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PORTS AND LOCAL DEVELOPMENT: EVIDENCE FROM ITALY

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Abstract: The role of infrastructure as an engine of growth and development of countries and regions is now widely accepted by scholars in the field. Among the various types of transport infrastructure, ports are considered as particularly strategic because of the increasing importance of maritime transport in connecting territories. In this paper we study the impact of ports on Italian provinces. To this end, we assume that sectoral employment is a function of a series of controls and of maritime traffic. We extend this framework to take account of selection bias as well, finding that the elasticity of service sector employment to maritime traffic is about 0.02.

Keywords: Local Development, Ports, Selection bias.
JEL Classification: H54, O47, C80.

1. Introduction

The provision of transport infrastructures and their relative efficiency is a fundamental factor in stimulating economic development. In particular, port efficiency has been found to be of key importance in determining transport costs and, hence, international trade among countries (Clark *et al.*, 2004). However, the impact of port infrastructure on local economies is rather unclear. Fujita and Mori (1996) propose a model based on new economic geography assumptions and argue that the construction of a port in a relatively backward region may deteriorate local economic conditions. Following Martin and Rogers (1995), Fujita and Mori (1996) argue that local industries may be crowded out by international competition, so that economic development may be enhanced by temporarily worsening transport costs. In other words, the impact of a port on the local economy crucially depends on the initial conditions, and it is not necessarily positive.

The transport economics literature, however, has stressed that ports drive economic development because they increase competition through enlarge-

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ment of the market areas of firms, thereby reducing prices for consumers (Goss, 1990).

These benefits generated by the presence of a port spread through a hinterland which grows more extensive as the (generalized) cost of land transport diminishes; otherwise, the territorial system hosting a port is considerably smaller than its hinterland. It should be stressed that it is the local system (and not the hinterland) which furnishes the port with its inputs – labour, land and capital – and which pays the costs of port activities in terms of pollution, congestion, and opportunity costs for land use (Hoyle and Hilling, 1984).

As the increasing reduction of the cost of land transport in real terms, the creation of custom unions, development of the logistics industry, and cargo unitization have made the port production function more capital- and land-intensive, they have produced the progressive overlapping of port hinterlands together with demaritimisation, i.e. the diminishing economic importance of port functions for a port region. As suggested by Gripaios and Gripaios (1995), rent generated by ports spreads through an economic system larger than the one in which the port is embedded. Thus as ports – and their efficiency – increase their importance for economic development, their role for the economic system of which they are part decreases. In this sort of paradox lies the importance recently acquired by surveys conducted on the economic impact of ports in order to determine the direct effects, and especially the indirect ones, of port activities: in other words, the importance of shifting from a *microeconomic* point of view founded on port efficiency, which is useful for a port's users, to *macroeconomic* assessments of labour, investments and income, which are useful for the port's community.

In general, Francou *et al*. (2007) classify port impact studies into three main categories according to they focus on:

a) the variation in the aggregate cost of some port stakeholders (Hille, 1978);

b) the estimation of the economic impact of Port Authorities and port-related activities (Haezendonck *et al*., 2000);

c) the estimation of the impact of activities at point b) plus the impact on final users (Musso *et al*., 2000).

The various methodologies used to assess port impact can be grouped into three approaches:

• direct surveys based on interviews and questionnaires or microeconomic data on firms (Coppens *et al*., 2007);

• input-output models constructed in order to inter-sectoral multipliers (Warf and Cox, 1989; Castro and Millan, 1998, Censis, 1998);

• models based on productive specialization that use a mix of tools typical of applied economics, such as comparison with a control region (Rietveld, 1994) or analysis of productive specialisations (Musso *et al.*, 2000).

Most of the literature has adopted the input-output approach and more importantly, have made an attempt at classifying the impacts of a port. In particular, port impact studies distinguish between four different types of impact, which are all in standard terminology of input-output literature (Bossche, 1997; Castro-Millan, 1998; Davis, 1983; Yochum and Agarwall, 1987 and 1988):

a) direct impact;
b) indirect impact;
c) induced impact;
d) catalytic impact.

Direct impact is the employment and income generated by the direct construction and operation of the port. Indirect impact is the employment and income generated by the chain of suppliers of goods and services, and the induced impact is the employment and income generated by the spending of incomes by employees created by the direct and indirect effects. Finally, the catalytic impact is the employment and income generated by the role of the port as a driver of productivity growth and then as an attractor of new firms.

In this paper we estimate the impact of port activity on local development in terms of employment in Italian provinces, but we adopt an approach different from previous methodologies. In fact, we use a two-stage econometric procedure which separately estimates a traffic and an employment equation. Our approach differs from the others in that it relies on an econometric model that correlates port output with the employment level in the province. The rationale is that the economic importance of a port is different from the level of investment undertaken to construct it in the past (as implicitly assumed by input/output-based port impact analysis) or the level of expenditure of Port Authorities to manage it. We maintain that the larger the port, the greater its direct, indirect and induced effects. Therefore, our model is designed to estimate the impact of ports on local economies by explicitly recognizing the relevance of their output. Our analysis shows that the elasticity of employment to seaport traffic depends on the sector under consideration, varying from 0.015 to 0.022. Yochum and Agarwall (1987 and 1988) have proposed the well-known definition of port required industries, port attracted industries and port induced industry. Hence, our methodology is suitable to estimate the total impact of ports in terms of employment all industrial across sectors.

In what follows, after describing the sample of Italian ports covered by our dataset (section 2), we adopt an econometric model in order to evaluate the impact of port activities on employment (Section 3). The results are presented in Section 4, while Section 5 concludes

2. Port activity in Italy

Owing to Italy's morphology, a relatively large number of ports currently operate in the country: today there are 27 Port Authorities (the public bodies responsible for the management of ports of international interest). Tables 1a-1d provide traffic volumes in main ports.

