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ΔΙΑΤΡΙΒΗ

για την απόκτηση διδακτορικού διπλώματος του Τμήματος Ναυτιλίας και Επιχειρηματικών Υπηρεσιών

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«The contribution of Greek-owned shipping to the Greek economy: Methodological issues and an estimation proposal – Πρόβλεψη συμβολής της ελληνόκτητης ναυτιλίας στην ελληνική οικονομία: Μεθοδολογικά προβλήματα και πρόταση εκτίμησης»

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Χίος, 2022

The contribution of Greek-owned shipping to the Greek economy: Methodological issues and an estimation proposal

PhD Thesis

Stylianos Th. Panagiotou

Chios, 2022

I am the sole author of the submitted PhD Thesis entitled "*The contribution of Greek-owned shipping to the Greek economy: Methodological issues and an estimation proposal*". This particular PhD Thesis is original and was prepared exclusively for obtaining the PhD degree of the Department of Shipping and Business Services. Any help I have had in its preparation is fully acknowledged and accurately referenced in the paper. I also accurately cite in the work the sources I have used, and mention by name the data or ideas that are the product of the intellectual property of others, even if their inclusion in this work has been indirect or paraphrased. More generally, I certify that during the preparation of the PhD Dissertation I have strictly adhered to the provisions of the law on intellectual property and have fully complied with the provisions of the law on personal data protection and the principles of Academic Ethics.

The approval of the PhD thesis by the Department of Shipping, Trade and Transport does not necessarily indicate the acceptance of views and opinions expressed by the author (Law 5343/1932, article 202, par.2).

Πρόβλεψη συμβολής της ελληνόκτητης ναυτιλίας στην ελληνική οικονομία: Μεθοδολογικά προβλήματα και πρόταση εκτίμησης

Διδακτορική Διατριβή

Στυλιανός Θ. Παναγιώτου

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Είμαι ο αποκλειστικός συγγραφέας της υποβληθείσας Διδακτορικής Διατριβής με τίτλο «*Πρόβλεψη συμβολής της ελληνόκτητης ναυτιλίας στην ελληνική οικονομία: Μεθοδολογικά προβλήματα και πρόταση εκτίμησης*». Η συγκεκριμένη Διδακτορική Διατριβή είναι πρωτότυπη και εκπονήθηκε αποκλειστικά για την απόκτηση του Διδακτορικού διπλώματος του Τμήματος Ναυτιλίας και Επιχειρηματικών Υπηρεσιών. Κάθε βοήθεια, την οποία είχα για την προετοιμασία της, αναγνωρίζεται πλήρως και αναφέρεται επακριβώς στην εργασία. Επίσης, επακριβώς αναφέρω στην εργασία τις πηγές, τις οποίες χρησιμοποίησα, και μνημονεύω επώνυμα τα δεδομένα ή τις ιδέες που αποτελούν προϊόν πνευματικής ιδιοκτησίας άλλων, ακόμη κι εάν η συμπερίληψή τους στην παρούσα εργασία υπήρξε έμμεση ή παραφρασμένη. Γενικότερα, βεβαιώνω ότι κατά την εκπόνηση της Διδακτορικής Διατριβής έχω τηρήσει απαρέγκλιτα όσα ο νόμος ορίζει περί διανοητικής ιδιοκτησίας και έχω συμμορφωθεί πλήρως με τα προβλεπόμενα στο νόμο περί προστασίας προσωπικών δεδομένων και τις αρχές Ακαδημαϊκής Δεοντολογίας.

Η έγκριση της διδακτορικής διατριβής από το Τμήμα Ναυτιλίας και Επιχειρηματικών Υπηρεσιών δεν υποδηλώνει απαραίτητα και αποδοχή της (Ν.5343/1932, άρθρο 202, παρ.2).

Στους γονείς μου *To my parents*

Στη σύζυγό μου και στις κόρες μου *To my wife and my daughters*

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«Σὰ βγεῖς στὸν πηγαιμὸ γιὰ τὴν Ἰθάκη,
νὰ εὔχεσαι νᾶναι μακρὺς ὁ δρόμος,
γεμάτος περιπέτειες, γεμάτος γνώσεις.
…
Ἡ Ἰθάκη σ᾽ ἔδωσε τ᾽ ὡραῖο ταξεῖδι.
Χωρὶς αὐτὴν δὲν θἄβγαινες στὸν δρόμο.
…
Ἔτσι σοφὸς ποῦ ἔγινες, μὲ τόση πεῖρα,
ἤδη θὰ τὸ κατάλαβες ἡ Ἰθάκες τί σημαίνουν. »

Κ. Π. Καβάφης
(Ιθάκη, περιοδικό Γράμματα της Αλεξάνδρειας (1911), τεύχος 9-10, σελ. 286-287)

Σας ευχαριστώ πολύ!

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Finally, a poet comes to my mind, which also describes my own journey towards the completion of the thesis.

"As you set out for Ithaka
hope your road is a long one,
full of adventure, full of discovery.
…
Ithaka gave you the marvelous journey.
Without her you wouldn't have set out.
…
Wise as you will have become, so full of experience,
you'll have understood by then what these Ithakas mean."

C. P. Cavafy,
(Translated by Edmund Keeley and Philip Sherrard.
Source: C.P. Cavafy: Collected Poems, Princeton University Press, 1975.)

Thank you very much!

Stelios Th, Panagiotou

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List of Abbreviations

ADF	Augmented Dickey-Fuller
AIC	Akaike Information Criterion
ARDL	AutoRegressive Distributed Lags
BoP	Balance of Payments
CA	Current Account
dwt	deadweight tonnage
ECM	Error-Correction Model
EL.STAT.	Hellenic Statistical Authority
GDP	Gross Domestic Product
GNP	Gross National Product
grt	gross registered tonnage
GSCC	Greek Shipping Co-operation Committee
GSEM	Greek Shipping Estimation Model
GSI	Greek Shipping Index
gt	gross tonnage
GVA	Gross Value Added
IMF	International Monetary Fund
IOBE	Foundation for Economic and Industrial Research
KEPE	Centre of Planning and Economic Research
LD	Legislative Decree
LNG	Liquified Natural Gas
LPG	Liquified Petroleum Gas
NAT	Seafarers' Pension Fund
NEE	Greek Chamber of Shipping
NSGG	National Statistical Service of Greece
OECD	Organisation for Economic Co-operation and Development
PP	Phillips and Perron
RCA	Revealed Comparative Advantage
SIC	Schwarz Information Criterion
TEU	Twenty-foot Equivalent Unit
UNCTAD	United Nations Conference on Trade and Development

Abstract

Sea transport export receipts, which almost exclusively relate to ocean-going shipping, have historically covered a significant part of Greece's perennial deficit in the trade of goods and in the current account. By the use of the Revealed Comparative Advantage indices, it is shown that Greece has a comparative advantage in exporting sea transport services.

Recently, in 2015, the compilation methodology for the sea transport services receipts in the Greek Balance of Payment was changed. The new (post-2015) compilation methodology is based on a statistical model - the Greek Shipping Estimation Model (GSEM) - that uses administrative data and data from international shipping databases. The international practice in other sea nations, especially those in the EU that were analysed in the thesis, suggests that the survey method is the preferred one for the compilation of the BoP accounts.

The determinants of the sea transport service receipts in the Greek BoP in the post-2015 period were investigated with the use of the AutoRegressive Distributed Lag (ARDL) bounds testing methodology - that was proposed by Pesaran et al (2001) - for the existence of cointegration between the variables. The ARDL bounds testing methodology is a relatively new one and has only recently found its way in the maritime economics empirical literature. The empirical analysis shows that the Greek Shipping Index (GSI), which is a Greek fleet specific freight revenue index, the cost of bunkers and the size of the active Greek-controlled fleet are the determinants of the sea transport receipts in the BoP in the post-2015 period. However, only the GSI and the bunker cost seem to be significant in the pre-2015 period, along with credit to shipping, a variable that it is not available anymore. These results indicate that the determinants before and after the compilation methodology are not the same, though the GSI is still a significant determinant. The thesis proceeds into backcasting the 2002-2014 period based on the post-2015 model with the aim to identifying the existence of any variation or convergence. The results indicate that the backcasted series is consistently below the old (pre-2015) methodology time series; however, towards the end of the backcasting period the two series start to converge.

Σύνοψη (Abstract in Greek)

Οι εισπράξεις από θαλάσσιες μεταφορές, που αφορούν σχεδόν αποκλειστικά την ποντοπόρο ναυτιλία, καλύπτουν διαχρονικά σημαντικό μέρος του ελλείμματος του εμπορικού ισοζυγίου και του ισοζυγίου τρεχουσών συναλλαγών της χώρας. Η Ελλάδα κατέχει συγκριτικό πλεονέκτημα στις εξαγωγές θαλάσσιων μεταφορών, σύμφωνα με τους δείκτες του Αποκαλυφθέντος Συγκριτικού Πλεονεκτήματος.

Πρόσφατα, το 2015, άλλαξε η μεθοδολογία κατάρτισης των λογαριασμών για τις υπηρεσίες θαλάσσιων μεταφορών. Η νέα μεθοδολογία κατάρτισης βασίζεται σε ένα στατιστικό μοντέλο - Greek Shipping Estimation Model (GSEM) - που χρησιμοποιεί δεδομένα τόσο από διοικητικές πηγές όσο και από διεθνείς βάσεις δεδομένων. Η ανάλυση της διεθνούς πρακτικής ανέδειξε ότι η χρήση ερωτηματολογίων είναι η προτιμώμενη μέθοδος.

Οι προσδιοριστικοί παράγοντες των εισπράξεων από θαλάσσιες μεταφορές την περίοδο μετά το 2015 διερευνήθηκαν με την εφαρμογή της μεθοδολογίας ελέγχου ορίων (bounds testing) του Αυτοπαλίνδρομου Υποδείγματος Κατανεμημένων Χρονικών Υστερήσεων (Autoregressive Distributed Lag - ARDL) - που προτάθηκε από τους Pesaran et al (2001) - για την ύπαρξη συνολοκλήρωση μεταξύ των μεταβλητών. Η μεθοδολογία αυτή είναι σύγχρονη και μόλις πρόσφατα άρχισε να χρησιμοποιείται στην εμπειρική έρευνα της ναυτιλιακής οικονομικής. Η εμπειρική διερεύνηση κατέδειξε ότι ο Ελληνικός Ναυλοδείκτης (GreekShippingIndex - GSI), ο οποίος είναι ένας σταθμισμένος δείκτης εσόδων ειδικά για τον ελληνόκτητο στόλο, το κόστος των καυσίμων και το μέγεθος του ενεργού ελληνόκτητου στόλου αποτελούν τους προσδιοριστικούς παράγοντες των εισπράξεων από θαλάσσιες μεταφορές. Ωστόσο, μόνο ο ναυλοδείκτης GSI και το κόστος των καυσίμων παραμένουν στατιστικά σημαντικά την περίοδο πριν από το 2015, μαζί με τα υπόλοιπα δανείων προς τον κλάδο της ναυτιλίας, μια μεταβλητή που δεν είναι πλέον διαθέσιμη. Συνεπώς, οι προσδιοριστικοί παράγοντες πριν και μετά τη μεταβολή της μεθοδολογία κατάρτισης δεν ταυτίζονται με εξαίρεση τον ναυλοδείκτη GSI. Η αναδρομική εκτίμηση για την περίοδο 2002-2014 έδειξε ότι η εκτιμηθείσα χρονοσειρά ήταν χαμηλότερα από την αρχική (προ του 2015), αν και οι δύο σειρές συγκλίνουν προς το τέλος της περιόδου εκτίμησης.

Impact Statement

Sea transport receipts represent close to 40% of total services receipts in the Greek Balance of Payments (BoP) and they are along with travel (tourism) receipts the key exportable services sector of the Greek economy. The compilation methodology of sea transport receipts had recently undergone a significant change, which affected the data series since 2015. The purpose of this study was to assess whether the determinants and the effect of these determinants were the same before and after the methodology change. Moreover, the study also compared the compilation methodology that is currently in use with the international practice.

The study identified that the Greek Shipping Index, a weighted average freight rate index for the Greek-controlled fleet, is a determinant for the sea transport services in the pre- and post-2015. The price of bunkers is another determinant in the post-2015 period, but it has only a short-run effect in the pre-2015. On the other hand, the capacity of the active Greek-controlled fleet which is a determinant in the post-2015 period, it does not seem to be statistically significant in the pre-2015; credit to domestic shipping companies provided a better fit in the pre-2015 period as a Greek shipping centre variable. Finally, on the basis of the estimated model, the sea transport time series for the 2002-2014 period was backcasted. Despite the fact that the original and the backcasted time series exhibited noticeable differences, they started to converge towards the end of the estimation period; time when the new compilation methodology was implemented.

From an academic point of view, the study revealed the determinants of sea transport receipts in the Greek BoP; the first one since the adoption of the new compilation methodology. Moreover, it developed a Greek-fleet specific freight index that reflects the average earning of the Greek-controlled fleet and employed the ARDL bounds testing methodology which recently started to find its way in the maritime and transport economics literature. Finally, it provided a backcasted timeseries of sea transport receipts for the period 2002-2014 based on the current compilation methodology; this time series can be employed by other researcher in their empirical applications.

From a public policy maker standpoint, the research identified that the key determinants of the sea transport inflows and therefore the policy makers can identify the variables that are within their policy design framework. Moreover, the international comparison of the compilation methodology of the sea transport receipts revealed that the collection of data is moving towards survey-based methodologies that can provide also additional information such as the size of the fleet, its employment and the actual freight earnings.

CHAPTER 1: INTRODUCTION

Chapter Summary: Receipts from the export of sea transport services represented more than 40% of total service receipts in the Greek Balance of Payments (BoP) in the 2002-2020 period and it is along with travel (tourism) receipts the key exportable services sectors of the Greek economy. The compilation methodology of sea transport receipts had recently undergone a significant change, which affected the data series since 2015. The purpose of the thesis is to assess whether the determinants and the effects of these determinants were the same before and after the methodology change. Moreover, the research also compared the compilation methodology currently in use with the international practice. The Chapter presents the thesis research questions, outlines the methodology employed and concludes with its contribution to the existing literature.

1.1 The research question: Background and research interest

The purpose of this study is to assess whether the determinants and the effect of these determinants were the same before and after the methodology change which affected the data series since 2015. The study also compares the compilation methodology that is currently in use with the international practice. In executing the empirical part of the study a number of challenges had to be addressed and a new methodological approach suggested.

1.1.1. Shipping and the Greek economy

Greece has a significant comparative advantage in the world trade of the sea transport services as it will be exhibited in the main body of the thesis (see Chapter 2) by the Revealed Comparative Advantage indices and by its long standing as the worlds' leading maritime power over almost half a century (Harlaftis, 1996; Harlaftis, Thanopoulou and Theorokas, 2009). The Greek-controlled fleet has increased significantly over the past 20 years, promptly following the developments in the world fleet which has about doubled within the present century (GSCC, 2021); this dynamic growth allowed the Greek-owned fleet to maintain its world share at around 16% in capacity terms (dwt) and its hegemonic position in world shipping (UNCTAD, 2021). On the one hand, the Greek-owned fleet exhibits higher specialization in the oil tanker and the dry bulk sector vis-à-vis world averages (GSCC; see also Chapter 2). On the other hand, the Greek owned fleet had until recently a lower specialisation in the liquid gas sector - in which it has caught up quickly - and in the container sector which constitutes about 6.4% of the Greek-owned fleet while the average for the world tonnage is 15.2% (GSCC, 2021). However, in recent year the gap in that former sector is starting to also narrow.

This large Greek shipping cluster has been built through a long history (Harlaftis, 1996), through astute investment strategies (Thanopoulou, 1996) and through mainly two legal pillars in the post-war period (Harlaftis et al, 2009):

a. the one related to the registration of vessels in the Greek registry

b. the legal framework related to the taxation and establishment of the Greek cluster companies (Harlaftis, 1993).

The management and the operation of the Greek-owned fleet under all flags is mainly taking place from Piraeus in Attica (and today the wider Attica region as well) as the traditional location of the Greek shipping cluster (Vaggelas and Pallis, 2019). Through this large shipping business cluster Piraeus itself is ranked among the top-5 shipping centers of the world (Menon Economics and DNV GL). The number of shipping and shipping-related activities offices and branches is constantly increasing in Greece, as well as the number of managed vessels (Ministry of Shipping, 2019).

1.1.2. The statistical recording of Greek shipping inflows: the focus of the research

The exports of sea transport services are recorded in the Balance of Payments (BoP), which summarises the transactions between residents and non-residents. Specifically, the sea transport services inflows are recorded in the service account. There is a variety of compilation methodologies depending on the economic structure and the data availability in the reporting country. Specifically in Greece, there were two different compilation methodologies employed during specific periods; pre- and post-2000. Even in the latter, there was a significant change in the compilation methodology which affected the data from 2015 onwards. Research on the determinants of sea transport inflows can be split into two periods, reflecting the two distinct Balance of Payments methodologies by the Bank of Greece; the first one for the period before 2000 and the second one after 2000.

The majority of studies based on data before 2000 advocated that domestic (e.g. CPI, number of seafarers) variables were the key determinants for the sea transport inflows in the Greek BoP, while international variables such as freight rates did not seem to play a significant role. The studies based on data post-2000 employed advanced econometric methodologies that were not available to the pre-2000 researchers. They identified both international (e.g. freight rates) and domestic variables (e.g. domestically provided shipping loans as a proxy of the shipping cluster) as determinants of sea transport inflows.

Receipts from the provision of ocean-going shipping services by Greek-owned ships, both under Greek flag or under foreign ones, have played a pivotal role in the development of

the Greek economy. This role ranged from a stabilising one during crises to this of a growth booster during periods of growth of the Greek economy. During the latter part of the 20th century few studies attempted to identify the determinants for the shipping inflows and the corresponding impact to the national economy. Their significance was not underestimated; taking into account the international nature of shipping, the inflows in the national economy seem to be the driver for the contribution/impact of the shipping industry in the national economy.

However, changes in context and methodology regarding the Greek shipping industry and the measurement of its main financial contribution to the economy have been significant: Until the end of the previous 20th century, shipping receipts were recorded under "transportation receipts", a constituent part of the "invisible" receipts in the current account; with the advent of the current century, these flows started to be recorded as "receipts from transportation services" (see Chapter 4). While both recording approaches reflect the inflows of real – usually contributed in USD – funds from shipping into the Greek economy, the methodology and the statistical needs served by each were different. As with time the relation of the Greek shipping as a whole with the national economy has clearly increased - as it became more and not less incorporated with the latter almost in its entirety at least in terms of management headquarters - (Harlaftis, 1996; Harlaftis, Thanopoulou and Theotokas, 2009) assessing the real impact through statistics is less clear.

1.1.3. The research question of the Thesis

The main research question of the study is built around modeling the determinants of the sea transport services inflows in the Greek Balance of Payment in the new era of a fully-fledged Greek maritime cluster around the ship-management and operation companies. The study will further address the issue on whether the determinants of the sea transport receipts have altered before and after the change in the compilation methodology that affected the sea transport services time series since 2015.

Therefore, the key and the auxiliary constituent parts of the research questions are:

A. Are the determinants of the sea transport services inflows before and after the compilation methodology change the same? More analytically:

A.1. What are the main determinants of the sea transport inflows after the compilation methodology change for the post-2015 period?

A.2 Are these determinants the same as in the pre-2015 period?

A.3. In case they are not, is the backcasted time series for the pre-2015 similar to the original one?

