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The effect of port activity on urban employment: An analysis for the Spanish functional urban areas

Soraya Hidalgo-Gallego *, Ramón Núñez-Sánchez

Departamento de Economía, Universidad de Cantabria (Spain), Avda. Los Castros, s/n., 39005 Santander, Spain

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ABSTRACT

This study aims to evaluate the impact of port activity on local employment in Spain. To do so, we have used a novel panel data at the functional urban areas (FUAs) level, considering cities' functional and economic extent based on daily people's movements. We have estimated a set of equations related to the port throughput-employment relationship for 2010-2020. Several estimation techniques are applied to different employment equation specifications to check the robustness of the results to the methodology employed. Additionally, three different samples have been used to assess whether the results significantly change when non-port FUAs are considered. Our results are robust to the different specifications, finding that employment elasticity to port activity ranges between 0.005 and 0.008. We find that industrial employment is more sensitive to changes in the volume of port operations than total or service employment. Finally, the analysis shows that the results significantly change when non-port FUAs are not considered in the analysis.

1. Introduction

Transport infrastructures are considered instruments to promote territorial cohesion and mitigate economic disparities, favouring regional development and convergence (Bottasso et al., 2014). However, the role of transport infrastructure in economic growth has often been debated. The main discussion is about the opportunity cost of the high investments of financial resources that building or expanding these infrastructures implies. Therefore, predicting the effects of transport infrastructure expansions is crucial to evaluate these projects accurately. These effects occur at the national, regional, and even local levels. Traditionally, the literature has focused on measuring them at the national and regional levels, but to a less extent at the local level.

In recent years, the development of new highly disaggregated data sources from a spatial point of view has promoted the analysis of the effects of transport infrastructure on local growth. Brueckner (2003) analyses the impact of the number of aircraft boarding passengers on total non-farm workers in the US metropolitan areas for 1996. Brooks et al. (2021) evaluate whether being close (<30 Km) to a containerised port impacts the growth of the US coastal counties' population, non-farm employees, wages or land prices. Shan et al. (2014) examine how port operations affect Chinese cities' annual growth rate of per capita GDP. These authors approximate port activity by cargo and container throughput measured in tons and TEUS, respectively. Sheard (2014 and 2019) studies how airport activity measured by the number of departing flights affects the number of employees in the US Core Based Statistical Areas[1] (CBSAs). Similarly, McGraw (2020) analyses how the existence of an airport affects the growth of employment and population in the US CBSAs. Green (2007) uses air transport data to predict employment and population growth in US urban areas. This author considers four measures of airport activity: boardings and passenger originations per capita, the existence of a hub airport for a primary carrier and cargo tonnage per capita. Finally, Padeiro (2013) examines the role that the existence of transport infrastructures such as motorways, railways and airports plays in the growth of the number of jobs at a municipality level in the metropolitan margins of Paris. In all these studies, a positive effect of infrastructure on the development of local economies has been found.

The main aim of this study is to evaluate the effect of port activity

* Corresponding author.
E-mail addresses: soraya.hidalgo@unican.es (S. Hidalgo-Gallego), nunezr@unican.es (R. Núñez-Sánchez).

[1] The CBSAs are defined by the US Office of Management and Budget as distinct sets of counties, where CBSA represents an urban core and the surrounding areas, which are integrated by commuting. The concept of CBSA in United States is quite similar to the Functional Urban Areas.

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proxied by a port's cargo traffic on the Spanish Functional Urban Area's[2] employment where that port[3] is located for 2010–2020. Spain seems to be a good case of study for several reasons. First, Spain is the European Union country with the longest coastline (8000 km.). Also, two archipelagos and two autonomous cities on the north of Africa are connected with the rest of the country by air or sea. Second, ports are a crucial element for Spanish international trade. Nearly 60% of exports and 85% of imports in the country pass through its ports, representing 53% of Spanish trade with the European Union and 96% with third countries (del Estado, 2022). Third, >4700 million euros were invested in the Spanish ports during the period of our analysis. Considering the previous, the port sector is considered highly relevant to Spanish development and international trade. In addition, although for the Spanish case, there is previous literature assessing the effect of port activity on Spanish economic growth at the regional level (for instance, Fageda and Gonzalez-Aregall, 2017), there are no earlier studies at the local level. Finally, regarding the spacial scope of the analysis, FUAs circumscribe the city's labour market extent, so they are better suited than other definitions of urban areas to estimate agglomeration economics. Moreover, they provide the accurate scale to face issues or carry out policies related to, for instance, infrastructure or transportation that affects the city and its surrounding commuting zone (Dijkstra et al., 2019). Therefore, it could be more appropriate to evaluate the effect of port activity on employment at the local level using the FUA spatial dimension than the city.

Methodologically, different econometric procedures and specifications have been applied to estimate the FUAs' employment equations. Additionally, these models have been reestimated for different samples, considering FUAs with port and not. We follow this procedure due to the lack of consensus about the method or sample composition in the previous literature. Thus, knowing the sensitivity of the data to the different approaches is vital to evaluate the validity of the results.

Then, the present research presents two main contributions regarding the previous literature. First, to the best of our knowledge, there are no previous studies about the relationship between port activity and local development at the spatial dimension of a FUA. Second, the results' robustness assessment has not been carried out in previous studies. However, the procedures and data choice vary from one work to another and could significantly modify the results.

Regarding the main results, it is found that port activity significantly affects the Spanish FUAs' employment. Moreover, the robustness analysis suggests that results are not sensitive to the econometric methodology but substantially change if we consider selection bias. The elasticity of local employment to port activity is about 0.1 when we consider a sample of FUAs with port facilities, decreasing to 0.005[4] for the more general sample, which contains port and non-port FUAs. These results could have important implications for port-local government coordination.

The remainder of the paper is structured as follows. Previous literature on the relationship between port activity and local economies is reviewed in Section 2. Sections 3 and 4 describe the estimation procedures and the data, respectively. In section 5, the results of the estimation are discussed. Finally, section 6 includes the concluding remarks and policy implications.

2. Literature review on ports and local/regional economies

This section reviews the empirical literature on the relationship between ports and the areas[5] where they are located. Firstly, the topic is contextualised by pointing out the benefits of ports for the area in which they are located. Secondly, we focus on the empirical studies evaluating ports' effect on economic growth and employment at the regional level. Finally, this section ends by describing some research focusing on the port activity's impact on local economies.

Ports play a vital role in transportation, international trade, tourism, and travel, being ports fundamental to connecting territories (Yoo, 2006). Due to its strategic function in the economy, a port could be considered a regional economic development[6] engine by increasing the demand for labour, wages, profits and tax revenues (Bottasso et al., 2013). Hence, port development is highly related to its regional economy (Deng et al., 2013). Regarding employment, the demand for labour produced by a port evolves with the development and operation of the port. Local service providers and workers are hired in the construction and port expansion stages. Moreover, port operation requires port operators and specific port service providers.

Further, Talley (2009) points out that a port region can benefit from port development in two ways. Firstly, the improvement of the transport system in the form of highways and rails to enhance the connectivity of the port infrastructure with regional, national and international markets. Secondly, the flows of benefits along the port's existence could drive larger economic growth within an area. Furthermore, port infrastructure could affect regional economic development in other ways as the following. On the one hand, improving transport infrastructure reduces operational costs and produces inter and intra-industry trade gains through comparative advantages, specialisation, and scale economies (Krugman, 1980). On the other hand, transport activities can originate a wide range of possible agglomeration mechanisms[7] that arise from greater integration with other companies, labour markets, product markets, and intermediate goods suppliers. These mechanisms affected the efficiency of individual companies and the organisation of economic activity in space (Lovely et al., 2017).

