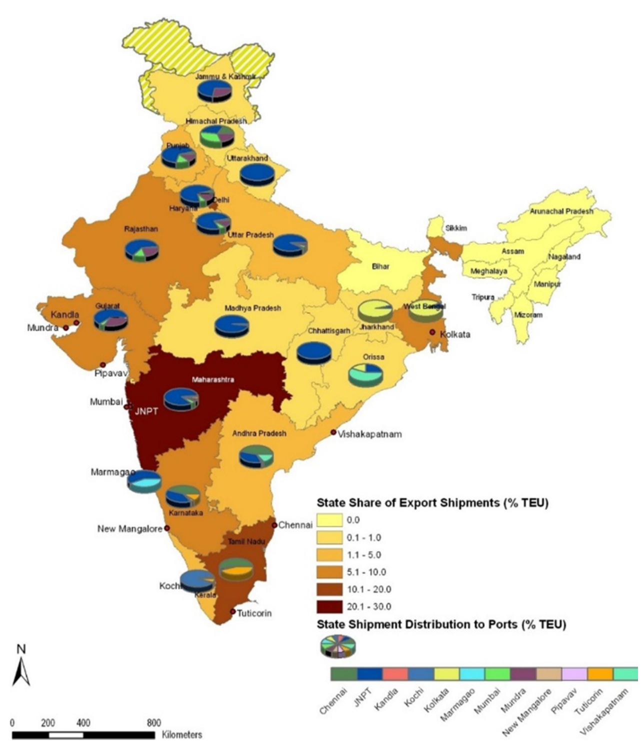

Fig. 1. Major Indian ports, their hinterland and shares of container shipments

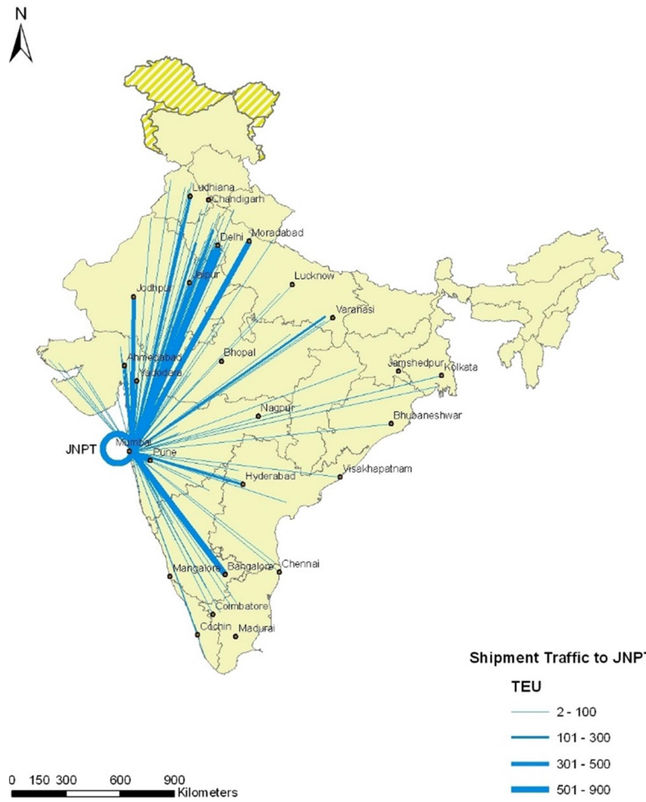

Fig. 2. Hinterland of JNPT

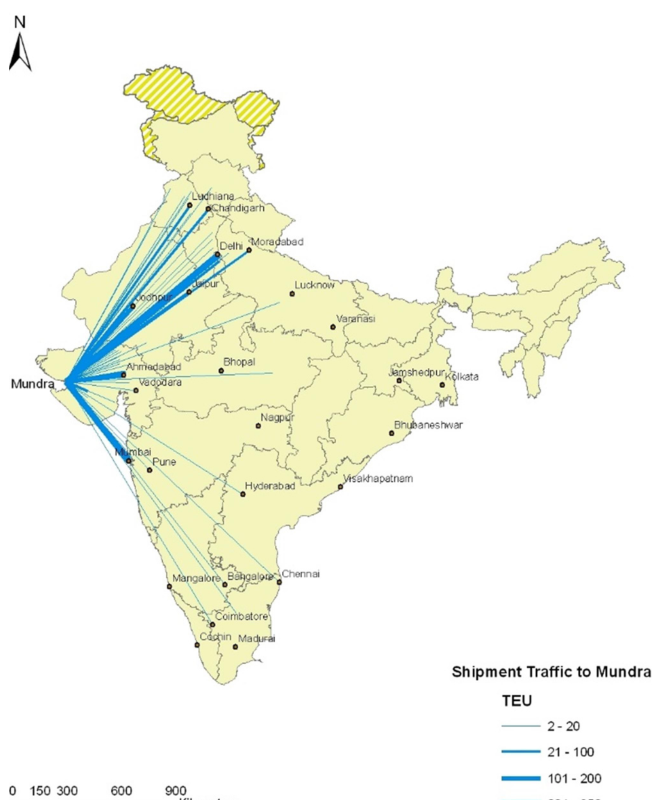

Fig. 3. Hinterland of Mundra

4. Methodology

The goal of the study, as mentioned before, is to understand the selection of private ports against the major State-owned ports. With this in mind, we focus on the captive region surrounding the Delhi-Mumbai and Mumbai-Chennai GQ corridors. Owing to the large concentration of industrial districts served by these two GQ corridors, West coast ports in India account for more than 70% of container shipments from India (Drewry, Indian Container market report 2017). Ongoing developments on these highways, such as dedicated freight corridors, make this study area particularly relevant to understanding future directions in private port development. Figure 4 shows the layout of this corridor as well as the origin location of shipments within this region. We define the captive zone to encompass territories within 100 miles on either side of the GQ highways. Since several national highways cross the GQ corridors, cities that are not directly connected to GQ still can access this freight corridor with relative ease, hence a 100-mile buffer is considered. The corridor passes through most of the major Industrial belts of India – Delhi –NCR region to Jaipur, Mumbai – Ahmedabad, and Bangalore-Chennai. Figure 4 also shows the location of the meaningful ports serving this region. Two of the largest state-owned ports, JNPT and Chennai, have their hinterland within this zone.