Containerisation and the increase in international trade have played a crucial role in maritime transport markets and have consequently generated impacts on local economies. As Table 1a shows, the growth of container traffic

Table 1a. Container traffic in Italian ranges ('000 TEUs).

Port	2000	2001	2002	2003	2004	2005	2006	06/00
North Tyrrhenian range	2,949	3,054	3,081	3,208	3,388	3,527	3,680	24.8
Genova	1,501	1,527	1,531	1,606	1,619	1,625	1,657	10.4
La Spezia	910	975	975	1,007	1,040	1,024	1,134	24.6
Livorno	501	502	520	541	639	658	658	31.3
Savona	37	50	55	54	90	220	231	524.3
North Adriatic range	685	692	695	638	676	724	796	16.2
Trieste	202	198	181	118	175	198	220	8.9
Ancona	84	90	94	76	41	64	97	15.5
Venezia	218	246	262	284	291	293	317	45.4
Ravenna	181	158	158	160	169	169	162	-10.5
South Tyrrhenian range	687	769	853	899	816	834	839	22.1
Napoli	397	430	444	433	348	374	445	12.1
Salerno	276	321	375	417	412	418	360	30.4
Civitavecchia	13	16	22	25	36	32	34	161.5
Bari	1	2	12	24	20	10	0	-100.0
Transhipment ports	2,678	2,700	3,555	4,121	4,525	4,537	4,518	68.7
Gioia Tauro	2,653	2,488	3,009	3,149	3,261	3,161	2,938	10.7
Taranto	3	186	472	658	763	717	892	29633.3
Cagliari	22	26	74	314	501	659	688	3027.3

Source: Port Authority of Genova.

Table 1b. Throughput in Italian ports (tons).

Port	2000	2001	2002	2003	2004	2005	2006
North Tyrrhenian range							
Genova	51,736,144	51,178,497	52,848,295	53,713,479	57,032,730	56,455,527	56,323,263
La Spezia	16,521,092	15,847,542	18,203,190	19,793,224	18,434,755	17,162,478	
Livorno	24,583,000		25,328,000	25,727,000	27,051,000	28,211,000	28,630,000
Savona	13,198,266	13,267,154	13,153,558	13,410,969	14,362,250	16,155,906	16,502,332
North Adriatic range							
Trieste	47,612,000	49,324,006	47,174,000	45,998,000	46,906,000	47,718,000	48,318,043
Ancona	11,152,000	13,717,290	12,514,000	9,575,000	9,098,000	9,210,000	9,231,542
Venezia	28,176,000	28,809,223	29,549,000	30,127,000	29,756,000	29,099,000	30,936,931
Ravenna	22,677,000	23,812,397	23,931,873	24,910,621	25,429,000	23,879,000	26,770,176
South Tyrrhenian range							
Napoli	14,784,000	16,923,830	18,851,633	19,634,448	19,667,000	21,009,000	22,100,000
Salerno	3,834,000	4,454,840	4,967,961	7,847,816	8,992,000	8,195,000	8,634,586
Civitavecchia	9,849,000		9,355,000	8,431,000	11,304,000	11,517,000	
Bari	3,455,000		3,609,000	3,928,000	3,816,000	4,416,000	5,215,711
Transhipment ports							
Gioia Tauro	30,818,000		25,585,000	25,454,000	26,361,000	24,765,000	
Taranto	33,880,000	34,529,673	34,673,000	37,513,000	43,582,000	47,657,000	49,400,000
Cagliari	30,316,000		31,597,000	34,074,000	32,237,000	37,913,000	36,485,356

Source: Port Authority of Genova.

Table 1c. Ro-ro traffic in Italian ports (tons).

Port	2000	2001	2002	2003	2004	2005	2006
North Tyrrhenian range							
Genova	6905	7173	7454	8306	8525	8486	8967
La Spezia	227	217	251	291	241	350	286
Livorno	6605	6143	7127	7715	7988	9023	9735
Savona	7	19	9	19	12	6	9
North Adriatic range							
Trieste	-	-	-	5792	-	-	5680
Ancona	2271	3033	5044	2304	2306	2197	2286
Venezia	-	-	-	-	-	2087	1971
Ravenna	-	888	61	837	845	749	814
South Tyrrhenian range							
Napoli	-	-	-	5587	7380	8172	7430
Salerno	-	335	400	2804	4116	3266	4160
Civitavecchia	-	-	-	-	-	-	4297
Bari	-	-	-	2252	2325	2810	3529
Transhipment ports							
Gioia Tauro							
Taranto							
Cagliari							

Source: Port Authorities' web sites.

Table 1d. Cruise and ferry passengers in Italian ports ('000).

