Port infrastructures and trade: Empirical evidence from Brazil☆

Anna Bottasso[a], Maurizio Conti[a,b], Paulo Costacurta de Sa Porto[c], Claudio Ferrari[a,*], Alessio Tei[d]

[a] Department of Economics and Business Studies, University of Genova, Italy
[b] European Commission, Joint Research Centre (JRC), Ispra, Italy
[c] Universidade Federal de Sao Paulo, Brazil
[d] School of Engineering, Newcastle University, UK

A B S T R A C T

In this study, we analyse the impact of port infrastructure on trade by estimating a gravity equation for exports (imports) of Brazilian states towards (from) all main Brazil's trading partners. In particular, we consider exports (imports) of the 27 Brazilian states towards (from) 30 of Brazil's most important trading partners over the period 2009–2012. By estimating a set of gravity equations with the Poisson pseudo-maximum likelihood estimator, we find that an increase in port infrastructure (as proxied by the piers extension in each Brazilian state normalized by that state's area) is associated to large increases in Brazilian exports, while the impact on imports is more mixed and generally lower. Our results are robust to controlling for a series of state and country fixed effects.

1. Introduction

The relation among transport endowment, efficient transport/logistics services and trade is well documented by a number of policy (e.g. Arvis et al., 2012) and scientific (e.g. Limao and Venables, 2001) papers. Several scholars (e.g. Vickerman, 1995; Camagni and Capello, 2013) and international institutions (e.g. World Bank [e.g. Arvis et al., 2012], European Union [e.g. Purwanto, 2010], OECD [e.g. Merk, 2012]) have discussed the potential benefits of an improved infrastructure network and its capability of fostering both regional competitiveness and economic development. Within this framework, it is relevant to highlight the link among the transport infrastructure endowment, the level of regional connectivity, and the international freight flows (e.g. Li and Qi, 2016). Transport network investments aimed at improving connectivity with international markets is an important issue within the debate on expansive policy interventions, especially for those countries whose economic growth is heavily linked to international trade, such as the Latin America and the Caribbean (e.g. Wilmsmeier and Hoffmann, 2008; Calatayud et al., 2017).

Different transport systems – and related infrastructure – affect regional competitiveness and trade openness in a number of ways, as shown by the results of those studies analyzing the role of air transport connectivity (e.g. Graham, 1998), land modal solutions (e.g. Handy, 2005; Coşar and Demir, 2016) and maritime transports (e.g. Wilmsmeier et al., 2006). Moreover, logistics plays an essential role in linking together different transport networks and favoring international production chains (e.g. Bensassi et al., 2015; World Bank, 2012; Hesse and Rodrigue, 2006).

Within this framework, it is important to stress that over 80% of international trade involves maritime services (Unctad, 2016), giving to port infrastructure a crucial role to improve international connectivity and propensity to international trade for a given

---

region (e.g. Guerrero et al., 2016; Ducruet and Notteboom, 2012; Ducruet and Itoh, 2016). Moreover, as also underlined by Rodrigue et al. (2016), transport systems are normally represented by networks in which nodal infrastructure (such as ports) plays a key role, by promoting accessibility and fostering local competitiveness for the hosting regions.

Indeed the relationship between transport infrastructure and international trade has been increasingly investigated by the economic literature. The importance of transport endowment for international openness is well documented for all the main transport modes (e.g. Moreno and Lopez-Bazo, 2007; Arbués et al., 2015), with maritime networks playing a major role in fostering international trade (e.g. Martínez-Zarzoso et al. 2003 In particular, a positive influence of sea access on regional export performance, has been highlighted by some studies (e.g. Cizkowicz et al., 2013; Matthee and Naudé, 2008); moreover, spillover effects stemming from maritime regions to landlocked ones are found to favor the exporting activity (e.g. Marquez-Ramos, 2016).

Most studies focus on the effects of port infrastructure, or port related transport systems, on the regional economy (e.g. Hall, 2009; Ng and Gujar, 2009; Bottasso et al., 2013, 2014; Song and van Geenhuizen, 2014; Wang et al., 2017), but only few of them (e.g. Portugal Perez and Wilson, 2012; Celbis et al., 2014; Olarreaga, 2016) try to assess the link between international trade and maritime infrastructure endowment. Hence, it seems that this issue is still under-investigated, despite evidence in favor of this relation is supported at both theoretical and empirical level.