B. Based on the international practice of other key shipping nations, how does the Greek compilation methodology compare to this of the latter?

1.2 Methodology

There are three major methodological choices which set the whole methodological framework of the research.

I. The main methodological approach of the Thesis is an econometric one, based on an AutoRegressive Distributed Lag (ARDL) model. The study uses the ARDL bounds testing methodology for the estimation of the determinants of the sea transport receipts in the Greek BoP before and after the change in the compilation methodology since 2015. As discussed extensively in the methodology related sections of the main body of the Thesis (see Chapter 7), the ARDL bounds testing methodology - which recently started to find its way in the maritime and transport economics empirical research - exhibits better estimation properties in small samples and provides reliable estimates. This was a key determining factor for the selection of the aforementioned methodology as the sample – under the new compilation methodology - is relatively small (less than 70 observations). Moreover, the ARDL model is used for backcasting the sea transport receipts time series for the period 2002-2014.

II. Towards the identification of the determinants, a Greek-fleet specific freight index (Greek Shipping Index – GSI) that reflects the average earning of the Greek-controlled fleet was developed. Moreover, as the new shipping inflows and

outflows statistics' compilation methodology was adopted in 2015, the size of the sample is relatively small from a time series technique point of view.

III. Finally, the international comparison of the compilation methodology of the sea transport receipts reveals how the Greek model compares to other key shipping nations and provides a number of suggestions for the enhancement of the compilation methodology.

1.3 Structure of the Thesis

The Thesis is comprised of nine chapters.

In Chapter 1, the Thesis motivation is outlined and the key research question as well as the research methodology are presented in summary.

Chapter 2 presents the core stylized facts of Greek Shipping and of the shipping inflows and outflows in the Greek economy. In this Chapter the key characteristics of the Greek-controlled fleet are also presented.

Chapter 3 describes the role of the Greek maritime cluster and outlines the contribution of the shipping cluster to the national economy.

Chapter 4 discusses the compilation methodologies of the sea transport services receipts in Greece and in other significant sea nations in EU and worldwide

Chapter 5 covers the literature review of research on shipping inflows determinants. Publications and unpublished research on the determinants of sea transport inflows before and after 2000 are presented and critically assessed.

Chapter 6 outlines the theoretical framework on which the empirical model is based upon with the data and their time series properties being presented.

Chapter 7 presents the ARDL bounds testing methodology and the steps for its implementation. The chapter concludes with a section on bibliometric review of the ARDL methodology applications across Transport and Maritime economics journals.

Chapter 8 presents the empirical results of the model. The determinants of the sea transport receipts in the Greek Balance of Payments are estimated on basis of the ARDL bounds testing methodology. The chapter concludes with the discussion of the empirical findings.

Chapter 9 concludes the Thesis with the presentation of the key findings, the corresponding policy implications and the contribution of the Thesis to the existent literature.

1.4 Contribution of the Thesis

In his inaugural address to the inaugural meeting of the International Association of Maritime Economists in 1992, Heaver (1992) described the many facets of maritime economics. Almost 30 years later, the framework his research offered on the research topics and avenues for more research in maritime economics is broadly valid. Heaver (1992) identified three main research branches with possible linkages between them. These are:

- Public policy research, dealing with issues such as national policy, externalities, market failures.
- Market studies such as those on freight markets, inputs to shipping, ship-building, infrastructure (e.g. canals)
- Managerial studies related to a great range and diversity of issues including fleet deployment, costing etc.

In terms of main focus area, this Thesis could be categorised as an econometric approach of contribution of shipping to the national economy, hence as falling within the public policy research branch of the maritime economics with linkages to market studies, especially in relation to freight and ship markets. More succinctly, this Thesis contributes in identifying the determinants of sea transport receipts in the Greek BoP and is the first completed research effort since the adoption of the new compilation methodology. Its main contribution in this regard is the provision of an empirical framework for the determinants of the sea transportation receipts and the assessment of the role of the determinants before and after the change in the compilation methodology.

1.5 Chapter 1 – Key takeaways

- The Thesis is built around 2 research questions. The first one attempts to identify the determinants of the sea transport receipts in the Greek BoP and the second to assess the methodology employed in Greece against international practice of other key shipping nations.

- The Thesis employs the ARDL bounds testing methodology for the estimation of the determinants of the sea transport receipts in the Greek BoP before and after the change in the compilation methodology since 2015.

CHAPTER 2: GREEK SHIPPING AND SHIPPING INFLOWS TO THE GREEK ECONOMY – STYLISED FACTS

Chapter Summary: Over the last 20 years, receipts from the exports of sea transport services represented more than 6% of GDP and covered close to 30% of the goods trade deficit of the Greek economy. Along with tourism, the sea transport exports constitute the key exportable services and amount to almost 50% of the total Greek exports. The significance of sea transport exports in the Greek economy (as % of the GDP) is higher compared to the EU average and only comparable to this of Cyprus and Denmark. Moreover, Greece has a significant comparative advantage in the world trade of sea transport services on the basis of the Revealed Comparative Advantage index. In the past 20 years, the Greek-controlled fleet has increased significantly and promptly followed the developments in the world fleet; this allowed the Greek-owned fleet to maintain its share at around 16% in capacity terms (dwt). The structure of the Greek-owned fleet presents differences with that of the world fleet, as the Greek one is more specialised in the oil tanker and the dry bulk sector vis-à-vis the world. On the other hand, the Greek owned fleet is less specialised in the liquid gas and the container sector; a gap which is starting to narrow in recent years, especially in the former sector.

2.1 Definitions and sources of statistical data for the Greek fleet and Greek shipping

Over the past 20 year, there were significant steps towards the harmonization of the Greek external sector statistics (i.e. Balance of Payments, National accounts and merchandise trade) (Theofilakou and Stournaras, 2013). This move was also reflected in the sea transport services receipts which is a constituent of the external sector statistics.

At the advent of 2000, there was a renewed research interest about the contribution of Greek shipping into the Greek economy (Harlaftis, Thanopoulou and Theotokas 2009; Bragoudakis and Panagiotou, 2010; Bragoudakis, Panagiotou and Thanopoulou, 2015). It was then that it was brought forward the question on the continuity and the comparability of data needed for the analysis of the Greek shipping contribution to the Greek economy. The availability and the good quality of data are prerequisites for academic research as well as for policy design. From the late 1990s to the early 2000s, there was a disruption on the shipping data collection that usually took the form of discontinued publications or changes in the shipping data of a key industry in the Greek economy (Bragoudakis and Panagiotou, 2010; Thanopoulou, 2007; Harlaftis, 1996).

The main sources for official data related to Greek shipping are the Hellenic Statistical Authority (EL.STAT) and the Bank of Greece. EL.STAT, which was previously known as National Statistics Service of Greece (NSSG), publishes data related to the Greek flagged fleet and to seafarers, while the Bank of Greece disseminates data on the sea transport services receipts as part of the Balance of Payments statistics (Thanopoulou and Panagiotou, 2011).[1]

The common statistic that is reported to national publications (see Section 2.1.1) or international publications (see for instance UNCTAD, 2021) is the size and the structure of the fleet The size of the fleet can be measured in number of vessels, in gross tonnage (gt) or deadweight tonnage (dwt), although there may be other units of measurement for specialized fleet such as Twenty Foot Equivalent (TEU) for containerships or cubic metres for LNG carriers. In addition, a country's fleet can be measured on the basis of the vessels

[1] This part is based on Thanopoulou and Panagiotou (2011) that was presented at ECONSHIP 2011 Conference.

flying the national flag or on the vessels that are owned or controlled by nationals but they are registered in other flags, usually in open registries or the so-called flags of convenience. In this thesis, the Greek-owned[2] fleet shall mean the vessels that are owned by Greek entities irrespective of the flag of registration, while Greek-flagged fleet shall refer to those vessels that are registered in the Greek flag.

Moreover, the contribution of the shipping industry can be measured by the receipts from sea transport services in the BoP and on the number of seafarers (Ejstrup and Bindslev, 2010). In the BoP context, the provision of sea transport services from a resident to a non-resident refers to the carriage of goods, people as well as the provision related supporting services. They are classified under freight transport, passenger transport, and other transport (IM, 2009). In this thesis, receipts from the provision of sea transport service will refer to the receipts (exports) of sea transport services that are recorded in the BoP.[3]

2.1.1 Hellenic Statistical Authority – EL.STAT (formerly known as National Statistical Service of Greece – NSSG or ESYE)

On the back of a Royal Decree in 1913, a Maritime Statistics Bulletin was published in 1916 (covering data for 1915). It presented ships' movements from and to the Greek ports of the previous year with a focus on maritime movements. It was published until 1946 (referring to 1942 data). After the Second World War, a Statistics Bulletin with data on the size and structure of the Greek fleet was compiled but then it was addressed to specific ministries and interested parties. In 1961, the first fully fledged Bulletin of Shipping Statistics was published in Greek and English by NSGG. It presented data from 1960 but including also data as back as 1952. Over the years, the Bulletin included additional statistics and by its last volume in 2001 with data for the year 1997, included data grouped in the following broad categories:

A. Greek Merchant Fleet: Fleet size in vessel numbers and total grt; tonnage categories & age and size distributions by main tonnage categories.

[2] The term Greek-owned fleet and Greek-controlled fleet will be used interchangeably.
[3] The term receipts from sea transport services, receipts from the provision of sea transport services and sea transport services receipts will be used interchangeably.

B. Greek Merchant Fleet with a mortgage.

C. Laid up Merchant Ships: Greek flagged laid up (domestically & abroad) as well as foreign flagged vessels laid up at Greek ports.

D. Employment of Greek and foreign seafarers.

E. Shipping Traffic in Greek Ports.

F. Traffic in foreign ports as well as transits of all ships through the Corinth Canal and transits of Greek ships through both the Corinth and the Suez Canal which continued to be included throughout the years the Bulletin was published

G. Shipping Causalties to Greek Merchant fleet and person injured on board.

H. Economic magnitudes of Merchant Shipping related to shipping foreign exchange inflows in the Balance of Payments.

I. Shipbuilding & Repairing activity

After the discontinuation of the Bulletin of Shipping Statistics, the other regular EL.STAT's official publication relating to shipping is the Greek Merchant Fleet monthly press release (in Greek) on the structure of the Greek Fleet which was initiated in December 2006. The Greek fleet data collection system has not been substantially altered since 1964. Effectively, the Domestic Port Authorities and the Greek Consulates (Marine Issues) submits to EL.STAT every month any changes (addition or deletions) that have been recorded to their ships' registries.

In addition, EL.STAT collects and publishes data on:

I. Persons injured on board of ships and in sea areas under the competency of port authorities. Since 1975 on an annual basis.

II. Laid-up Greek and foreign merchant ships in Greek ports. Annually since 1998 but existed also previously.

III. Shipbuilding and ship repairing Industry (activities). Annually since 2000.

IV. Enlisted Greek seamen. Annually since 1998.

V. Census of merchant ships and crews (Seafaring Labor Force). It is conducted every 2 years on the 20th of September of the reference year (since 1978).

2.1.2 Bank of Greece

Since 1948, in the context of the compilation of the Greek BoP, the Bank of Greece records receipts and payments of shipping related activities. Before 1999, the shipping receipts/payments were recorded in the "Invisibles" account And these data - reported in US dollars - were initially published in the monthly *Foreign trade bulletin of Greece* (published from 1964-1979) and then in the *Monthly Statistical Bulletin* of the Bank of Greece. Since April 2004, when the Monthly Statistical Bulletin publication ceased, the BoP data after the change in methodology are published – in euros – in the *Bulletin of Conjectural Indicators;* however, there is no granularity in the sea transport inflow/outflows data.[4] The sea transport services receipts and payments data are available in the External Sector Statistics – Services Balance of the Bank of Greece's website.[5] Apart from the Balance of Payments data, Bank of Greece issues a monthly Press Release named *Bank credit to the domestic private sector*, which includes a breakdown of loans per economic activity (including shipping). However, since March 2019 the loans to shipping companies which have their registered office abroad (i.e. the majority of the Greek-controlled ship owning corporations) are not included in credit to the Greek (domestic) economy but to the country of the registered office (i.e. Other Countries). Finally, since 2022 the series is not available. [6]

[4] The Bulletin of Conjectural Indicators was initially published almost monthly (7-10 times per year) but since 2012 is bi-monthly.

[5] Bank of Greece publishes monthly a Press release on the Balance of Payment. This press release does not explicitly present data on sea transport but rather on transportation as a whole.

[6] The series of the bank credit to the shipping sector dates back to 1988. However, there have been two changes, in 2001 and 2010. In the first case, as the euro became legal tender, data were reported thereafter in the new currency rather than in Greek Drachma and the outstanding amounts of offshore companies were included in the credit to domestic residents. In the second one, there was a reclassification of loans in June 2010 which affected the outstanding amounts of credit to shipping. The series is available only until December 2021.

2.1.3 Other public national sources

The Ministry of Mercantile Shipping (or as it currently called, Ministry of Maritime Affairs and Insular Policy) occasionally publish annual data – in the form of press releases – on the number and capacity of the vessels managed from Greece by companies that have established an office in Greece according to Law 27/1975 along with data such as on the number of employees, expenses of the offices registered in Greece.

2.1.4. Greek Shipping Co-operation Committee (GSCC)

Since 1988, the GSCC publishes the *Greek Controlled Shipping* report which is a detailed analysis of the Greek-controlled and the Greek-flagged based on data provided currently by IHS Markit and in the past by Lloyd's Register of Shipping / Fairplay. This annual report covers a long period of data with a seemingly unchanged methodology. The advantage of the Greek Controlled Shipping report compared to EL.STAT data lays on the depth of the data presentation as it covers not only the Greek-flagged vessels but also the Greek-controlled ones.[7]

2.1.5 Other sources

The Review of Maritime Transport by UNCTAD publishes data on the world fleet and on the ownership of the world fleet. The Review is published annually since 1968. The fleet calculation by the UNCTAD was originally based on data by Lloyds Register Fairplay (up to 2010). Since 2011, the respective figures are based on Clarkson Research Services data.

Finally, private firms and consultancy corporations publish – in some case on a regular and timely manner – data on Greek shipping. One such report is Petrofin which publishes its own Greek shipping company and shipping finance statistics.

[7] Before the GSCC report, a key source for Greek Shipping statistics in relation to the Greek-owned fleet was Naftika Chronika; a meticulously collected and remarkably presented by the standards of that era data series (Thanopoulou and Panagiotou, 2011).

Table 2.1: Sources on the Greek fleet data

Source	Threshold	Data presented	Frequency	Type
EL.STAT	Greek flagged vessels of more than 100 grt	Number & grt Breakdown: GRT classes Age classes Vessels types	Monthly	Primary data collected through Port Authorities & Consulates
GSCC	Greek flagged and Greek controlled vessels of more than 1.000 gt	Number, gt & dwt Breakdown: Age classes Vessels types Flag	Annually	Secondary data provided by Lloyds Register/Fairplay/ IHS Markit.
UNCTAD	Greek flagged and Greek controlled vessels of more than 1.000 gt (until 2010) or 100 gt (from 2011)	Number & dwt	Annually	Secondary data provided by Lloyds Register/Fairplay (until 2010) and Clarksons (from 2011)

Source: Thanopoulou and Panagiotou (2010). Adapted and updated by the author.

2.2. The shipping sector in the Greek economy

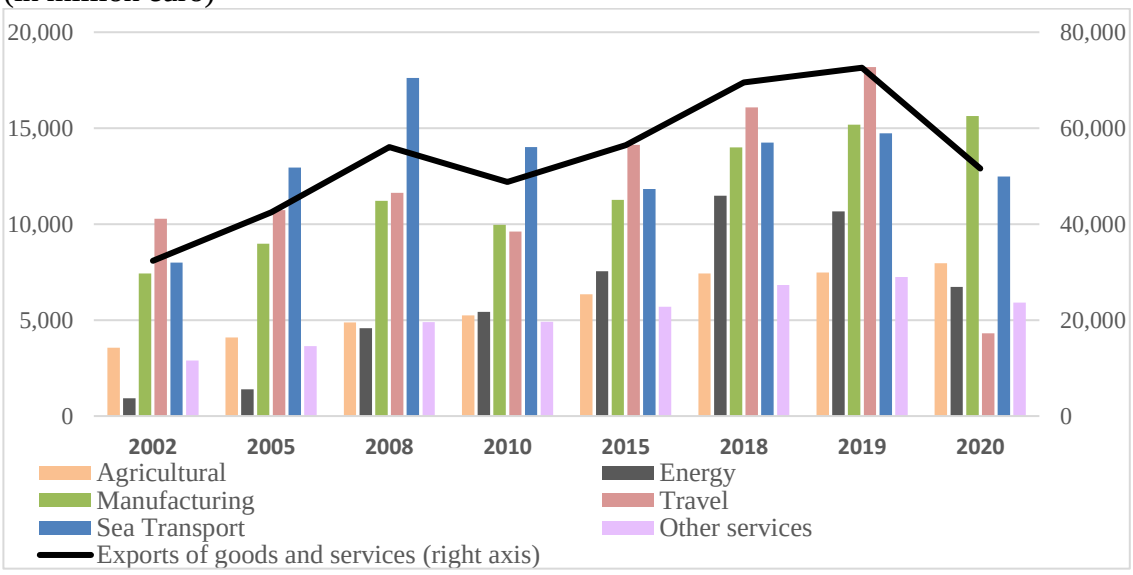
The inflows from the provision of sea transport services played and still plays a paramount role in the Greek economy. Over the last 20 years, they represented for more than 6% of the Greek GDP, even during the sovereign debt crisis in 2010s. The participation of the sea transport inflows averaged more than 7% of GDP in the post-2015 that coincides with the introduction of the new compilation methodology of the shipping account in the Balance of Payments (BoP). Turning to the net sea transport inflows, which take into account the respective payments,[8] their share to the Greek GDP is less than 4%; in the pre-2015 amounted 3.9% while in the post-2015 stood at 3.5%. This figure can be termed as the direct impact of the shipping services to the Greek economy, without taking into account

[8] It is noted that the sea transport payments account in the BoP to a large extent reflects payments that are related to the provision of sea transport services especially in the post-2015 period. However, other BoP accounts (e.g. insurance services) may include inputs/costs necessary for the provision of sea transport services (for a detailed discussion on the BoP, see Chapter 4).

any other (indirect or consumption induced[9]) effects (see Chapter 3). Finally, the net receipts from shipping cover almost 30% of the deficit in the Greek balance of goods.

From an exports point of view, sea transport along with travel are the two main exportable services in the Greek economy and they represent – together – more than 80% of the total Greek receipts from exports of services. Exports of sea transport services until 2015 were higher that the exports of manufactured goods, and since 2016 – with some exceptions – are almost at the same level. Specifically, sea transport receipts amounted – on average in 2002-2020 period – to 43% of the total services exports while travel receipts represented 40%. In the period 2004-2014, the sea transport receipts were higher than the respective inflows from travel (Graph 2.1). This also happened in 2020 though mainly reflecting the unprecedented fall in travel services due to the COVID-19 pandemic and the restrictions in travel. In addition, the receipts from sea transport services represented close to 25% and travel receipts close to 23% of the total exports of goods and services; thus, these two sector represented almost half of the total Greek exports of goods and services (Table 2.2).

Graph 2.1: Structure of Greek exports of goods and services (selected years)
(in million euro)



Sources: Eurostat for merchandise trade data and Bank of Greece for BoP data.

[9] The indirect and consumption induced effects can be estimated from the Input-Output Tables (see Chapter 3 for a review).

