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The Potential for an Irish Maritime Transportation Cluster: An Input-Output Analysis

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Abstract

Economically, Ireland depends heavily upon its shipping sector. However, structural changes arising from the globalisation of shipping fleets and the recent global recession has resulted in a decline in Europe's shipping sector. Acknowledging the need for direct measures to halt this decline the Irish government introduced a range of policies aimed at developing a maritime transportation cluster in Ireland. Research has indicated that industrial clusters are important for the creation of economic value at the national, regional and sectoral level. Disaggregating the 2007 Input-Output table to include ten additional marine based sectors, this paper examines the potential for developing a maritime transportation cluster given the current characteristics of the sector. The analysis found that given the strength of the maritime transportation linkages with the broader economy, including its intermediate input role in a number of key economic sectors, there is a clear rationale for the development of a cluster for the sector.

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1. Introduction

Within the EU, the move to a single market and the increased rate of globalisation has led to a recognition that not all industrial sectors would benefit from trade liberalisation [1]. The difficulty in maintaining traditions and safe-guarding employment is particularly evident in the shipping sector [2]. Central to world trade, transporting approximately ninety percent of internationally traded produce [3] the shipping industry has undergone dramatic changes in the last two decades. In Ireland, acknowledging the need for direct measures to halt the decline in the shipping industry and to prevent the migration of the industry to alternative jurisdictions the Irish government introduced a range of policies aimed at stimulating the sector [4]. Core to these policies is the development of a maritime transportation cluster [4]. However, while there is clear evidence that clustering can produce economic development within a sector [5], research has documented concerns that the current emphasis on cluster formation is rarely supported by empirical evidence that (a) indicates why a particular sector should be a focus of resources, and (b) how far their promotion might be linked to regional/national growth prospects and competitiveness [6, 7, 8].

Thus, using input-output analysis, this paper seeks to empirically examine the potential for cluster formation within the maritime transportation sector, based on the strength of its linkages with its support services and with the wider economy. The paper continues as follows: section 2 presents a brief introduction to the maritime transportation sector and continues. The section continues by outlining cluster theory and the sectoral characteristics required for the development of a successful cluster. Section 3, outlines the Input-Output methodology and linkage analysis used to examine the maritime transportation sector. Section 4 presents the results of the linkage analysis and places the findings within the context of cluster development. Section 5 offers a discussion of the results and Section 6 offers some concluding comments.

2. Constructing clusters within the maritime transportation sector

The maritime transportation sector has undergone dramatic changes in the last two decades. On one hand, fuelled by the globalisation of economic activity the international shipping sector grew dramatically from the mid-1990s [4, 9]. However, the onset of the global recession in 2007 resulted in significant losses for the sector with the vast majority of international shipping markets presenting marked declines in output [3]. Furthermore, structural changes in the market; including the flagging-out of vessels from high tax industrialised countries, the introduction of open ship registers, the hiring of seamen from low-wage countries, extended vessel lives, and relocation of ship building capacity from high-cost European countries to lower cost locations like South Korea and China [10] has meant that most European maritime transportation sectors are in decline [3, 4].

Ireland is a small, open, island economy, with a 'trade to GDP ratio' of 88 in 2007. Sea transportation is therefore an important input into economic activity, with 95% and 99% of the overall value and volume of goods traded passing through Irish seaports [11]. It is important to note that within this paper maritime refers to water transportation based services and/or sector. In contrast the marine sector refers to the broader marine based commercial activity such as fishing, aquaculture, oil and gas extraction, coastal tourism, etc [12]. Figure 1 presents the industries within the Irish maritime transportation sector. Table 1 presents the economic structure of the Irish maritime transportation sector and its

service support sectors for 2007. Table 1 indicates that in 2007 there were 63 shipping companies in Ireland which generated €697 million in turnover and €197 million in gross value added (GVA) to the economy [12]. They further employed 1,077 individuals in full time equivalents (FTEs). With regard to maritime support industries, there were approximately 200 commercial companies which provided a range of services to the shipping sector. These services included banking, finance, insurance, port services and management consultancy. In 2007, these industries generated approximately €292 million in turnover and €182 million in GVA and employed 1,100 individuals in FTEs [13]. Also included in Table 1 is the economic profile of the road freight sector. As one can see from Table 1 the road freight industry is much bigger than the maritime sector in Ireland. This is mainly due to the dispersed nature of retail and wholesale in Ireland (Aylward and O'Toole, 2007). Geographically, the maritime transportation sector is spread along most of the coastline; however recent research has identified a specific cluster of maritime industries around the greater Dublin area [15].

