Journal of Transport Geography 34 (2014) 142–150

Contents lists available at ScienceDirect

Journal of Transport Geography

journal homepage: www.elsevier.com/locate/jtrangeo

Exploring causality in trade and air passenger travel relationships: the case of Asia-Pacific, 1980–2010

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ARTICLE INFO

Keywords:
Granger causality
Asia-Pacific
Trade
Air passenger travel

ABSTRACT

This paper explores the potential of heterogeneous Granger analysis in transport geography research by applying this method to a specific case of the often complex and potentially reciprocal linkages between the deployment of transport infrastructures and spatial economic development: the linkages between rising intra-regional volumes of trade and air passenger traffic in Asia-Pacific. Although conceptual and empirical linkages between both indicators can be assumed based on previous research, relatively little is known about the actual causality. Using heterogeneous Time Series Cross Section Granger causality analysis for the period 1980–2010, we explore the presence of four 'causality scenarios' amongst different country-pairs: (1) there is no co-evolution, implying that both patterns develop independently (e.g. Japan–Australia); (2) there is 'real' co-evolution in that both patterns influence each other through feedback loops (e.g. South Korea–Philippines); (3) air passenger traffic is facilitated by trade (e.g., South Korea–Philippines); or (4) trade is facilitated by air passenger traffic (e.g. Australia–Malaysia). Some tentative interpretations of this heterogeneity are offered.

1. Introduction

One of the core research areas in transport geography concerns the conceptual and empirical linkages between the deployment of transport infrastructures and services, and spatial economic development (e.g. Banister and Berechman, 2001). As Meijers et al. (2012) point out, these linkages have been debated ever since the first roads, railways and canals were built (e.g. Jefferson, 1928; Mitchell, 1964; Mohring and Harwitz, 1962; Dodgson, 1974; Chandra and Thompson, 2000), and this research field has remained vibrant in the face of the deployment of more recent infrastructures and services such as high-speed railway and airline networks (e.g. Bowen, 2000; Kasarda and Green, 2005; Levinson, 2012). It seems fair to state that the dominant focus in this literature has been on the analysis of the *generative economic effects of infrastructure developments*, e.g. estimating employment growth after the creation of a railway link as in Hensher et al. (2012).

Overall, this literature clearly demonstrates that the impact of the deployment of transport infrastructures and the introduction of new transport services on spatial economic development is complex to say the least. This is because generative effects depend on numerous contextual and intervening factors (e.g. Button, 1998; Brueckner, 2003; Ishutkina and Hansman, 2009), but also more implicitly because some distributive effects may remain hidden (e.g. Meijers et al., 2012). An additional problem is that in analyses of the effects of transport infrastructures and services, spatial economic development – however conceived – is an endogenous variable, i.e. it is an influence upon the distribution and operation of transport infrastructures and services in its own right. This effect can especially be seen in cases where transport investments can be realized relatively quickly and efficiently, such as the creation of an extra air passenger connection between cities. Here the new connection can be both *cause and outcome* of spatial economic developments. Or, as O'Connor and Scott (1992, p. 251) noticed in an analysis of the evolution of airline services between metropolitan areas in the Asia-Pacific region between 1970 and 1990: the relationships between economic development and airline connectivity are "circular and cumulative" (see also Shin and Timberlake, 2000; Doganis, 2010). The implication, then, is that it can be assumed that the linkages between spatial economic development and the deployment of transport infrastructure and services work in two directions, reflecting a two-way relation that takes the form of co-evolution through feedback loops (see Ishutkina and Hansman, 2009).

Although regression-type analyses of the generative effects of transport infrastructures and services on economic developments are able to tackle this endogeneity problem, the more fundamental question of the dominant causality is not addressed in such

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http://dx.doi.org/10.1016/j.jtrangeo.2013.12.001

analyses as the focus remains on how transport influences the economy. The purpose of this paper is to develop and test a possible empirical verification of the premise of co-evolution through feedback loops. In particular, we aim to show that recent advances in Granger causality analysis are particularly suited to analyze the linkages between the deployment of transport infrastructures and services on the one hand, and spatial economic development on the other hand. Originally presented in 1969, Granger causality analysis has developed into a broader suite of techniques that now for example allow analyzing data that have both temporal *and* heterogeneous spatial components. The inclusion of spatial heterogeneity in the framework allows assessing regional variation of cause/effect relations in a single framework, and is therefore of special interest to geographers and regional scientists. Using the general observation of O'Connor and Scott (1992) as our starting point, in this paper we apply this altered Granger framework to assess the causality in the evolving geographies of air passenger transport and trade connections. Our empirical focus is on the developments in Asia-Pacific between 1980 and 2010, a period in which the region experienced rapid growth in both trade and air transport connections, fueled by rapid but uneven economic liberalization and deregulation.