The port of Pipavav handles less than 1% of the shipments compared to Mundra. Hence, for all practical purposes, Mundra can be used to represent the private port option available to shipper in the target region. Accordingly, we limit the analysis of choice between Mundra and rest of the state-owned ports, dropping Pipavav from further considerations. In order to conduct empirical analyses, we create the binary variable indicating whether a shipment was transported to Mundra for export to the US. While JNPT dominates the public-sector ports and will have significant weight in determining the choice, the GQ corridor used as study area also provides access to other ports, such as Chennai, Tuticorin and Kochi, especially for hinterland in Southern India. While these ports may not be in direct competition with Mundra in the current context, the scenario may change in the future. Hence, we analyze shipments going to all state-owned ports versus those going to Mundra.

4.1. *Analytical Strategy*

The selection process of a port by a shipper is not straightforward, as acknowledged in literature review above. Decision making is a complex process involving shippers, agents and intermediaries, forwarders and carriers. However, containerized shipments are organized around major shipping carriers who play an important role in coordinating the logistics of inland transportation. Also, carriers' relationship with ports, and their sensitivity to ports' efficiency and performance determine the volume and frequency of vessel calls and configuration of shipping services, therefore influencing how the shipper chooses the respective port of export.

The process of this influence is unobserved or hard to observe; hence, only a few prior studies have integrated shipper characteristics and port characteristics with the unobserved heterogeneity in port selection due to carriers. Most previous studies on port selection use discrete choice modeling approaches such a conditional multinomial logit, but these methods fail to account for clustering of shipments around carriers' logistical networks.