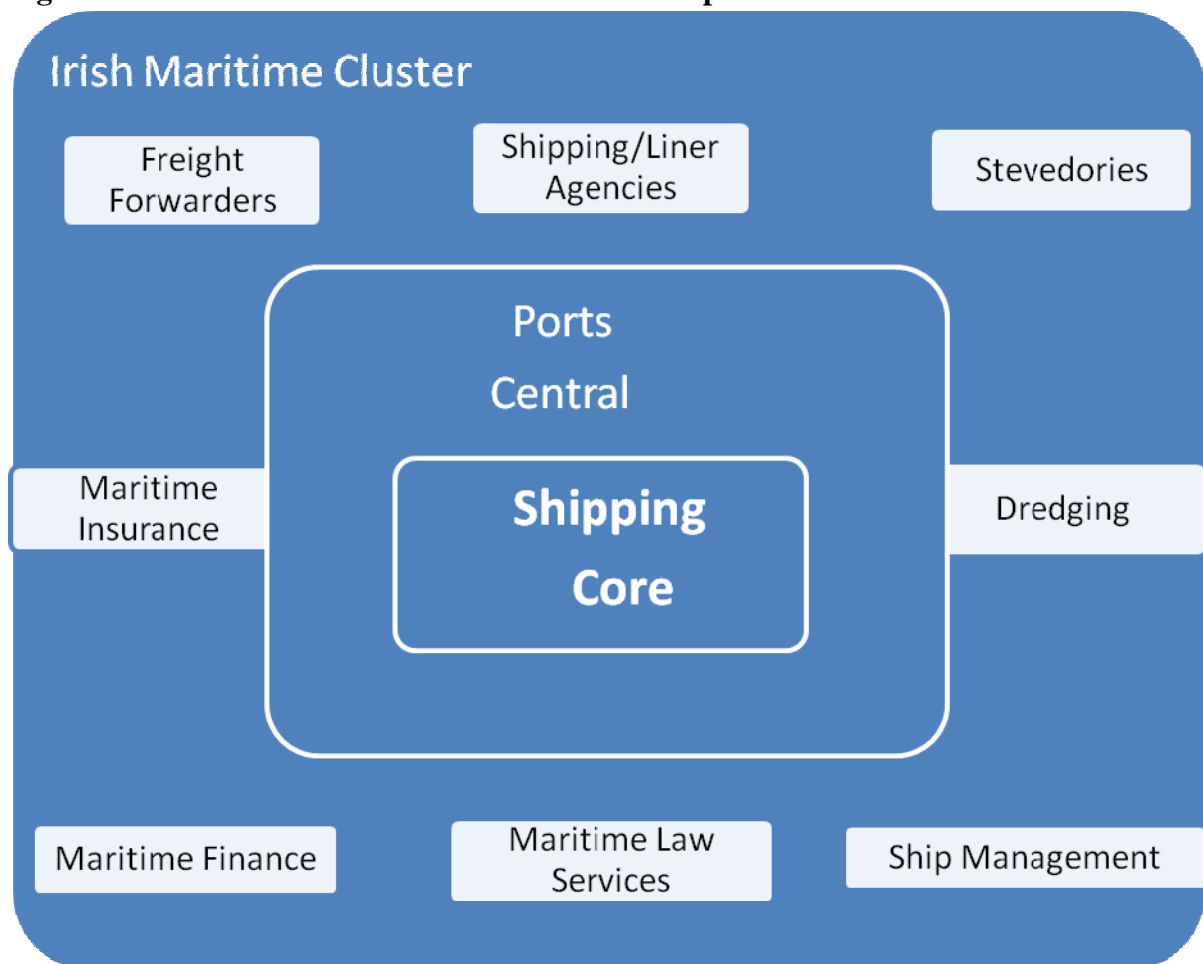**Figure 1 Industries within the Irish maritime transportation sector**