However, port benefits in an area could decrease if, for instance, a port uses labour and acquire intermediate goods outside this area (Talley, 2009). Additionally, containerisation and more capital-intensive processes have reduced the direct employment effect (Grobar, 2008; Musso et al., 2000) and split the positive impacts of ports on regional economies over nearby regions (Bottasso et al., 2013, 2014).

In this context, there is a growing body of empirical studies on the links between the port industry and economic growth or employment at the regional level. Some of these studies are reviewed below. First, we focus on those that evaluate the effect of ports on economic growth and, second, on those that assess this effect on employment.

In the case of China, Song and van Geenhuizen (2014) and Song and Mi (2016) analyse the links between port investment and regional economic growth. Song and van Geenhuizen (2014) evaluate the impact of port infrastructure investment on regional GDP, applying a production function approach. These authors find a positive effect of port investment on the regional economy. Based on their results, these authors recommend balancing investment to improve port efficiency more than increasing capacity. Song and Mi (2016) investigate the causality between port investment and regional economic growth. Applying the error correction model (ECM) to test the Granger causality to panel data, they find short-term bidirectional causality between port investment and economic growth. In contrast, the long-term causality from port

[2] A city and its commuting zone form a FUA. Appendix 1 explains the EU-OECD method to define a FUA spatially.

[3] The scope of our study is only focus on seaports, no considering dry ports. Therefore, the term port is only referred to seaports.

[4] This means that a 10% increase in the port traffic would lead to 1% or 0.05% increase local jobs, depending on the sample used.

[5] Considering regions or smaller territorial units. Specifically, the regional level includes regions or provinces, while the local covers more spatially disaggregated areas such as FUAs, CBSAs, conurbations or cities.

[6] The concept of economic development or development is used in this study as a general term including economic, employment or population growth.

[7] The agglomeration mechanism most commonly considered in the literature on agglomeration economies are those identified by Marshall (1920): labour market pooling, sharing inputs and knowledge spillovers.

investment to economic growth is unidirectional. These authors recommend policies that stimulate public and private investment in port facilities as instruments for regional economic growth. Also, for the Chinese case, Deng et al. (2013) analyse the effects of port supply, port demand, and value-added activity imports on regional development[8] using a structural equation modelling (SEM). Their results show that value-added activities positively impact regional development, whereas port demand and port supply do not. However, port supply indirectly impacts regional development through its positive effect on value-added imports. Therefore, according to their results, port cargo demand needs to be expanded to improve the value-added port activity and, in turn, enhance regional economies. In the European context, Bottasso et al. (2014) analyse how port operations impact GDP. Applying a spatial Durbin model to a sample of 621 European regions, these authors obtain that port throughput positively affects the regional GDP. Moreover, their results suggest that spillover effects are higher than direct effects. Therefore, the positive impact of port throughput is higher on the GDP of other regions than in the port area. These authors suggest that non-port regions should share the costs of future port infrastructure investments because they benefit from the port activity. Furthermore, they also should participate in port governance. Finally, Park and Seo (2016) assess the impact of seaports on economic growth in Korean regions. They conduct an augmented Solow model and obtain that cargo and container throughput positively affect economic growth. However, the positive impact of cargo occurs from a certain volume of cargo traffic, being negative below this threshold value. Finally, these authors find that despite port investment not presenting a significant direct effect on economic growth, it indirectly does through its influence on cargo and container flows. According to their results, port policymakers should strive to create large ports instead of having multiple small ports to boost the regions' economies.

Regarding the studies focus on the effect of port traffic on regional employment, we find Ferrari et al. (2010), Bottasso et al. (2013), Fageda and Gonzalez-Aregall (2017) or Seo and Park (2018). Firstly, Ferrari et al. (2010) investigate how ports impact Italian provinces' sectorial employment. They propose a two-stage procedure[9] to consider the selection bias produced by the location of the port infrastructure. Their main results show a positive impact of traffic variables in the employment equations, being significant only in some cases depending on the sector considered and the type of cargo. According to these authors, the impact of port activity on employment is lower than in the case, for instance, of airports because the increasing relative use of capital in port operations or the fact that containerization splits the positive effects among neighbouring regions. Secondly, Bottasso et al. (2013) evaluate the impact of port activities on European regions' employment. They estimate a set of employment equations with the GMM-System estimator of Blundell and Bond (1998). Their findings suggest that port throughput positively impacts regional employment, while the volume of passengers does not. Authors recommend governments to try to exploit the full potential of ports as instrument of regional development. Fageda and Gonzalez-Aregall (2017) explore how all transport modes (including port activity proxied by port cargo traffic) impact regional industrial employment in Spain. They apply a spatial econometric approach and find that only ports generate total positive effects on the industrial employment of Spanish regions. Their results suggest that expanding industrial activity needs to improve international connectivity, which can be achieved by fomenting port activity. Seo and Park (2018) evaluate ports' effect on the Korean regions' unemployment rates. These authors estimate static and dynamic employment equations considering potential and actual cargo and container throughput by applying a similar procedure to Ferrari et al. (2010) in the case of port potentials. They find that port activities reduce regional unemployment rates when port potentials in cargo and containers are employed, but these results are not maintained in the estimates with actual flows. Then, policymakers should take advantage of the existence of a port to achieve higher levels of employment.

To end this section, we review the empirical works that analyse the effect of port activity on economic development at the local level (city, conurbations, or urban functional areas), which are less common in the literature. On the one hand, Shan et al. (2014) study how port cargo flows affect port cities' economic growth. They employ a linear regression paned data model on data from the major port cities in China. Their analysis shows that port cargo throughput positively affects the GDP growth city where the port is located. Regarding spatial effects of port flows, these authors find that the port activity in neighbours cities has a greater impact on the host city's economic growth than the activity of the own port. Therefore, policymakers should facilitate cooperation among ports in the same region to enhance their total cargo flow, which benefits all port cities in the area. On the other hand, Brooks et al. (2021) investigate the causal effect of containerisation on the long-run population growth in the US coastal counties. They propose measuring this effect using a difference in differences approach, using the port depth pre-containerisation as an instrument to deal with the endogenous containerisation strategy of ports. Their findings suggest that counties near container ports grow more than the rest. These gains predominate in counties with low population density and manufacturing in the first years of the studied period.

3. Data

The data and variables used to estimate the effect of port activity on local employment are described in this section. This study includes 70 Spanish functional urban areas (FUAs) observed from 2010 to 2020.[10] The data set comprises functional urban areas in the peninsula and Island regions (Balearic Islands and Canary Islands). The two territories located in the North of Africa, Ceuta and Melilla, are excluded in our study as they are not considered as functional urban areas. Twenty-seven of these functional urban areas have a port located in the coastline, with the exception of Sevilla, which has the only inland maritime port in Spain. The Spanish port system formed by 46 ports of general interest managed by 27 port authorities (Fig. 1).

The starting point of the empirical specification is the following employment equation

$$Emp_j = f\left(X_f, \boldsymbol{ECV}, \boldsymbol{OC}\right) \tag{1}$$

where Emp_j denotes employment in category j (total employment, industrial employment or service employment), X_f is a variable related to the port freight f (total cargo, bulks or containerised cargo), $\boldsymbol{ECV}$ is a vector of control variables related to wage and non-wage employment determinants, and $\boldsymbol{OC}$ is a vector of other control variables related to inland transport infrastructure.

