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Density economies and transport geography: Evidence from the container shipping industry

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ABSTRACT

By exploiting the 1995 Hanshin earthquake in western Japan as an exogenous shock to the container traffic of Northeast Asia, our study shows that economies of density in the transportation sector can influence transport geography. This earthquake caused great damage to the port of Kobe, resulting in a diversion of its container traffic to the nearby port of Busan, which increased markedly after this windfall. The strengthened economies of transport density therefore allowed Busan to expand its hinterland to regions whose container shipping operations had not even been directly affected by the earthquake, such as eastern Japan. The empirical evidence from the port choice dynamics in eastern Japan supports this mechanism. Substantial diversions of container traffic occurred after 1995 from the major ports in this region to the port of Busan. Furthermore, these unintended container shipping diversions led to a structural change in the manufacturing sector of related regions after the late 1990s.

1. Introduction

The level of unit transportation costs is endogenous to the spatial structure of the economy, because the distribution of economic activities directly affects trade flows and, therefore, unit shipping costs decrease in the presence of density economies in the transportation sector (Behrens et al., 2006). For instance, density economies arise in the container shipping industry because higher transport density allows for larger vessels to be used and the more intensive use of port facilities and related services, resulting in lower transportation costs per unit handled. Based on the estimates of Mori and Nishikimi (2002), monetary transportation costs from Japan to Manila (a non-hub port) are, on average, 22.6% higher than those from Japan to Hong Kong (a hub port), even though these routes are similar in distance.[1] Increasing returns in transportation provide an incentive for collective cargo transport and stimulate the development of trunk routes, leading to the endogenous formation of trunk links and hub-and-spoke transportation structures. Hence, economies of transport density could be the primary reason for industrial localization (Mori, 2012).

Nevertheless, given the ample evidence of a negative correlation between unit transportation costs and transport density, few empirical studies have examined the role of transport density in shaping transport geography, as predicted in theory. This study bridges this gap by employing a longitudinal prefecture-port level container traffic dataset of Japan and exploiting the exogenous shock of the 1995 Hanshin earthquake to Northeast Asia's container cargo flows.

The Hanshin earthquake destroyed the port of Kobe—the largest container port of Northeast Asia at the time—in western Japan. Consequently, Kobe's container traffic was largely diverted to Busan, a nearby major port, reintegrating the container transportation market of Northeast Asia. This exogenous windfall significantly increased the traffic flow in Busan, strengthening density economies in its transportation industry. The costs of transporting cargoes through Busan were therefore expected to decrease, allowing it to expand outward hinterland even to regions not directly affected by the disaster, such as eastern Japan, which are close to Busan but previously were not its hinterland market.

We test the aforementioned mechanism by examining the dynamics of shippers' port choice behaviors in eastern Japan. This region was historically the hinterland of the Keihin port area, the largest container carrier in eastern Japan, which covered more than 80% of the container freight volume before the earthquake.[2] However, the situation was

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[1] This also applies to time costs. For example, the port of Singapore is a large hub port linked to international trunk routes with a high frequency of ship calls, making total transportation time (including the time costs for marshaling, loading, and unloading) to Japan only half that from Jakarta, albeit with similar distances to Japan (Shipping Gazette, 1997). Similar evidence was found by Braeutigam et al. (1982),Caves et al. (1984), Brueckner et al. (1992), and Xu et al. (1994) for various transportation modes.

[2] The "Keihin port area" refers to the ports of Tokyo and Yokohama, which are around 30 km apart. Similarly, the "Hanshin port area" stands for the ports of Kobe and Osaka.

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subverted shortly after the earthquake, as port choice behaviors began to differ among the prefectures in eastern Japan. After 1995, Keihin's market share fell dramatically in prefectures relatively far from it (assumed to be Keihin's less stable hinterland), whereas those in the vicinity of the Keihin port area (assumed to be its stable hinterland market) followed their previous port choice strategies. Keihin's reduced market share in related prefectures was diverted to the port of Busan because of its strengthened density economies. These findings are validated by using a difference-in-difference (DID) estimation strategy comparing the prefectures far from the Keihin port area to those near Keihin, before and after 1995, and by eliminating interference from a variety of endogenous factors.

We then analyze the impact of container traffic diversions on the relocation of economic activities. The empirical evidence, although still preliminary, shows that prefectures diverting their container cargoes to the port of Busan expanded their container trade tonnage volumes, whereas trade values (the values of manufacturing input and output as proxies) were essentially unchanged compared with the control prefectures after the late 1990s. We interpret these results as more efficient shipping systems (through the expanded port of Busan) shifting the economic activity in related regions toward the production of heavy goods (i.e., low value per unit weight). This is consistent with the results of Duranton et al. (2014), who find that cities in the United States with dense highways specialize in sectors producing heavy goods.

This study contributes to two strands of the literature. First, to the best of our knowledge, this is the first study to provide empirical evidence that density economies in the transportation sector can influence transport (or economic) geography, which is consistent with existing theoretical studies such as Behrens et al. (2006) and Mori (2012). Second, our analysis adds to the literature on the evidence of multiple equilibria in economic locations, such as Davis and Weinstein (2001, 2008), Bosker et al. (2007), and Redding et al. (2011), which has hitherto been far from conclusive.