Table 2.2 : Basic macroeconomic data on sea transport receipts

																				Average	
	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2002-2014	2015-2020
Sea transport (in billion USD)																					
- Receipts	8.0	9.0	12.4	13.0	13.3	15.7	17.6	12.3	14.0	12.7	11.8	10.7	11.4	11.8	10.6	12.4	14.2	14.7	12.5	12.4	12.7
- Payments	4.0	3.8	4.5	4.6	5.0	5.4	6.5	4.8	5.9	5.1	4.4	3.1	2.9	6.1	4.8	6.2	7.3	7.6	6.9	4.6	6.5
- Net receipts	4.0	5.1	7.9	8.3	8.3	10.3	11.1	7.5	8.1	7.6	7.3	7.5	8.6	5.8	5.7	6.2	7.0	7.1	5.6	7.8	6.2
Sea transport receipts as % of:																					
- GDP	4.9	5.0	6.4	6.5	6.1	6.7	7.3	5.2	6.3	6.3	6.2	5.9	6.5	6.7	6.0	7.0	7.9	8.0	7.5	6.1	7.2
- services receipts	37.8	41.7	46.3	47.4	46.7	49.9	51.6	45.2	49.1	44.4	42.7	38.1	36.9	37.4	35.4	36.8	38.3	36.7	54.9	44.7	39.1
- total exports	24.7	27.0	30.7	30.5	28.8	30.1	31.4	27.4	28.7	24.6	21.8	19.7	20.0	21.0	19.4	20.1	20.5	20.3	24.2	26.4	20.8
Sea transport payments as % of:																					
- GDP	2.4	2.1	2.3	2.3	2.3	2.3	2.7	2.0	2.6	2.5	2.3	1.7	1.6	3.4	2.8	3.5	4.0	4.2	4.2	2.3	3.7
- services payments	34.5	33.9	35.0	35.6	34.8	33.3	35.1	30.7	36.0	33.8	32.2	25.4	22.6	40.2	35.7	39.5	40.7	40.0	44.6	32.7	40.2
- total imports	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
- sea transport receipts	49.8	42.6	36.2	35.8	37.9	34.6	36.8	39.2	42.4	40.0	37.6	29.3	25.3	51.2	45.7	49.8	51.0	51.7	55.1	36.9	50.9
Sea transport receipts (net) as % of:																					
- GDP	2.5	2.9	4.1	4.2	3.8	4.4	4.6	3.1	3.6	3.8	3.9	4.2	4.8	3.3	3.3	3.5	3.9	3.9	3.4	3.9	3.5
- services net receipts	41.7	50.5	56.6	58.2	59.0	67.7	71.0	64.9	66.9	56.1	53.0	47.9	46.9	34.8	35.2	34.5	36.1	33.7	77.0	57.1	38.0
- cover of goods deficit	17.8	20.4	28.1	28.3	23.4	24.0	25.1	22.5	29.7	32.6	36.1	38.3	41.5	32.7	31.9	31.4	31.0	31.1	30.2	27.3	31.4

Sources: Bank of Greece and Eurostat.

In EU-27, sea transport receipts represented on average (2010-2020) less than 1% of GDP while in Greece - during the same period – amounted to 6.8%. The other two countries with comparable to Greece figures are Cyprus (12.8%) and Denmark (9.8%). In Norway, the sea transport services share is 3.3% of GDP, in Germany 0.8% of GDP and in the UK less than 0.4% of GDP (Table 2.3). Therefore, the key role of shipping for the Greek economy is evident even in comparison to the EU-27 and other maritime nations.

Table 2.3: Sea transport services receipts as % of GDP
(selected countries and years)

	2010	2012	2015	2017	2018	2019	2020	Average 2010-2020
EU - 27	1.0	1.0	0.9	0.9	0.9	0.9	0.9	0.9
Cyprus	10.8	11.4	14.1	13.8	13.7	13.7	13.4	12.8
Denmark	9.9	10.2	10.0	8.9	9.6	10.3	10.2	9.8
Greece	6.3	6.2	6.7	7.0	7.9	8.0	7.5	6.8
Estonia	4.2	3.9	3.8	3.4	3.4	3.2	2.2	3.6
Norway	-/-	-/-	-/-	-/-	3.2	3.4	3.2	3.3
Belgium	2.7	2.6	1.7	1.7	1.6	1.5	1.6	1.9
Netherlands	-/-	-/-	1.5	1.3	1.3	1.3	1.4	1.4
Germany	0.9	0.9	0.8	0.8	0.8	0.8	0.8	0.8
United Kingdom	0.3	0.3	0.3	0.3	0.3	0.3	0.4	0.3

Source: Eurostat, Office for National Statistics (UK).

2.3 The comparative advantage of the sea transport services

In the international economics literature, countries are expected to specialise in goods and services that have a comparative advantage. The concept of comparative advantage was presented by David Ricardo in explaining the specialisation of a country in goods production (Ruffn, 2002). As it is relatively difficult to identify *a priori* the comparative advantage of an economy, the use of indices which are based on the actual trade flows between countries, are employed with the aim to reveal the comparative advantage of an economy. The Revealed Comparative Advantage (RCA) index (or Balassa index) was first proposed by Balassa (1965) and – even today – they are customarily used in empirical work in analysing a country's trade specialisation (Davis, 1997; De Benedictis and Tamberi, 2002).

The RCA index is defined as:

$$RCA_i = \frac{X_{ic}/\, X_c}{X_{iw}/\, X_w}$$

where

X_{ic} (X_{iw}): the exports of product/service *i* from country *c* (from world, *w*)

X_c (X_w): total exports from country *c* (from world, *w*)

The numerator presents the share of product/service *i* to total exports of country *c*, while the denominator the same share for the world. The RCA index ranges from zero to infinity with unity being the threshold between comparative disadvantage and advantage. In more detail:

When RCA_i>1, the share of product/service *i* to total exports of country *c* is greater compared to corresponding world share, a country has a comparative advantage in this product/service.

On the other hand, when RCA_i<1, the share of product/service *i* to total exports of country *c* is smaller compared to corresponding world share. Thus, the country is deemed as having a comparative disadvantage.

In the case that RCA_i=1, the country's share of exports in product/service *i* equals that of the world, and therefore the country does not exhibit any specialisation compared to the world.

One disadvantage of the RCA lays on the fact that it is asymmetric. A method to transform the index into symmetric was proposed by Laursen (1998) in the Symmetric Revealed Comparative Advantage index which is defined as:

$$SRCA_i = \frac{RCA_i - 1}{RCA_i + 1}$$

The SRCA index ranges from -1 to +1. A country has a comparative advantage in product/service i when $SRCA_i > 0$. A comparative disadvantage exists when $SRCA_i < 0$.[10]

The studies on the Revealed Comparative Advantage usually focus on the trade of goods (for Greece see, Dimelis, 2004; Konstantakopoulou, 2015; Konstantakopoulou, Magdalinos and Skintzi, 2019), although there is a number of – more recent studies – that discuss the trade in services (Langhammer, 2004). The aim of the following analysis is to identify whether Greece has a comparative advantage in the exports of see transport services compared to other nations and the ranking of Greece's comparative advantage between transport and travel services.

The comparative advantage is assessed on the basis of the Balassa Revealed Comparative Advantage (RCA) index as well as the Symmetric RCA (SRCA). Moreover, two set of indices are calculated. The first one on the basis of the total export of goods and services (RCA1 and SRCA1) and the second based on the exports of services (RCA2 and SRCA2). The first one analyses the existence of comparative advantage against the total exports of the economy, while the second only against the exports of services. If the RCA is above unity, a country has a comparative advantage on sea transport services; otherwise (i.e. the RCA is below unity) a country has a comparative disadvantage. Similarly, if the RSCA is above zero, a country has a comparative advantage on sea transport services; otherwise (i.e. the RSCA is below zero) a country has a comparative disadvantage.[11]

[10] The above transformation does not alter the ranking of the sectors if calculated with the RCA method; though it ensures symmetry between comparative advantage and disadvantage, which is required for empirical work.

[11] RCA takes values from zero to infinity, while RSCA is symmetric around zero and takes value from -1 to 1.

Table 2.4: Exports of Sea Transport Services: Revealed Comparative advantage index - Selected countries

	RCA 1 - Goods and Services			RCA 2 - Services		
	2005-2009	2010-2014	2015-2020	2005-2009	2010-2014	2015-2020
Greece	16.0	12.8	12.9	5.0	4.9	5.9
Cyprus	9.1	12.9	11.5	2.2	3.1	3.4
Denmark	-/-	11.5	11.5	-/-	6.0	6.6
Norway	4.1	4.5	6.0	3.9	4.0	4.8
Singapore	-/-	4.3	5.4	-/-	3.5	3.8
Germany	0.9	1.0	1.0	1.3	1.3	1.4
United Kingdom	0.9	0.8	0.8	0.4	0.4	0.4
Netherlands	-/-	0.8	0.7	-/-	0.8	0.7
China	-/-	-/-	0.6	-/-	-/-	1.5

Notes: Data availability for China 2017-2019, for Denmark 2015-2019 and for the Netherlands 2014-2020. Countries are ranked according to the RCA1 index for the 2015-2020 period.
Source: data UNCTAD, calculations: author

The RCA index reveals that the Greek economy possesses a strong comparative advantage in the sea transport services especially on the basis of total exports of goods and services are considered. The significance of the comparative advantage is maintained even in the context of the exports of services. The other countries with a relative high RCA index is Cyprus, Denmark, Norway and Singapore. On the other hand, Germany exhibits a marginal comparative advantage in sea transport service in the total exports of goods and services, which marginally improves when estimated on the basis of the exports of services. The UK and the Netherlands exhibit a comparative disadvantage in the exports of sea transport services. Finally, China – despite the limited data availability – seems to have comparative advantage in the export of sea transport services in the context of services, but not when goods and services combined are taken into account (Table 2.4).

The symmetric RCA re-affirms the finding of the RCA index, providing a symmetric view around zero for the comparative advantage in sea transport services. Greece, Cyprus, Denmark, Norway and Singapore hold a strong comparative advantage in the export of sea transport services. Germany has a marginal one while the UK and the Netherlands exhibit a comparative disadvantage (Table 2.5).

Table 2.5 : Exports of Sea Transport Services: Symmetric Revealed Comparative Advantage index - Selected countries

	SRCA 1 – Goods and Services			SRCA 2 – Services		
	2005-2009	2010-2014	2015-2020	2005-2009	2010-2014	2015-2020
Greece	0.9	0.9	0.9	0.7	0.7	0.7
Cyprus	0.8	0.9	0.8	0.4	0.5	0.5
Denmark	-/-	0.8	0.8	-/-	0.7	0.7
Norway	0.6	0.6	0.7	0.6	0.6	0.7
Singapore	-/-	0.6	0.7	-/-	0.6	0.6
Germany	-0.1	0.0	0.0	0.1	0.1	0.1
United Kingdom	-0.1	-0.1	-0.1	-0.4	-0.4	-0.4
Netherlands	-/-	-0.1	-0.2	-/-	-0.1	-0.2
China	-/-	-/-	-0.3	-/-	-/-	0.2

Note: Data were available for China 2017-2019, for Denmark 2015-2019 and for the Netherlands 2014-2020. Countries are ranked according to the RCA1 index for the 2015-2020 period.
Source: data UNCTAD, calculations: author

As it was previously discussed, sea transportation and travel (almost exclusive related to tourism) are the two main services exports in Greece. The two sectors can be ranked on the basis of SRCA, which indicates in which sector the economy has a greater comparative advantage. While both travel and sea transport exhibit a comparative advantage, the size of the index is greater in the sea transport exports compared to the travel. This deviation is greater in the case of the SRCA 2 that takes into account only services and thus allows to compare the comparative advantages among services only. Therefore, sea transport exports have a greater comparative advantage compared to travel.

Table 2.6 : Travel and Sea Transportation - Greece: Symmetric Revealed Comparative Advantage index

	2005-2009	2010-2014	2015-2020
	SRCA 1 – Goods and Services		
Travel	0.7	0.6	0.6
Sea Transport	0.9	0.9	0.9
	SRCA 2 - Services		
Travel	0.2	0.2	0.3
Sea Transport	0.7	0.7	0.7

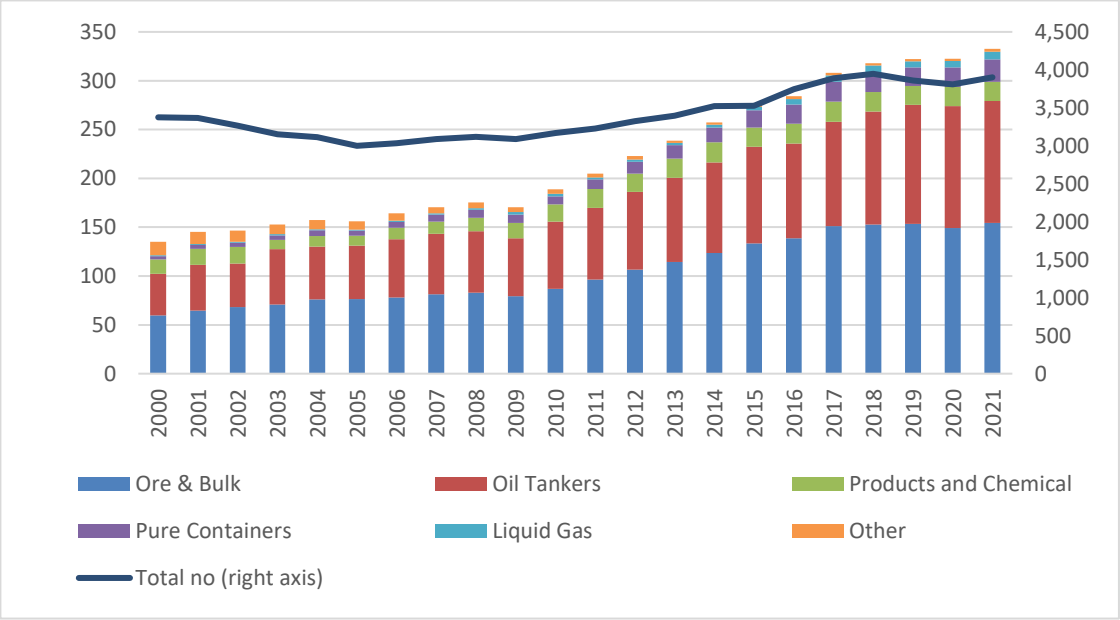
Source: UNCTAD, calculations: author.

2.4 Greek-owned and Greek-controlled fleet versus international fleet

2.4.1 Fleet capacity development

During the first decade of 2000s, the Greek-owned fleet increased and successfully adapted to the needs and the regulatory framework requirements (Thanopoulou, 2007). This adaptation process continued in the second decade of the 2000s. From 2009 until the beginning of 2021, the Greek-owned fleet almost doubled in size in line with the developments in the size of the world fleet; therefore the share of the Greek-owned fleet to the world fleet was maintained at around 16% based on GSCC data (Graph 2.2).

Graph 2.2: Development of the Greek-owned fleet (2000-2021)
(in million dwt)



Note: Data refer to month March of the respective year.
Source: GSCC.

In more detail, more than 1 out of the 4 oil tanker capacity is under Greek-control after 2015, while in the dry bulk sector that had followed a downwarding trajectory, 1 out of 6 vessels belong to the Greek controlled fleet. Significant increase was registered in the liquid gas sector, in which the Greek controlled fleet represent close to 10% in 2021 (Table 2.7).

Table 2.7: Share of the Greek-owned fleet (% of world fleet)
(based on dwt)

	2000-2004	2005-2009	2010-2014	2015-2020	2021
Ore & Bulk	24.6	22.8	18.1	18.6	17.6
Oil Tankers	21.0	21.0	22.5	26.1	26.2
Products and Chemical	17.1	13.3	14.1	13.1	11.8
Pure Containers	5.7	5.3	6.0	7.8	8.0
Liquid Gas	5.3	5.5	5.4	9.6	10.3
Total	18.1	16.5	15.2	16.6	16.1

Source: GSCC.

2.4.2. Structure of the Greek-owned fleet

The structure of Greek-owned fleet differs from that of the world fleet, as there is variation in the shares among different sectors, indicating a higher concentration in the oil tanker and the dry bulk sector compared to the world fleet. On the other hand, there is lower concentration compared to the world fleet in the product and chemical tankers, the containers and the liquid gas carriers. It is noticeable, that in the most recent period (2015-2020) the gap vis-à-vis the world fleet primarily in the liquid gas and secondarily in the container sector is decreasing as the share of Greek-owned fleet increases in these sectors (Table 2.8).

Table 2.8: Structure of the Greek owned and the world fleet

	2000-2004		2005-2009		2010-2014		2015-2020	
	Greek-owned	World	Greek-owned	World	Greek-owned	World	Greek-owned	World
Ore & Bulk	46.0	31.2	47.6	32.0	47.4	38.5	48.0	41.8
Oil Tankers	33.1	27.6	35.7	26.7	36.0	22.3	36.3	20.3
Products & Chemical	9.4	9.9	7.6	9.7	8.7	9.5	6.5	8.6
Pure Containers	3.0	10.9	4.1	14.4	5.2	14.8	6.4	15.2
Liquid Gas	0.7	2.7	0.9	3.1	1.1	3.3	1.9	3.6
Other	7.8	17.8	4.0	14.2	1.5	11.6	0.8	10.5

Source: GSCC.

In order to assess the specialisation of the Greek-fleet vis-à-vis the world fleet, the methodology of the Symmetric RCA is employed as well based of the carrying capacity (dwt) of the vessels. If the share of a specific sector is the same in both the Greek-owned fleet and the international fleet, the SRCA index will equal to zero. If the Greek-onwed share is higher than that of the world, indicating a higher specialisation in the Greek-onwed fleet vis-à-vis the world, the SRCA index will be higher than zero. If the contrary holds, it will be below zero.[12] The Greek-owned fleet exhibits a higher specialisation – as the index is positive - in the crude oil tanker and the dry bulk sector compared to the world fleet. On the other hand is almost at par with the world fleet specialisation in the product and chemical tanker sector. However, it exhibits a lower specialisation in the gas carriers and the container sector. As it was previously mentioned, in the 2015-2020 period, the specialisation of the Greek-owned gas carriers and containership fleet vis-à-vis the world fleet improved and this trend continued in 2021. This development reflects the acceleration in the purchases and/or investments in these sectors (Table 2.9).

Table 2.9: Specialisation of the Greek-controlled fleet
(based on dwt)

	2000-2004	2005-2009	2010-2014	2015-2020	2021
Oil Tankers	0.1	0.1	0.2	0.3	0.3
Ore & Bulk	0.2	0.2	0.1	0.1	0.1
Products and Chemical	0.0	-0.1	0.0	-0.1	-0.2
Liquid Gas	-0.6	-0.5	-0.5	-0.3	-0.2
Pure Containers	-0.6	-0.6	-0.5	-0.4	-0.4

Source: GSCC, calculations: author

The latter finding is evident by the development in the specialisation in the orderbook of the Greek-controlled fleet against the world orderbook. On the one hand, the increased Greek-owned orderbook of gas carriers vis-à-vis the world in the 2005-2009 period and at par with the world in the 2010-2015 period contributed to the improvement of the share of the gas carriers in the Greek-controlled fleet. On the other hand, the deceleration in the orderbook in the product and chemical tanker in the 2010-2020 period indicated the

[12] As the Greek-controlled fleet represents a significant part of the world fleet and in specific sectors, the shares of the world fleet are calculated after having deducted the respective capacity of the Greek-owned fleet. This approach warrants that the structure of the Greek-controlled fleet will not influence the structure of the world fleet.

expected decline of this sector in the Greek-owned fleet compared to the world one (Table 2.10).