Table 1 Economic structure of the maritime transportation sector (reference to road transport) 2007

	Shipping Sector	Maritime Services	Road Transport
Number of Companies	63	200	7,912
Turnover	€697 million	€292 million	€4,666 million
GVA	€197 million	€182 million	€2,004 million
Employment (FTEs)	1,077	1,100	1,100

Given the economic value of both the shipping sector and its downstream support services and their role in foreign trade, the Irish government, in line with EU Maritime Transportation policy [16] has introduced a range of policies aimed at stimulating the sector over the last decade [4]. These policies range from economic based incentives such as the introduction of a tonnage tax scheme and the flagging or reflagging to Community flags to the promotion of maritime safety and short sea shipping. Although, seemingly diverse in range, a key underlying component of these policies is their role in the creation of a maritime transportation cluster with shipping operations at its core, supported by the maritime service activities presented in Figure 1 [4].

The policy focus on cluster development reflects the insights of research in the early nineties by Porter [17] which found that internationally competitive industries usually occur in the form of specialised clusters of 'home-based' industries, which are linked together through vertical relationships (buyers/suppliers) or horizontal relationships (common customers, technology, skills, distribution channels, etc). Competitive advantage arises as result of these linkages and the Marshallian idea that geographic proximity creates the type of collaborations, knowledge spillovers, and positive externalities that firms can use and exploit [10, 16]. These externalities are based on the presence of qualified labour, production inputs (for example, support services), and benefits stemming from industrial technological advancement [9, 10, 18]. Based on these externalities Porter [17] identified four determinants of competitive advantage, the 'national diamond' which encourages cluster formation. These determinants include;

- factor conditions (e.g. employee skills set),
- demand conditions (predominately indigenous),
- related and supporting industries (to develop a skilled employee base or technical knowledge) and
- firm strategy, structure and rivalry (through knowledge transfer)

The diamond model also includes two residual influences, government and chance events. The conditions which bring about industry clustering grow directly out of these four determinants; thus a key feature of the model is that the determinants operate as a system within the scope of a core anchoring sector. Thus, the first step in developing cluster policy involves identifying the cluster core. A cluster core should comprise of a sector that has a relative abundance of firms within a spatial concentration, has a relatively high share of national or regional output, has a high level of exports and most importantly has strong pre-existing linkages with related economic sectors.

In an effort to stem the impacts of globalisation [1, 19] cluster theory has become the focal point for many new industrial policy initiatives [5, 7]. However, although there are

numerous theoretical and empirical studies on clusters, many make the implicit assumption that clusters operate and develop along similar lines regardless of the regional or industrial context. However, in practice, there is often a significant difference in the way clusters develop and evolve across sectors [7]. Research on cluster development has revealed singularities in the form, path development, and growth patterns of different clusters based on their sector and region [20]. As such research indicates that these singularities make it impossible to develop a policy framework or a model of 'best-practice' suited to and effective for every sectoral context [21]. In terms of developing an Irish maritime transportation sector, a number of papers both in Ireland and internationally have examined the potential benefits for the sector within a cluster based framework. Within Ireland, recent research using the Delphi method found that the greater Dublin area currently displays evidence of firm agglomeration across the maritime transportation sector. However, current consensus within the sector indicates that whilst the cluster exists, it is limited and there are gaps in the services provided [15].

Using Porter's cluster framework, research in Norway found that the Norwegian maritime transportation sector complies with most characteristics of strong industrial clusters including strong inter-sectoral linkages, sectoral diversity, and competitive rivalry [9]. Research on the Dutch maritime sector [10] found that clustering among different maritime industries could be observed at different levels. For example, at lower levels of aggregation it was found that ports could be regarded as the core of two large clusters. Further, research in Norway using econometric analysis examined potential linkages between the service-oriented shipping sectors and the manufacturing-oriented ship industry sectors [22]. This analysis revealed that significant economies of scale exist in the maritime industry. Such economies of scale were mainly found within sub-clusters rather than between sub-clusters, suggesting that the predominantly downstream-oriented shipping sector and the mainly upstream-oriented ship industry sectors largely behaved as two self-reinforcing but independent sub-clusters. Given, therefore, the existence of international maritime clusters and previous Irish research on the potential for a maritime cluster, there is a rationale for industrial policy in the creation of an Irish maritime transportation cluster.

