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Directional imbalance in transport prices and economic geography

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ABSTRACT

This paper examines how and why transport prices become imbalanced with respect to the direction of shipments and how this affects economic geography. It is shown that the equilibrium transport price of the shipment in a particular direction is a nondecreasing function of the relative size of the embarkation region. Furthermore, we show that the directional imbalance in transport prices increases the likelihood of the symmetric pattern being stable and decreases the likelihood of the core-periphery patterns being sustainable. In short, the imbalance acts as a dispersion force.

1. Introduction

It is often observed that transport costs depend on the direction of the shipments. Many of us, for instance, know that a flight from the East Coast to the West Coast of the US can cost more/less (depending on various factors) than the flight from the West Coast to the East Coast. To give another example, the report on the freight rates in three major liner trade routes by UNCTAD (2008) indicates marked differences between pairwise direction of shipments (see Table 1). In addition, Cariou and Wolff (2006) compute the freight rates of maritime transport between Europe and the Far East taking account of the bunker adjustment factor (BAF), and show that the rates exhibit a significant directional imbalance during the period 2000–2004: the rate for westbound cargo is almost always two to three times that for eastbound cargo. Finally, Jonkeren et al. (2008) report that the freight rates for trips originating from Rotterdam are 32% higher than those arriving there during the period 2003–2007.

One of the most important reasons for this directional imbalance is the difference in the trade volumes in each direction. Jonkeren et al. (2008), using the data on inland waterways in northwest Europe, find that the freight rates of the shipments in a particular direction positively depend on the total amount of shipments in that direction. In a standard textbook, this is explained as follows (see, for example, Boyer, 1997; Stopford, 2009). Consider the situation in which the demand for transport services in one direction is larger than that in the opposite direction. The shipment in the former direction is sometimes called a "front-haul" and that in the latter direction, a "back-haul." Thus, the demand curve for the front-haul lies above that for the back-haul. An equilibrium is realized when the sum of the demand price (marginal evaluation) of the front-haul and that of the back-haul at a particular number of round trips equals the cost per round trip. In other words, the equilibrium is reached at the point where the curve derived by adding the two demand curves vertically cuts the curve representing the cost per round trip. The total cost of a round trip is then divided between the front-haul and the back-haul according to the demand prices. Therefore, the front-haul is inherently more expensive than the back-haul at the equilibrium. Note that it is the cost *per round trip* but not the cost of each one-way trip that matters in this explanation. This is because transport firms or "carriers" produce transport services (shipments) in two directions *jointly*. The main reason for this is that

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Table 1
Freight rates (market averages) per TEU in three major liner trade routes. ($ per TEU). *Source*: UNCTAD (2008).

	Transpacific		Europe–Asia		Transatlantic	
	Asia–USA	USA–Asia	Europe–Asia	Asia–Europe	US–Europe	Europe–USA
2006						
First quarter	1836	815	793	1454	995	1829
Second quarter	1753	828	804	1408	1010	1829
Third quarter	1715	839	806	1494	1041	1854
Fourth quarter	1671	777	792	1545	1066	1762
2007						
First quarter	1643	737	755	1549	1032	1692
Second quarter	1675	765	744	1658	1067	1653
Third quarter	1707	780	777	1952	1115	1725
Fourth quarter	1707	794	905	2054	1147	1766
2008						
First quarter	1725	861	968	2021	1193	1700
Second quarter	1837	999	1061	1899	1326	1652

they usually face a physical constraint in that transport equipment such as cargo ships, freight cars, and cargo trucks eventually return to their home port; this constraint is referred to as a *return constraint*.

This intuitive explanation, though quite helpful to grasp the nature of the matter, has several limitations. For one thing, it lacks an analysis of the underlying behaviors of individual carriers. What decisions they make is not self-evident, however, because their problem involves joint production with a return constraint. More importantly, this explanation implicitly assumes that the demand for transport services in a particular direction is independent of the price of the services in the opposite direction. This is not true in reality. A change in the price of transport services in one direction affects the demand behaviors of consumers in the destination through a change in the delivered prices of goods, which in turn gives impacts on wage rates not only in the destination but also in the region of embarkation. This further changes regional incomes as well as price indices in both regions. To take into account these effects, we need to conduct a general equilibrium analysis, in which prices and quantities of transport services in each direction are determined simultaneously. Nevertheless, there have been surprisingly few attempts to discuss the determination of transport prices within a general equilibrium framework. One reason might be that researchers have long lacked a tractable general equilibrium framework that can deal with the relationship between regional trade and transport costs. However, we are now provided with a variety of so-called new economic geography models, which have been developed by a number of researchers since Krugman (1991). The first purpose of this paper is, thus, to explain from the behaviors of individual carriers, the determined levels of transport prices and why and how the transport prices are directionally imbalanced, based on a general equilibrium model of new economic geography.

The study of the determination of transport prices, especially when the possibility of directional imbalance is taken into consideration, is a matter of great significance in its own right. However, there is another reason why this is important: the locations of economic activities are affected by transport prices. In particular, one would expect that the demand for transport services from a "core," a bigger region, to a "periphery," a smaller one, is larger than that in the opposite direction. When transport prices are determined endogenously, the price of the services in the former direction becomes more than that in the latter direction. As a result, exports from the core become more expensive than those from the periphery at the respective places of consumption, ceteris paribus. This shelters the periphery from the imports from the core and, at the same time, gives the former region a good opportunity to penetrate the market of the core. To that extent, the force driving agglomeration weakens. On the other hand, price index tends to be higher in the periphery than in the core, which reinforces it. The second purpose of this paper is, thus, to examine such effects of a directional imbalance in transport prices upon economic geography when we take into account the fact that transport prices are endogenously determined.

For these purposes, we extend a conventional model of economic geography with two regions and two sectors to incorporate a transport sector. Carriers jointly produce transport services in two directions under the return constraint mentioned earlier. Their decision-making process is formulated as a simple game à la Bertrand. Furthermore, as in the conventional models in the literature, we characterize two types of distribution patterns—a symmetric pattern (in which a mobile factor is distributed equally in the two regions) and core-periphery patterns (in which the mobile factor is concentrated in one region)—and examine how the possibility of a directional imbalance in transport prices affects the conditions for each type of distribution patterns being supported by a stable equilibrium.

The main findings are summarized as follows. First, the equilibrium transport price of the services in a particular direction is a nondecreasing step-shaped function of the relative size of the embarkation region. More specifically, as the relative size of a region gradually increases from a very low base, the price of the services from that region to the other region first rises, then stays constant, and then rises again. A corollary of this finding is that the transport price in a "binding direction," the direction with a larger amount of shipment, is higher than that in a "slack direction," the opposite direction. Second, if the two regions are sufficiently alike in size, the amounts of inter-regional shipments in both directions are equal. Instead, if one region is significantly larger than the other, the volumes of trade get imbalanced. Third, as we allow for directional imbalance, the likelihood of the core-periphery patterns being sustainable decreases. Last, the directional imbalance in transport prices stabilizes the symmetric pattern. The last two results demonstrate that *directional imbalance acts as a dispersion force*.

For all its importance, the determination of transport costs has rarely attracted the attention of researchers in the field of new economic geography (see Fujita et al., 1999; Fujita and Thisse, 2000, 2002; Combes et al., 2008). Most studies assume an *iceberg*-type transport cost with a fixed parameter: a fixed portion of products "melts" away in the course of shipping. Further, the transport sector is usually abstracted away and the fact that transport costs are determined by the decision making of transport firms is simply disregarded. Given the above, there are several attempts that tackle the problem of endogenous determination of transport costs. First, some researchers study the impact of transport density