Previous research on the trade/air passenger transport-nexus suggests that different forms of interrelations may indeed be expected. The impact of air travel on trade can be explained based on the de facto importance of face-to-face contact in trade negotiations as discussed by Leamer and Storper (2001). These arguments are part of a much wider literature showing how declining communication costs and growing communication opportunities impact international trade and operations (see Fink et al., 2002; Orozco-Pereira and Derudder, 2010). In the case of air travel, it can be argued that as trade has boomed and become more complex as it began to incorporate the movement of components along global production networks, the co-ordination tasks grew, and strengthened the need for face-to-face contact (Storper and Venables, 2004). Thus better and more air services can be expected to help overcoming the difficulties of coordinating and running increasingly complex production networks, which is consistent with Poole's (2013, p. 24) observation that business air travel "helps to overcome informational asymmetries in international trade, generating international sales in the form of new export relationships". Similarly, in their article on the business travel patterns of professionals in the Irish ICT-cluster, Wickham and Vecchi (2008) state that air travel enables firms to build up trust relations with distant customers and suppliers. The effect of travel on trade may vary, however, as the effect "is stronger for differentiated products and for higher-skilled travelers, reflecting the information-intensive nature of differentiated products and that higher-skilled travelers are better able to transfer information about trading opportunities" (Poole, 2013, p. 24).

Meanwhile, growing volumes of trade and the associated rise in deal-making, follow-up, etc. may in turn lead to heightened demand for air travel (see Ishutkina and Hansman, 2009). Cristea (2011), for instance, finds robust evidence that the demand for air travel is directly related to the export of US states: an increase in the volume of exports has been shown to raise the local demand for business air travel. Simultaneously, she shows that close communication between trade partners, via face-to-face-interactions, is essential for successful trade transactions, because these meetings have the potential to both improve the transaction and add value to the exported products. Furthermore, Frankel (1997, p. 45) stresses the importance of the reciprocal relationship between travel and exports in the high-tech capital goods sector: "to begin sales in a foreign country may involve many trips by engineers, marketing people, higher ranking executives to clinch a deal", but at the same time it may involve the movement of "technical support staff to help install the equipment or to service it when it malfunctions", implying export can also precede additional travel. Again, this proves that the strength of the relationship may depend on the nature of the products involved, with for instance high-end services being particularly travel-intensive (Van De Vijver et al., 2013; Bel and Fageda, 2008). In addition, it is clear that the impact of trade on travel is complicated by the fact that, especially compared to air freight connections, trade-related air travel is but one of the many motivations for air travel, alongside tourism, visiting friends and relatives, and non-trade related business travel (Kulendran and Wilson, 2000).

This brief literature review suggests that the relationship between trade and air services may be complex and varied. These potentially wide-ranging relationships between trade and air travel services can be summarized in four possible 'causality scenarios': (1) trade and air passenger geographies develop independently, i.e. both geographies chiefly develop according to different rationales and processes (e.g. air travel being only of secondary importance for trade and/or primarily being driven by other motivations); (2) there is 'real' co-evolution in that both patterns influence each other through feedback loops; (3) air passenger traffic is facilitated by trade, but does not facilitate trade; and (4) trade is facilitated by air passenger traffic, but does not facilitate air passenger traffic. Using a Granger framework, these four scenarios will be statistically tested for the Asia-Pacific region as a whole as well as for individual country-pairs within the region. Our chief purpose is hereby to methodologically address and indicate the heterogeneous relationships that can occur between trade and air passenger travel, i.e. no comprehensive analysis of the development of the air transport and trade geographies in this the region is intended.

The remainder of this paper is organized as follows. The next section describes the previous use of Granger causality analysis in air transport-related studies, and uses this discussion to advance the case for using a version that allows for (spatial) heterogeneity. The third section describes our empirical framework: we review why Asia-Pacific is a good test case, discuss our data, and the preparatory steps towards Granger causality testing. The detailed procedure, the results of the analysis, and some interpretations are discussed in the fourth section, after which the paper is concluded with an overview of the main implications and potential avenues for further research.

2. Spatially heterogeneous Granger causality analysis

Granger causality tests are the most widely used methods for empirically examining causal relationships between variables. 'Causality' is, of course, an elusive concept, and Granger analysis basically adds to our empirical understanding by providing a statistical indication of the *precedence* of change in one variable to change in another variable. Put differently: Granger testing is a statistical technique that can help with the uncovering of causality through a systematic appraisal of the chronological order in which change unfolds. In the remainder of this paper, we therefore use 'cause'/'causality' as a narrowed-down shorthand for situations where taking into account past values of X leads to better predictions of Y than merely taking into account past values of Y. The observation that past changes in X help forecasting the evolution of Y is therefore taken as a statistical sign that change in X 'causes' change in Y, which can be expressed as:

$$y_t = a + \sum_{k=1}^{p} \gamma_k y_{t-k} + \sum_{k=1}^{p} \beta_k x_{t-k} + u_t \quad (1)$$

where a represents fixed effects; γ_k and β_k are autoregressive and regression coefficients, respectively; y_{t-k} and x_{t-k} are lagged values