3. The input-output methodology and linkages within the Irish maritime sector

An important dimension of industry and cluster development is the nature or strength of buyer–supplier link [6]. Sectors do not exist in a vacuum; rather they rely on other sectors for inputs (backward linkages) into their production process, while simultaneously selling their output to sectors (forward linkages) to generate profit. Backward linkage effects are strongly induced by industries with high intermediate input coefficients, such as manufacturing industries. Symmetrically, strong forward linkages are generally induced by the primary and material industries, whose outputs are used by other industries as intermediate goods [23]. The intensity of inter-sectoral linkages between related industry groups has been highlighted as a key determinant of the technical and competitive progress of an economy [24]. As such, the identification of sectors that display strong linkages is believed to be a useful planning tool for stimulating overall economic growth.

Considering the complexity of inter-sectoral linkages, it would be an enormous task to trace and measure an entire sector's direct and indirect backward and forward relations to other sectors [25]. However, developed by the economist Wassily Leontief, IO models may be used to trace the entire backward (or forward) linkages within a sector. Given the

publication of data on maritime transportation and port activity within most national accounts a number of studies have used IO analysis to examine the sector. Research in Korea found that using IO analysis to simulate changes in the industrial output of the port sector and examine the subsequent impacts on downstream and upstream sectors was a valuable tool for policymakers to plan future investment in the sector based on predicted growth of maritime traffic [26]. Using IO analysis, research in Germany examined the relationship between public policy and the economic performance of the German maritime sector [27]. Using the results the research examined the impact of four different policy approaches to the German maritime sector; the continuation of present German shipping policies, a total lassiez-faire approach and two framework policies. The effect of public policy on the sector was then examined through an evaluation of the effect each policy had on the value-added, employment, tax revenues and expenditures generated by the sector. Such an analysis provided an insight to the effectiveness of IO analysis in examining the impact of public policy on a sectors economic performance [27].

Research in Wales, linking a number of business sector datasets and administrating a survey to the tenants of the Association of British Ports (ABP) within an IO framework, found that port infrastructure played an important role in supporting other Welsh businesses [28]. Their results indicated that given the value of ports in terms of direct economic impacts and the economic impacts their infrastructure (through the provision of rental space to commercial companies outside the sector) provides to South Wales, governments should carefully consider the value of the port sector for regional economic development. Finally, recent research in the Taiwan [29] used IO analysis, including the demand-driven model, the supply-driven model, inter-industry linkage effect analysis and the Leontief price model, to investigate the role of the maritime sector in the national economy from 1991 to 2004. Using the multitude of analysis methods available with the IO framework it was found that it would be difficult for the sector to be considered a leading industry and increased government investment would not have large gains for the economy as a whole.

Following this international research and using the data contained with the SEMRU marine company database [12], this paper disaggregates the national fifty-one sector Irish IO table to contain ten additional marine sectors. These sectors included fishing and aquaculture, seafood processing, oil and gas extraction and production, marine engineering, marine water construction, boat building, maritime transportation, auxiliary services to maritime transport, marine water-based tourism activities and chandlery and boat sales. This paper presents the first application of the IO methodology to a marine based sector – the Irish maritime transportation sector. The next section provides a formal overview of the IO methodology and the derivation of backward and forward linkages.