Table 2.10: Specialisation of the Greek-controlled orderbook
(based on dwt)

	2000-2004	2005-2009	2010-2014	2015-2020	2021
Oil Tankers	0.2	0.2	0.3	0.4	0.4
Ore & Bulk	-0.7	-0.3	0.3	0.3	0.1
Products and Chemical	0.1	0.0	-0.2	-0.2	-0.7
Liquid Gas	0.0	0.1	0.0	-0.3	-0.3
Pure Containers	-0.6	-0.6	-0.1	-0.5	-0.8

Source: GSCC. calculations: author.

In recent years, the capacity (in dwt terms) of the dry bulk and the pure container vessels in the Greek-owned fleet were larger by 10% and 20% compared to the corresponding ones in the world fleet. The oil tankers were at par, while the product and chemical tankers were almost double in size (80% bigger). Finally, the gas carriers have covered a significant part of the distance with the world fleet; they were just 10% smaller than the corresponding one of the world fleet (Table 2.11).

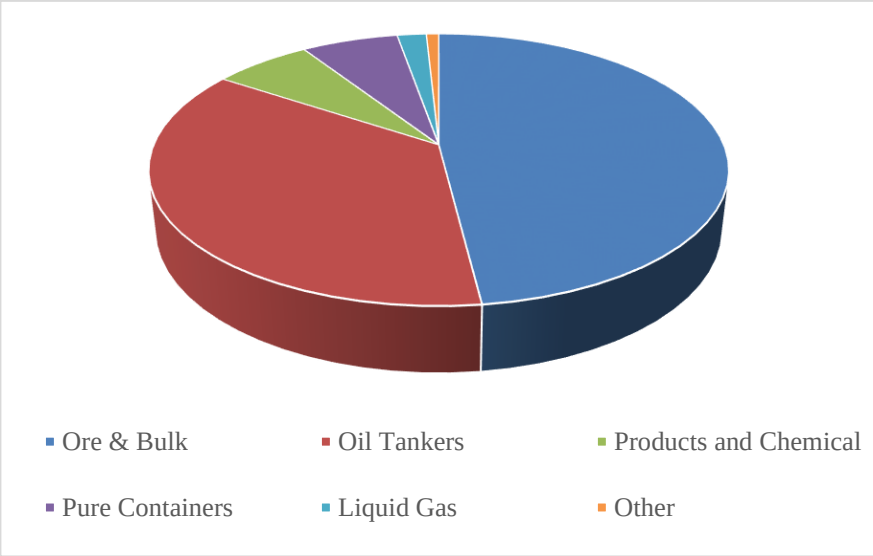
Table 2.11: Ratio of average size of Greek-owned fleet vessels vs. average world fleet vessel size
(based on dwt)

	2000-2004	2005-2009	2010-2014	2015-2020	2021
Ore & Bulk	1.1	1.1	1.1	1.2	1.2
Oil Tankers	1.1	0.9	0.9	1.0	1.0
Products and Chemical	2.1	1.8	1.7	1.8	1.9
Pure Containers	1.1	1.2	1.2	1.1	1.1
Liquid Gas	1.2	0.7	0.7	0.9	1.1
Total	**2.1**	**2.2**	**2.2**	**2.3**	2.4

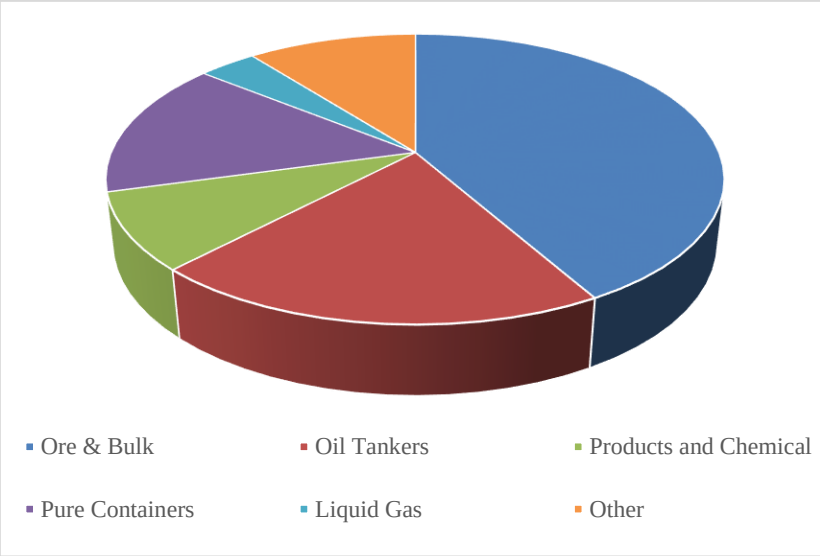
Note: When the index is equal to 1, the Greek-controlled and the world fleet have the same average size. If the index is above (below) 1, the Greek-controlled average vessel is bigger (smaller) that the corresponding world average vessel.
Source: GSCC, calculations: author.

Graph 2.3: Structure of the fleet – Average: 2015-2020
(based on dwt)

A. Greek-owned fleet



B. World (excluding Greek-owned)

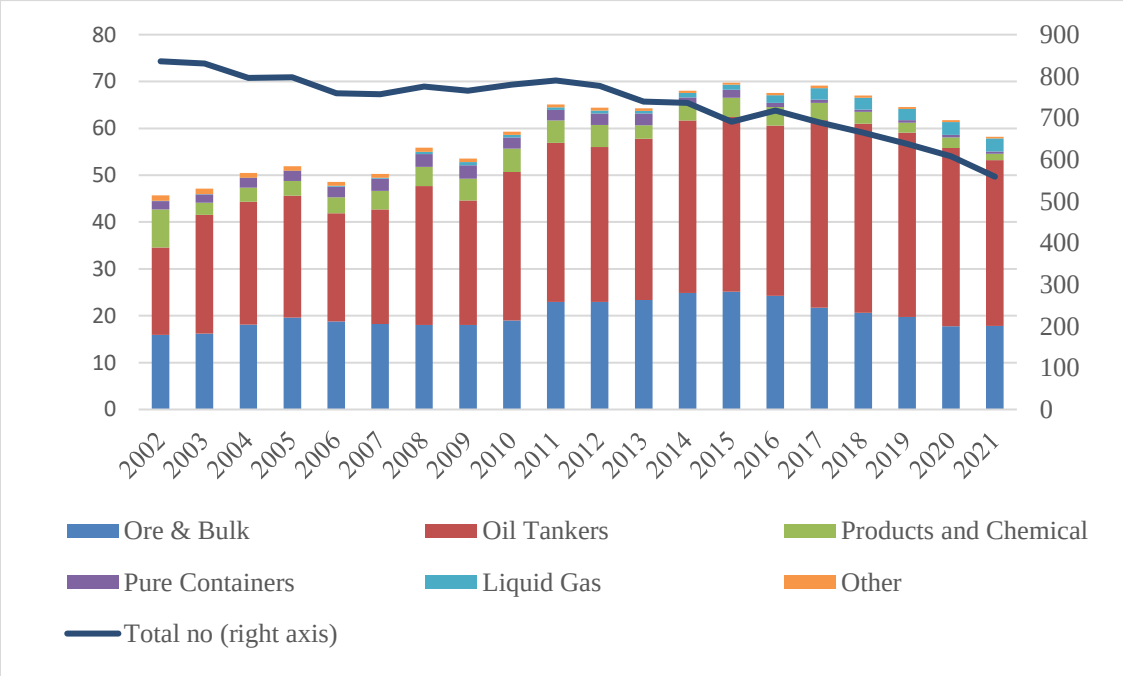


Source: GSCC, calculations: author.

2.4.3 Structure of the Greek-flagged fleet

The structure of the Greek-flagged fleet exhibits differences compared to the Greek-owned fleet. Although dry bulk vessels represent almost half of the Greek-controlled fleet, in the Greek-flagged they represent around 30%. Even more important is the downward trend in terms of dwt, which is decreasing since 2016, showing though some signs of stabilization in 2020-2021. On the other hand, oil tankers, which account for approx. 35% of the Greek-controlled fleet, are more than 50% of the Greek-flagged fleet and in 2020 reached 61.6%. In absolute dwt terms, the oil tanker were in an upward trend since 2010, reaching a plateau in 2017-2018 before starting a declining movement which accelerated in 2021. The Liquid Gas carrier sector that still represents a small share in the Greek-flagged fleet (around 4.9% in 2021), it is in an upwards trend in both its share and in absolute dwt since 2013, when it represented close to 1%. Finally, the product and chemical tankers and the containerships are exhibiting a declining share in the Greek-flagged fleet (Graph 2.3).

Graph 2.4: Development of the Greek-flagged fleet (2000-2021)
(million dwt)



Source: GSCC.

An alarming fact is the decreasing number of vessels in the Greek-flagged and recently, since 2017, in carrying capacity (dwt). This fact is also highlighted by the fact that in all shipping sectors, with the exception of Liquid Gas, the share of Greek-flagged fleet (as % of the Greek controlled) is decreasing. In the Liquid Gas sector, more than 1/3 of the Greek-controlled fleet is also registered in the Greek flag. In total, the Greek-flagged fleet has increased at a considerable slower pace compared to the Greek-controlled growth, which led to a decrease in the share of the Greek-controlled vessels that were registered to the Greek flag. In 2021, only 17.5% of the Greek-controlled fleet (in dwt terms) was flying the Greek flag, when in the first decade of 2000s was standing – on average – at 31% (see Table 2.12).

Table 2.12 : Share of the Greek flagged fleet (% of Greek-controlled fleet)
(based on dwt)

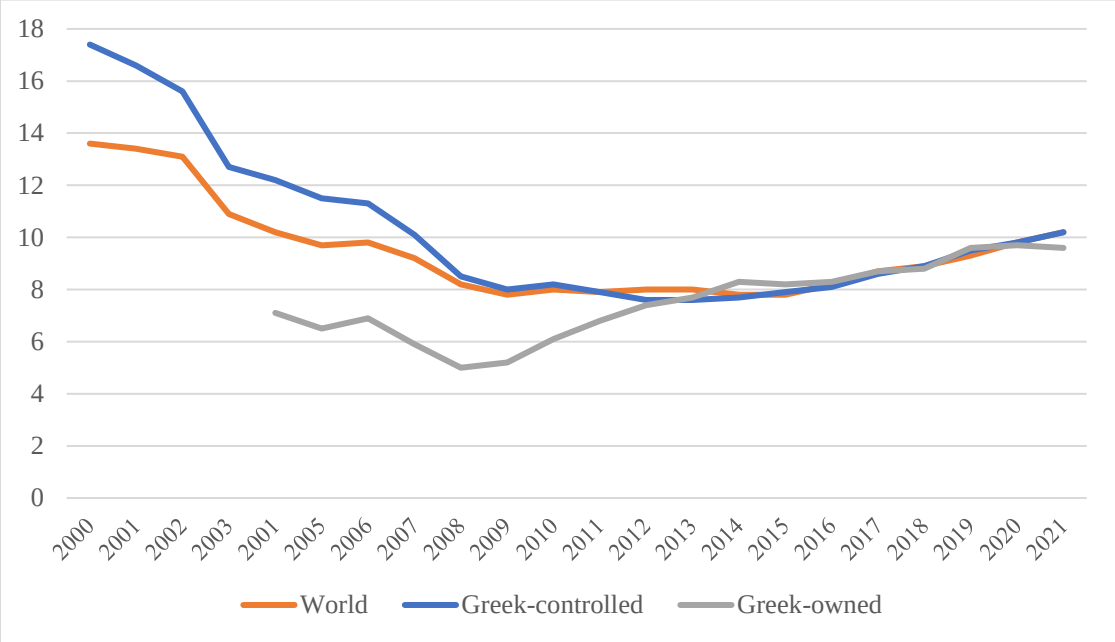
	2002-2004	2005-2009	2010-2014	2015-2020	2021
Ore & Bulk	23.3	23.3	21.6	14.8	11.5
Oil Tankers	45.1	43.4	42.7	35.0	28.4
Products and Chemical	33.8	30.4	21.8	15.6	7.0
Pure Containers	38.9	36.5	20.2	4.3	1.9
Liquid Gas	4.2	18.4	26.9	35.0	35.7
Total	31.4	31.1	29.1	22.0	17.5

Source: GSCC.

2.4.4 Age structure

At the advent of the new millennium, the Greek-controlled fleet was by almost 4 years older than the world fleet. The investments in newer and newbuilding vessels led to covering this age gap and by 2011 the Greek-controlled fleet's age was at par with that of the world fleet (Thanopoulou, 2007). In 2012-2013, the Greek-owned fleet was marginally younger (by 5 months) to the world and since 2014 remained at the same age as the world fleet. Another interesting finding is the age gap between the Greek-registered and the Greek-owned fleet. In 2002, the former was 5 years younger than the latter. The renewal trends of the Greek controlled fleet in the following years contributed to extinguishing the age gap and effective since 2012 the Greek-owned fleet to be at par – age wise – with the Greek-flagged. It is even noticeable that in 2021 the former is marginally younger than the latter (see Graph 2.5).

Graph 2.5: Average age of fleet (2000-2021)
(dwt weighted)



Source: GSCC.

2.5 Chapter 2 – Key takeaways

- Over the last 20 years, the receipts from sea transport services represented more than 6% of GDP and covered close to 30% of the goods trade deficit of the Greek economy.

- The significance of sea transport exports as % of the GDP is higher compared to the EU average and only comparable to this of Cyprus and Denmark.

- Greece has a comparative advantage in the exports of the sea transport sector on the basis of the Revealed Comparative Advantage indices. The exports of sea transport services are ranked higher in terms of comparative advantage compared to the travel services.

- The Greek-controlled fleet has increased significantly and maintained its share at around 16% in capacity terms.

- On the one hand, the Greek-owned fleet exhibits a higher specialization in the oil tanker and the dry bulk sector vis-à-vis the world. On the other hand, the Greek owned fleet has lower specialisation in the liquid gas and the container sector. However, in recent years the gap in the latter two sectors has significantly narrowed.

- The age of the Greek-owned fleet has recorded a significant improvement over the last 20 years and it is now at par with the age of both the world fleet and the Greek-flagged fleet.

CHAPTER 3: INFLOWS AND THE GREEK SHIPPING CLUSTER

Chapter Summary: The Greek shipping cluster – traditionally located in Piraeus (Attica) and spreading with time in the Attica area around the capital Athens – is ranked among the top-5 shipping centers of the world. It has grown significantly in the post-World War 2 period aided by the regulatory context for the registration of ships in the Greek registry and the taxation and legal status of the Greek cluster companies. The number of shipping and shipping-related businesses is constantly increasing in Greece, as is the number of vessels managed from Greece. The water transport sector represents almost 3% of the Greek Gross Value added (GVA) and was the 11th most important industry in 2018-2019 in terms of GVA. Various studies have estimated the number of employment generated by the Greek maritime industry (directly and indirectly) at around 200-300 thousand posts. Despite the fact that the exports of sea transport services exhibit a relatively high domestically produced value added of approx. 70% in 2018, there is a significant erosion over the years; a finding that it is in line with the input-output analysis. Significant is the contribution of vessels' taxation on the public revenues, especially in the aftermath of the great recession of 2008 and the Greek economic adjustment programmes.

3.1 The Greek Shipping Cluster

According to Porter (2000, p. 15), "*a cluster is a geographical proximate group of interconnected companies and associated institutions in a particular field, linked by commonalities and complementarities*"; it includes not only the companies in the specific industry but also their specialised suppliers and extends to associated institutions (e.g. trade associations or education institutions). These firms compete among them but - at the same time - there is a connecting form of co-operation. The geographical element of the cluster may extend from a specific city to the nationwide level. These types of cluster provide a competitive advantage in these industries and therefore to entire nations; the modern Greek shipping cluster is such an example as it transpires along the path of its development going back to the 19th century. The Greek tramp fleet had founded its success in the network structures that already existed at the end of 19th century and extended into the 20th century. In the 1950s and the 1960s, the Greek shipping companies were operating in London and in New York; however since the end of 1950s their headquarters were transferred in Piraeus (Harlaftis, 1996; Grammenos and Choi; 1999; Pallis, 20077). The shipping crisis in 1980s was marked by the remarkable flagging out from traditional sea nations, In the following decades, the Greek shipping industry made significant adjustments (Thanopoulou, 2007) and responded to the new challenges stemming from the new environmental rules and the availability of new financing instruments (Syriopoulos, 2007).

Following the 1958 start of the massive return of Greek-onwed ships to the Greek registry (Harlaftis, 1996), and already in the 1970s, the role of the modern Greek Shipping cluster was identified in Harlaftis et al (2009). Georgantopoulos (1977) viewed that merchant shipping acted as a centre around which a number of activities are developed such as shipbuilding and ship-repairs, agencies, brokers, information services' providers for the ship or its management, banking, insurance, legal, provisioning, travel as well as steel industry, manufacturing etc.

The Greek shipping cluster encompasses today a number of activities related to the shipping industry. Apart from the core ship owning and ship management companies, it includes *inter alia* brokers, suppliers, shipping finance and insurance firms, accounting and legal services, communication services. ship-building and ship-repair, education and

training, classification societies, public services. The core of the shipping cluster are the ship-management and operations that account – in the Piraeus area – for close to 30% of all shipping related companies (Vaggelas and Pallis, 2019).

Nowadays Piraeus and the surrounding Attica is ranked within the top-5 leading maritime cities in the world over the past 10 years partly due to the number of shipping companies that are headquartered in Piraeus and the size of the fleet (owned or managed). However, this is not so in areas such as finance and law or port and logistics is not ranked into the top-10 maritime cities,[13] indicating the focus of the Greek maritime cluster in the ship-owning/ship-management activities. A fact that it is also evident from the increase, since 1960s, in the share of Greek-owned shipping firms headquartered in Piraeus vis-à-vis other shipping centers (Harlaftis, 1996; Grammenos and Choi, 1999).

Table 3.1: Leading Maritime Capital - Shipping Centres

	2012	2015	2017	2019	2022
Oslo	1	-/-	-/-	-/-	-/-
Singapore	2	2	1	1	2
Piraeus/Athens	3	1	3	2	1
Tokyo	4	4	-/-	-/-	3
Hong Kong	5	5	5	4	-/-
Hamburg	-/-	3	2	3	5
London	-/-	-/-	4	-/-	-/-
Shanghai	-/-	-/-	-/-	5	4

Source: Menon Economics and DNV GL (various years)

3.2 The legal framework of the Greek Shipping cluster

The Greek shipping cluster is mainly structured around two legal pillars which were complemented or slightly altered through subsequent legislation: The first one - Legislative Decree 2687/1953 art. 13 - governs the registration of vessels in the Greek flag (Harlaftis,

[13] Menon economics and DNV GL (various years) assess 5 aspects of the candidate maritime capitals: shipping centre; finance and law; maritime technology; ports and logistics; attractiveness and competitiveness. The Shipping centre aspect takes into account objective criteria such as the size of the national fleet, the number of shipping companies headquartered in the city as well as subjective criteria based on the surveys.

1993) and the second one- Law 27/1975 - set the tonnage tax of the Greek-flagged vessels and the status of the shipping cluster companies (article 26).

Article 13 of the Legislative Decree (LD) 2687/53[14] treats the Greek-flagged ships as foreign capital investment in Greece; the terms of the investment are described in the Ministerial Decision for the registration of the vessel which cannot be adversely – from the investor point view – amended. Therefore, the investment is protected against any adverse future legislative changes. In addition, the aforementioned LD was introduced in a period of foreign exchange controls in Greece and the characterization of ships as foreign investment allowed capital movements in foreign exchange without any restrictions. These provisions are still valid for the registration of the vessels in the Greek registry (Athanasiou, 2016).