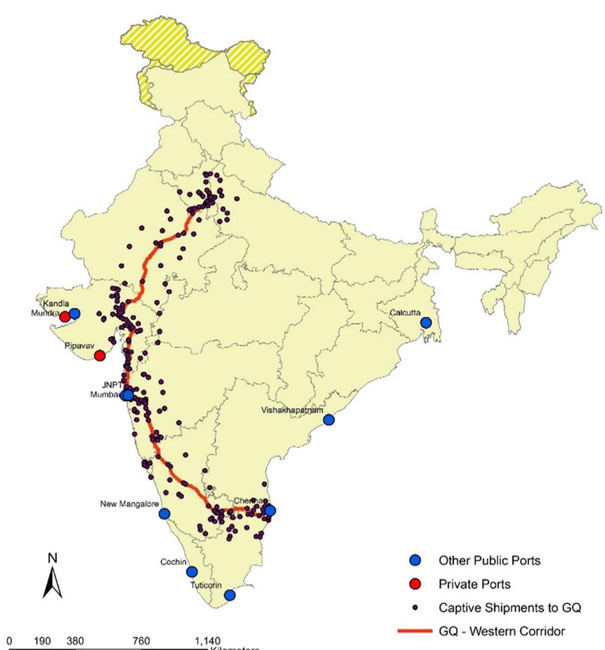

Fig. 4. Study Area (Shipment locations within the captive zone of GQ western corridors)

In this study, we propose a multi-level modeling approach adapted to account for unobserved heterogeneity of preferences and choices due to clustering of shipments around carriers. Multilevel models, also known by labels such as random coefficient model, random effects models or hierarchical models, flexibly accommodate correlations between individual observations due to one or more higher-order clusters (Snijders and Bosker, 1999; Raudenbush and Bryk, 2002) and allow exploration of complex relationships between clusters and individual observations. We regard that individual shipments are clustered by carriers and the probability of selecting a private port needs to account for this stochastic variability of odds due to unobserved network characteristics of inland transportation and business models followed by carriers and their associated stakeholders. Since it is impossible to control for all the variables of logistics business, the multilevel approach offers a parsimonious yet robust method of accounting for unobserved variance. The multilevel model we propose in this study allows carriers to have varying probability of choosing a private port. In addition, the model allows for shipper-level factors to randomly vary for different carriers, thus effectively accounting for unmeasurable interactions between shipper and carrier that result in port choice.

4.2. *Modeling Framework and Model Specification*

The basic equation of the multi-level model of private port choice is as follows:

Private Port selection ~ f (attributes of shipments, attributes of shippers, attributes of ports, attributes of shippers to ports relationships). (1)

Let us refer to the predictor variables generally as X, which vary among shippers i and carriers j. Also let W be the vector of carrier-level variables that vary among carriers j. Then the random-effects model is written as follows.

For a **null model** without covariates,

Level 1: $Y_{ij} = \beta_{0j} + r_{ij}$, (2)

Level 2: $\beta_{0j} = \gamma_{00} + u_{0j}$, (3)

Combined model: $Y_{ij} = \gamma_{00} + u_{0j} + r_{ij}$ (4)

Where Y_{ij} is the dependent variable (selection of private port) of a shipper i who used the shipping services of carrier j, which varies around the carrier mean β_{0j} and the within-carrier variance as captured by r_{ij}. Also, β_{0j} is the level 1 intercept which is a function of grand mean γ_{00} and its deviation from the grand mean as captured in the random variance u_{0j}. Thus, we have a combined model by substituting for β_{0j} in level 2.

Then, for a random-intercept model that accounts for random variability in port selection across carriers, we have the following corresponding formulation:

Level 1: $Y_{ij} = \beta_{0j} + \beta_{1j}(X_{ij} - X_j) + r_{ij}$ (5)

where X_j is the average of level 1 variables of carrier j;

Level 2: $\beta_{0j} = \gamma_{00} + \gamma_{01}(W_j - W) + u_{0j}$, (6)

and β_{1j} (fixed slope) = γ_{10}, since slopes are not allowed to vary across carriers. Also, W is the grand mean of the predictor variables.

Combined model: $Y_{ij} = \gamma_{00} + \gamma_{10}(X_{ij} - X_j) + \gamma_{01}(W_j - W) + u_{0j} + r_{ij}$. (7)

The random intercept of carriers captures the differential preference of carriers due to their relationships with certain ports or the characteristics associated with vessel scheduling / routing. The variance captures the extent of variation in the odds of a carrier choosing a private port.