In the existing literature on multiple equilibria, Redding et al. (2011) is most relevant to this study. They examine the development of German airports before and after Germany's division following World War II and identify the shift of the air hub from Berlin to Frankfurt as the presence of multiple equilibria in industry location. Our study differs from the work of Redding et al. in two respects. First, we use port-prefecture level container traffic data, whereas they rely on aggregate airport level traffic variations; one important advantage of our disaggregated data approach is that it allows us to identify the source and heterogeneity of transport traffic changes and exploit the underlying mechanism. Second, we study related issues from a cross-country perspective instead of a closed-economy one: since the leading hubs for container shipping, as well as air transportation, are generally positioned globally, restricting the related analysis to a closed-economy perspective may lead to a one-sided analysis.

The remainder of this paper is organized as follows. Section 2 presents background information on the containerized shipping process and port hierarchy in Northeast Asia. Sections 3 and 4 present the empirical strategy and evidence, respectively. Section 5 concludes.

2. Background

2.1. Typical container shipping process

Container cargo has become the major form of international maritime shipping since the 1970s.[3] Container shipping, as a transportation mode serving the interregional (intercontinental) carriage of freight, is operated under managed hub-and-spoke networks, which are subject to fixed time schedules, routes, and ship calls. Briefly, the typical process of container shipping consists of two parts: transportation in trunk and transportation in feeder routes.

The purpose of operating trunk route transport is to connect major international ports. Container ships navigating a specific trunk route call only at designated major ports for loading and unloading, but not at small-scale regional ports.[4] Regional ports are usually not directly accessible for long-haul international destinations without transshipments to major ports because they do not have sufficient cargoes to be connected by a long-haul route. As a complement, feeder routes are maintained for the carriage of freight between a major port and its nearby small-scale regional ports, setting up a "bridge" for cargo shipments between regional ports and international destinations.[5] This transport structure is essentially similar to that of passenger airlines. Owing to the frequent switching of container freight in trunk and feeder routes under hub-and-spoke networks, transshipment cargo has become an important component of the freight volume in major ports. For example, in 2009, 45% of the container freight volume at the port of Busan was transshipment cargoes (Busan Port Authority, 2011).

For container shippers close to a regional port (and far from a major port), port choices for transshipment are mainly determined by the minimization of "generalized" transportation costs including overland transportation costs and time costs in the feeder routes. In general, the nearby major ports, which are easy to reach and result in relatively low costs in feeder services, are favored. In the context of multiple nearby major ports, the largest one is preferred because it has the highest transport density and, usually, the lowest generalized transportation costs. For shippers, there is no operational difference between domestic and foreign ports to transship their cargoes if accessibilities are similar, because a container ship can freely land and make ship calls in any country based on the "Principle of the Freedom of Shipping," which differs from air transportation.

Therefore, in addition to the port infrastructure and facilities (e.g., berth length and water depth), the availability and capacity of container ships such as ship size, number of trunk/feeder routes, and average frequency of ship calls also influence the capacity of a container port.

2.2. Hanshin earthquake and the Northeast Asian port hierarchy

As Japan is a typical island country, its international trade is highly dependent on maritime transportation. In 2003, more than 99% of its international trade cargoes (in tons) were freighted by maritime transportation (Japan Association for Logistics and Transport, 2005).[6] Among the dozens of seaports in Japan, Kobe was historically the largest one and was its first container port in 1967. During the late 1970s and 1980s, with the generalization of scale economies on

[3] For instance, in 2013, 95% of Japan's maritime exports (in tons) were in the form of container cargoes; for imports, this figure was 99% (Japan Association for Logistics and Transport, 2015). In South Korea in 2010, 90% of the throughput (in tons) at Busan port (the largest port of the country) was handled by containers (Busan Port Authority, 2011).

[4] Trunk routes are operated by only a small number of large shipping companies (12 major shipping companies in 2017), or mainly by three shipping alliances. For example, CMA-CGM and COSCO—two leading container shipping companies, and members of the "Ocean Alliance"—jointly operate a trunk route between East Asia and North America. The ships on this route set sail from Shanghai port, call at the ports of Ningbo and Busan, and finally reach the eastbound Los Angeles port. Subsequently, they return to Shanghai directly (without any stops) because of the limited transportation demands on westbound routes. The voyage is completed in 35 days (Ocean Commerce Ltd., 2017).

[5] For instance, a regional port in Japan may have feeder routes (or short-haul liner services) to the ports of Kobe, Tokyo, or Busan. It is less likely that a Japanese regional port operates a feeder route to the ports of Kaohsiung, Singapore, or Hong Kong, because these are relatively far from Japan and inaccessible for most small-scale regional ports of Japan.

[6] Unlike the international transportation, Japan's domestic freight traffic, especially short-haul transportation, is mainly dominated by road transportation. In 2003, maritime transport accounted for 35.8% of transportation distances of 300–500 km, 37.4% of distances of 500–750 km, and 55.9% of distances of 750–1,000 km; for distances of 100–300 km and less than 100 km, it accounted for only 18.0% and 3.0%, respectively (in tons; Japan Association for Logistics and Transport, 2005).