Statistical information from different sources has been merged to build the final dataset. First, data specific to functional urban areas has been collected from Eurostat and the Spanish National Statistics Institute. These entities publish a series of statistical indicators covering different domains (labour market, living conditions, among others) from

[8] These authors measured regional development through the following variables: the gross domestic product (GDP), the per capita GDP, the added value of the tertiary industry, the urban population scale, urban residents' per capita disposable income and urban workers' average annual wage income.

[9] In the first stage, they estimate a port traffic equation by a Tobit model that allows obtaining the adjusted traffic variable. This variable is used in the employment equation of the second stage, where they estimate the effect of port traffic on regional employment.

[10] There are only available data for the period 2015–2020 for 25 of the 70 functional urban areas included in the analysis. Therefore, the final unbalanced panel of data consists of 575 observations.

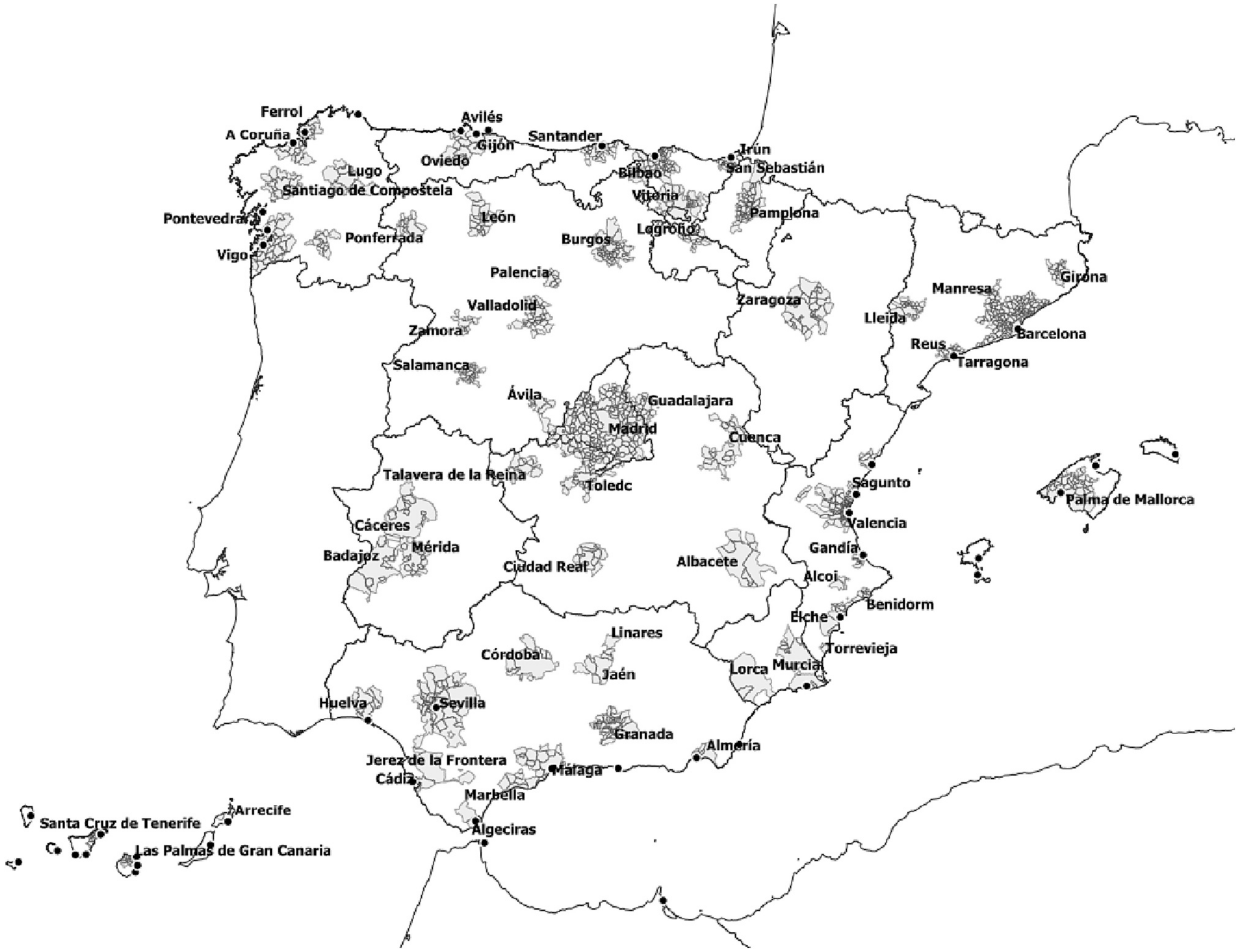

Fig. 1. Functional urban areas and ports of general interest.
Source: Own elaboration. Note: black dots represent Spanish ports while grey areas denote the functional urban areas.

2010 through the European Urban Audit project.[11] Secondly, data related to ports have been obtained from the annual reports provided by Puertos del Estado (Puertos del Estado, several years). Additional information has been obtained from the yearly publications of the Spanish Ministry of Transport, Mobility and Urban Agenda.

First, we consider different dependent variables. For the initial specifications, *total employment* is defined as the total number of employees in the FUA. Industrial and service employees have also been considered for additional specifications.[12] Second, following previous studies (Ferrari et al., 2010; Park and Seo, 2016) we propose three different categories for the port activity: (1) total cargo throughput (*cargo*), (2) liquid and solid bulk (*bulk*), and (3) containerised cargo throughput (*container*). The disaggregation of total cargo throughput allows us to test differences on impact for types of cargo on local employment.[13]

Other variables have been incorporated into the analysis as controls to reduce potential omitted variable bias by capturing other factors that may affect local employment. According to Blanchard et al. (1992), Elhorst (2003) and Seo and Park (2018), it has been included the following variables in the employment equation: population as a proxy of non-wage labour supply determinants, the number of firms proxies non-wage labour demand determinants and household income as a wage-setting factor. We include kilometres of motorways and railways[14] to control the level of inland transport infrastructure development in the region where the FUA is located.

Finally, the linear meters of port quays and the square meters of deposit area, obtained from the annual reports provided by Puertos del Estado (Puertos del Estado, several years), have been used as an instruments to deal with the potential endogeneity of the variables related to port activity. In linear models, an instrument must fulfil two

[11] In the late 1990s, the European Urban Audit project was born to collect statistical information and compare the quality of life of European cities. The compilation of the data corresponds mainly to the national statistical institutes of the member states involved in the project. The Urban Indicators publication used in this work contains a limited set of 39 indicators covering different domains, with information since 2010.

[12] Other studies that use employed people to proxy the level of employment are Ferrari et al. (2010), Bottasso et al. (2013) or Fageda and Gonzalez-Aregall (2017) for the case of provinces (NUTS-3 level in the European territorial unit classification).

[13] We distinguish between bulk traffic and containerised cargo traffic due to several reasons. For instance, the nature of captive traffic for liquid and solid bulk, but also the technical requirements needed by bulk handling activity.

[14] Statistical information about motorways and railways is available at different spatial levels. While motorways information is at the province level (NUTS-3 level in the European territorial unit classification), railways' data is available at the autonomous region level (NUTS-2).

requirements. First, it must be highly related to the endogenous variable. Second, it must be independent of the regression's error term. In our analysis, the linear meters of quays proxy the port infrastructure. On the one hand, port infrastructure and cargo volumes are highly related. On the other hand, it is assumed that the infrastructure level is not correlated to the error term of the employment equation, which means that port infrastructure affects local employment only through the volume of port activity.

Appendix 2 describes the variables and displays their main descriptive statistics.