As a next step, we introduce random slopes of select variables that warrant further investigation. The random slopes, estimated as the variance of the parameter estimates in the fixed part, allow us to examine the shippers' sensitivity around choosing a private port across the various carriers. When slopes are allowed to vary,

$\beta_{1j} = \gamma_{10} + u_{1j}$. (8)

Now the combined version of the **random-slopes model** can be expressed as

$Y_{ij} = \gamma_{00} + \gamma_{10}(X_{ij} - X_j) + \gamma_{01}(W_j - W) + u_{0j} + u_{1j}(X_{ij} - X_j) + r_{ij}$. (9)

Within this econometric framework, Model (1) is specified as follows:

Private Port selection ~ f (distance/impedance + port performance + destination + access to inland freight facilities + commodity specialization). Following is the description of the independent variables and their measurement.

4.2.1 Direct Transportation Costs

Distance or Impedance measures the base transportation costs of a given shipment. We include the straight-line distance to Mundra, to JNPT and to Chennai as three individual variables that allow a comparison of the odds of private port selection as the relative geographic distances change.

4.2.2 Service Quality / Port Performance

Service quality of ports could encompass an array of port-related attributes that may affect the overall cost of export transactions, thus proving vital to both the shipper and the carrier. The quality of service refers primarily to its operational performance that makes shipping and vessel movements faster and easier. Higher quality ensures a quicker transit for the shipment and increased vessel throughput. Both of these qualities are expected to influence the shipper's decision. We develop a synthetic measure for the ports' quality of service termed the 'port service index' (PSI). This index combines four important operational performance measures, obtained from IPA and Fossey et al. (2008).

1. Number of Vessels handled per year: This refers to the number of container vessels calling at each in the year 2007 and relates to its capacity as well as efficiency.
2. Average Turn-around time: The average time (days) taken by the port to load the vessel and allowing it to resume its voyage. This variable is inverted before adding to the index in order to maintain measurement consistency.
3. Number of Direct-call liner services: The amount of direct port calls per week reflects the availability to vessels for a given destination. Higher direct-call services indicate efficient and vessel-friendly port operations, thus increasing the options for shippers.
4. Terminal Storage Capacity: Storage capacity is measured by the amount of designated container storage area available at a port and its terminals. Container storage availability at the port terminals is expected to decrease logistical delays of shipment thus attracting more shippers as well as vessels.

These measures are individually standardized and combined to develop the composite index. A higher measure of the index indicates a better service quality. In this model, we use the PSI of the specific port of choice for each shipper.

4.2.3 Connectivity Characteristics

The third dimension of variables pertains to the connectivity characteristics of the shipper and ports. Shipments are transported as 'full container load (FCL)' or 'less than container load (LCL)'. LCL refers to compiling articles from different shippers bound towards the same destination into a single container. Thus, shipments might undergo a series of logistical operations and transfers between land-based carriers before it reaches the port. Inland container depots (ICD) allow these operations and they function as nodes to collect and compile container loads, primarily serving the railway freight network. Hence, we expect the shipper's geographic affinity to the ICD locations to have influence on the choice. We measure this affinity by computing the straight-line distance of the nearest ICD location for each shipment record.

Also included in the connectivity attributes is the destination of the shipments. These variables are purely based on the nature of physical geography of India and of the U.S. in the context of shipping routes. Since both U.S. and Indian ports are characterized by distinct eastern and western port systems due to their geography, shipment routes could be broadly distinguished as trans-Atlantic or trans-Pacific based on the destination U.S. port. Since vessel routing and schedules can be critical to the overall transport costs, we expect a stronger association between India's East coast ports and U.S. West coast ports and vice versa. We assume this association is induced on the shipper, thus influencing its decision making process on the port of choice. We measure these as a set of dummy variables indicating whether the shipment is destined for the East Coast, the West Coast or the Gulf Coast of the U.S. To avoid perfect collinearity, we only use the dummy variables for the West Coast and the Gulf Coast in the model.

4.2.4 Commodity Characteristics

In addition to the three main aspects of port selection described above, we also include commodity-specific variables that may indicate the influence of regional economic specialization on port selection. We expect that specialization could translate into an influence on the preferences of shippers who produce such commodities. To measure the effects of specialization, we specify four commodity dummy variables, indicating whether the shipment belongs to 1. Textiles and related products, 2. Machinery and Mechanical Appliances, and 3. Base Metal Articles and 4. Stone articles and products. These are four of the most common types of containerized commodities shipped from India to the U.S. as revealed in the exploratory analysis shown in fig 5.