A related issue that has been receiving increasing attention in recent years is the link between transport costs and trade: for instance, Clark et al. (2004) show that port efficiency is an important determinant of shipping costs and that port efficiency differentials can be explained by excessive regulation, the prevalence of organized crime and the country's overall infrastructure endowment. In turn, Haddad et al. (2010) apply a spatial, interregional CGE model to simulate the impacts of increases in port efficiency in Brazil. They evaluate three different scenarios and conclude that in all cases improvements in port efficiency lead to a faster growth, more competitiveness and more openness of the Brazilian economy. Similarly, Tiller and Thill (2017) apply a Trade Impedance Quotient to better evaluate if transport costs are acting as trade barriers in South America, potentially limiting benefits of trade on the related regions. Interestingly, Cassey (2011) focuses on USA exports data observed in 2003 and shows the importance of analyzing the link between the geographical characteristics, as affected by the transport system, and international trade; the author suggests that such analysis provides further insights with respect to the study of transport costs.

The current paper contribute to this literature since we analyse the impact of port infrastructure on trade by estimating a gravity equation with Poisson quasi-maximum likelihood techniques for exports (imports) of Brazilian states towards (from) all main Brazil's trading partners. In particular, we consider exports (imports) of the 27 Brazilian states towards (from) 30 of Brazil's most important trading partners over the period 2009–2012 and we quantify the impact of port infrastructure endowment on the international trade and its distribution over different Brazilian regions.

In terms of econometric identification strategy, we follow the most recent econometric practice to deal with endogeneity and simultaneity concerns in the estimation of gravity equations by including a full set of trading partners fixed effects, which control for any unobserved time-invariant heterogeneity at the level of any possible combination between a Brazilian state and a foreign country. Moreover, in the most extended model specifications we also control for a full set of foreign countries-by-year and Brazilian regions-by-year fixed effects, which in turn control for unobserved time-varying shocks at the level of each foreign country and each Brazilian region (which are the aggregate of various Brazilian states), respectively. In other words, the inclusion of trading partners as well as Brazilian regions-by-year fixed effects, allows us to identify the effects of Brazilian port infrastructure on Brazilian trade by exploiting only port infrastructure variation over time across Brazilian states within a Brazilian region, thereby controlling for the various unobserved determinants of trade and port infrastructure developments in the most possible granular way, given our data. This is a significant improvement in terms of econometric strategy with respect to the previous studies that have attempted to estimate the effect of port infrastructures on trade.

The choice of Brazil is mainly related to its peculiar economic structure and its presence on foreign markets: as underlined by Boehe et al. (2016), Brazilian exports strongly affect local company performance and regional growth. Moreover, the role played by Brazil in the WTO seems to reveal the government's desire to foster Brazilian international visibility (Hopewell, 2015). Despite this, transport policies (e.g. Nuñez and Önal, 2016) and related investment (e.g. Garcia-Escribano et al., 2015) are not always consistent with the objectives of the government and several bottlenecks have been registered in the transport network, with many critical issues related to port activities and freight distribution (e.g. Barros et al., 2015; Galvão et al., 2017). Given the abovementioned scenario, investigating the link between trade and transport infrastructure (mainly ports) in Brazil assumes particular policy relevance.

The paper is organized as follows: Section 2 will focus on the Brazilian framework and on the data used in our analysis. Section 3 is dedicated to the methodology and the description of the econometric strategy. Section 4 discusses empirical results while Section 5 addresses conclusive remarks and focus on policy implications of our analysis.

2. Data and institutional setting

During the last decade Brazil has been one of the fastest growing markets and the biggest South American economy: real economic growth averaged more than 3.7% above the continental value and only in the last couple of years registered a reduction (IMF – International Monetary Fund, 2017). Similarly, GDP in purchase power parity pro-capita has registered an almost constant growth in the last 15 years – with only few years of negative records – and an average value of more than 3%. Most of Brazilian economy is now connected to international trade, being one of the leading export countries for many raw materials as well as finished products. Brazil is one of the two main world suppliers of iron ore and coal and also one of the top leading countries in export of other primary sector outcomes, being the third exporter of agricultural products as well as the first chemical industry producer of the southern hemisphere (OECD, 2016). According to IMF statistics (2017), the value of exported goods has increased 8 times in the last thirty years, with