Methodology: input-output analysis
Standard approaches to assessing inter-industry linkages begin with a conventional representation of Input–Output relations in an economy [30, 31]:

$$x = X_{e\text{-}} + f$$
$$\Rightarrow A\,x + f$$
$$\Rightarrow x = (I - A)^{-1} f$$
$$(1)$$

Where matric X transaction flows between sectors of activities is the sum of gross outputs, matrix I is an identity matrix, vector x is the sum of gross outputs, vector f represents the part of gross output sold to final demand, and A is a matrix of input coefficients defined as,

$$A = a_{ij} = \frac{z_{ij}}{x_j}$$
  (2)

Where z_{ij} is intermediate demand for inputs between sector i, and the supply sector j and x_j is the final output for sector i. Finally the matix $(I - A)^{-1}$ refers to the Leontief inverse which represents the total direct and indirect outputs in sector i per unit of final demand for sector j [32].

The Chenery and Watanabe approach is based on the matrix of direct Input–Output coefficients [33], A, such that backward linkage indicators can be measured by e'A, where α is a column summation vector ($e_1 = 1$ for all i, sectors) that measures the impact of a unit final demand change in sector i on total output. Adding subscript 'e' to the new matrices and subscript 'M' to vectors related to the individual maritime transportation sector gives $e'(I - A)^{-1}(F_e + A_M X_M)$. Assuming $\Delta F_e = 0$ yields;

$$\Delta X_e = (I - A)^{-1} A_M \Delta X_M$$
  (3)

One captures both direct and indirect backward linkages [34, 35]. With regard to forward linkages, Leontief row sums (denoted as α_i) are controversial as it calculates measures of forward linkages based on the strength of backward linkages [35]. As such, the forward oriented Ghoshian model is a popular alternative [6, 35] and uses the output coefficient β_i to calculate both direct and indirect forward linkages.

Summing the rows of the matrix β whose typical element b_{ij} represents the share of output of sector i sold to sector j, gives $\beta'=V'(I - B)^{-1}$, where a prime ($'$) represents the transpose. As with the demand driven I-O model, treating the marine sector as exogenous and assuming that there is no change in value-added in other sectors yields [23]:

$$\Delta X'_e = B_M \Delta X_M (I - B_e)^{-1}$$
        (4)

These two standard linkage measures provide general and complementary information about a given sectors inter-sectoral relationship [34]. Sectors with large Leontief supply-driven multipliers have strong backward linkages, which imply that shocks on these sectors' production would potentially have large impacts on their upstream input suppliers. Symmetrically, sectors with large Ghosh supply-driven multipliers have strong forward linkages, which imply that production shocks on them would potentially have significant impacts on their downstream demanders. A sector's backward-linkage index is calculated by dividing its Leontief supply-driven multiplier by the average Leontief supply-driven multipliers for all the sectors. Thus, a backward-linkage index higher than one implies that the sector has strong backward linkage relative to other sectors in the economy. Forward linkage indices can be calculated similarly by using the Ghosh supply-driven multipliers. Using the IO methodology and linkage analysis the next section presents the first empirical analysis of backward and forward linkages within the Irish maritime

transportation sector. Such an analysis will provide a deeper understanding as to whether current public policy to create a maritime transportation cluster, is effectively targeting the sectors with the strongest linkages to the actual sector.

4. Results

In Ireland, research on the economic value of the maritime transportation sector has been limited to date. This is mainly due to a lack of publically available data on the sector [12]. However, recent research on devising and utilising a methodology to value the commercial value of the Irish marine resource found that the maritime transportation sector generated €697 million in turnover and provided €197 million in gross value added (GVA) to the Irish economy in 2007 [12]. However, as outline in Section 3, sectors do not exist in a vacuum; instead they exist within a complex web of inter-sectoral linkages. The remainder of this section presents the strength of linkages within the maritime transportation sector.

Linkages within the maritime transportation sector

Before examining the maritime transportation sector specifically, table 2 presents (a) the sectors that are most strongly backward linked within the Irish economy and (b) the backward linkage for each of the ten marine sectors. A broad examination of the linkages within the Irish economy indicates that 'mining and quarrying' has the highest backward linkage score (134). However, what is of interest is that within the wider Irish economy, three marine sectors are ranked within the top ten strongest backward linkages – seafood processing, maritime transportation and water construction. Each of these sectors had a backward linkage greater than one, thus implying that these sectors are important input suppliers to other sectors. Overall, the average backward linkage for the Irish economy was 58. This indicates that the sectors in the wider Irish economy had low (less than one) backward linkage effects. This result is not surprising given that Ireland is a small open economy and many of its inputs into the process of production are imported from outside the country. Indeed further analysis of the Irish Input-Output table found that on average imports for each of the sixty-two sectors as a percentage of inputs were 60% across the wider economy. In contrast, the ratio of imports to exports in the seafood processing, water construction and water transportation sectors are 0.06%, 15% and 16%, respectively. Thus, indicating the key linkages between the maritime transportation and the broader marine sector and indigenous companies within the Irish economy.