Table 3.2: Offices and Branches of foreign shipping companies established in Greece (art 25, L27/75): Selected years.

number	1985	1990	1995	2000	2005	2010	2015	2016	2017	2020
Companies	598	701	1,045	1,137	1,153	1,359	1,343	1,382	1,387	1,419
Managed vessels	-/-	-/-	-/-	-/-	-/-	3,288	4,065	4,182	4,353	4,717
Employees	6,722	7,323	10,114	10,998	11,764	-/-	-/-	16,467	17,061	17,872
- Greek	6,117	6,492	8,774	9,527	10,383	-/-	-/-	14,901	15,465	-/-
- Foreigners	605	831	1,340	1,471	1,381	-/-	-/-	1,566	1,596	-/-

Sources: Spathi et al (2010) and Ministry of Shipping (various years).

Law 27/1975, as amended, describes the tonnage taxation system of the Greek-flagged vessels (see later).[15] However, Article 25 of the abovementioned law provides for the exemption of any income tax and levies on offices or branches of foreign companies in Greece that are exclusively engaged in a number of shipping cluster activities (see also section 3.3). These activities include *inter alia* ship management, insurance, average

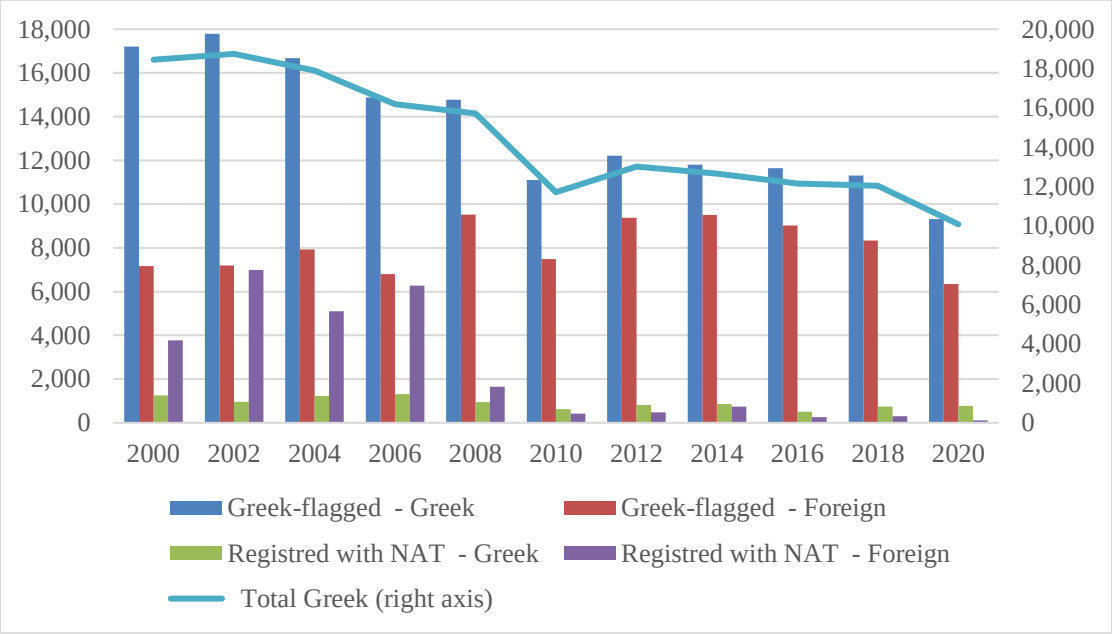
[14] The elements of this article were later clarified in a legislative act (so called authoritative interpreted) by Legislative Decree 2928/1954. Article 107 of the current Greek Constitution made an explicit reference to supra-legislative status of the foreign capital investment legislation and kept it in force.

[15] Chapters A to D of Section A of Law27/1975 set out the tonnage tax principles for the Greek-flagged vessel that belong to Category A (mainly ocean-going vessels). This part of the law enjoys a higher legislative status than other legislation pursuant to Article 107 of the Greek Constitution on the protection of foreign capital.

adjustment, shipbroking. The obligation of these companies was to cover the expenses of the Greek-based establishments by foreign exchange remittances which could not be less than 50,000 USD per annum (Mavraganis and Koutnatzis, 2016).

The number of these companies are generally increasing over the last 40, and at the beginning of 2020 were more than 1,400; the vast majority of them were employed in ship management activities with a managed fleet – Greek or foreign-flagged – of more than 4,700 vessels. The number of employees in these companies was also increasing over the same period reaching more than 17,800 employees in 2020; around 90% of employees are Greek nationals (Table 3.2).

Graph 3.1: Employment of Greek and foreign seafarers



Note: The number of seafarers refers on the 20th of September of the corresponding year that are employed on merchant ships of 100 GRT and above that are registered in the Greek flag or Greek-owned under foreign flag that are contracted with NAT.
Source: EL.STAT.

Contrary to the shipping companies' personnel that has registered an increase over time, the number of Greek seamen is following a downward trajectory, at least in the Greek-flagged and the NAT contracted vessels. At the advent of the new millennium, there were more 17,000 seafarers in Greek-flagged vessels and another 1,248 in foreign-flagged that were contracted with NAT. In 2020, the number of seafarers on Greek-flagged vessels was

standing at 9,322 while those in foreign-flagged contracted with NAT were 765 (Graph 3.1). The decrease in the number of seafarers could at some extent be explained by the decrease in the number of vessels in the Greek flag, although the decrease in the seafarers was much higher than that in the number of Greek-flagged vessels.

3.3 Contribution of Greek shipping to the Greek economy

The ocean sea transport services are included in the Water Transport Division in the NACE Rev.2[16] classification. The Water Transport Division (H.50) is comprised of the following economic activities (Eurostat, 2008):

- 50.10: Sea and coastal passenger water transport.
- 50.20: Sea and coastal freight water transport.
- 50.30: Inland passenger water transport.
- 50.40: Inland freight water transport.

Table 3.3 : GVA of the Transportation and Storage section

(share in total Greek GVA – average of period)	2000-2004	2005-2009	2010-2014*	2015-2020*
Section H: Transportation And Storage	***6.34***	***7.67***	***6.88***	***7.00***
Land transport	1.68	2.14	1.85	1.84
Water transport	3.32	4.14	3.46	2.82
Air transport	0.21	0.24	0.34	0.38
Warehousing and support activities for transportation	0.73	0.78	0.95	1.62
Postal and courier activities	0.40	0.37	0.28	0.33

* There is a break in year 2010, as the revision of data for the period 1995-2009 is in progress by EL.STAT. Data for 2019-2020 are provisional.
Source: EL.STAT.

Although it is difficult to separate the ocean-going from the coastal water transport, in the case of Greece, the sector reflects primarily the development in the ocean-going

[16] NACE stand for "Nomenclature statistique des activités économiques dans la Communauté européenne" (Eurostat, 2008).

shipping.[17,18] According to the Gross Value added generated by the industries in Section *H.Transportation and Storage*,[19] the *Water transport* one exhibits the highest GVA compared to the other activities in the section and it represented 3.5% of the total GVA in 2010-2014 period, a figure which decreased to 2.8% in the 2015-2020 period as the GVA of the Water Transport industry declined in the second period. However, water transport is the 11th most important out of 64 industries in the Greek economy in GVA terms.[20]

Hellenic Chamber of Shipping and University of Piraeus (2005) following the input – output methodology[21] estimated that the number of directly employed persons in the Greek shipping industry accounts to 50,000 while the number of the those indirectly employed – through sectors dependent on shipping – were estimated as high as 250,000 in 2004. The study also identified the labour cost of sea-going personnel.[22]

Later, IOBE (2013) attempted to identify the contribution of the Greek-owned ocean shipping to the Greek economy through the use of the input-output methodology. The findings of the study showed that approx. 6.1% of the 2009 Greek GDP was directly and indirectly (including consumption induced effects) related to the sea transport services. The sector employed – directly and indirectly – 192 thousands persons in 2009.[23] In 2009, the

[17] IOBE (2014) estimated the direct value added of the domestic passenger water transport at 149 million euro (or 0.1% of GDP) in 2013. In the same year, the value added of the water transport division amounted to 5.3 billion euro (or 3.30%).

[18] Some further shipping related activities are recorded in the following classes of Division 52:
52.22: Service activities incidental to water transportation which includes activities such as terminal operations (including harbours), navigation, pilotage etc.
52.24: Cargo handling which includes loading and unloading of goods (irrespective of mode of transportation), stevedoring etc.
52.29: Other transportation support activities that includes inter alia brokerage for ship.

[19] Section H. Transportation and Storage is comprised of the 5 divisions: Land transport and transport via pipelines (H.49), Water transport (H.50), Air transport (H.51), Warehousing and support activities for transportation (H.52) and Postal and courier activities (H.53).

[20] It is noted that the decline in the GVA of the Water Transport industry coincides with the change in the BoP compilation methodology for the sea transport related accounts as the BoP accounts are an integral component of national accounts (see Chapter 4).

[21] See Haralambides (1996) for a discussion on the economic impact of shipping on the national economy.

[22] In 2020, there was an amendment in the Greek legal framework that allows low-rank Greek seafarers that are employed in Greek-flagged vessels to be remunerated according the terms of the international collective agreements of the ITF or the IBF (see Law 4714/2020, art. 130).

[23] The study describes a limitation that relates to the data availability of ocean-going water transportation. It is based on the Water Transportation Industry (NACE 2.2) H.50; it assumes that coastal transportation is limited compared to the ocean-going one.

direct value added of the sea transportation industry amounted to 8.4 billion euro, the indirect one (without the effect of private consumption) to 0.95 billion euro and the induced effect (stemming from the effect of sea transportation on private consumption) to approx. 3.0 billion euro. The total contribution (direct, indirect and induced) of the sector amounted to 13.3bn euros of value added, i.e. close to 6.5% of the total value added of year 2009. As expected the key sectors that are connected to the sea transportation are the services that support activities for transportation, legal and accounting services and the real estate activities.

Backinezos, Panagiotou and Vourvachaki (2019) applied also the input-output methodology for the estimation of the sectoral multiplier effects (output, gross value added and employment) on the basis of the 2015 input-output tables. The simple output multiplier[24] for the water transport industry amounted to 1.61 which is higher than the average of the Greek economy (1.53); the water transport industry was ranked in position 20 out of the 62 industries in the Greek economy that they were analysed.[25] It was noted that when the use of imported intermediates is high, the simple multiplier is lower as there are greater leakages from the domestic production system. This could be the first indication that – by increasing the input from the domestic industries – the effect of the sea transport industry can be further enhanced. However, when the GVA multiplier is considered, Water transport industry's one is below the county's average (0.73 against 0.80).[26] The employment multiplier indicated that an increase in the final demand for water transport services by 1 million euro causes an increase of employment by 11 positions. Finally, the import content of the water transport services (i.e. the share of imported input, direct and indirect, to the total output of the sector) was estimated at 21%.

[24] It takes into account the initial increase in output as well as the required increase in the production of direct and indirect supplies of intermediates.

[25] In the Greek economy, on average, the output multiplier amounts to 1.53 indicating that an increase of 1 euro in final demand would lead to an increase of 1.53 euro in domestic output.

[26] The gross value added multiplier shows the increase of GVA that it is caused by an increase of final demand by 1 euro, when direct and indirect production effects are taken into account. It is below unity as the use of intermediate inputs – domestically produced or imported – are considered as leakages. It is noted that the GVA is closer to the GDP compared to the gross output.

Table 3.4: Top-5 sector for inputs in the Water Transport Industry

	Domestic inputs		Foreign inputs
Water transport	17.4	Water transport	48.9
Coke and petroleum	7.1	Coke and petroleum	4.8
Warehousing and transport support services	4.9	Warehousing and transport support services	1.2
Architectural and engineering	3.7	Financial services	0.3
Financial services	2.6	Other transport equipment	0.2
Other	8.3	Other	0.6
Total domestic	**44.0**	**Total imported**	**56.0**

Note: The figures above represent the share of each input to the total of direct inputs to the Water Transport Division.
Source: Eurostat Input-Output tables (2015), calculations: author.

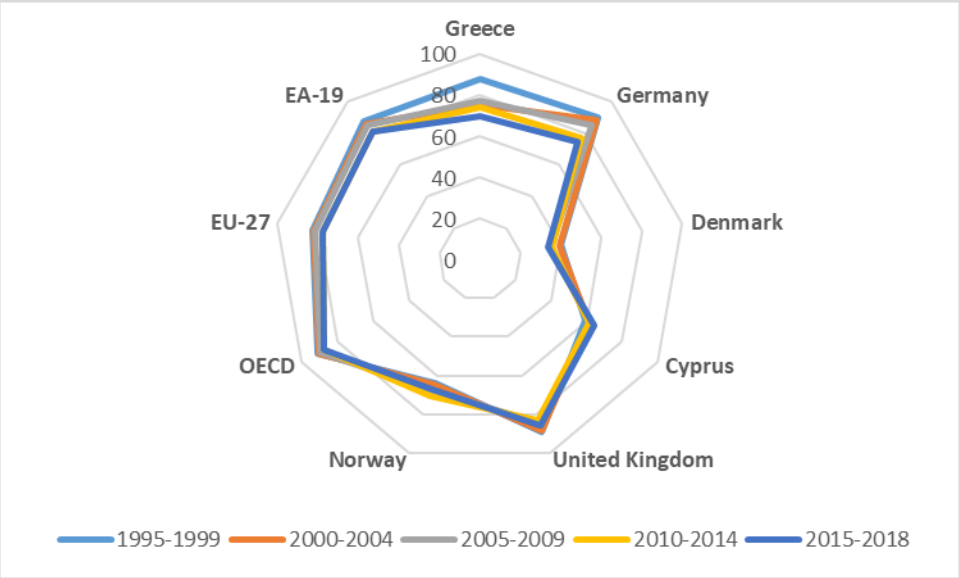
In February 2022, EL.STAT announced the revised 2015 input-output tables which incorporated also the new methodology on compilation of the shipping account in the BoP. Following the input-output methodology that Backinezos et al (2019) applied, the various multipliers were re-estimated. On the basis of the revised input-output tables the simple output multiplier for the Water Transport industry decreased to 1.42 meaning that an increase in the final demand of the industry by 1 euro will increase the total output of the economy by 1.42 euro.[27] The GVA multiplier also decreased - compared to the previous vintage of input-output tables - to 0.48, indicating that an increase of the final demand of the water transport industry by 1 euro will lead to a 0.48 euro increase in the economy's GVA.[28] The above changes are stemming from the fact that the there was a significant increase in the input that the Water Transport industry sources from itself and therefore there are less intersector relationships for that industry. Looking closely to the inputs used in the Water Transport industry production in 2015, 44% were domestically sourced and 56% were imported. From the direct domestic inputs, 17% is sourced within the water transport section, 7.1% relates to petroleum products and 4.9% are sourced from transport support services (including ship brokerage). Turning to the direct imported inputs, the main supplier – almost exclusively - was from its own economic section (i.e. water transport). It

[27] The economy-wide average simple output multiplier recorded a marginal increase at 1.55.
[28] The economy-wide average GVA multiplier remained unchanged at 0.80.

is followed by the petroleum products and the support services to water transport but with a very small share. The direct imported inputs as a share to the Water Transport industry's output amounts to 0.37, which increases to 0.48 for each unit of when the direct and indirect imported inputs are taken into consideration production (i.e. import content).

The latter finding is further confirmed by the OECD data in Trade in Value Added (TiVA) though it may not yet reflect the revised input-output tables by EL.STAT. Overtime there was a decrease in the domestic value added of the sea transport exports, not only in Greece but in other countries including EU-27 as a whole. Denmark exhibits a significant low domestic value added of gross export (around 36%),[29] while the EU-27 average stand at 80%. Compared to Greece, Cyprus and Norway have a lower domestic value added, while Germany and the UK have a higher one (Graph 3.2). In 2018, the last year that the TiVA tables are available, the domestic value added in the sea transport exports of Greece stood at 62.9%, having decreased from 72.2% in 2015.

Graph 3.2: Sea Transport - Domestic value added content of gross exports
(% of gross exports)



Source: OECD TiVA

[29] It is noted that for A.P. Moller – Maersk, the leading Danish shipping firm, in 2018 (2017) the chartered-in fleet as percentage of its total fleet was standing at 50% (56.5%) in terms of number of vessels and at 36.1% (41.8%) in terms of TEU capacity (A.P. Moller – Maersk annual report for 2018).

3.4 Contribution of Greek shipping to the tax revenues

The flagging-out of vessels from traditional maritime nations to the so-called open registries (often termed then Flags of Convenience) was already evident in the 1960s and - especially - in the 1970s. Developments in the international division of labour (Thanopoulou, 1995) and the quest for shipping competitiveness (Thanopoulou, 1998) was the driving forces behind this development. One element of the shipping competiveness relates to the taxation of the shipping operation. In the 1970s, Greece was the first traditional maritime nation to introduce the tonnage tax regime through the adoption of Law 27/1975.

In broad terms, the following categories of tax revenues from ships are (Panagiotou and Thanopoulou, 2019):

1. Greek Tonnage tax of Greek flagged vessels (Law 27/1975) which ever since became the basis for the taxation of Greek-flagged vessels. The vessels are split into two categories; the first one mainly refers to vessels of more than 3,000 GT[30] and the second to all other vessels. The tax is calculated in USD but it is payable in euros (see Appendix I).[31]

2. Tonnage Tax on foreign flagged vessels operated by companies based in Greece: During the economic adjustment programme period and specifically in 2013, foreign-flagged vessels operated by companies based in Greece became also subject to tonnage tax and it is calculated in the same way as for the Greek-flagged vessels. There is though a deduction for any tonnage tax paid abroad.[32]

[30] It is noted that Chapters A to D of Section A of this Law, which set out the taxation procedure (criteria, rates and scales) and respective deductions, enjoy a special higher legislative status pursuant to Article 107 of the Greek Constitution on the protection of foreign capital.

[31] From the end of 2011, the tonnage tax scheme and the other tax reliefs of Law 27/1975 have been subject of an investigation by the European Commission regarding their compatibility with the Community guidelines on State aid to maritime transport. A letter was sent to the Greek authorities on 18/12/2015 (C(2015) 9019 final) with subject: *State aid SA.33828 (2012/E, 2011/CP) – Tonnage tax scheme and other tax relieves provided in Law No 27 of 19 April 1975 as amended*.

[32] Law 4110/2013 Article 24, which amended Article 26 of Law 27/1975.

3. The Voluntary contribution of the shipping community[33] to the Greek state was concluded in the summer of 2013, in the form of a Memorandum of Understanding, and it was another measure that was adopted in the economic adjustment programme period. The voluntary contribution had finally a duration of 5 years (2014-2018)[34] and effectively doubled the tonnage tax that the shipping companies paid.