4.2.5 Carrier Characteristics

Given the multi-level structure of the model specification, we include carriers as the source of unobserved heterogeneity in port choice. This assumes carriers or business groups who control or influence inland transportation as well as vessel movements will have differential levels of affinity to the private port based on their business relationships with the port as well as the region. Specific carriers used for shipping enter the model as varying (random) intercepts that capture their individual likelihoods of shipping through Mundra for unobserved reasons. In addition, we add the total TEUs handled by the carrier internationally as a proxy variable to measure whether dominant carriers are attracted to private ports in a way that differs from smaller carriers.

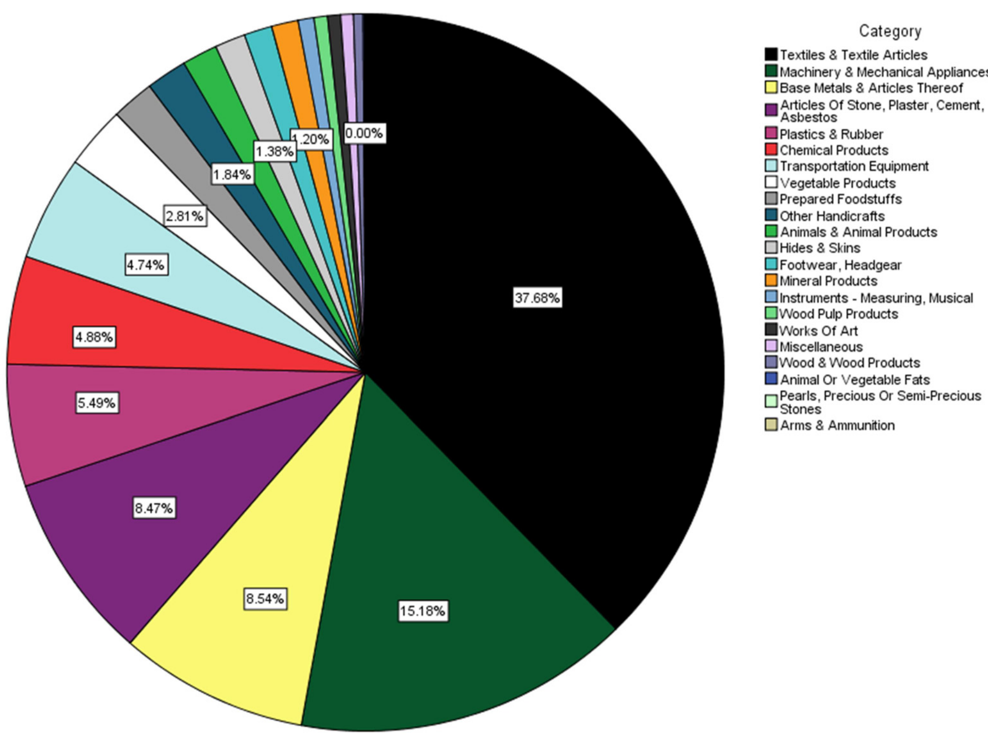

Fig. 5. Commodity distribution of containerized shipments from the observed ports (percent of TEUs)

5. Results and Discussion

We specify four successive models with estimates reported in Table 1 and Figure 6. The first model is the basic binary logit regression model (Table 1, Panel 1). We do not interpret the parameter estimates due to the biased standard errors, but we use them as a reference. The pseudo r-square of this model is 0.5339, indicating a good statistical fit. Hence, given this reference r-square and the deficiencies of this model, we expect more refined output in the subsequent models.

The next model (Table 1, Panel 2), is a random-intercept model. This encompasses all the measured variables discussed in the previous section and specifies carrier-specific intercepts, while the standard errors are robust and adjusted for clustering. We observe that distance variables are statistically significant but the odds ratio indicates that shippers are generally indifferent about choosing Mundra over other ports based on distances alone. While increase in distance to Mundra for a specific shipment marginally decreases the odds of choosing this private port, increase in distance to JNPT does not significantly increase the odds of choosing Mundra. There is also a marginal positive effect on Mundra's attraction as a port of choice as distance to Chennai increases. All these indicates that regional effects other than distances could play an important role in attracting shipments from the captive GQ region to private ports.