Table 2 Backward linkages in the Irish economy and the Irish marine sector

Top 10 sectors with the strongest backward linkages		Backward Linkages within the Marine Sector	
Other mining and quarrying	134	Seafood Processing	126
Seafood Processing	126	Maritime Transportation	109
Research and development services	109	Water Construction	106
Maritime Transportation	109	Fishing	77
Sewage and refuse disposal services	107	Boat Building	73
Water Construction	106	Marine Engineering	69
Post and telecommunication services	103	Marine Retail	63
Forestry	96	WBA	62
Construction work	94	Oil & Gas Extraction	44
Membership organisation services	90	Auxiliary Transport	44

With regard to the maritime transportation sector specifically, from Table 2 one can see that the magnitude of the water transportation sectors backward linkage is €1.09. This implies that for every €1 produced within the water transportation sector, €0.09 is backward linked to its direct and indirect upstream suppliers. Four cents of this €0.09 belongs to the water transportation sectors direct suppliers and €0.05 belongs to its indirect suppliers (e.g. the suppliers of its direct suppliers). Table 3 continues the analysis by presenting the sectors with which the maritime transportation sector has the highest backward linkages. From table 3, one can see that the sector has high backwards linkages (excluding itself) with auxiliary transportation services, computer and related services, maritime specific auxiliary transportation services (these services include berthing, liner and port services and facilities), financial intermediation services, post and telecommunications, insurance and pension, petroleum and other manufacturing products and motor fuel and vehicle trade and repair. These results indicate that for the maritime transportation sector the most important input suppliers are within the professional service sector. As outlined above, the Irish government have developed a number of policy supports, notably the Irish tonnage tax system, to encourage the growth and development of a high tech, professional service led, maritime cluster. Using the disaggregated IO table, it was found that the maritime sector has above average backward linkages. With such strong linkages already observed, this analysis indicates that there is a strong rationale for development of an Irish maritime transportation cluster

Table 3 Sectors with backward linkages to the maritime transport sector

Sectors with Backward Linkages to the Maritime Transport Sector	
Water transport services	47
Auxiliary transport services and travel agencies	18
Computer and related services	8
Auxiliary Transport Marine	4
Financial intermediation services	4
Post and telecommunication services	3
Insurance and pension services	3
Other business services	3
Petroleum and other manufacturing products	2
Motor fuel and vehicle trade and repair	2
Highest Linkage Score in the Overall Irish I-O table - 134	
Average Linkage Score - 31	
Average Linkage Rank – 58	

Forward linkages

Table 4 presents (a) the sectors that are most strongly forward linked within the Irish economy and (b) the forward linked for each of the ten marine sectors. As indicated above, a sector is forward linked to other sectors through its direct and indirect sales to them. A broad examination of the linkages within the Irish economy indicates that 'forestry' has the highest backward linkage score (199). Overall, the average backward linkage for the

Irish economy was 62. From table 4 (b) one can see that that only one marine sector; maritime transportation has a forward linkage greater than one (120). This implies that every €1 produced by the maritime transportation sector is forward linked to €0.20 to the production of the sectors direct and indirect downstream demanders. In detail, for €1 of the production of water transportation services, €0.49 is sold directly for final consumption, including €0.08 for local consumption and €0.41 for exports. The rest €0.20, are bought by the water transportation sectors downstream demanders. The small forward linkages of the other nine marine based sector, particularly the marine retail, boat building, seafood processing, water based activities and water construction reflects the fact that for these sectors almost all of their goods and services are sold for final consumption.