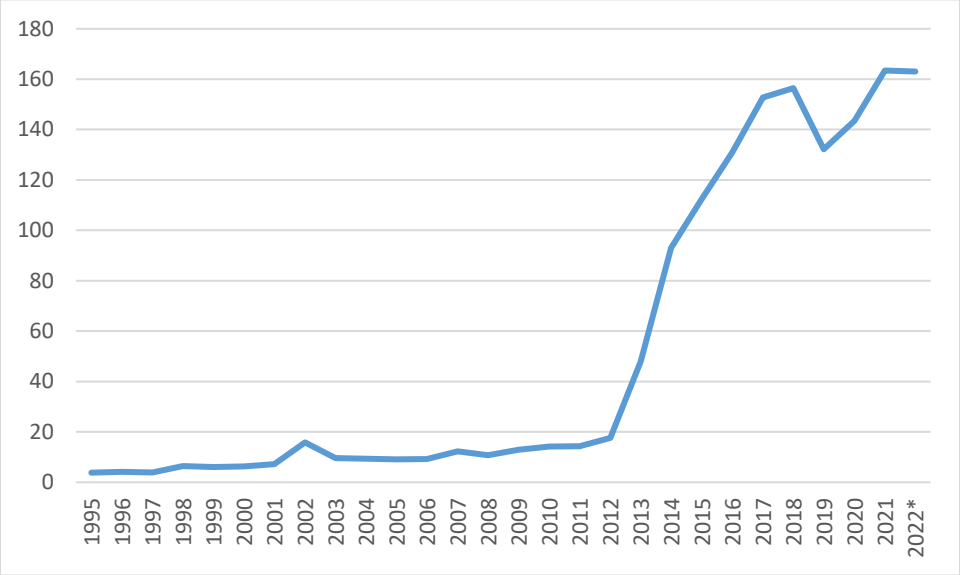
4. Voluntary "perpetual" contribution of 10% shipping company dividends remitted: As the voluntary contribution ended in 2018, it was replaced by a voluntary "perpetual" contribution of 10% on the dividends that the shipping companies are remitting to Greece.[35] Compared to the previous voluntary contribution scheme, the current one is levied on the individuals based on dividends received in Greece while the previous one was levied on the ship-owning company.

5. Contribution (tax) on incoming remittances of ship cluster companies, other than ship-management (e.g. shipbroking): The tax revenues from ships also include the contribution on the incoming remittances of the ship cluster companies of Law 27/1975 (art. 25). This was another measure that was introduced during the economic adjustment programme period and it was introduced in 2013 as a temporary measure, which then extended and currently is a permanent one. [36]

The adoption of these measures contributed to a significant increase in the tax revenues from ships (including the cluster companies' contribution) by more than 9 times from 2012 to 2021 (from 17.7 million euros to 163.4 million euros). Taking into account that every 5 years there is legislative initiative that imposes a 4% p.a. increase in the tonnage tax rates, the upward trend is expected to be maintained (Graph 3.3).[37]

[33] The agreement took the form of a voluntary contribution so as to avoid legal issues stemming from the supra-legislative status of specific articles of Law 27/1975.
[34] The initial duration was for three years (2014-2016) and then it was twice extended by one year. The corresponding ratification was made with Laws 4301/2014 and 4484/2017.
[35] It was ratified by Law 4607/2019 and is of indefinite duration starting from 2019.
[36] Initially, the levy ranged from 3%-5% (for 2012-2015) then it increased to 5%-7% (2016-2019) on the incoming remittances of the respective companies (Law 4111/2013, art. 43, as amended). It became permanent with Law 4607/2019 (art. 53).
[37] The most recent such legislative initiative was in Article 146, par. 1 of Law 4808/2021 that increased the tonnage tax rates by 4% p.a. for the period 2021 to 2025 (inclusive).

Graph 3.3: Evolution of tax revenues on ships
(in million euro)



* refers to budgeted revenues for year 2022.
Sources: State budget (Ministry of Finance) and Independent Public Revenue Authority (AADE).

3.5 Chapter 3 – Key takeaways

- The number of shipping cluster firms is constantly increasing in Greece, as well as the number of managed vessels.

- The water transport industry represents almost 3% of the Greek Gross Value added and was the 11th most important industry in 2018-2019 in GVA terms.

- Various studies have estimated the number of employment posts related to the sea transport sector (directly and indirectly) at around 200-300 thousands.

- The most updated – in 2022 - input-output tables for year 2015 indicate that the import content of the water transport is 48% of the industry's output. Therefore, increasing the use of domestic sources could enhance the contribution of the sector to the economy.

- In the aftermath of the great recession of 2008 and the Greek economic adjustment programmes, the ships taxation revenues increased by a factor of 9.

CHAPTER 4: COMPILATION METHODOLOGIES FOR SEA TRANSPORT SERVICES IN THE BALANCE OF PAYMENTS

Chapter Summary: A key element of the Balance of Payments – which summarises the transactions between residents and non-residents - is the trade balance which represents the balance between exports and imports of goods and services. Sea transport services inflows are recorded in the service account. There is a variety of compilation methodologies depending on the economic structure and the data availability in the reporting country. In Greece, there have been two different methodologies which have been employed during two specific periods respectively before and after the year 2000. Even in the second period, there was a significant change in the compilation methodology which affected data from 2015 onwards. Following a brief introduction on the Balance of Payments and its interrelations with macroeconomic variables, this Chapter discusses the methodologies for the compilation of sea transport services in Greece and in other significant maritime nations in the European Union (EU) and beyond. On their basis, the chapter concludes with suggestions towards improving the sea transport services statistical recording based on international experience and serves as background for the model-related chapters which follow.

4.1 Introduction to the Balance of Payment

The Balance of Payments (BoP) is defined in the 6th edition[38] of the IMF Manual (IMF, 2009) as "*…a statistical statement that summarizes transactions between residents and nonresidents during a period"*[39] and consists of the following accounts (see Table 4.1):

1. *Goods account*: Transactions in goods, i.e. exports (credits) and imports (debits) of goods (1.A.a).
2. *Services account*: Transactions in services i.e. receipts/exports (credits) and payment imports / (debits) of services (1.A.b).
3. *Primary income account*: Income associated with the production process (e.g. wages) or the ownership of a financial asset (e.g. dividends, interest). Credits (debits) represent inflows in (outflows from) the reporting economy (1.B).
4. *Secondary income account*: Current transfers[40] for example workers' remittances and current taxes (1.C).
5. *Capital account*: Capital transfers and non-produced nonfinancial assets (such as leases and licenses) (2).
6. *Financial account*: net acquisition and disposal of financial assets and liabilities (such as shares, loans, debt securities) (3).

The balance of the first two accounts is also known as the trade balance of goods and services, while the balance of the first four accounts is the Current Account (CA). The sum of the CA and the capital account represents the net lending (surplus)/net borrowing (deficit) position of the economy vis-à-vis the rest of the world. The financial account is equal to the net lending/net borrowing of the economy (with the opposite sign) and it

[38] The first edition of the IMF's BoP manual was published in January 1948 aiming at a consistent and timely compilation of countries' BoP statistics (IMF, 1948).
[39] Residency is the territory that the institutional unit (e.g. household, corporation) has its strongest connection; an operational definition relates to the actual or intended location for one year or more. As each institutional unit can be resident in only one economic territory, the non-residents are those that are not identified as residents (IMF, 2009).
[40] A transfer represent a provision of a good, service etc without a corresponding return of an economic value item. There are further distinguished in capital and current. Capital transfers are typically large and infrequent; usually entailing the transfer or acquisition/disposal of an assets (e.g. fixed assets). Current are those that are not capital (IMF, 2009).

represents how the economy is financed.[41] The BoP follows the double-entry accounting system, meaning that each individual transaction creates two accounting entries and ensures that the sum of credits equals the sum of debits (IMF, 2009). The fact that the BoP is in accounting balance, does not mean that it is in equilibrium as well. According to IMF (2009) "*Transport is the process of carriage of people and objects from one location to another as well as related supporting and auxiliary services*." The transport services can be further classified according to the mode of transport (e.g. sea, air) and what is transported (passengers or freight). Therefore, the sea transport services includes the transport by sea-going vessels and they can be classified as:

a) **Passenger** which describes the transport of people[42]
b) **Freight** which records the transport of goods. It can be further distinguished into:
    i. Freight for exported and imported goods
    ii. Cross-trade freight which describes the transport service between other countries.
c) **Other** which include auxiliary to sea transport services such as cargo handling services, pilotage etc.[43]

[41] In principal, the financial account equals the current and capital account. Due to source data and compilation methods imperfections, in practice there is a balancing item, reported separately, titled *Net Errors and Omissions* (4.) which warrants that the BoP is in balance.
[42] Cruise fares are excluded as they are recorded under Travel services.
[43] It is noted that a number of shipping related services are not recorded in this category. For instance, marine insurance is included in the insurance services account, repairs of vessels in the maintenance and repair services.

Table 4.1: Balance of Payments and sea transport account

Balance of Payments	Credits	Debits	Balance (surplus/ deficit)
1. Current account (1.A. + 1.B. + 1.C.)			
1.A. Goods and Services (1.A.a + 1.A.b)			
1.A.a Goods			
...			
1.A.b Services			
...			
1.A.b.3 Transport			
1.A.b.3.1 Sea Transport			
1.A.b.3.1.1 Passenger			
1.A.b.3.1.2 Freight			
1.A.b.3.1.3 Other			
…			
1.A.b.4 Travel			
...			
1.B.Primary income			
1.B.1 Compensation of employees			
1.B.2 Invstment income			
1.B.3 Other primary income			
1.C.Secondary income			
1.C.1 General Government			
1.C.2 Financial corporations, nonfinancial corporations, households, and NPISHs			
1.C.3 Adjustment for change in pension entitlements			
2. Capital account			
…			
Net lending (+) / net borrowing(-) (from current and capital accounts) (1 + 2)			
	Net acquisition of financial assets	**Net incurrence of liabilities**	**Net**
3. Financial account			
3.1 Direct investment			
3.2 Portfolio investment			
3.3 Financial derivatives (other than reserves) and employee stock options			
3.4 Other investment			
3.5 Reserve assets (change)			
	Credits	**Debits**	
4. Net errors and omissions (Balancing item: 4 = 3 - 1 - 2)			

Source: Adapted from IMF (2009) - Appendix 9 Standard Components and Selected Other Items.

The activities of the shipping companies are reflected in a number of Balance of Payment account including the sea transport services. In more detail, though not exhaustive, the following accounts can record shipping-related activities between residents and not residents:

1. The purchases and sales of vessels are recorded in the *Goods accounts* (imports and exports, respectively).
2. Bunkers and victualling supplies purchases are also recorded in the *Goods account* (e.g. bunkers purchased in the reporting country by non-resident vessels are recorded as exports).
3. The transactions relating to the maintenance of vessels shall be recorded in the *Services account* under Maintenance and repair services.
4. The provision of insurance services, financial services and accounting services shall be recorded in the *Services account* under Insurance, Financial and Other business services, respectively.
5. Crew-related expenses are recorded in the *Primary Income account* under Compensation of employees.
6. The payment of interest on loans and of dividends from the shipping companies are recorded in the *Primary Income account* under Investment Income.
7. The loan advancements or repayments are recorded in the *Financial account*.

The focus of our discussion will be on *Sea transport services* as they represent the key account of the shipping activities between residents and non-residents in the Balance of Payments.[44]

4.2 Sea transport services and the other macroeconomic variables

Exports and imports of sea transport services is an integral element in other key macroeconomic variables as defined in the System of National Accounts - SNA (Eurostat, 2013). In more detail.

[44] Haralambides (1990) described and illustrated some difficulties in the sea transport account.

A. *Sea transport account and the GDP*: The exports and imports of sea transport services through the Trade Balance of goods and services are included in the GDP accounting identity (expenditure approach) (Lequiller and Blades, 2014).

$$GDP = C + G + I + X - M, \quad (4.2.1)$$

where:

$C =$ Final consumption expenditure of Households and non-profit institutions serving households (NPISH)

$G =$ Final consumption expenditure of General Government

$I =$ Gross Capital formation (i.e. investment in non-financial assets)

X = Exports of Goods and Services

M = Imports of Goods and Services

In the case of Greece, as will be discussed later in Secton 4.3.1, before 1998, part of the shipping-related inflows and outflows in the Greek BoP were recorded in the Primary Income account. As a result, the full effect of the shipping related inflows/outflows was not reflected in the GDP but rather in the Gross National Income (GNI), which is defined as

$$GNI = GDP + BPI = C + G + I + X - M + BPI, \quad (4.2.2)$$

where:

$BPI =$ Balance on primary income.

B. *Sea transport account and Trade Balance & Current Account*: Sea transport services account, as a constituent of the trade balance in goods and services, directly affects the current account. Specifically:

$$TB = X - M = X^G + X^S - (M^G + M^S) \quad (4.2.3)$$

$$X^S = X^{TRAVEL} + X^{SEA\ TRAN} + X^{OTHER\ SERVICES} \quad (4.2.4)$$

$$M^S = M^{TRAVEL} + M^{SEA\ TRAN} + M^{OTHER\ SERVICES} \quad (4.2.5)$$

where,

$TB =$ Trade Balance in Goods and Services,

$X\ (M) =$ Exports (Imports) of Goods and Services

$X^G(M^G) =$ Exports (Imports) of Goods

$X^S(M^S) =$ Exports (Imports) of Services

$X^{TRAVEL}(M^{TRAVEL})$ = Receipts/Exports (Payments/Imports) of Travel Services

$X^{SEA\ TRAN}(M^{SEA\ TRAN})$ = Receipts/Exports (Payments/Imports) of Sea Transport Services

$X^{OTHER\ SERVICES}(M^{OTHER\ SERVICES})$ = Receipts/Exports (Payments/Imports) of Other Services (e.g. aviation, construction, financial services, other business services etc)

Moreover, the Current Account Balance (CAB) is defined as:

$$CAB = TB + BPI + BSI = X^G + X^S - (M^G + M^S) + BPI + BSI \quad (4.2.6)$$

BPI = Balance on primary income.

BSI = Balance on secondary income.

From equations (4.2.3) – (4.2.6), an increase (decrease) in receipts of sea transport services contributes positively (negatively) to total exports, the trade balance and the current account. On the contrary, an increase (decrease) in imports of sea transport services negatively (positively) affects the current account.

C. Sea transport account and Savings-Investment gap

Another way to present the contribution of the sea transport services account to the macroeconomic variables is through the savings and investment gap, which is mirrored in the Current Account balance (IMF, 2009). In more detail, the Gross National Disposable Income (GNDY) is defined as:

$$GNDY = C + G + I + X - M + BPI + BSI \quad (4.2.7)$$

but $CAB = X - M + BPI + BSI$. (4.2.8)

Thus, $GNDY = C + G + I + CAB$ (4.2.9)

In the System of National Accounts (SNA), Gross Saving (S) is defined as:

$$S = GNDY - C - G. \quad (4.2.10)$$

By substituting (4.2.9) in (4.2.10), we get $S = GNDY - C - G = I + CAB$

and thus

$$S - I = CAB \quad (4.2.11)$$

Thus, the savings and investment gap corresponds to the CAB. Namely, in the case that domestic savings (both private and general government) are not sufficient to cover the investment expenditures of the economy, the CAB will be in deficit as the external sector finances the gap. On the contrary, a positive CAB indicates that savings are greater than investment, and therefore the economy is a net lender to the rest of the world

The role of the balance of sea transport services in the saving and investment gap can be explicitly presented as follows:

$$S - I = CAB^{excl.\ sea\ tran} + (X^{SEA\ TRAN} - M^{SEA\ TRAN}) \qquad (4.2.12)$$

where

$CAB^{excl.\ sea\ tran}$ = Current Account Balance excluding the sea transport services balance.

Sea transport services inflows can play an important role in financing the economy; an increase in the export of sea transport services contributes to the improvement of the CAB and thus covering part of the investment which is not financed by saving, *ceteris paribus*.

A more interesting presentation is the one that distinguishes the savings and investment between the private and the general government. In this instance, identity (4.2.11) and (4.2.12) can be re-written as:

$$S - I = (S^p + S^g) - (I^p - I^g) = (S^p - I^p) + (S^g - I^g) = CAB \qquad (4.2.13)$$

$$(S^p - I^p) + (S^g - I^g) = CAB^{excl.\ sea\ tran} + (X^{SEA\ TRAN} - M^{SEA\ TRAN}) \qquad (4.2.14)$$

where,

$S^p(S^g) =$ Savings of private (general government) sector

$I^p(I^g) =$ Investment of private (general government) sector

Thus, if the general government is running a negative savings and investment balance which is not offset by the private sector, the CAB will be in deficit. The sea transport inflows can cover the savings and investment gap of either the government or the private sector as per identity (4.2.14).

For EU member countries, there is an additional facet in the context of the economic surveillance procedure towards prevention and correction of macroeconomic imbalance in the economies' of Member States (European Commission, 2016). In the annual – since 2012 – Alert Mechanism Report (AMR) of the European Commission, which is embedded in the European Semester,[45] a number of Macroeconomic Imbalance Procedure (MIP) indicators are calculated. Two out of the five indicators covering External Imbalances and Competitiveness can be directly affected by the sea transport services account; the current account as % of the GDP and the export market shares changes (see Table 4.2). In the first one, sea transport services balance is an element of the CAB while in the second one exports of sea transport services is a constituent of the economy's total exports. Thus, an improvement in the sea transports exports (net in the first case, receipts only in the second) can assist a country in achieving a figure above the required threshold.

Table 4.2: MIP Scoreboard Indicators - External Imbalances and Competitiveness

	Unit	Threshold
Current account balance	% of GDP 3 year average	Lower: - 4% Upper: +6%
Export market shares	5 year % change	Lower: - 6%
Net international investment position	% of GDP	Lower: -35%
Real effective exchange rate	3 year % change	± 5% - for euro area (EA) countries ± 11% - for non-EA countries
Nominal unit labour cost	3 year % change	+9% - for EA countries +12% - for non-EA countries

Source: European Commission (2016).

[45] The scoreboard of indicators under MIP and the AMR were introduced by Regulation (EU) No 1176/2011.

4.3. Compilation of Balance of Payment: The case of sea transport services in Greece

Since 1920s, there were attempts for improving the compilation of Balance of Payments data for Greece. These efforts, which were paused during the second-world war, were revamped in 1950s. The foreign exchange controls that were in place since the early 1930s were the basis for the methods of compilations of such data. The Bank of Greece, on the basis of its Statute that was ratified by Law 3424/1927, is responsible for the administration of the country's foreign exchange (Pantelidis, 1997).

4.3.1 The first period of the Balance of Payment (1965-1998)

The system for Balance of Payments data compilation - that was fully developed in early 1970s - was based on the existence of foreign currency restrictions and controls. In this context, financial institutions were (and in many cases still are) obliged to report foreign exchanges transactions to the Bank of Greece. For the compilation of the balance of payments the Bank of Greece used the Bank Reporting Method, i.e. the method of the International Transactions Reporting System (ITRS). Effectively, it recorded foreign currency transactions (acquisition or disposal of foreign currency) performed through the Greek banking system. The basic concept of that system was the impact of the foreign currency transactions on the country's reserves.

At that time, the Bank of Greece was not conducting surveys to estimate the receipts or payments of foreign currency in activities such as shipping or tourism. Specifically, ship management companies based in Greece – irrespective of the flag their vessels are flying - were not legally obliged to report/remit their receipts from their operations back to Greece, the only exception being the funds related to their expenses in Greece, as their operating costs in Greece needed to be paid in foreign currency (i.e. USD). The methodology used at that time followed – to the extent possible, according to the Bank of Greece (Eurostat, 1986) – the IMF recommendations of the BoP Manual, 4th edition (IMF, 1977); however,

differences and deviations existed.[46] It is noted that then the Balance of Payments was compiled and published in USD.

In the traditional presentation of the Balance of Payments, transportation (mainly shipping) credits/receipts and debits/payments were recorded in the invisibles account together with other services such as travel as well as investment income and unrequited transfers.[47] As far as services are concerned the time of the transaction recording coincided with that of the actual receipt or payment for the service (which did not necessarily coincide with the time of the service provision - accrual principle).