Port performance has a statistically significant effect on the selection of private ports. As the performance index of a chosen port increases, the odds of choosing Mundra decrease substantially. The prominence of JNPT as a major player with significantly more port calls and handling facilities than its competitors adds to the multidimensional performance index, hence influencing the estimates. For a given carrier, shippers expect efficiency and greater choices, so that performance will continue to matter in port selection.

As for shipping destinations, shipments to the U.S. Gulf Coast compared to the East Coast have similar odds of selecting Mundra over state-owned ports. But shipments bound to the West Coast of the U.S. are highly unlikely to choose Mundra. This is either due to its location along the north-western edge of the Indian peninsula, or less developed connections with transshipment terminals such as Colombo or Singapore. Shipments attracted to Mundra from the captive GQ zone are overwhelmingly bound to the East Coast of the U.S.

Parameter estimates also show a strong effect of commodity specialization attributes. While both textile products (produced largely in Western and Southern India) and Stone products (North-Western India) are less likely to be shipped via Mundra, we see that machinery and mechanical appliances are more likely to shipped through this port. This is a striking finding since we observe that the traditional exports of India are still largely inclined to use the State-owned ports, while private ports seem to be better connected to the more modern manufacturing sectors that India has been attempting to promote in the recent years.

Table 1

Parameter Estimates of the Private Port Selection Model (** means significant at 5%, * means significant at 10%)

Private Port Selection Model	Binary Logit			Random Intercept (Without Hinterland)			Random Intercept			Random Slope (Hinterland)		
	Odds Ratio	**z**	**P>z**	**Odds Ratio**	**z**	**P>z**	**Odds Ratio**	**z**	**P>z**	**Odds Ratio**	**z**	**P>z**
Distance to Mundra	0.9772	-3.02	0.002**	0.9604	-3.13	0.002**	0.9643	-1.24	0.215	0.9670	-1.15	0.251
Distance to Chennai	1.0283	4.74	0**	1.0332	5.48	0**	1.0326	2.89	0.004**	1.0349	3.01	0.003**
Distance to nearest ICD	1.0035	3.42	0.001**	1.0020	1.35	0.176	1.0037	2.05	0.04**	1.0036	1.96	0.05*
Distance to JNPT	1.0155	1.44	0.15	1.0086	1.1	0.271	1.0228	0.9	0.369	1.0177	0.71	0.481
PSI (performance of chosen port)	0.6181	-47.41	0**	0.5063	-9.21	0**	0.5000	-10.27	0**	0.4955	-10.41	0**
Destination Coast												
Gulf Coast	0.0229	-8.42	0**	0.2381	-1.04	0.296	0.1959	-1.3	0.195	0.1759	-1.18	0.238
West Coast	0.0274	-11.87	0**	0.0269	-5.29	0**	0.0255	-5.93	0**	0.0229	-5.97	0**
Commodity												
Textile Products	0.4743	-6.15	0**	0.4339	-2.07	0.038**	0.4176	-2.16	0.031**	0.4354	-2.05	0.04**
Stone Articles	0.5728	-2.56	0.01**	0.2793	-2.72	0.007**	0.2819	-2.57	0.01**	0.2701	-2.85	0.004**
Base Metal Products	0.8950	-0.86	0.392	0.9921	-0.06	0.953	0.9903	-0.07	0.944	0.9946	-0.04	0.971
Machinery	2.1370	5.28	0**	2.8816	2.28	0.023**	2.7204	2.21	0.027**	2.7978	2.18	0.029**
Hinterland												
Gujarat	5.0531	4.99	0**				4.4898	2.69	0.007**	3.6846	2.21	0.027**
Maharashtra	3.4384	1.87	0.061*				5.4451	1.78	0.075*	4.6255	1.91	0.057*
Tamil Nadu	0.5422	-0.78	0.434				0.7727	-0.49	0.626	0.7772	-0.57	0.571
Delhi	0.8618	-1.13	0.259				0.8170	-0.68	0.499	0.8167	-0.65	0.514
Carrier TEUs	1	-9.98	0**	1	-0.28	0.782	1	-0.26	0.793	1	-0.24	0.813
Constant												
Carrier ID	0.0045	-34.12	0**	0.0003	-8.41	0**	0.0003	-8.16	0**	0.0003	-8.09	0**
Variance Components						**95% CI**			**95% CI**			**95% CI**
var(Gujarat)										0.7384	0.296985	1.835833
var(Maharashtra)										1.1384	0.555505	2.333048
var(**Constant**)				7.413071	2.606415	21.08	7.360801	2.510157	21.58486	7.5082	2.514801	22.41672