4. Methodology

In this section we present several methodology issues of our research. Firstly, we show the empirical specification for the local employment equation. Secondly, we discuss about some econometric issues for the estimation of the empirical specification. Thirdly, we propose the estimation of a two-stage model to take into account potential endogeneity of port activities, but also to consider those inner functional urban areas that do not have seaports.

Employment eq. (1) is specified as a log-linear function, so the estimated coefficients in eq. (2) can be interpreted as elasticities. Spatial dummy variables are included to collect the existence of local disparities in employment. However, because independent variables present low variability within a given FUA, spatial disparities are collected in the model through market[15] dummies (Bottasso and Conti, 2012). Additionally, time effects are also considered. So, the final econometric specification of eq. (1) is the following:

$$lnEmp_{jit} = \beta_0 + \beta_1 lnX_{fit} + \beta_2 lnHI_{it} + \beta_3 lnFI_{it} + \beta_4 lnPOP_{it} + \sum_{c=1}^{C} \delta_c OC_{cit} + \gamma_m + \tau_t + u_{it} \tag{2}$$

where Emp_{jit} is the employment in category j in the i_{th} FUA at the t_{th} period; X_{fit} is the volume of tons of cargo *f* moved by the port located in the i_{th} FUA at the t_{th} period[16]; HI_{it}, FI_{it} and POP_{it} denote the average household income, the number of firms and the population of the i_{th} FUA at the t_{th} period, respectively; OC_{cit} presents the c_{th} control variable; finally, γ_m, τ_t and u_{it} collect the market effect, the time effect and the error disturbance, respectively.

The estimation of eq. (2) presents several econometric issues. The first one is the existence of functional urban areas in our study with no seaports. Therefore, port activity related variables for all functional urban areas, both port FUAs and non-port FUAs, are heavily skewed and have nonnormal kurtosis due to the presence of significant number of 0 values. Then, censoring is an issue. Different approaches to dealing with this issue coexist in the literature. Some authors' strategy is not to have them into account non-port urban areas. Some examples are Shan et al. (2014), Song and van Geenhuizen (2014) and Sheard (2014, 2019) for the case of airports. Other authors such as Ferrari et al. (2010) and Park and Seo (2016) consider a problem of selection bias and treat zeros by estimating the port potentials of the areas or regions applying a Tobit model. Finally, authors such as Bottasso et al. (2013) do not carry out a particular procedure to deal with zeros, but they include observations with no ports in their samples.

The second problem is related to the potential endogeneity of the port activity variables. Whereas some studies do not consider this issue or state that their models have no endogeneity, other authors use instrumental variable models. Bottasso et al. (2013) apply the Blundell and Bond (1998) GMM-SYS estimator, which jointly estimates the employment equation in levels and differences. This estimator assumes that the only available instruments are internal, but it allows including external ones (Roodman, 2009). Alternatively, Sheard (2014, 2019) applies instrumental variables techniques for the case of American airports. In Sheard (2014), the distribution of airports is instrumented by the 1944 National Airport, while Sheard (2019) calculates changes in traffic by different categories (airlines, aircrafts…) that are posteriorly used as an instrument in the employment equation estimation. Finally, McGraw (2020) evaluates the impact of airports on metropolitan areas' employment by a different approach. This author deals with areas with no airports and the potential endogeneity of airport activity by applying difference-in-difference models. However, this methodology requires long panel data covering periods before port construction, which is not available for the Spanish case.

After considering the methods applied in previous studies and the available statistical information for Spanish FUAs and ports, we assume that the methodology followed by Ferrari et al. (2010) and Park and Seo (2016), is the most appropriate because of the nature of our data. It allows for dealing with the selection bias, and the potential endogeneity of port activity and the non-port FUAs.

In the first stage, we estimate a Tobit model to obtain the predicted values of port activity, which are included in the second stage as a regressor in the employment equation. Because our port activity variables contain observations with zeros (non-port FUAs) and positive values (port FUAs), the estimation of a Tobit model is more recommendable than the estimation of Ordinary Least Squares. OLS regression is inconsistent because the censored sample does not represent the population (Cameron and Trivedi, 2010).

The port activity equation is defined as follows:

$$\ln X_{fit}^{*} = \alpha_0 + \alpha_1 \ln Q_{it} + \alpha_2 \ln S_{it} + \alpha_3 \ln HI_{it} + \alpha_4 \ln FI_{it} + \alpha_5 \ln POP_{it} + \sum_{c=1}^{C} \theta_c OC_{cit} + \rho_m + \varphi_t + \varepsilon_{it} \tag{3}$$

where X_{fit}^{*} is the volume of tons of cargo *f* moved by the port located in the i_{th} FUA at the t_{th} period; Q_{it} is the number of linear metres of quays in the port of the the i_{th} FUA at the t_{th} period if there is a port, otherwise is equal to zero; S_{it} is the number of squared meters of storage area in the port of the the i_{th} FUA at the t_{th} period if there is a port, otherwise is equal to zero; HI_{it}, FI_{it} and POP_{it} denotes the average household income, the number of firms and the population of the i_{th} FUA at the t_{th} period, respectively; OC_{cit} presents the c_{th} control variable; ρ_m and φ_t collect the market and time effect, respectively; finally, ε_{it} is the error disturbance that $\varepsilon_{it} \sim N(0, \sigma^2)$.

The observed port activity variable lnX_{fit} is related to the latent variable lnX_{fit}^{*} through the following rule:

$$\ln X_{fit} = \begin{cases} \ln X_{fit}^{*} & \text{if } \ln X_{fit}^{*} > 0 \\ 0 & \text{if } \ln X_{fit}^{*} \leq 0 \end{cases} \tag{4}$$

The censoring probability is

$$Pr\left(lnX_{fit}^{*} \leq 0\right) = \Phi\left(-\frac{1}{\sigma}\left(\alpha_0 + \alpha_1 \ln Q_{it} + \alpha_2 \ln HI_{it} + \alpha_3 \ln S_{it} + \alpha_4 \ln FI_{it} + \alpha_5 lnPOP_{it} + \sum_{c=1}^{C} \theta_c OC_{cit} + \rho_m + \varphi_{tt} + \varepsilon_{it}\right)\right) \tag{5}$$

Finally, the expected value of lnX_{fit} is

[15] Markets are identified as the Spanish regions at the NUTS 2 level. However, some neighbour small areas with few FUAs in the sample have been considered a single market. These are the cases of Cantabria and Asturias, and La Rioja, Navarra and Aragón.

[16] The lnX_{fit} has been calculated as $ln(\pm X_{fit} - k)$, choosing k and the sign of X_{fit} so that the skewness of lnX_{fit} is zero to deal with zeros when logarithms are calculated.

$$E\left(lnX_{fit}|(Q_{it},S_{it},\ HI_{it},FI_{it},POP_{it},\boldsymbol{OC}_{it}),lnX_{fit}>0\right)=\left(\alpha_0+\alpha_1\ln Q_{it}+\alpha_2 lnHI_{it}+\alpha_3 lnS_{it}+\alpha_4 lnFI_{it}+\alpha_5 lnPOP_{it}+\sum_{c=1}^{C}\theta_c OC_{cit}+\rho_m+\varphi_t\right)+\sigma\frac{\varphi\left(\frac{\left(\alpha_0+\alpha_1\ln Q_{it}+\alpha_2 lnHI_{it}+\alpha_3 lnS_{it}+\alpha_4 lnFI_{it}+\alpha_5 lnPOP_{it}+\sum_{c=1}^{C}\theta_c OC_{cit}+\rho_m+\varphi_t+\varepsilon_{it}\right)}{\sigma}\right)}{\Phi\left(\frac{-\left(\alpha_0+\alpha_1 lnQ_{it}+\alpha_2 lnHI_{it}+\alpha_3 lnS_{it}+\alpha_4 lnFI_{it}+\alpha_5 lnPOP_{it}+\sum_{c=1}^{C}\theta_c OC_{cit}+\rho_m+\varphi_t+\varepsilon_{it}\right)}{\sigma}\right)} \tag{6}$$

Where $\phi(\cdot)$ and $\Phi(\cdot)$ represent the standard normal density and the standard normal cumulative distribution functions, respectively. The expected value of lnX_{fit} differs from that obtained by applying the Ordinary Least Squares[17] estimator because of the censoring.