According to the methodology up to the end of 1990s, the foreign exchange receipts (credits) from shipping corresponded to the earnings from the international operations of Greek-controlled/managed vessels. Predominately these receipts were reflecting the goods and services that these companies were acquiring in or through Greece. This system had an inherent discrepancy compared to similar ones of other countries in the Freight Earning account; it reflected only the operating expenses incurred by the shipping firms in Greece, which stemmed from the Greek legal system that did not oblige the shipping firms to "surrender" all their foreign exchange receipts. [48]

Specifically, the main categories of receipts (credits) were (Eurostat, 1986):

a) *Shipowners' remittances*: The receipts from this category were usually used to cover:
    i. Operating expenses of the ship management companies in Greece as well as purchases of goods and services for the managed ships from Greece.
    ii. Salaries and other income payments to seafarers made through the ship management company.

[46] For instance, in the Greek BoP, a transaction was recorded when the foreign exchange transaction took place, which did not necessarily coincide with the change of ownership in goods or the provision of services, as recommended by the IMF (Eurostat, 1986).
[47] Notwithstanding methodological changes in the compilation of BoP statistics, the goods account was referred as visible trade, while the services account as invisible trade.
[48] The special treatment of shipping was founded on the fact that the shipping firms were performing the majority of their operations in cross-trade, and not in the transportation of Greek exports/imports.

iii. Payment of taxes and other related expenses. In some cases, the payment of taxes could occur directly without the intermediation of the ship management company.

iv. Cost of living of ship-owners and their families.

It is noted that the payments especially of the last three categories are not made directly to the respective recipients (e.g. seafarers) but rather through the Greek-based ship management companies.

b) *Seafarers' remittances:* It included the seafarers' salaries that were exchanged for Greek drachmas, both through remittances or withdrawals in drachmas from their foreign exchange accounts.[49]

c) *Contributions to seafarers' pension funds:* It included the ship-owners and the seafarers' contributions to the social security funds, the main being NAT (Seafarers's Pension Fund).[50]

d) *Freights*: It reflected a portion of the freight cost for the transportation of Greek exports of goods.

e) *Supplies and repairs*: The receipts (credit) from the provision of supplies and repairs in Greece.[51]

f) *Passengers' fares*: The foreign exchange receipts from the international transportation of passengers. It is though noted that it covered the foreign currency receipts by all means of transportation (i.e. ships, planes, trains and busses). It is estimated that this figure is underestimated due to the offset between receipts and payments.

On the other hand, the main payments (debit) categories are:

a) *Shipping office expenses* (Ship-owners expenses): The foreign exchange paid by ship management offices to cover their expenses abroad.

[49] It is noted that the inflows and outflows in foreign exchange bank account for seafarers (and immigrants) were recorded under the capital account.

[50] As NAT is allowed to hold/maintain a portion of its reserves in foreign currency abroad, this account includes also any foreign currency exchange for Drachmas in Greece (see Article 9, par. 3 of Presidential Decree 913/1978)

[51] In the case of sale of bunker (transit basis), the domestic value added is only included in this account.

b) *Passengers' fares*: The foreign exchange payments for the international transportation of passengers (travelling abroad).

g) *Supplies and repairs*: The foreign exchange currency provided to Greek carriers for the payments (debits) from the provision of supplies and repairs to abroad.[52]

The main element of the sea transport account of the BoP and the respective correspondence with the IMF recommendations (BoP Manual – 4th edition) as well as its correspondence to the National Accounts (as compiled by the Hellenic Statistical Authority, then National Statistical Service of Greece - NSSG) is presented in Table 4.3.

Significant elements of the sea transport services in the BoP (such as shipowners and seafarers remittances) were treated in national accounts as income (either investment or compensations of employees). As income, it was not included in the Gross Domestic Product (GDP) but rather in the Gross National Income (GNI)[53], the inflows from shipping were not having an effect on the country's export and thus on the GDP.

The compilation methodology by the Bank of Greece and especially the aforementioned break-down of the shipping inflows had attracted the critique of academics. Georgantopoulos (1977, 1982) emphasized the fact that ship-owners' remittances may include amounts channeled to activities described by other categories in the sea transport account. For example, payments to pension funds, instruction from seafarers to payments to their families, payments of services (i.e. repairs) rendered in Greece. Similar concerns were expressed by Goulielmos (1996), who even proposed a new classification of the ITRS system which resembled more a survey type compilation method.

[52] Another account that it is of interest is the exchange of foreign currency into Greek Drachmas from foreign currency accounts (the so-called convertible drachma deposits). This account, part of the invisible account, covered a wide range of transactions (hotel services, immigrants' remittances, shipping-related transactions etc.). However, the break-down of credits was not available. In addition, two account in the capital account had a shipping interest; a) *Purchases of/investment in real estate (credit)* which included Greek seafarers foreign exchange inflows for the purpose of purchasing real estate *and b) Other Credit Institutions, Short-term (credit and debits)* which included the capital inflows in foreign exchange of Greek seafarers.

[53] Note that gross national income is the current title of the gross national product (GNP) in the old terminology of national accounts (Lequiller and Blades, 2014).

Table 4.3: Correspondence Table

Bank of Greece	IMF – BoP Manual (4th ed)	NSGG – National Accounts
Credits		
Shipowners' remittances	Other Transportation	Income receipt – Investment income
Seafarers's remittances	Other Transportation	Income receipt – Compensation of employees
Contributions to seafarers' pension funds	Other Transportation	Income receipt – Compensation of employees
Freights	Shipment	Exports of Goods and Services – Transport
Supplies and repairs	Other Transportation	Exports of Goods and Services – Transport
Passengers' fares	Other Transportation – Passenger services	Exports of Goods and Services – Transport
Debits		
Ship-owners expenses	Other Transportation	Imports of Goods and Services – Transport
Passengers' fares	Other Transportation – Passenger services	Imports of Goods and Services – Transport
Supplies and repairs	Other Transportation	Imports of Goods and Services – Transport

Source: Eurostat (1986), adapted by the author.

4.3.2 The second period of the Balance of Payment (2000-today)

The gradual relaxation of the currency controls (e.g. use of credit cards abroad) already in early 1990s adversely impacted the effectiveness of the compilation and recording system. Against this background and gradually since September 1997, the Bank of Greece implemented a new methodology for the compilation of the BoP in accordance with the conceptual framework of the IMF Balance of Payment 5th edition (IMF, 1993). In

comparison to the previous methodology, the "new" one is based on transactions between residents and non-residents. This is a significant difference compared to the previous methodology that recorded foreign currency transactions (acquisition or disposal of foreign currency).

The main elements of the "new" system were the following:

a) It was based on the 5th edition of the IMF Balance of Payments Manual. As a result, IMF standard categories and account were used, in line also with Eurostat requirements.
b) The transactions between residents and non-residents were compiled on a monthly basis, irrespective of the currency of the transaction.
c) The concept of the resident was defined – in an operational way – as:
    i. A natural person residing or intending to reside in the country for at least one (1) year and
    ii. A legal person/entity based in Greece or o foreign legal person based and operating in Greece.
d) Transaction data were provided by resident Financial Institutions as well as directly reported by resident natural and legal persons. Additional data are also provided by other companies such as Mutual Funds, Credit Card issuing companies etc.

The "new" system was gradually implemented since the second quarter of 1998, and it continued in the last two quarters of 1998. However, Bank of Greece continued to use the "old" system for the publication of the data. The transitional period expanded into 1999, with the new data and presentation started effectively in 2000.

Since the implementation of the "new" system in late 1990s, the basic elements of the system for the compilation of the BoP are still valid today; however, several enhancements in line with international standards have taken place.[54]

[54] For instance, the border survey for the travel receipts and payments in 2002, the implementation of the IMF Balance of Payments Manual 6th edition and the use of merchandise trade in 2015, the use of the administrative sources and commercial databases for the estimation of the Balance of Payments items related to shipping activity.

In the interim period (1998-1999) from the foreign currency transactions system (pre-1998) to the resident/non-resident transaction one (post-1998), Bank of Greece continued to publish the current account on the basis of the old system utilising though the data of the new system.[55] Against this background, the comparison of disaggregated data (e.g. receipt from transport services) between the two systems turn out to be problematic. However, this issue seemed to be resolved when comparing aggregated (big) group of accounts, i.e. the total current account. Effectively, as from 1999, the new system was in full implementation and since then – or rather to be more accurate since 2000 - the data are comparable in the sea transport account.[56] However, currently the Bank of Greece time series officially exists since 2002.

4.3.2.1 The first phase of the post-2000 system (2000-2014)

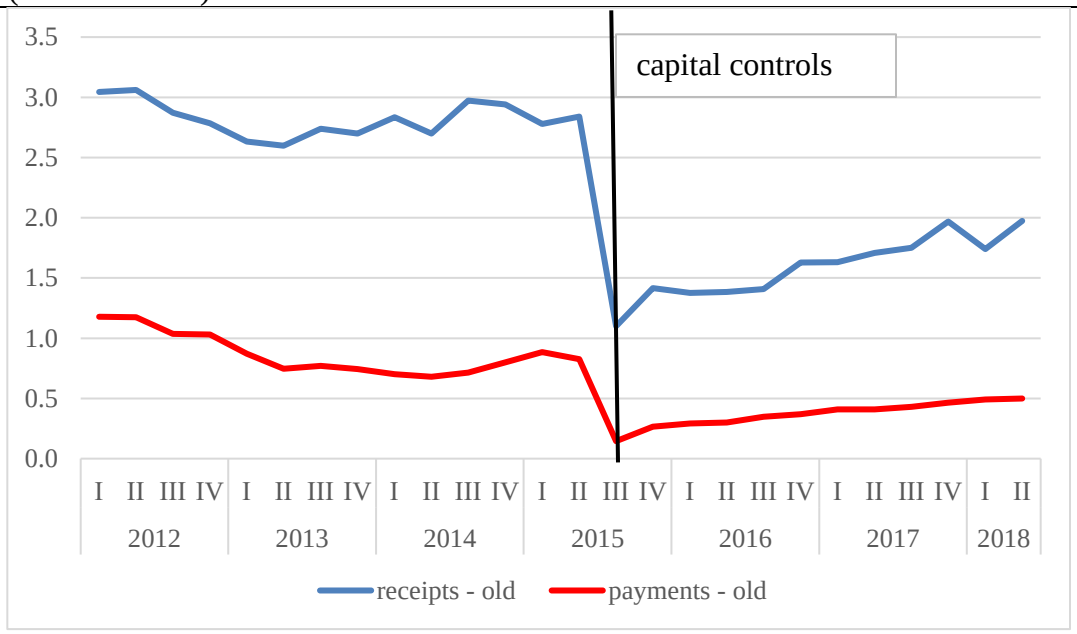
In the case of sea transport services and according to the Bank of Greece guidelines (Bank of Greece, 1997), the receipts from and payment for the provision of sea transport services in the BoP were distinguished into the following 5 categories:

1. *Sea transport of persons*: The receipts (payments) of residents (non-residents) that manage ships under any flag (foreign flag) from non-residents (residents) for the transportation of non-resident (resident) persons. The definition includes the revenues from both passenger and vehicle tickets.[57]
2. *Sea transport of exported/imported goods*: The receipts (payments) of residents (non-residents) that manage ships under any flag (foreign flag) from non-residents (residents) for the transportation of exported (imported) goods.
3. *Sea transport between third countries (cross-trading)*: The receipts of residents from non-resident that manage ships under any flag for the transportation of goods between third countries. This account is the most important in the sea transport receipts.

[55] According to the Bank of Greece (1999), data based on the new compilation method was initially collected in Q2:1998 as a number of financial institutions provided data; the collection increased gradually in Q3:1998 and Q4:1998. In 1999, Bank of Greece expressed the expectation that soon enough there will be a full transition to the new system.
[56] See for example Bank of Greece (2001) page 215.
[57] It is noted that the revenues from cruising, yachting and non-resident domestic sea transport are included in the Travel account of the Balance of Payments.

4. *Sea transport – Other services*: The receipts (payments) of residents (non-residents) from non-residents (residents) for sea transport related services such as ship agency, towage, port fees, maintenance and cleaning of ships etc. This account included also cash withdrawals from the accounts of resident shipping companies.

Graph 4.1: Sea transport services receipts and payments – Old methodology
(in billion euro)



Source: Bank of Greece

In June 2015 and following the introduction of capital controls, the system mentioned aboved proved inefficient for the compilation of sea transport accounts. Specifically, the receipts from sea transport services reduced greatly after the introduction of capital controls although the actual activity of Greece-based shipping companies was not reduced to the same extent (see Graph 4.1). Against this background, Bank of Greece started working on a new compilation methodology for the sea transport accounts in the Balance of Payments (Bank of Greece, 2018b).

4.3.2.2 The second phase of the post-2000 system (2015-today)

The new methodology was introduced in November 2018 (reference month September 2018) with retroactive application from January 2015 and it was based in the so-called the Greek Shipping Estimation Model (GSEM). It was not based anymore on bank settlement

data (ITRS) but on administrative sources (e.g. Ministry of Merchant Shipping) and on international shipping-related databases (e.g. Lloyds List intelligence) (see also Appendix II.1). [58]

Compared to the previous compilation methodology that the Greece-based banks were transmitting the relevant aggregated data to the Bank of Greece, the new system is a vessel specific model; revenues and expenses per vessel that are managed from Greece are estimated. The estimation is based on a combination of data from official sources and international shipping databases. The first step in this process is the selection of vessels that are included in the population for the compilation of revenues and expenses that then are recorded in the BoP. To this end, vessels that are included in the Ministry of Merchant Shipping list of ship management companies and that have their commercial operator in Greece – according to the international databases – are included in the population. Additionally, Greek ship-owning companies with Greece-based commercial operators are also included.[59] The information, especially in relation to the international databases, are updated on a monthly basis (Petralias and Papaspyrou, 2019).

Following the determination of the population of Greece-managed vessels, a vessel is characterized as active – thus generating revenues and expenses – if its draft is above 20%-30% of its max depth; inferring that the vessels is chartered. In addition, if there is a port movement, the vessel is also deemed as hired. The relevant information is received by the international databased every 10 day (i.e. 3 times per month). As the active vessels are singled out of the population, then revenues and expenses are estimated based on the charter rates, operating expenses, bunker, port expenses etc. based on the data retrieved by the international shipping-related databases. Finally, the relevant accounts of the BoP are credited/debited according to the BoP Manual 6th edition (IMF, 2009). It shall be noted that the new methodology accommodates the payment of the net freight earnings from the

[58] It is noted that two methodological changes took place in 2015 that did not impact the sea transport services account. Firstly, Bank of Greece adopted IMF Balance of Payments Manual 6th edition. Secondly, Bank of Greece started using external trade data from the Hellenic Statistical Authority (ELSTAT) for the exports and imports of Goods. For more details on these changes, see Belli and Backinezos (2016).

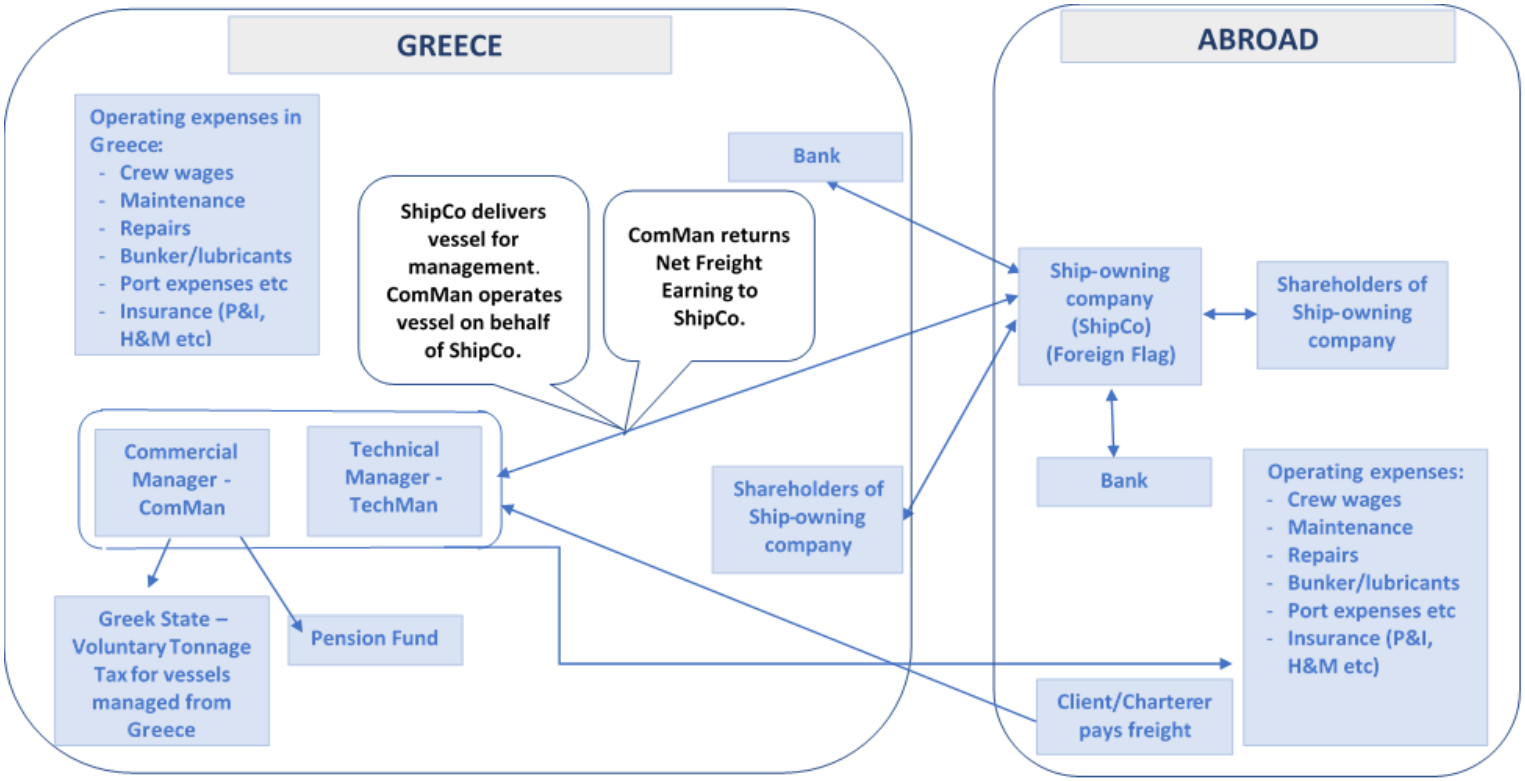
[59] Vessels bareboat chartered abroad (to Greece) are excluded (included). It is noted that vessels more than 30 years old or with no movement since 2000 are excluded as well.

Commercial Operator (in Greece) to the Legal Owner (usually abroad). This payment is recorded under Payments (imports) of sea transport services. Net freight earnings are defined as Freight Revenues minus Voyage and operating expenses for each vessel (Petralias and Papaspyrou, 2019). [60]

In more detail, the transactions between residents and non-residents in the case that the ship-owning company is registered abroad and the vessel is flying a foreign flag but the ship management is performed from Greece is presented in Figure 4.1. In this case, the foreign-registered ship-owning company (legal owner of the vessels) denoted here by "ShipCo", delivers the vessel for commercial management to the Greece-based denoted here "CommMan" commercial vessel's management company, which acts on behalf of the "ShipCo". The CommMan company receives all freight earnings from clients/charterers (e.g. voyage or time charter freights) and makes all the necessary payments in relation to the vessel operations such as bunker expenses (usually abroad), crew wages (in Greece for Greek/resident seafarers and abroad for non-Greek/non-resident seafarers), tonnage taxes (in Greece for Greek flagged vessels or Greece-operated vessels) etc. The Net Freight Earning, which are freight revenues minus the vessel's voyage and operating expenses are transferred to the foreign (non-resident) ShipCo, and are recorded as payments of sea transport services. The ShipCo, as the legal owner of the vessel, makes the loan servicing payments (to Greece for resident financial institutions and abroad for non-resident financial institutions), dividends payments (to Greece for resident shareholders and abroad to other shareholders) etc.