Port	Passengers	2000	2001	2002	2003	2004	2005	2006
Genova	cruise	397.5	471.2	567.5	615.8	287.9	395.8	475.1
	ferry	2368.2	2410.1	2639.9	2734.3	2727.5	2642.2	2638.3
	total	2765.7	2881.3	3207.4	3350.1	3015.4	3038	3113.4
Spezia	cruise	0	0	15.3	25.8	24.9	34.1	43.5
	ferry	75.6	113.7	31.5	14.7	16.2	19.5	18.6
	total	75.6	113.7	46.8	40.5	41.1	53.6	62.1
Savona	cruise	120.1	109.6	105.4	195.3	530.1	647.6	592
	ferry	357.4	377.8	337.6	329.4	303.5	314.6	303
	total	477.5	487.4	443	524.7	833.6	962.2	895
Livorno	ferry	1717.5	1894.6	1975.2	2167	2378.9	2513.4	2916.5
	cruise	229	263.6	297.7	363.8	387.4	462.4	607.8
	total	1488.5	1631	1677.5	1803.2	1991.5	2051	2308.7
	roro	6605	6143	7127	7715	7988	9023	9735
Piombino	ferry	3205.6	3521.9	3631	3656.3	3615.4	3637.3	3852.3
	cruise	0	0	0	0	0	0	0
	total	3205.6	3521.9	3631	3656.3	3615.4	3637.3	3852.3
Napoli	cruise	405.6	469.6	485.1	613.6	773.2	830.2	971.9
	ferry		6900	6238	6772	7003	6384	6322
	total		7369.6	6723.1	7385.6	7776.2	7214.2	7293.9
Salerno	cruise	0	0	0	0	0	0	0
	ferry	0	18.3	85.4	102.7	188	139.1	
	total		18.3	85.4	102.7	188	139.1	
Bari	cruise				157	184.9	277.9	303.3
	ferry				1151.8	1154.5	1176.9	1272
	total				1308.8	1339.4	1454.8	1575.3
Brindisi	cruise	0	0	0	0	0	0	0
	ferry	949.8	863.2	721.2	684.6	544.5	562.3	454.4
	total	949.8	863.2	721.2	684.6	544.5	562.3	454.4
Palermo	cruise		1520	1529	1656	1764	2003	1725.5
	ferry		502	131	211	193.1	329.8	320.5
	total		2022	1660	1867	2064	1897	2046
Civitavecchia	cruise							1268.4
	ferry							2310.6
	total							3579
Trieste	cruise		0	0	0	0	0	37
	ferry		283	315	322	262	90	66
	total		283	315	322	262	90	103
	roro							
Venezia	cruise	337.4	526.4	507.5	689.8	677.6	815.1	885.6
	ferry	535.8	496.3	482.6	434.4	359.8	550.3	567.9
	total	873.2	1022.7	990.1	1124.2	1037.4	1365.4	1453.5
Ancona	cruise	0	0	0	0	4.1	39.3	19
	ferry	1210	1341	1470.9	1480	1407.9	1496.7	1555
	total	1210	1341	1470.9	1480	1412	1536	1574
Ravenna	cruise			2.9	47.8			
	ferry			7	4.9			
	total			9.9	52.7			

Source: Port Authorities' web sites.

has varied greatly across Italian ports, and it is likely that this variability is due to the different characteristics and marketing strategies of ports (Table 2). As regards to roro traffic and the Motorways of the Sea, it should be stated that the growth rate of this mode has been particularly sustained during the past years. However, this amounts to a mere 6-8% of total throughput (in tons), hence, at present, it is not possible to give a comprehensive assessment of such transport scheme, although it is likely to generate considerable social benefits (Baird, 2007).

In what follows we outline port activity in Italy by considering three different macro-regions, i.e. the North Tyrrhenian, North Adriatic and Southern ranges. This division into clusters has been performed both on the basis of geographic proximity and of distinctive features of the local economies (CENSIS – Federazione del mare, 1998).

Table 2. Characteristics of ports in the main ranges.

Features	**Range:**		
	North Tyrrhenian ports	*North Adriatic ports*	*South Italian ports*
Port terminal characteristics	High efficiency, some cases of congestion and shallow ? bottoms	Narrow spaces and unsuitable bottoms restrict port efficiency (Trieste excepted)	High efficiency and broad areas available (with the exception of Naples and Salerno)
Placement in maritime network	Not on the main route but in the middle of the ?network linking ? the West Mediterranean ports	Out of route with respect to major flows, with the exception of the routes to/from East Mediterranean	Located at the core of the routes between Suez and Gibraltar
Inland connections efficiency	High congestion for both road and rail legs (port manoeuvres and re-launching beyond Apennines)	Limited to inland regional legs	Limited to inland regional legs ; few rail links because of inefficiencies in the railway network

Source: Baccelli *et al.* (2007).

North Tyrrhenian ports serve almost 84% of the North Italian market. They are quite far from the main maritime routes, but relatively close to some of the biggest ports in the Western Mediterranean area like Marseille, Barcelona and Valencia. Containerized trade in the North Tyrrhenian ports has undergone rapid development in recent years, but it still falls far short of the volumes handled in the main European ports in the Northern range. The port of Savona is mainly specialized in handling cars, fruit (it has the biggest Mediterranean fruit terminal), and liquid bulk traffic, which represents almost 50% of the port's total throughput and serves the refinery of Trecate. Savona, since the inauguration of the new dedicated cruise terminal in 2003, is the home port of the cruise company Costa Crociere, and its presence has allowed an increase in the number of passengers, taking it from approximately 100,000 cruisers in 2002 to about 592,000 in 2006.

La Spezia is growing quite fast (a +24.6% increase in 2000-2006), and in 2006 its container traffic amounted to more than 1.1 million TEU. It is the second Italian port (transhipment excluded) by number of TEU handled after Genoa, which handles about 1.6 million TEU and nearly 60 million tonnes of goods, both general cargo and dry/liquid bulk. The port of Genoa is also important for its ferry and cruise traffics: in the year 2006 about 2,638,000 ferry passengers and 475,000 cruise passengers passed through this port.

The ports of this range suffer from a lack of efficient inland connections which diminishes their competitiveness (in terms of capacity to attract traffic) with respect to other North Mediterranean ports like Barcelona or Marseille. The port of Genoa, for instance, has numerous difficulties in competing for the Swiss and Central European markets owing to the congestion of the connections with its hinterland, and the port of Livorno suffers from an inadequate use of inland areas and a lack of connections with the rail network. The port of La Spezia, by contrast, has better rail connections (more than 30% of its container traffic is forwarded to the hinterland by rail) and it has also an inland port at S. Stefano Magra, which is used as a logistics platform.