5. Results

This section presents the results obtained by the estimation of the traffic (3) and employment (1) equations. The section is structured into two subsections. In the first one, the estimation results are explained and discussed. Meanwhile, in section 2, a robustness analysis of the results is carried out among different specifications, methodologies, and samples.

5.1. Effects of port activity on local employment

Table 1 and Table 2 show the traffic (3) and employment (1) equations estimates, respectively. Firstly, Table 1 displays the traffic equations estimates for total cargo, bulk[18] and container cargo applying a Tobit specification (first stage). The estimation results of the Tobit specifications confirm that port infrastructure measured by the linear meter of quays and the square meters of deposit area positively affects the potential volume of port traffic in a given FUA. However, the effect of each type of port infrastructure differs depending on the kind of traffic considered. While the length of the quay impacts total cargo and bulk, container traffic is affected by the port's storage area extension. Moreover, the other variables' coefficients also differ across the three specifications in aspects such as the sign of the parameters or the level of significance. These results suggest differences between traditional port activities (cargo and bulk) and more mechanised traffic as containers (Seo and Park, 2018).

Secondly, Table 2 presents the estimations of the employment (1) equation. Nine specifications have been estimated for this equation, with differences in the estimation approach and the dependent and independent variables. Moreover, all specifications in Table 2 include time and market effects.

Before focusing on the results, the specifications considered are explained. In specification 1, the effect of port activity on local

Table 1
Estimates of port traffic equation for all FUAs in the sample.

Specification	(1)	(2)	(3)
Method	Tobit	Tobit	Tobit
Dependent variable	Cargo	Bulk	Container
Quay	1.622***	2.713***	0.901
	(0.108)	(0.339)	(0.551)
Deposit area	0.279***	−0.155	2.169***
	(0.072)	(0.216)	(0.347)
Household income	1.106	10.06***	−5.331
	(0.837)	(2.547)	(4.180)
Firms	0.0999**	0.0774	1.554***
	(0.050)	(0.149)	(0.238)
Population	−0.693***	−0.609*	−2.816***
	(0.111)	(0.344)	(0.551)
Motorways	−0.147	−1.480***	−1.701**
	(0.158)	(0.472)	(0.759)
Railways	0.543***	1.587***	0.290
	(0.194)	(0.583)	(0.938)
Passengers	−0.524***	−0.985***	2.072***
	(0.097)	(0.301)	(0.484)
Constant	−14.29*	−111.7***	37.52
	(8.639)	(26.03)	(42.36)
Time effects	Yes	Yes	Yes
Market effects	Yes	Yes	Yes
Observations	575	575	575

Standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Sample: all FUAs.

[17] The expected value of lnX_{fit} with a OLS estimator is $E\left[lnX_{fit}|(Q_{it},HI_{it},FI_{it},POP_{it},\boldsymbol{OC}_{it})\right]=\alpha_0+\alpha_1 lnQ_{it}+\alpha_2 lnHI_{it}+\alpha_4 lnFI_{it}+\alpha_5 ln POP_{it}+\sum_{c=1}^{C}\theta_c OC_{cit}+\rho_m+\varphi_t$

[18] We do not differentiate liquid and solid bulk given that according to Bottasso et al. (2013): "the potential employment effect of liquid bulk traffic is usually considered not very important because of both the reduced labour force needed to handle it and the low value produced for the region where the ports are located".

Table 2
Estimates of employment equations for all FUAs in the sample.

Specification	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Estimation method	OLS	IV	IV	TOBOLS	TOBOLS	TOBOLS	TOBOLS	TOBOLS	TOBOLS
Dependent variable	Total employment	Total employment	Total employment	Total employment	Industrial employment	Service Employment	Total employment	Total employment	Total employment
Cargo	0.008***	0.007***	0.008***	0.007***	0.016***	0.005***	-	-	0.005***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.003)	(0.001)			(0.001)
Bulk	-	-	-	-	-	-	0.005***	-	-
							(0.001)		
Container	-	-	-	-	-	-	-	0.003***	-
								(0.0005)	
Passengers	-	-	-	-	-	-	-	-	0.108***
									(0.022)
Household Income	0.703***	0.711***	0.707***	0.703***	2.256***	0.702***	0.662***	0.708***	0.658***
	(0.089)	(0.089)	(0.089)	(0.090)	(0.270)	(0.095)	(0.093)	(0.087)	(0.089)
Firms	0.935***	0.935***	0.929***	0.929***	0.773***	0.951***	0.929***	0.924***	0.925***
	(0.009)	(0.009)	(0.010)	(0.010)	(0.030)	(0.011)	(0.010)	(0.010)	(0.010)
Population	−0.003	−0.001	−0.008	−0.004	−0.100**	0.028*	−0.004	−0.003	−0.017
	(0.014)	(0.014)	(0.014)	(0.014)	(0.042)	(0.015)	(0.014)	(0.014)	(0.014)
Motorways	-	-	0.041**	0.042**	0.045	0.042*	0.049**	0.045**	0.033*
			(0.020)	(0.020)	(0.061)	(0.022)	(0.021)	(0.020)	(0.020)
Railways	-	-	−0.030	−0.034*	−0.106*	−0.017	−0.038**	−0.032*	−0.027
			(0.019)	(0.019)	(0.056)	(0.020)	(0.019)	(0.019)	(0.019)
Constant	−4.732***	−4.828***	−4.719***	−4.653***	−20.13***	−5.456***	−4.227***	−4.629***	−4.082***
	(0.901)	(0.901)	(0.932)	(0.941)	(2.821)	(0.995)	(0.975)	(0.927)	(0.929)
Time effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Market effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	575	575	575	575	575	575	575	575	575
R-squared	0.978	0.978	0.979	0.979	0.845	0.977	0.978	0.979	0.979

Standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Sample: All FUAs.

Table 3
Hausman test for endogeneity of variables related to port activity.

		All FUAs sample	Port FUAs sample	Lager port FUAs sample
Specification	Null Hyphotesis	t-statistic	t-statistic	t-statistic
Specification 2	H_0: Exogeneity of total cargo traffic	5.71**	19.61***	30.06***
Specification 3	H_0: Exogeneity of total cargo traffic	5.78***	18.99***	29.81***

Table 4
Multicollinearity test for cargo and passenger throughput variables. Variance impact factor.

	(1) OLS	(1) OLS with passengers
Variable	VIF	VIF
Passenger	–	10.24
Cargo	2.38	9.3
Household income	3.73	3.73
Population	3.6	3.67
Firm	2.2	2.33
Time effects	Yes	Yes
Market effects	Yes	Yes
Mean VIF	2.1	2.69

employment is estimated by OLS. Specification 2 and 3 are estimated by the Two-Stage Least Square estimator, using the line meters of quays as instrument. Table 3 displays the result of the Hausman test for specifications 2 and 3 to examine the possible endogeneity of total cargo. The results in Table 3 suggest that cargo throughput is endogenous. Finally, the Tobit two-stage approach is applied in specifications 4 to 9.