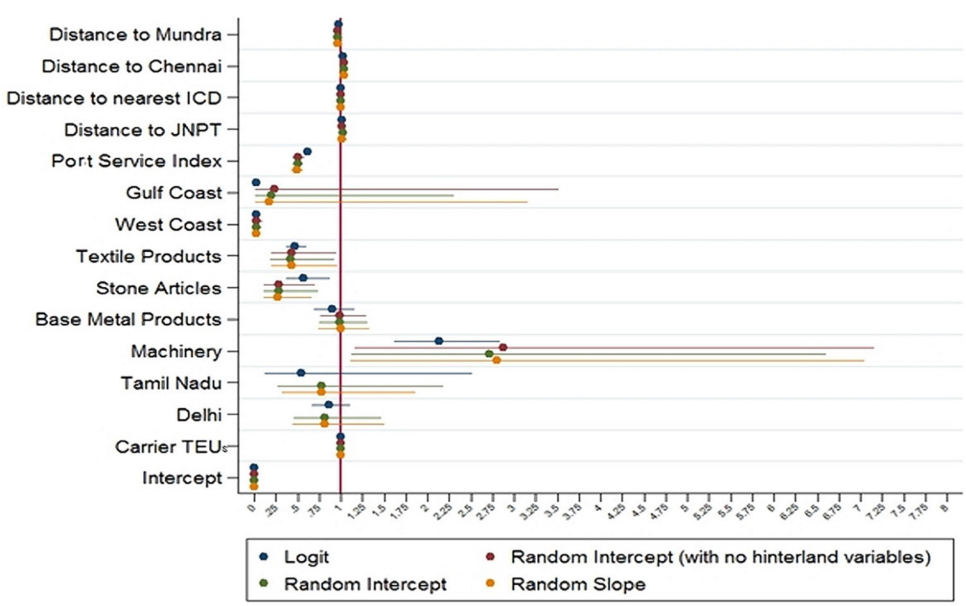

Fig. 6. Parameter Estimates and Confidence Intervals of Port Selection Factors under Four Modeling Frameworks

The third model (Table 1, Panel 3) introduces regional fixed effects into consideration. This lets us understand how shipments from the primary captive hinterland of Mundra (Gujarat) and its competing hinterland of JNPT (Maharashtra) vary in their likelihoods of choosing the private port option. We also specify two other major industrial zones within the GQ corridor, Delhi and Tamil Nadu. All else being equal, Gujarat appears to be strongly influenced by the private port of Mundra given the estimated high odds ratios. Since the comparison is made between these states versus all other states, these results reinforce that private ports are beginning to be important players in the prime industrial region served by the GQ western corridor.

In the fourth iteration of this modeling process, we also specify random slopes in the regional fixed effects (Table 1, Panel 4). With this more general specification, we find statistically significant variance in the effects of regional origins of shipments on port choice. In other words, although shipments from Gujarat and Maharashtra have higher odds of being shipped through Mundra, these odds ratios vary highly among different carriers. The configuration of logistics network and business relationships may explain this effect. Figure 7 gives the range of logged odds (coefficients) of carrier-specific intercepts showing the heterogeneity among carriers in choosing a private port versus others. This figure shows that there are a set of carriers with positive logged odds, implying these carriers are more likely to prefer Mundra for shipments they deal with than any of the public port options. Conversely, there is also a set of carriers who are less likely to ship through Mundra. Overall, a rather large number of carriers are indifferent to the choice between private and other ports.