The North Adriatic ports are out of route with respect to the major maritime network flows, with the exception of the routes to/from the eastern Mediterranean. They mainly serve north-eastern Italy, the Balkan area and the eastern part of Europe. With the sole exception of Venice, also the ports in this range suffer from inadequate rail and road network connections, together with limited quays and low soundings, hamper their competitiveness both nationally and internationally. In fact, those ports handle less than 10% of total Italian port throughput, although the GDP produced in those regions is more than one third of the national total. The ports of this range nevertheless have a great share of Ro-Ro and passengers traffic. In particular the port of Venice is important for cruises and ferries (about 1,500,000 passengers in 2006) and Ancona for its Motorways of the Sea and ferry traffics.

The ports of the southern range of Italy have developed constantly in the past few years, mainly because the biggest world maritime companies have made substantial investments in this range. The bulk of southern port traffic consists of maritime transhipment from main lines to feeder vessels able to reach the smaller Mediterranean ports. The port of Gioia Tauro, located near the "ideal route" linking Suez with Gibraltar, is the main transhipment port in Italy and one of the most important hubs in the Mediterranean Sea.

Ports in this range are undergoing quite rapid growth, boosted especially by the three transhipment ports: Cagliari (+3,027% in the past few years; 687,600 TEU handled in 2006); Gioia Tauro (more than 3 million TEU in 2005, 2.9 million in 2006); and Taranto (892,000 TEU). A share of Cagliari's traffics consists of petroleum and refined products, because of its proximity to the great SARAS refinery. Taranto instead, is also an industrial port serving the ILVA steel plants. Owing to this strong relationship with the steel sector, this port is the first in Italy for dry bulk traffic, with more than 24 million tons. handled in 2006.

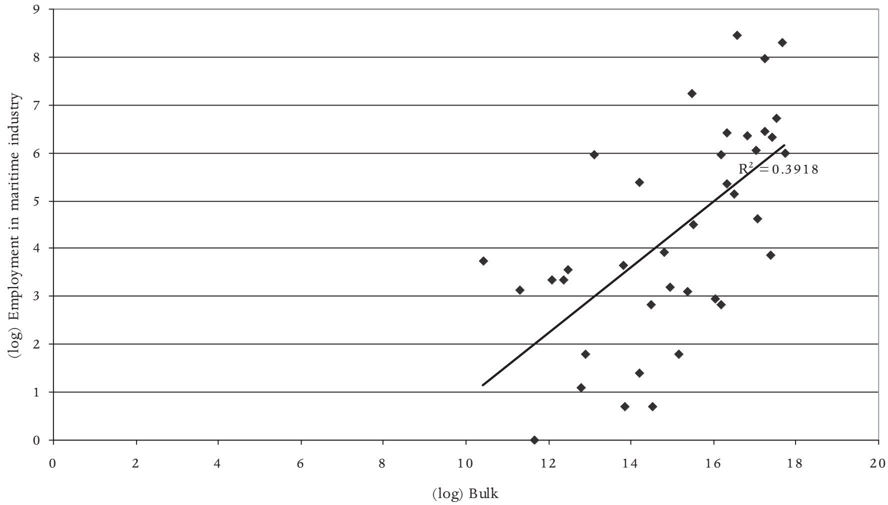
In the Southern range however there are also some direct call ports. The most important of them, the port of Naples, handled almost 450,000 TEU in 2006 (+12.1% in the period 06/00) and its total throughput was more than 20 million tons. This port is one of the biggest port of the World for passenger traffic: in 2006 the cruise traffic counted about 1 million passengers and the ferry sector, thanks to the connections with the Island of Capri, Ischia and Procida and with Sicily, counted more than 6,3 million passengers. The port of Salerno is specialized in general cargo, particularly containers (360,000 TEU in 2006), car imports/exports and Ro-Ro cargo. These two ports, together with the port of Civitavecchia, have some embedded ferry routes (Motorways of the Sea) towards Spain, Northern Tyrrhenian ports and Italian Islands.

Also the ports of Bari and Brindisi have substantial passengers and Motorways of the Sea traffic flows towards North Adriatic ports and towards the Balcanian and the Greek Peninsula.

Musso *et al*. (2000) argued that port impact on local development is only weakly influenced by actual maritime traffic. However, as Figures 1 and 2 show, in the case of Italy, the correlation between maritime traffic and employment is quite significant at provincial level.

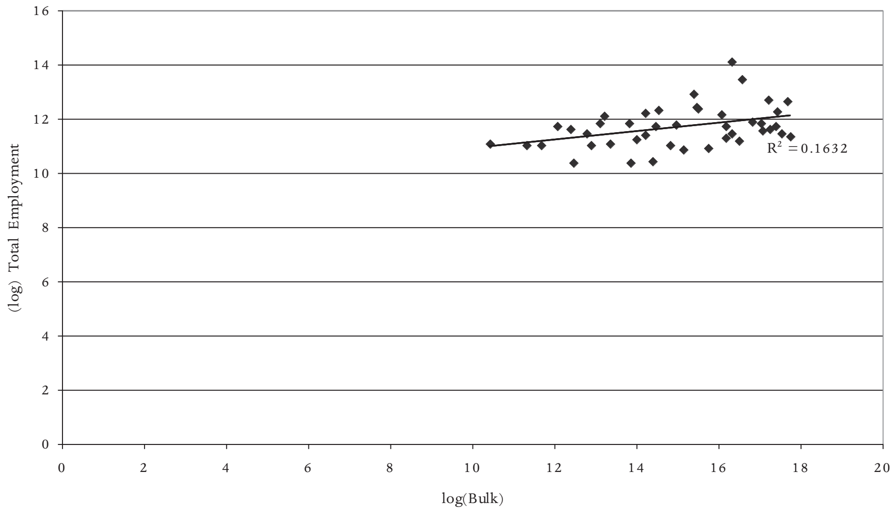
Figure 1 illustrates the importance of maritime traffic (in terms of tons of bulk) in explaining the level of employment in the maritime industry as a whole.[1] Although the importance of ports for maritime industry is obvious, one might be puzzled when considering employment in other sectors. However, as depicted in Figure 2, the relevance of the port is significant also for the economy as whole, i.e. both for the manufacturing and the service sectors. This implies that ports are likely to enhance inter-sectoral spillovers that, as such, may propagate outside city borders by hollowing out the effects in the hinterland (in our case we will consider the province level).