The basic specification of the employment equation is estimated in specifications 1 and 2. This specification only includes the port traffic and labour-related independent variables. From specification 3, the length of motorways and railways is included. In specifications 4 and 5, the dependent variables are industrial and service employment, respectively, while in the other specifications, the dependent variable is the total employment in the FUA. In specifications 7 and 8, port traffic is measured by the tons of bulk and container cargo instead of total throughput like in the other specifications. Finally, in specification 9, we include a proxy of the level of passenger traffic. Because a high correlation exists between the number of passengers and the tons of cargo moved by ports, including both variables in the same specification could lead to multicollinearity problems. Table 4 displays the values of the variance impact factor (vif) of the estimations of specification 1 without and with the number of passengers as an independent variable. Values of vif higher than 5 suggest the existence of multicollinearity among some variables in the specification. It can be seen in Table 4 that when the continuous variable of passenger traffic is removed from the specification, the multicollinearity disappears. Then, including a dummy variable is considered a solution to control passenger volume and avoid multicollinearity issues. This variable takes values equal to 1 if a port moves >100,000 passengers per year, and 0 otherwise.

Regarding the results, they show a positive the effect of port activities on FUAs' employment, as the elasticity of employment to port activity ranges between 0.005 and 0.008. Specifically, on average, increasing one million tons of cargo implies a higher number of workers in the area, fluctuating between 221 (specification 9) and 354 (specification 1) more workers. Distinguishing by sectors, we found that employment in the industrial sector is more sensitive to changes in the volume of port operations than in the service sector. This result is also achieved by Bottasso et al. (2013), who justify it by the link between more captive traffics as bulk with the secondary sector. In this line, the analysis of Ferrari et al. (2010) and ours find a slightly higher impact of traffic bulk on industrial employment than containers.

Additionally, all specifications include a set of control variables related to the labour market, such as the number of firms, the average household income, and the population density in the FUA. The

Table 5
Difference test over port activity parameters across the specifications.

Specification	1	2	3	4	5	6	7	8	9
1	–	0.146	0.089	0.402	2.045**	1.013	1.093	2.498**	1.161
2	–	–	0.233	0.245	2.119**	0.858	0.919	2.279**	1.004
3	–	–	–	0.491	1.981**	1.092	1.180	2.579***	1.239
4	–	–	–	–	2.322**	0.660	0.701	2.134**	0.814
5	–	–	–	–	–	2.623***	2.760***	3.574***	2.710***
6	–	–	–	–	–	–	0.041	1.169	0.144
7	–	–	–	–	–	–	–	1.434	0.203
8	–	–	–	–	–	–	–	–	0.985

$H_0 : \beta_{model_i} = \beta_{model_j} i, j = 1, \ldots 9; i \neq j$ Sample: All FUAs. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

parameters related to household income and firms are positive and significant in all specifications. Therefore, FUAs with higher income and more firms tend to have higher employment levels. Otherwise, population is statistically significant only in specification 6, implying that a higher population positively impacts services employment, not affecting total and industrial employment.

Specifications 3 to 9 includes the kilometres of motorway and railways in the region where the FUA is located as a control. Previous literature demonstrates that inland transport infrastructure affect regional employment and production (Bottasso et al., 2013; Seo and Park, 2018), so it could be expected to affect local too. Another reason to include the kilometres of motorways is the FUA's definition. As we previously mentioned, FUAs are geographically limited by the work commutes, being mainly made by car. However, the parameter of the motorway is only significant in specification 7, while the coefficient related to railways is just significant in specification 8. Finally, it can be seen in specification 9 that those FUAs with a port that moves higher levels of passenger traffic shows better employment levels, ceteris paribus.

5.2. Robustness analysis

Finally, in this subsection, we check the robustness of the result across different estimation approaches, specifications, and samples.

Table 5 shows the hypothesis test results about the parameters of port activity across the specifications in Table 2. The null hypothesis is that the effect of port activity on local employment is equal between specifications. It can be seen that this hypothesis cannot be rejected for all pairs of specifications except if specification 5 or specification 8 are involved. Therefore, the results obtained are robust to different specifications and estimation approaches. Still, the effect of port activity on local employment changes when industrial employment is considered, or the container traffic approximates port activity. Additionally, the impacts of control variables on industrial employment also differ regarding total or service employment or the type of traffic included as a regressor in the employment equation.

The previous specifications in Table 1 and Table 2 have been estimated for different samples to check the results' robustness across different data sets. In the tables of the Appendix 3, these estimations are presented. Tables A3.1 and A3.2 display the port traffic and employment specifications estimates for a subsample that includes only the FUAs with a port. While, in Tables A3.3 and A3.4, the sample is further restricted to the largest FUAs with port. In this line, Table 6 shows a set of contrast over port activity parameters of the same specification across the different samples of data used. It is checked that the coefficients of port activity significantly change when non-port FUAs are removed from the sample. Specifically, the impact of port activity on local employment increases in all specifications. However, there are no essential differences between the parameters of the same specification if we compare the results of port FUAs and the largest port FUAs samples.

6. Conclusions and policy implications

This study aims to evaluate the impact of the port activity on local employment in Spain using a novel panel data at the functional urban area level. This concept, promoted by the EU and the OECD, allows the international comparison of cities. It considers the functional and economic extent of cities based on daily people's movements, beyond considering density and population size only. To the best of our knowledge, this is the first study evaluating port activity's impact on employment at this geographical level. Additionally, different procedures, specifications and samples have been used to check the robustness of the results. This robustness analysis shows that results are not quite sensitive to the estimation procedure or specification. Still, the sample choice significantly affects employment elasticities' values to port operations.

Our results show robust evidence of port activities positively affecting local Spanish employment. We find that the employment elasticity to port activity ranges between 0.005 and 0.008 when the port and non-port FUAs are included in the sample. However, if only the port FUAs are considered, these elasticities increase until 0.1, 0.25 in the case of industrial employment. In terms of new jobs, on average, an increase of one million tons moved by a port generates between 221 and 354 new job positions in the FUA where the port is located.

The lower employment elasticities belong to container traffic. This result can be explained by the capital-intensive nature of container activities in contrast to more labour-intensive operations related to other types of cargo (Seo and Park, 2018). Additionally, Bottasso et al. (2013) argue that some of the benefits related to port activities can be stronger for regions far away from the city where the port is located. This fact may be reinforced by the nature of containers, specially designed for transhipment and intermodality.

Another interesting finding is the higher effect of port operations on industrial employment. We also find the lowest employment elasticity when considering service employment. According to Bottasso et al. (2013), the first result is related to the existing link between the industrial sector and bulk traffic that presents a high weight on total cargo, while the second one might be since main port-related services are

Table 6
Difference test over port activity parameters for the same specification across samples.

Specification	1	2	3	4	5	6	7	8	9
All FUAs vs Port FUAs	6.333***	6.835***	7.556***	7.988***	9.138***	6.968***	6.598***	9.114***	7.831***
All FUAs vs The Largest Port FUAs	6.732***	7.298***	7.211***	8.940***	13.133***	7.647***	5.285***	9.032***	7.877***
Port FUAs vs The Largest Port FUAs	1.228	1.699	1.402	1.979	3.212***	1.623	2.277	0.719	1.711

$H_0 : \beta_{model_i}^{sample_s} = \beta_{model_i}^{sample_r} i = 1, \ldots 9$; *s*, *r* = *all FUAs, port FUAs, bigger port FUAs*; $s \neq r$. *** p < 0.01, ** <0.05, * $p < 0.1$

outside the FUA.