Table 4 Forward linkages in the Irish economy and the Irish marine sector

Top 10 sectors with the strongest forward linkages		Forward Linkages within the Marine Sector	Linkage
Forestry	199	Water transport services	120
Other mining and quarrying	185	Auxiliary Transport	95
Recycling	176	Marine Engineering	95
Other non-metallic mineral products	148	Fishing	69
Post and telecommunication services	**139**	Oil & Gas Extraction	62
Electricity and gas	137	Water Based Construction	53
Maritime transportation services	120	WBA	52
Wood and wood products	**116**	Seafood Processing	28
Services auxiliary to financial intermediation	114	Boat Building	1
Fabricated metal products	111	Marine Retail	0

Examining the sectors with which the maritime transportation sector has high forward linkages, from table 5, one can see that (excluding itself) the sector has high forward linkages with wholesale trade (15), post and telecommunications (10), construction work (10), auxiliary transportation services (6), hotel and restaurant services (3), fishing (2), food and beverages (2), motor fuel and vehicle trade and repair (2) and services auxiliary to financial intermediation (2). To continue examining the role the maritime transport sector plays in the Irish economy, table 6 provides the relative position of the top five sectors within the Irish economy in terms of turnover and exports in 2007. Comparing the sectors with which the maritime transportation sector has high forward linkages with to the strongest performing sectors in 2007, from table 6, one can see that the sector was an important input supplier to four of the five sectors with the highest turnover in 2007, construction (€47.5 billion), wholesale trade (€20.8 billion), financial intermediation (€20.2 billion) and food and beverages (€19.1 billion). It was also was an important input supplier to two of the five sectors with the highest exports in 2007, (€13.9 billion) and wholesale trade (€9.2 billion).

Placing the high forward linkage demonstrated by the water transportation sector in context, the maritime transportation sector is a service sector and is strongly forwarded linked because it provides a service to other sectors in the economy. Furthermore, as outlined above, Ireland is a small, open economy and its island status means that sectors in the wider economy rely heavily on water transportation as a means of importing and exporting goods. Thus, given the structure and geo-economic status of the country, it is

unsurprising that maritime water transportation is an important intermediate service in the production process of Irish industrial and manufacturing sectors.

Table 5 Sectors with forward linkages to the maritime transport sector

Sectors with Forward Linkages to the Maritime Transport Sector	
Water transport services	47
Wholesale trade	15
Post and telecommunication services	10
Construction work	6
Auxiliary transport services and travel agencies	6
Hotel and restaurant services	3
Fishing	2
Food and beverages	2
Motor fuel and vehicle trade and repair	2
Services auxiliary to financial intermediation	2
Highest linkage within the Disaggregated Irish I-O table – 199	
Average Linkage Rank – 31	
Average Linkage Score – 62	

Table 6 Relative position of the top 5 strongest sectors in terms of income and export within the Irish economy, 2007

Sector	Turnover (€'000)	Sector	Exports (€'000)
Food and beverages	19176	Chemical products & man-made fibres	31101
Financial intermediation services	20218	Office machinery and computers	15208
Wholesale trade	20855	Printed matter and recorded media	14465
Chemical products & man-made fibres	33592	Food and beverages	13940
Construction work	47587	Wholesale trade	9207

In line with global trends, between 1992 and 2002, output in the Irish maritime transportation sector declined by 50%. As outlined in Section 2, to halt the further decline of the sector, government policy has been implemented to stimulate growth in the Irish maritime transport sector, through the formation of a maritime transportation cluster. This cluster would include shipping operations at its core and with potential linkages to high value added, technological based professional services in areas such as banking, law, maritime commerce, ship finance and insurance. From the linkage analysis presented in this section, one can see that in 2007 the sector has strong linkages with the wider Irish economy. Thus, given the general requirements for the successful development of a cluster – a relatively high abundance of firms spatially concentrated with strong linkages to related sector, the future development of a maritime transportation cluster could potentially have large effects on the rest of the economy.