[1] See section 4 for a description of the variables. However, in the case of employment in the maritime industry, we use data from the 2001 Census.



Note: Both employment in maritime industry (in thousands of jobs) and bulk (in thousands of tons) are in logarithms.

Figure 1. Ports and maritime industry employment (2001).



Note: Both employment in maritime industry (in thousands of jobs) and bulk (in thousands of tons) are in logarithms.

Figure 2. Ports and total employment (2003).

The aim of this paper is to identify (and verify) the positive impact of port activity by controlling for other variables that may influence the level of employment. In addition, in the next section we present a methodology able to take into account of the fact that ports are not located everywhere in Italy. In fact, we have considered only provinces with at least one port in FIGURES 1 and 2. But this procedure gives rise to a selection bias in our data that, if not taken properly into account, may lead to over-estimation of the port impact.

3. The methodology

In order to quantify the impact of seaport traffic on employment, we estimated an equation in the form (Percoco, 2007):

$$E = f(T, \mathbf{X}) + u \tag{1}$$

where T is maritime traffic, $\mathbf{X}$ is a vector of exogenous variables that influence employment, and u is an error term.

As pointed out in the Introduction to this paper, ports have always been considered as important means to enhance development, and in a broad sense they can be viewed as a regional development policy. However, as is commonly reported in the policy evaluation literature, estimation of (1) may be problematic because of selection bias. To overcome this problem we drew on recent developments in the well-known propensity score methodology.

In general, the propensity score controls for differences between groups when treatment is binary. In the present case, one may argue that, given the fact that a port is either located or not located in a province, a binary treatment is in place. However, our model used port throughput, which assumes 0 values if no ports are in the province and a continuum of values otherwise. In order to take this fact explicitly into consideration, we applied the general framework proposed by Imai and van Dyk (2004) and Hirano and Imbens (2004) to our specific case.

We assumed that seaport traffic is the treatment variable in the form:

$$\begin{aligned} T_i = T_i^{*} \quad & \text{if} \quad T_i^{*} > 0 \\ T_i = 0 \quad & \text{if} \quad T_i^{*} = 0 \end{aligned} \tag{2}$$

where T_i^{*} is the latent variable. In other words, location of a port in province i is not a binary local development policy; rather, is it a continuous treatment. Estimating a model in which the dependent variable is expressed as in (2) implies estimation of a tobit model, from whose well-known properties we have that:

$$E\left(T_i \middle| T_i^* > 0\right) = E\left(T_i^* \middle| T_i^* > 0\right) \quad (3)$$

Note that in this case $E(\bullet)$ denotes the expected value operator. If we assume that port traffic depends on a set of variables, $\mathbf{Z}$, it follows that the generalized propensity score is given by:

$$T_i^{GPS} = E\left(T_i^* \middle| T_i^* > 0\right) = \mathbf{Z}_i\hat{\mathbf{a}} + E\left(\varepsilon_i \middle| T_i^* > 0\right) \Rightarrow E\left(T_i^* \middle| T_i^* > 0\right) > \mathbf{Z}_i\hat{\mathbf{a}} \quad (4)$$

where β is a vector of parameters to be estimated and ε is an error term. Equation (4) simply states that T_i^{GPS} is the fitted value of a tobit model.

The generalized propensity score measures the fact that a given province may have a port of a given size conditional on the set of variables $\mathbf{Z}$, a sort of "port potential". Hirano and Imbens (2004) demonstrate that the use of the generalized propensity score removes the selection bias when estimating (1). Note that the estimation of tobit models entails the maximization of a likelihood function (Cameron and Trivedi, 2005).

To sum up, our econometric methodology consisted in a two step procedure involving the estimation of a tobit traffic model and the employment equation. The next section presents the data and estimates of our model as from equations (1) and (4).

It should be mentioned that our method consists in a cross-section model, not a panel one. This is because several explanatory variables in equations (1) and (4) are not time-varying, or the temporal dimension is currently lacking in the Italian statistical system. For this reason we decided to rely on a cross-section estimation. In so doing, we followed the small but rapidly growing literature on the economic impact of the services supplied by point infrastructures, such as airports (Brueckner, 2003; Cohen and Morrison, 2003; Green, 2006; Percoco, 2007). However, in order to reduce the possible bias emerging from cross-section estimates, we averaged our dependent variables in both the first and second stages over the years 2001-2005, i.e. we smoothed abnormal peaks possibly occurring in 2003.

4. Data and empirical results

The data used for the analysis related to 2003, with some exceptions, and they were drawn from different sources. Appendix 1 sets out the descriptions and sources of the variables.