After the analysis of these results, some policy implications arise. Firstly, in the Spanish port system, the board of directors of the port authority is formed by different national, regional, and local agents. Given the impact of port traffic on local employment, representatives of local entities could have incentives to promote bulk traffic instead of more added value traffic for the port authority, such us containerised traffic. Secondly, inland transport infrastructure is relevant both for port traffic, and local employment. However, the effects of motorway and railway infrastructures are different. Then, port-local government co-ordination regarding infrastructure investment is necessary.

Further research could investigate spatial spillover effects considering spatial econometric methods. Additionally, it would be interesting to evaluate how port activities impact other relevant economic magnitudes for the functional urban areas, such as economic growth, income or population. Finally, the impact of other transport infrastructure, such as airports on local employment may allow to analyse the existence of complementarities with port facilities. Then, we may propose new forms of joint transport infrastructure management implemented in some US cities, analysed in Albalate et al. (2013).

CRediT authorship contribution statement

Soraya Hidalgo-Gallego: Conceptualization, Data curation, Formal analysis, Methodology, Software, Writing – original draft, Writing – review & editing. **Ramón Núñez-Sánchez:** Data curation, Formal analysis, Methodology, Software, Writing – original draft, Writing – review & editing.

Declaration of Competing Interest

None.

Data availability

Data will be made available on request.

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Appendix 1. FUAs definition and structure

A Functional Urban Area is formed by a city, in some cases the greater city, and its commuting zone. The EU-OECD method define these spatial levels (Dijkstra et al., 2019; Eurostat, 2017). If we focus on the commuting zone, this method identifies it as follows. First, if 15% of employed people that live in a city work in another city, the first city belongs to the FUA of the second one. Second, municipalities whose at least 15% of their residents work in a city belong to that city's FUA. Third, municipalities that share 100% of their border with the FUA also are included. Fourth, municipalities non-contiguous to the FUA are excluded.

As an example of a FUA, Fig. A1 shows the different spatial levels of the FUA of Barcelona: the city, the greater city, and the commuting zone. The darkest colour corresponds to the City of Barcelona, defined as the local administrative unit (LAU from hereafter) where most of the population lives in an urban centre of at least 50,000 inhabitants. In addition, the Greater city of Barcelona is plotted in a lighter colour, which approximates the urban centre when this stretches far beyond the administrative city boundaries. Finally, the commuting zone of Barcelona is plotted in the lightest colour. Therefore, the city and the greater city of Barcelona with the commuting zone forms the FUA of Barcelona.

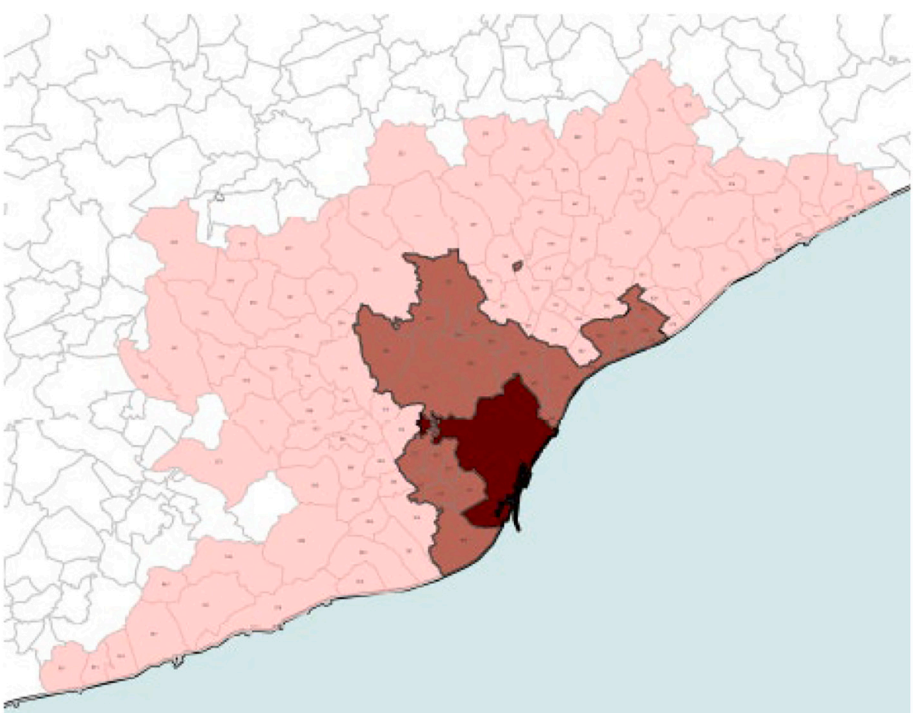

Fig. A1. Functional urban area of Barcelona.
Source: Instituto Nacional Instituto Nacional de Estadística (2022).

Appendix 2. Variables' description and descriptive statistics

Table A2.1
Non-port FUAs.

Variable	Abbreviation	Source	Units	Mean	Std. Dev.	Min	Max
Total employment	Total employment	INE	Number	209,653	586,112	18,913.23	3,862,420
Service employment	Service employment	INE	Number	170,576	495,502	13,808.55	3,303,142
Industrial employment	Industrial employment	INE	Number	20,282	42,866	979.50	287,159.1
Firms	Firms	INE	Number	25,677	77,105	2578	553,138
Household income	Household income	INE	Constant euros 2011	27,354	3893	13,992	38,219
Population density	Population density	INE	Persons/squared meter	322	254	36	1108
Motorways	Motorways	Ministry of Transport, Mobility and Urban Agenda	Km	341	154	117	783
Railways	Railways	Ministry of Transport, Mobility and Urban Agenda	Km	1440	812	1	2536

INE is the acronym for Spanish National Statistic Institute. Puertos del Estado is the public-owned entity that coordinates and controls the entire Spanish port system.

Table A2.2
Port FUAs.

Variable	Abbreviation	Source	Units	Mean	Std. Dev.	Min	Max
Total employment	Total employment	INE	Number	316,511	492,852	35,922	2,725,966
Service employment	Service employment	INE	Number	255,663	400,289	25,401	2,242,107
Industrial employment	Industrial employment	INE	Number	34,903	62,165	2311	357,485
Firms	Firms	INE	Firms	40,712	73,959	4238	422,196
Household income	Household income	INE	Constant euros 2011	27,584	3090	20,531	35,250
Population density	Population	INE	Persons/squared meter	681	377	188	1903
Motorways	Motorways	Ministry of Transport, Mobility and Urban Agenda	Km	281	159	85	726
Railways	Railways	Spanish observatory of transport and logistics	Km	902	891	1	2442
Total cargo throughput	Cargo	Puertos del Estado	Tons	1.18E+07	1.88E+07	8198	1.05E+08
Liquid and solid bulk	Bulk	Puertos del Estado	Tons	6,186,774	9,105,167	0	3.35E+07
Container cargo throughput	Container	Puertos del Estado	Tons	4,050,261	1.20E+07	0	6.43E+07
Quay	Quay	Puertos del Estado	Linear meters	8796	7198	322	28,289
Storage area	Storage area	Puertos del Estado	Squared meters	978,877	1,206,989	1445	5,309,825

INE is the acronym for Spanish National Statistic Institute. Puertos del Estado is the public-owned entity that coordinates and controls the entire Spanish port system.

Appendix 3. Estimates of port traffic and employment equations for other subsamples

Table A3.1
Estimates of port traffic equation for port FUAs subsample.