However, we acknowledge that this study is limited to the data of containerized trade between India and the United States. Hence, the analysis may not represent the container port selection characteristics of shipments to other destinations or in overall. However, given that the United States is the biggest trading partner of India in exports (Department of Commerce, India 2015) with a highly diversified trade portfolio we view this study as a valuable case to understand the nature of port selection and modalities of shippers or carriers.

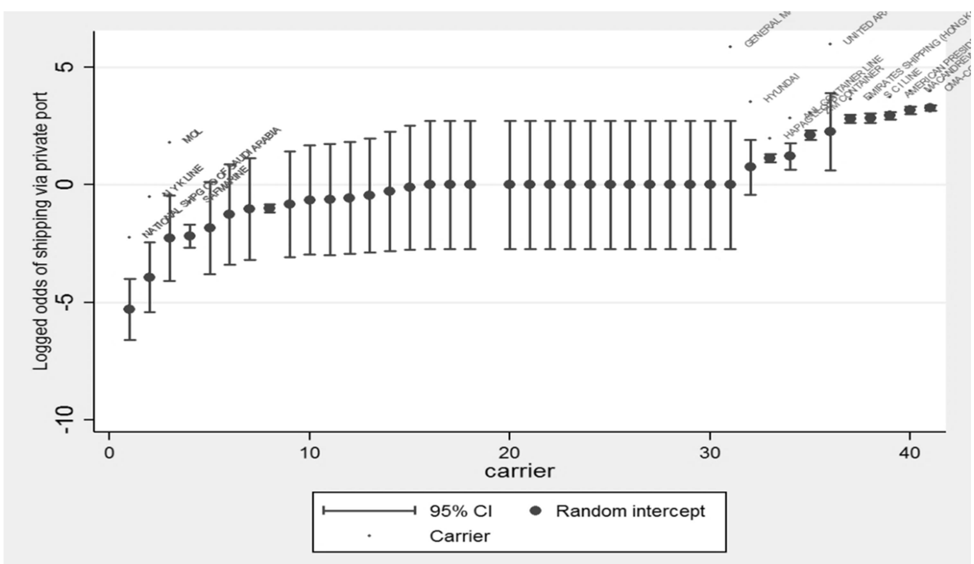

Fig. 7. Carrier (logged) odds of choosing private port

6. Conclusions

In this study, we see that the private port of Mundra has systematic and non-trivial effects on the hinterlands held by other state-owned ports in the primary industrial zone served by the GQ western corridor. Shipments belonging to specific commodities, shipments bound to the East Coast of the U.S., and shipments originating in the highly contestable parts of the hinterland appear to prefer the private port. The current infrastructural arrangement dominated by the Indian railways is still highly advantageous for the state-owned ports. The large size of the country and relatively long transit time on the inland transportation system would also mean more localized container transportation to the nearest regional ports rather than shipping to the private ports situated in the western corner of the peninsula. However, the fact that the development of a major private port is significantly disrupting competition to JNPT in their common hinterland suggests that future expansion of private ports in other sections of the Coast may hold significant promise in reshaping port competition as India ventures further along the path to privatization of the transportation infrastructure and its operators and service providers.

India's private ports development generates interest, both from an academic as well as from a policy perspective. The reconfiguring spatial dynamics of inland transportation and commerce due to the changes in market brought by private competition to a landscape of near-monopoly business arrangement contributes to the literature on spatial economics as well as regional development. Insights from the model of private port selection gauges the extent of this competition and change. While the political and economic context of the hinterland in India may be different from other developing countries, the overarching regulatory environment and the resistance to privatization is shared in many developing countries. The impact of Mundra on JNPT's dominance therefore offers a review of how an increasingly supportive environment for privatization may impact commercial outcomes for the most prominent private port development in the region. Concurrent developments in privatization such as leasing or privatizing terminals and specific port services within publicly owned ports are bound to change these dynamics further and start the next phase of port competition in India as well as in other developing countries. As the private sector's involvement in the shipping business matures, modeling port selection demands more nuanced and flexible specification that allows investigating relationships with finer granularity. The multilevel modeling approach used in this article offers a readily adaptable framework for unravelling and scaling the complexities in privatization as well as studying multiple regions and ports simultaneously.

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