Three different definitions of employment were used as dependent variables: total employment in the province (*EMP*), employment in the manufacturing sector (*INDEMP*), and employment in the service industry (*SERVEMP*).

The reason why we took provinces as units of observation and not cities was that we were mainly interested in estimating the total economic impact of ports in terms of spatial and inter-sectoral spillovers, and hence also the effect on the hinterland. However, it should be stated that we did not make use of local labour systems, because these amount to more than 800, while there are only 20 ports. As a consequence, the limited number of observations different from zero would have produced inconsistent estimates, also in a tobit framework.

As for the variables measuring port traffic, we used throughput expressed in tonnes (*THROUGHPUT*), TEUs (*TEU*) and tonnes of bulk, as defined by the sum of liquid and dry bulk (*BULK*).[1] Those measures of output are consistent with the recent literature on the multi-output cost function for ports (Jara-Dìaz *et al.*, 2002).[2] The sample of ports was made up by the 20 largest ports in Italy, i.e. those in which freight transport is present.

Other controls included total population (POP) measured in 1991 in order to avoid problems of endogeneity. We also considered the percentage of the population aged 65 or over (*OLD*) and the percentage of the population with a college degree (*COLLEGE*). The rationale for including these variables was that the older the population, the lower is economic development, owing to the existence of a demographic dividend. The variable *COLLEGE* was a proxy for human capital. Finally, we controlled for accessibility by including an index of road and railway provision (*ROAD* and *RAIL*, respectively) in the employment regressions. Dummies were used for the geographical positions of the provinces.[3]

In order to estimate the regressions in equation (4), we needed to establish the determinants of port traffic. To this end, we considered geographical position, as measured by *NORTH, CENTER* and *SOUTH*, to be of key importance in determining bulk transport, as well as the length of coasts (*COAST*). In addition, we included a dummy variable for major transhipment ports (Cagliari, Gioia Tauro, and Taranto; *TRS*) because the traffic in these ports is subject to double-counting and, as stated by some surveys (Musso *et al.*, 2004), its impact on the local economy is comparatively lower. We again used *RAIL* and *ROAD* because a port located in a large infrastructure network is more likely to attract bulk owing to larger shipping capacity. The total area

[1] The difference between *THROUGHPUT* and *BULK* is the general cargo of the port.

[2] As noted by a referee, those measures do not take into account cargo value. However, given the lack of data, we rely on those variables as good proxy of port physical output, likely meant to be positively correlated with the monetary output.

[3] Appendix 1 shows the distribution of the provinces according to their geographic positions.

of intermodal centres (*INTERMODAL*) was meant to measure the port's attractiveness as a hub for the distribution of freight in the inland market (Notteboom and Winkelmans, 2001; Ferrari *et al.* 2006).

In addition we considered variables intended to measure port capacity, in particular, storage capacity (*STORE*), quay length (*QUAY*) and yard surface (*YARD*), since these are the most important infrastructural features liable to restrict port output. In fact, they are usually used as input data in port capacity investigations (Tongzon, 2001; Cullinane *et al.*, 2006). Hence, our identification methodology implied that *COAST, TRS, INTERMODAL, STORE, QUAY, YARD* variables do not have a direct impact on the level of employment in the province because they do not appear in the second stage regression. We deemed this choice appropriate because we mainly considered the technical characteristics of ports as fundamentals in attracting traffic. It should also be noted that *COAST, TRS, INTERMODAL, STORE, QUAY, YARD* do have an impact on the level of employment, although it is mediated by port throughput, i.e. through traffic equations. Hence, they are meant to have an indirect local development effect.

Table 3 reports descriptive statistics for some selected variables.

Table 3. Summary statistics.

	Min.	**Max.**	**Mean**	**St. Dev.**	**N. obs.**
Ports characteristics:					
THROUGHPUT	3,928,000.00	53,713,479.00	21,334,527.85	14,173,073.68	20
BULK	0.00	38,375,528.00	8,346,869.10	11,473,651.64	20
TEUS	0.00	3,148,662.00	447,623.50	756,555.15	20
INTERMODAL	0.00	1,191.00	169.73	295.16	20
STORE	2.00	2,660,200.00	364,759.65	659,300.28	20
QUAY	2,723.00	25,352.00	10,498.75	5,763.36	20
YARD	2,000.00	3,089,425.00	853,011.75	915,980.00	20
Employment variables:					
EMP	33.00	2,077.60	235.66	293.49	103
INDEMP	8.70	620.90	68.48	79.25	103
SEREMP	20.30	1,577.60	156.70	222.61	103

Table 4 sets out the estimates of the first stage regressions. The second column reports the model in which the dependent variable is *THROUGHPUT.* A number of results arise from this as well as from other regressions. On average, ports located in Southern Italy have a competitive advantage over those in Northern and Central provinces, as the sign of the coefficients for the two dummies *NORTH* and *CENTER* is negative. As expected, transhipment ports have larger traffic and port characteristics in terms of *STORE, QUAY* and *YARD* are also positively and significantly correlated with *THROUGHPUT*. Interestingly, although the provision of public capital (as expressed by *ROAD* and *RAIL*) is not significant, the capacity of inland terminals is positive and significant. Finally, the length of the coasts is not significant in explaining port traffic.

TABLE 4. Traffic equation estimates (first-step regression; tobit models).