Model	(1)	(2)	(3)
Method	Tobit	Tobit	Tobit
Dependent variable	Cargo	Bulk	Container
Quay	1.548***	2.700***	0.901
	(0.116)	(0.347)	(0.551)
Deposit area	0.261***	−0.160	2.169***
	(0.073)	(0.218)	(0.347)
Household income	1.533*	10.18***	−5.331
	(0.879)	(2.628)	(4.180)
Firms	0.104**	0.0781	1.554***
	(0.050)	(0.149)	(0.238)
Population	−0.748***	−0.616*	−2.816***
	(0.116)	(0.347)	(0.551)
Motorways	−0.184	−1.492***	−1.700**
	(0.160)	(0.477)	(0.759)
Railways	0.599***	1.602***	0.290
	(0.197)	(0.589)	(0.938)
Passengers	−0.472***	−0.978***	2.072***
	(0.102)	(0.305)	(0.484)
Constant	−17.67**	−112.7***	37.52
	(8.911)	(26.63)	(42.36)
Time effects	Yes	Yes	Yes
Market effects	Yes	Yes	Yes
Observations	240	240	240

Standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Sample: Port FUAs.

Table A3.2
Estimates of employment equations for port FUAs subsample.

Model	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Method	OLS1	IV2	IV3	TOBOLS4	TOBOLS5	TOBOLS6	TOBOLS7	TOBOLS8	TOBOLS9
Dependent variable	lemp	lemp	lemp	lemp	lindemp	lseremp	lemp	lemp	lemp
Cargo	0.081***	0.100***	0.112***	0.110***	0.274***	0.100***			0.105***
	(0.010)	(0.012)	(0.013)	(0.012)	(0.025)	(0.013)			(0.0112)
Bulk							0.074***		
							(0.010)		
Container								0.049***	
								(0.004)	
Passengers									0.107***
									(0.031)
Household Income	0.527*	0.374	0.181	0.206	0.883	0.289	−0.149	0.457*	0.268
	(0.276)	(0.283)	(0.289)	(0.280)	(0.590)	(0.294)	(0.320)	(0.254)	(0.274)
Firms	0.935***	0.934***	0.908***	0.908***	0.740***	0.928***	0.908***	0.855***	0.903***
	(0.0147)	(0.0148)	(0.0159)	(0.0155)	(0.0326)	(0.0163)	(0.0162)	(0.0161)	(0.0152)
Population	0.0126	0.0298	0.0261	0.0238	0.00561	0.0479	−0.0116	0.0257	−0.0357
	(0.0354)	(0.0362)	(0.0361)	(0.0351)	(0.0738)	(0.0368)	(0.0358)	(0.0330)	(0.0382)
Motorway			0.190***	0.187***	0.259**	0.187***	0.300***	0.150***	0.163***
			(0.0491)	(0.0477)	(0.101)	(0.0501)	(0.0563)	(0.0442)	(0.0470)
Railway			−0.170***	−0.166***	0.00527	−0.224***	−0.220***	−0.0283	−0.0993
			(0.0645)	(0.0627)	(0.132)	(0.0658)	(0.0685)	(0.0572)	(0.0641)
Constant	−4.215	−3.031	−0.847	−1.060	−12.39**	−2.025	3.165	−2.683	−1.563
	(2.683)	(2.734)	(2.908)	(2.826)	(5.949)	(2.964)	(3.226)	(2.608)	(2.759)
Time effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Market effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	240	240	240	240	240	240	240	240	240
R-squared	0.970	0.970	0.971	0.973	0.892	0.972	0.971	0.976	0.974

Standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Sample: Port FUAs.

Table A3.3
Estimates of port traffic equation for the largest port FUAs subsample.

Model	(1)	(2)	(3)
Method	Tobit	Tobit	Tobit
Dependent variable	Cargo	Bulk	Container
Quay	0.979***	1.142***	1.171*
	(0.130)	(0.220)	(0.624)
Deposit area	0.435***	0.0332	2.014***
	(0.0710)	(0.120)	(0.340)
Household income	2.361**	3.854**	−8.267*
	(1.016)	(1.716)	(4.868)
Firms	−0.178***	−0.322***	1.051***
	(0.0595)	(0.100)	(0.285)
Population	−1.681***	−1.172***	−2.380***
	(0.160)	(0.270)	(0.764)
Motorways	0.590***	0.325	0.315
	(0.185)	(0.313)	(0.887)
Railways	0.226	0.315	1.031
	(0.206)	(0.347)	(0.985)
Passengers	−0.135	−0.944***	1.484***
	(0.110)	(0.186)	(0.528)
Constant	−16.33	−29.76*	52.77
	(10.24)	(17.30)	(49.06)
Time effects	Yes	Yes	Yes
Market effects	Yes	Yes	Yes
Observations	210	210	210

Standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Sample: the largest port FUAs.

Table A3.4
Estimates of employment equations for the largest port FUAs subsample.

Model	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Method	OLS1	IV2	IV3	TOBOLS4	TOBOLS5	TOBOLS6	TOBOLS7	TOBOLS8	TOBOLS9
Dependent variable	lemp	lemp	lemp	lemp	lindemp	lseremp	lemp	lemp	lemp
Cargo	0.111***	0.153***	0.157***	0.167***	0.451***	0.149***			0.156***
	(0.0142)	(0.0188)	(0.0195)	(0.0169)	(0.0300)	(0.0177)			(0.0181)

(continued on next page)

Table A3.4 (*continued*)

Model	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Method	OLS1	IV2	IV3	TOBOLS4	TOBOLS5	TOBOLS6	TOBOLS7	TOBOLS8	TOBOLS9
Dependent variable	lemp	lemp	lemp	lemp	lindemp	lseremp	lemp	lemp	lemp
Bulk							0.160***		
							(0.0284)		
Container								0.0556***	
								(0.00528)	
Passengers									0.0546
									(0.0355)
Household Income	0.610*	0.232	−0.0542	−0.147	0.860	−0.0723	−0.0333	0.813***	0.0426
	(0.341)	(0.365)	(0.378)	(0.342)	(0.608)	(0.359)	(0.432)	(0.301)	(0.362)
Firms	0.959***	0.968***	0.963***	0.967***	1.069***	0.959***	0.981***	0.870***	0.960***
	(0.0161)	(0.0167)	(0.0232)	(0.0211)	(0.0374)	(0.0221)	(0.0272)	(0.0194)	(0.0214)
Population	0.114**	0.201***	0.213***	0.237***	0.737***	0.225***	0.206**	−0.00389	0.172**
	(0.0511)	(0.0579)	(0.0663)	(0.0591)	(0.105)	(0.0620)	(0.0824)	(0.0442)	(0.0724)
Motorway			0.0333	0.0240	−0.814***	0.111	0.135*	0.0822	0.0198
			(0.0717)	(0.0653)	(0.116)	(0.0685)	(0.0726)	(0.0624)	(0.0651)
Railway			−0.218***	−0.225***	0.111	−0.277***	−0.270***	−0.199***	−0.186**
			(0.0734)	(0.0671)	(0.119)	(0.0704)	(0.0807)	(0.0650)	(0.0715)
Constant	−6.459**	−3.840	0.338	1.062	−17.49***	0.271	−0.0941	−4.828	−0.522
	(3.246)	(3.404)	(3.700)	(3.360)	(5.973)	(3.525)	(4.068)	(3.109)	(3.503)
Time effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Market effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	210	210	210	210	210	210	210	210	210
R-squared	0.966	0.965	0.966	0.972	0.927	0.970	0.963	0.973	0.972

Standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Sample: the largest port FUAs.

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