Employment Impacts of the Irish Marine Transport Sector

Policymakers are frequently preoccupied with the employment-creating effects of industrial expansion. The marine sector as a whole is believed to be of high employment

benefit to local and coastal communities [35, 36]. For this reason, it is important to be able to derive employment multipliers as well as production multipliers from the I-O model. Table 7 presents the five highest ranking employment inducing sectors in 2007 and the relative position of the maritime transportation and auxiliary maritime services sector.

Within the marine sector, the water construction sector (0.9) has the highest employment inducing effect and is the fifth highest sector across the whole Irish economy. This means that for every €100,000 invested in the water construction sector 0.9 individuals are employed (as full time equivalents, FTE). Specifically examining the water transportation sector and the auxiliary marine transport sectors, the total impact of the marine sector on employment is 0.27 (water transport services, 0.14 and marine auxiliary transport services, 0.13). That is for every €100,000 invested in the marine sector as a whole approximately 0.13 individuals, FTE, will be employed. The low employment inducing income of the maritime transportation sector (particularly relative to its high production inducing effect) has been identified by international research as a direct implication of the Flags of Convenience policy, which allows shipping companies to source labour outside of their home country [37].

Table 7 Top 5 Employment Multipliers for the Irish Economy in 2007 and the Maritime Transports ranked position

Sector	Multiplier (Rank)
Agriculture	2.3 (1)
Real estate services	2.0 (2)
Construction work	1.7 (3)
Food and beverages	1.0 (4)
Water Construction	0.9 (5)
Water transport services	0.1 (51)
Auxiliary Transport Marine	0.1 (52)

To continue the analysis, Table 8 provides a breakdown of the maritime transportation and auxiliary marine transportation services employment multipliers by the sectors that they have the greatest impacts on (according to the linkage analysis provided above). In terms of water transportation sector, the sectors receiving the largest downstream FTE employment impacts are other business services (Water Transport, 0.06), auxiliary transport services (0.025) and construction (0.02). In terms of auxiliary marine transport services, the sectors receiving the largest downstream FTE employment impacts are other business services (Water Transport, 0.05), construction (0.02) and computer and related services (0.01). Thus, similar to the analysis on marine production effects, the employment multiplier presented in this paper indicates that the sector has the strongest impacts with the Irish service sectors.

Table 8 Marine employments multipliers and the downstream sectors greatest impacted

Sector (Total Multiplier)	Sub-Sectors receiving the greatest impact by individual marine sector (FTE)		
Water Transport (0.1)	Other business services	Auxiliary transport services and travel agencies	Construction work
	0.035	0.025	0.02
Auxiliary marine transport services (0.1)	Other business services	Construction work	Computer and related services
	0.05	0.02	0.01

5. Discussion

The main objective for developing cluster policies is to improve the business environment, capabilities, and performance of local firms in targeted industries [7]. It is within this context, that Irish public policy is focused on the development of a maritime transportation cluster. This cluster would include shipping operations at its core and with potential linkages to high value added, technological based professional services in areas such as banking, law, maritime commerce, ship finance and insurance. However, recent research has questioned the current emphasis on cluster formation given that it is rarely supported by empirical economic evidence indicating that cluster formation would be of benefit to both the sector in question and the wider economy [6, 7]. The objective of this paper was to formally examine the direct and indirect impact of the maritime transportation sector and its potential for cluster formation. Using input-output analysis, it was found that the maritime transportation sector had the second highest backward linkage and highest forward linkage in the Irish economy in 2007. In terms of backward linkages the analysis found that in 2007 the sector had high backwards linkages with a number of professional and technology based services, such as the computer, insurance and banking sectors. Symmetrically, with regard to forward linkages the analysis showed that the maritime transportation sector was an important input into three of the most economically valuable sectors in the Irish economy – the food and beverages sector, the construction sector and wholesale trade. In line with the cluster theory presented in Section 3, given the strong linkages to a number of key service sectors already in place and the large backward linkages to a number of key economic sectors, the future development of a maritime transportation cluster could potentially have large effects on the rest of the economy. Acknowledging research that indicates that clusters tend to operate and develop along different paths depending on the sector and regional [7, 21], future public policy on the development of a Irish maritime cluster needs to focus on best practice related to the maritime transportation sector in itself

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