	1 **Dep. Var.: *THROUGHPUT***	2 **Dep. Var.: *TEU***	3 **Dep. Var.: *BULK***
Constant	-15949215 (-2.571)***	-1127167 (-3.136)***	-1966891 (-0.699)
NORTH	-12745867 (-1.843)*	-377353.9 (-1.078)	-6596261 (-2.250)**
CENTER	-7680739 (-1.280)	-225850.7 (-0.700)	-3560572 (-1.222)
COAST	5436.148 (0.313)	2174.069 (1.779)*	3914.667 (0.355)
TRS	24741511 (2.678)***	2200015. (4.271)***	19280126 (3.103)***
ROAD	-8089.247 (-0.804)	160.1432 (0.297)	-5974.365 (-1.196)
RAIL	32964.87 (1.167)	1022.610 (0.676)	-2491.997 (-0.170)
INTERMODAL	27732.20 (3.062)***	1109.380 (2.387)**	12862.95 (2.454)**
STORE	10.989 (2.467)***	0.206 (0.857)	7.433 (2.374)**
QUAY	27732.20 (3.006)***	111.085 (3.396)***	1638.716 (4.394)***
YARD	4.553 (0.971)	0.296 (1.181)	0.970 (0.314)
N. obs.	103	103	103
R^2	0.802	0.689	0.769

Note: z-statistics in parenthesis; ***: p<0.01; **: p<0.05; *: p<0.1.

In the third and fourth columns, the dependent variables are *TEU* and *BULK* respectively. In this case, too, all variables maintain the same sign as in model

1, although the level of significance changes for some parameter estimates (*YARD*, in model 2, and *STORE* in both models 2 and 3). Finally, to be noted is that *TRS* is always significant.

Turning to the second stage regressions, Table 5 reports the regressions for *INDEMP, SEREMP* and *EMP*. As expected, Northern and Central provinces have more employees than those in the South, while *ROAD* and *RAIL*, although with negative sign, are not significant. The larger the population the higher the employment, although the elder the population the lower employment is. Also *COLLEGE* is positive, although not significant in explaining employment in manufacturing. It is of interest that the fitted value of *THROUGHPUT (cond_THROU)* as shown by the results in Table 5 has a positive and not significant coefficient, prompting an elasticity of *INDEMP* to port traffic equal to 0.019. These results are also confirmed in models 2 and 3, where, as a sensitivity check, we use the fitted values of *TEU* (*cond_TEU*) and of *BULK* (*cond_BULK*) to measure port activity, although the significance increases slightly.

Turning to *SEREMP*, we find that all variables maintain their sign and significance, with the sole exception of *COLLEGE*, which is now highly significant and positive. In this case, the impact of the port is positive and significant with an elasticity of *SEREMP* to port traffic lying in the interval 0.010-0.022, implying that a 10% increase in port traffic will increase service employment by 0.1-0.2%.

Models 7-9 report the overall impact of ports on local development. We find a moderately positive elasticity of total employment amounting to between 0.015 and 0.021.

Finally, in order to corroborate our instruments in the first stage regressions in Table 4, we ran a Hausman test over all the considered specifications. The results confirmed our choice of instruments at 99% level.

To sum up, we have found evidence of a positive impact of ports on local development, with an elasticity lying in the interval [0.015-0.024], and being slightly more significant in the tertiary sector. Our results should be read as an estimate of the total impact (defined as the sum of the direct, indirect and induced employment impact of ports) of ports, in terms of cargo moved, on local development. If we consider other estimates of point-infrastructure effects, such as those of airports, we find that port impact is comparatively smaller. In fact, Brueckner (2003) reports an elasticity of employment to airline traffic in U.S. metropolitan statistical areas of about 0.1, while Percoco (2007), who applies the same methodology as in the present paper to Italian airports, finds an elasticity of the service sector of about 0.045. The difference may be due to both the increasing intensity of capital of ports and to

Table 5. Employment equation estimates (second stage regressions; LS estimates).

	Dep. Var.: INDEMP			Dep. Var.: SEREMP			Dep. Var.: EMP		
	1	2	3	4	5	6	7	8	9
Constant	-1.509 (-1.558)	-2.128 (-2.093)**	-0.725 (-0.788)	-3.396 (-9.341)***	-3.227 (-8.617)***	-3.542 (-9.864)***	-1.804 (-5.954)***	-1.905 (-5.996)***	-1.663 (-5.476)***
NORTH	0.492 (3.612)***	0.663 (6.266)***	0.476 (4.366)***	0.237 (4.647)***	0.218 (5.605)***	0.242 (5.699)***	0.257 (6.044)***	0.298 (9.012)***	0.264 (7.324)***
CENTER	0.408 (3.089)***	0.534 (4.632)***	0.391 (3.472)***	0.215 (4.333)***	0.202 (4.755)***	0.226 (5.148)***	0.211 (5.106)***	0.241 (6.699)***	0.218 (5.870)***
RAIL	-0.064 (-0.978)	-0.066 (-0.986)	-0.112 (-1.854)*	-0.023 (-0.953)	-0.026 (-1.089)	-0.017 (-0.746)	-0.023 (-1.133)	-0.025 (-1.212)	-0.034 (-1.722)*
ROAD	-0.134 (-1.521)	-0.005 (-0.076)	-0.117 (-1.645)*	0.027 (0.835)	0.008 (0.318)	0.026 (0.935)	-0.023 (-0.869)	0.004 (0.194)	-0.015 (-0.668)
POP	1.105 (15.812)***	1.097 (15.405)***	1.139 (17.607)***	1.070 (40.813)***	1.064 (40.576)***	1.064 (42.144)***	1.063 (48.644)***	1.058 (47.556)***	1.067 (49.943)***
COLLEGE	0.191 (1.145)	0.198 (1.173)	0.207 (1.320)	0.171 (2.736)***	0.166 (2.666)***	0.167 (2.728)***	0.125 (2.397)**	0.125 (2.363)**	0.126 (2.438)**
OLD	-0.157 (-0.448)	-0.289 (-0.841)	-0.137 (-0.431)	-0.205 (-1.561)	-0.208 (-1.645)	-0.202 (-1.626)	-0.096 (-0.875)	-0.059 (-0.551)	-0.089 (-0.852)
Cond_THROU	0.019 (1.029)			0.020 (2.128)**			0.017 (1.776)*		
Cond_TEU		0.015 (1.843)*			0.016 (1.854)*			0.015 (1.734)*	
Cond_BULK			0.024 (1.920)*			0.022 (2.583)**			0.021 (2.083)**
N. obs.	103	103	103	103	103	103	103	103	103
R^2	0.876	0.873	0.891	0.978	0.978	0.979	0.984	0.984	0.984

Note: All variables are in logs. *t*-statistics in parenthesis; ***: $p<0.01$; **: $p<0.05$; *: $p<0.1$.

the fact that containerization has reduced the location competitive advantage of port regions/cities (Musso *et al.* 2000; Levinson, 2006).

5. Conclusions

Globalization of economies and increasing international trade flows have made maritime traffic even more important than it was in the past. As a consequence, policy makers are currently addressing port development issues with major policy interventions in order to stimulate both national and local development. This paper has estimated the impact of ports on local development, as proxied by manufacturing, service and total employment. Our analysis differs from previous port impact studies in that we have made a first attempt to use an econometric methodology that considers both endogeneity and selection bias in order to estimate employment elasticity to port traffic. In particular, our model consisted in a two stage procedure whose first step was estimation of a traffic equation, followed by an employment equation in which one of the explanatory variable was the predicted value of the first step.

By considering Italian major ports, we have found that the impact of a port depends on the sector being considered, and it lies in an interval [0.015-0.024], depending on the traffic variable used in the regressions.

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Appendix 1
Description of the variables

Variable	Definition	Source
EMP	Total province employment (in '000). Average 2001-2005	ISTAT, *Conti territoriali*
INDEMP	Total province industrial employment (in '000). Average 2001-2005	ISTAT, *Conti territoriali*
SERVEMP	Total province service employment (in '000). Average 2001-2005	ISTAT, *Conti territoriali*
POP	Province population in 1991.	ISTAT, *Conti territoriali*
OLD	Percentage of 2002 population aged 65 or over.	ISTAT, *Conti territoriali*
COLLEGE	Percentage of 1991 population with a college degree	ISTAT, *Conti territoriali*
ROAD	Total kms of paved roads in the province in 1996.	ISTAT, *Conti territoriali*
RAIL	Total kms of railways in the province in 1996.	
NORTH	Dummy variable equal to one for northern region provinces. Centre is used as a reference variable.	Own calculations
SOUTH	Dummy variable equal to one for southern region provinces. Centre is used as a reference variable.	Own calculations
THROUGHPUT	Liquid and solid bulk and general cargo (in '000 tonn.). Average 2001-2005	ISTAT, Banca dati Infrastrutture and Port Authorities website
TEU	Twenty-foot Equivalent Units of containers (in '000). Average 2001-2005	ISTAT, Banca dati Infrastrutture and Port Authorities website
BULK	Liquid and solid bulk (in '000 tonn.). Average 2001-2005	ISTAT, Banca dati Infrastrutture and Port Authorities website
COAST	Length of coastline in the province (in kms.)	ISTAT, *Conti territoriali*
INTERMODAL	Total area of logistics centres in correspondence to the port (in sq. metres), 2003	ISTAT, Banca dati Infrastrutture and Port Authorities website
STORE	Total area of stores in the port (in sq. metres), 2003	ISTAT, Banca dati Infrastrutture and Port Authorities website
QUAY	Total length of quay (in metres), 2003	ISTAT, Banca dati Infrastrutture and Port Authorities website
YARD	Total surface of docks (in sq. metres), 2003	ISTAT, Banca dati Infrastrutture and Port Authorities website

Appendix 2
Ports in the sample and geographical distribution of the provinces

Ports in the sample: Ancona, Bari, Brindisi, Cagliari, Catania, Genova, Gioia Tauro, La Spezia, Livorno, Messina, Napoli, Palermo, Ravenna, Roma, Salerno, Savona, Siracusa, Taranto, Trieste, Venezia.

Northern Italy: Alessandria, Asti, Belluno, Bergamo, Biella, Bologna, Bolzano, Brescia, Como, Cremona, Cuneo, Ferrara, Forlì-Cesena, Genova, Gorizia, Imperia, La Spezia, Lecco, Lodi, Mantova, Milano, Modena, Novara, Padova, Parma, Pavia, Piacenza, Pordenone, Ravenna, Reggio Emilia, Rimini, Rovigo, Savona, Sondrio, Torino, Trento, Treviso, Trieste, Udine, Varese, Venezia, Verbano-Cusio-Ossola, Vercelli, Verona, Vicenza.

Central Italy: Ancona, Arezzo, Ascoli Piceno, Chieti, Firenze, Frosinone, Grosseto, L'Aquila, Latina, Livorno, Lucca, Macerata, Massa-Carrara, Perugia, Pesaro e Urbino, Pescara, Pisa, Pistoia, Prato, Rieti, Roma, Siena, Teramo, Terni, Viterbo.

Southern Italy: Agrigento, Avellino, Bari, Benevento, Brindisi, Cagliari, Caltanissetta, Campobasso, Caserta, Catania, Catanzaro, Cosenza, Crotone, Enna, Foggia, Isernia, Lecce, Matera, Messina, Napoli, Nuoro, Oristano, Palermo, Potenza, Ragusa, Reggio Calabria, Salerno, Sassari, Siracusa, Taranto, Trapani, Vibo Valentia.