[60] In the special case, that net freight earnings are negative, i.e. the Legal Owner has to reimburse the balance of costs to the Commercial Operator (in Greece), this payments is recorded as an inflow (exports) from broad.

Figure 4.1: Foreign Shipping Company controlled by Greek interests, Foreign Flag and Managed from Greece



Source: Bank of Greece (2018a) and Petralias and Papaspyrou (2019), adapted by the author.

A key consideration on the GSEM relates to the fact that a notable amount of data from various databases needs to be combined. This element should be evaluated in relation to the possible changes in the fields and definitions in the international shipping-related database used for the BoP accounts compilation. Moreover, as shipping is an international business, exogenous developments can occur due, for instance, international environment legislation. Such change could require the introduction of new variables (e.g. type of fuel consumed or scrubber fitted vessel) that may or may not be available in the international shipping databases (Petralias and Papaspyrou, 2019).

4.4 Methodologies for recording Shipping Inflows – International

The Balance of Payments and International Investment Position Compilation Guide (IMF, 2014) suggests that – depending also on the circumstances of each individual country – the sources and methods suitable the compilation of the transport account are enterprise surveys or an International Transactions Reporting System (ITRS) of resident and non-resident operators or alternatively a data model. In the latter case, as it is indicated in Eurostat (2020), compilers can use administrative data as well as commercial databases aiming at achieving the best use and complimentary of the available data. United Nations Department of Economic and Social Affairs (2016) further assessed the advantages and disadvantages of the main sources for the collection of transport data on the basis of five criteria:

- Coverage
- Accuracy in reporting
- Timeliness and Frequency
- Relevance
- Burden of reporting and processing data (see Appendix II.2).

Notwithstanding national circumstances that may result in non-availability of a data source or that a data source may not be the best option, the enterprise and establishment surveys seem to be the best option especially as far as coverage of data is concerned. However, they are less advantageous in relation to timeliness as data are usually available quarterly; the use of an ITRS model or of third-party data may ensure more timely and frequent

availability. As far as the burden and the data analysis, the surveys seem to be more disadvantageous compared to the ITRS model or the third-party data especially as soon as the data analysis system is in place. However, the use of third-party data sources may create further burden if estimation on the data supplied is needed.

On the basis of the data sources used in key maritime nations in the EU and the world, there is a tendency towards the use of surveys, despite the existence of many exceptions or different approached in the surveys performed (Table 4.4). In the Greek-case the pre-2015 model was mainly based on ITRS (mainly based on financial institutions transactions data), while the post-2015 Greek Shipping Estimation model is a data model making use of both administrative and international (third party) data sources. The other EU countries utilise a direct reporting system, according to which the enterprises declare their transaction with non-residents, a sample-based survey approach or a combination of both.

For instance, in *Germany* the regular direct reporting system is used, while in *France* the direct reporting system is further augmented by a Supplementary Survey on international trade in services. In *Italy*, a dedicated Survey on International Merchandise Transport is taking place every year and the findings are presented in an annual report. In *Cyprus*, the Central Bank of Cyprus performs a Ship Management Survey every 6 months and a Shipowning Survey annually on a sample of companies. A Ship Management Survey report, based on the data collected from the respective survey, is published every 6 months and it contains key information on the recent development in the ship management sector in Cyprus. Turning to the European non-EU countries, Norway and the UK both collect sea transport related data via surveys. Statistics Norway publishes annually key tables from the Operating survey for vessels in water transport. The UK Office for National Statistics publishes two datasets; "UK shipping industry international revenue and expenditure" and "UK shipping industry: transactions by vessel type". The key maritime nations in Far East, Japan and China, make use of the ITRS which – in the case of Japan – is augmented by shipping enterprises direct reporting data. In Singapore and Korea, the survey method was elected. Finally, the USA key sources of sea transport data are monthly and quarterly surveys of ship operators (Table 4.4).

Table 4.4 Data sources for the compilation of sea transport services

	Country	Compilation methodology	Frequency	Institution	Comment
EU	Greece	Greek Shipping Estimation Model	Monthly	Bank of Greece	It is a type of Data model
	Germany	Direct reporting System	Monthly	Deutsche Bundesbank	Regular BoP reporting system. Adjustment procedure to comply with BPM6.
	France	Direct reporting System complemented by Supplementary Survey on International Trade in Services	Monthly Annual	Banque de France	 The survey is based on a sample of non-bank corporations that are not full direct reporters.
	Denmark	Survey on international trade in services	Monthly/Annual	Statistics Denmark	The Survey is a combination of monthly reports and annual reports.
	Belgium	Survey in Transactions in services by the major enterprises Survey in Transactions in services by smaller enterprises	Monthly/Quarterly Quarterly	National Bank of Belgium	The Survey for the major enterprises is exhaustive, while the one for the smaller enterprise is on a sample.
	Netherlands	Direct reporting for large enterprises Survey for small and medium enterprises	Quarterly	Statistics Netherlands	The Survey of small and medium enterprises contains less details compared to the direct reporting of large enterprises.
	Italy	Survey on International Merchandise Transport	Annual	Banca d'Italia	It is based on a sample
	Cyprus	Ship-management survey	Semi-annual	Central Bank of Cyprus	They are based on a sample.
		Ship-owning survey	Annual	Central Bank of Cyprus	

	Country	Compilation methodology	Frequency	Institution	Comments
Non-EU	Japan	ITRS, augmented by direct reporting of shipping enterprises	Monthly	Bank of Japan/Ministry of Finance	
	China	ITRS (mainly)	Quarterly	State Administration of Foreign Exchange (SAFE)	
	Singapore	Survey of International Trade in Services	Annual	Singapore Department of Statistics	
	South Korea	Surveys of resident shipping companies (primary) and ITRS (FEIS)	Monthly	Bank of Korea	The FEIS is an electronic reporting system that records and classifies all international transactions associated with flows of foreign exchange.
	USA	Surveys	Monthly/Quarterly	Bureau of Economic Analysis	
	Norway	Operating survey for vessels in foreign going trade	Annual	Statistics Norway	
	UK	Survey to largest members and to all members	Quarterly Annual	UK Chamber of Shipping	

Notes: Countries are presented in the table on the basis of the size of their fleet (in dwt) according to UNCTAD data on beneficial ownership (average 2015-2021).
Sources: Banca d' Italia (2017), Banque de France (2015), ECB (2016), Statistics Denmark (2020), IMF SDDS and SDDS plus.

4.5 Assessment and Implications

In accordance with the IMF (2014) compilation guide and without prejudice to national circumstances, the majority of key maritime nations have elected the survey method for the collection of sea transport data for the balance of payments. The development and use of the Greek Shipping Estimation Model may signal that there are specific national circumstances and conditions that did not allow the development of a survey based system.

Comparing the Greek system to a survey based system, it can be deduced that:

1. The GSEM can quite swiftly - after the end of the reference period (month) - estimate the sea transport receipts and payments for the reference month. In a survey system, there is a period of several weeks between the end of the reference period and the collection of the survey data. For instance, in Cyprus the submission of the Ship-management survey by the respondent shall take place within 35 working days (almost 2 months) after the end of the six-monthly reference period. Moreover, surveys may take place in longer interval for example every six months in Cyprus, or once a year in the UK.
2. The GSEM creates no administrative burden to the Greece-based shipping companies compared to a survey that would create an additional administrative burden to shipping operators.
3. The GSEM is based on market data for international shipping for freight rates and operating expenses, including bunkers. Therefore, the estimated revenues and expenses reflect the international averages[61] and not necessarily the actual revenues and expenses of the Greece-based shipping companies. From a user's point of view, these data may not correctly reflect the competitive advantages (or disadvantages) of the Greece-based shipping companies compared to their international competitors. On the other hand, surveys collect actual data directly from the shipping companies and thus reflect more accurately their revenues and costs.[62]
4. As it was previously mentioned, the GSEM is data intensive and susceptible to exogenous developments in international shipping, requiring the inclusion of new

[61] Even if there are market averages for specific trading routes or bunkering ports.
[62] Provided that the survey is well designed (e.g. representative sample).

variables or the alteration of existing ones. For instance, it is not clear how the model can distinguish between scrubber-fitted vessels, which can still use the high sulphur marine fuel, and non-scrubber fitted ones, unless a new variable about the existence of scrubbers in each vessel in the database is included. In the case of a survey, such developments may be less problematic as the respondents continue to report revenues and costs.

The advantages of the Greek Shipping Estimation model with respect to the timely production of data and the absence of administrative cost for the shipping companies are self-evident. However, its disadvantages against surveys can be also addressed. Against this background and without prejudice to the Greek shipping specific economic circumstances, a policy suggestion for a survey of the Greece-based shipping companies can significantly supplement the data production of the Greek Shipping Estimation model. The design of the survey needs to be agreed with the shipping community and a number of issues need to be addressed such as:

i. *Frequency*: An annual survey may suffice for a supplementary survey as this seems to be the experience from France. Even in countries that surveys are the main source of data such as in Norway and Italy, they take place once a year; Cyprus though has elected for semi-annual surveys.
ii. *Coverage*: Although it would be desirable to include all Greece-based shipping company, a sample-based survey as it is the international experience may be more preferable. The first option covering all the companies could be performed in longer intervals (e.g., every 2 years). For example, in Cyprus and Italy the surveys are based on sample, while in the UK the quarterly survey is based on key operators and the annual one to all the members of the UK Chamber of Shipping.
iii. *Responsibility*: Bank of Greece, as the compiler of the Balance of Payments, or an institution (e.g. Hellenic Chamber of Shipping[63] or Union of Greek Shipowners) representing the shipping industry could be responsible for such survey. From

[63] It is noted that since 2020 (Law 4676/19-3-2020, article78), non-Greek flagged vessels can become members of the Hellenic Chamber of Shipping allowing the expansion of its membership base and thus effectively covering the Greek-controlled fleet and Greek maritime cluster.

international experience, the Central Bank usually conducts such surveys; however, in the UK the survey is conducted by the UK Chamber of Shipping.

iv. *Time:* At the end of January each year, the ship management companies (established according to art. 25 of Law 27/1975) and the Greek Shipping companies of Law 27/1975 are required to report to the Ministry of Merchant Shipping *inter alia*: a) the operational expenses of their offices in Greece; b) the vessels details that they managed and c) their employees. Therefore, the survey can be planned in the same timeframe with the aim of minimising the administrative burden to the ship management companies.

4.6 Chapter 4 – Key takeaways

- There have been two distinct methodologies for the compilation of sea transport receipts in the Balance of Payments before and after 2000. In the latter one, there was a significant change thereafter, which affected the data series from 2015 onwards.

- In the pre-2000 era, the vast proportion of the sea transport receipts was treated as remittances and therefore were not part of the GDP, only of the GNP, although traditionally calculated as part of the GDP for calculating the contribution of shipping.

- In the post-2000 era, the receipts from the provision of sea transport services are a constituent part of the export of services and therefore an element of the GDP.

- Data from 2015 onwards are compiled on the basis of the new methodology (Greek Shipping Estimation Model) which is a statistical model. Unlike other key maritime nations which have elected the survey method for the collection of sea transport data for the balance of payments.

- The combination of the GSEM for timely data and of a survey on ship-management companies for reality control could enhance the quality of the BoP data.

CHAPTER 5: DETERMINANTS OF SEA TRANSPORT INFLOWS - REVIEW OF ESTIMATION MODELS IN LITERATURE

Chapter Summary: Research on the determinants of sea transport inflows can be split into the two periods defined by the two distinct BoP methodologies by the Bank of Greece, before and after 2000; a division followed in the structure of Chapter 5. The majority of studies based on data before 2000 advocated that domestic (e.g. CPI, number of seafarers) variables were the key determinants for the sea transport inflows in the Greek Balance of Payments, while international variables such as freight rates did not seem to play a significant role. The studies based on data post-2000 employed advanced econometric methodologies that were not available to the pre-2000 researchers; they identify both international (e.g. freight rates) and domestic variables (e.g. domestically provided shipping loans - as a proxy of the shipping cluster size - as determinants of sea transport inflows.

5.1 Pre-2000 period

As discussed in Chapter 4, the BoP data in Greece can be distinguished in the pre- and post-2000 period, as they reflected different methodologies. The same distinction holds for the studies on the determinants of sea transport inflows. The first recorded and thorough quantitative attempt for the identification of the determinants of the Greek foreign exchange inflows from shipping was made by Konstantopoulou (1976).[64] Her research was performed within the context of the 5-year economic planning of the Greek Government for the period 1976-1980; the main target of the Konstantopoulou (1976) research was to forecast the future path of the shipping foreign exchange inflows. In the introduction of that study it was stated that the connection of Greek shipping to the national economy was probably loose, as Greek shipping companies were based abroad and, therefore, foreign exchange inflows from shipping were related to the operational expenses of the based operations in Greece of the shipping companies (including the income of ship-owners residing in Greece) and the earnings of Greek seafarers.

Konstantopoulou's (1976) starting point was the hypothesis that the Greek shipping foreign exchange inflows depended on

a) the salaries of seafarers
b) the operating expenses of Greece-based shipping offices
c) ship repairs and supplies
d) invested capital income (i.e. shipowners).

As extensively presented in Chapter 4 of the present thesis, during the pre-2000 period, sea transport inflows in the Balance of Payments statistics[65] were recorded under the following items:

1. Freights – mainly related to imports and exports of goods

[64] There are a number of studies that perform a qualitative analysis of the determinants or a comparison in the development between sea transport related remittances and various variables (e.g. seafarers' employment, laid-up tonnage). For instance, see Georgantopoulos (1977) and Goulielmos (1997).
[65] Up to the end of 1999, Bank of Greece was following the IMF (1977) Balance of Payments Manual – 4th edition.

2. Seafarers' remittances
3. Shipowners' remittances
4. Shipping taxation
5. Supplies and Repairs etc
6. Contributions to seafarers' pension funds (NAT[66])
7. Passenger fares

Although disaggregated data based on the above 7 categories were available, Konstantopoulou (1976) initially elected to estimate the determinants of shipping foreign exchange inflows of three aggregated variables, namely:

1. Freight and Passenger fares
2. Seafarers' remittances and contributions to seafarers' pension funds (NAT)
3. Shipowners' remittances and others (e.g. taxation, ship repairs etc)

Her methodology was based on the calculation of the income of the 'factors of production' – labour and capital – and their impact on the foreign exchange inflows from shipping. Konstantopoulou (1976) estimated a number of equations and used a variety of explanatory variables (see Appendix III.1), before selecting the one with the highest explanatory power (Goodness of Fit) based on the adjusted co-efficient of determination ($\bar{R}^2$); she estimated finally a single equation on the basis of her econometric results which suggested that the individual equations were not better performing than the aggregated one.

In that final equation, the dependent variable was the total shipping foreign exchange inflows excluding passenger tickets and freight; a separate one for passenger tickets and freight was also estimated. Along with the estimation of the equations in levels (and logarithms), she estimated the equation in first differences as a robustness check of her results. The estimation period was 1960-1974, the data frequency was annual (i.e. 15 observations) and the estimation method was Ordinary Least Squares (OLS). The one with the highest $\overline{R}^2$ was:

$$\log SR_t = \underset{}{-5.54} + \underset{(10.7)}{0.808}\log SI_t + \underset{(3.4)}{0.219}\log GSR_t \qquad \overline{R}^2 = 0.989 \quad DW=1.80 \qquad (5.1.1)$$

[66] NAT is the Greek abbreviation of the Seafarers Pension Fund.

where:

SR: Shipping Foreign Exchange Inflows (in million USD) sourced from the Bank of Greece Balance of Payments statistics.

SI: Seafarers' Income (in USD) which is a derived (calculated) independent variable. It was calculated as the product of the annual average wage of seafarers[67, 68] and the number of Greek seafarers (serving in Greek and foreign flagged vessels, sourced from EL.STAT and NAT).

GSR: Greek Shipping Revenues which is a derived (calculated) independent variable. It was calculated as the product of the Fleet size under Greek Flag (in grt) multiplied by the weighted average freight rate of Greek flagged fleet.[69]

Equation 5.1.1 indicated that the elasticity of Shipping Foreign Exchange Inflows with respect to Seafarers' Income is quite high (0.808) which is an indication of the significance of seafarers' income on shipping inflows at the time as the number of Greek seafarers was very high (Harlaftis, 1996). Effectively, the econometric results of Konstantopoulou (1976) showed that a 10% increase in the seafarers' income would increase the Shipping Foreign Exchange Inflows by about 8.1%. The respective elasticity with respect to Greek-flagged fleet shipping revenues was lower (0.219), a finding that endorsed Konstantopoulou's hypothesis that freight rates did not play a significant role in shipping inflows. Effectively, if Greek-flagged fleet revenues increased by 10%, the Shipping Foreign Exchange Inflows would increase just by approximately 2.2%. According to Konstantopoulou (1976) these

[67] Seafarers' simple average wage was calculated on the basis of a) ELSTAT seafarers data (ranking and speciality) and their respective shares in total seafarers workforce, and b) collective agreements wages. The wages stemming from the collective agreements includes also relevant allowances for Sunday work, overtime etc. As wages were expressed in British pounds, the respective USD/GBP exchange rate was used for expressing them in USD. The annual wage is calculated as 13 times of the monthly one.

[68] Konstantopoulou calculated in addition a variant of the above described Seafarers Income. The variant was triggered by her observation that there was a break in the first series in the year of a new collective agreement. Therefore, she smoothened the initial series using anecdotal experiences of seafarers.

[69] The shares of tankers and dry-bulk (in grt) in the Greek flagged fleet were used as weights. The respective freight rates (tanker and drybulk) were sourced from Norwegian Shipping News.

results indicated the close relation between shipping foreign exchange inflows and the earnings of seafarers as resulting from the number employed and the level of wages; Konstantopoulou (1976) commented that the sum of the two coefficients was close to unity. In addition the study concluded that[70]:

1. The effect of freight rates on the foreign exchange inflows from shipping was small.
2. The shipping inflows were primarily comprised of seafarers' income, and thus the former closely followed the developments in the latter.
3. The impact (elasticity) of the average wage on shipping inflows is greater than that of the number of seafarers (elasticity of 0.79 and 0.65, respectively). The corresponding elasticity of the Greek-flagged fleet is even lower (0.42).

Konstantopoulou (1976) also emphasized two issues:

a) The lack of Greek-shipping specific freight indices, based on the types of vessels, on the commodity transported and on type of charter-party.
b) The lack of the required infrastructure for the expansion of the shipping and shipping related activities from Greece.

Before assessing the analysis of Konstantopoulou (1976), we need to take into account the fact that Engle and Granger (1987) seminal work on co-integration was published 11 years later; therefore that study's regression analysis could not have benefitted by the tests for the existence of a co-integration relationship between the variables used or for the existence of unit roots in the series.

Konstantopoulou (1976) used a relatively small sample of 15 observations, and therefore the degrees of freedom were quite small, especially when estimating multi-variate equations. Moreover, the adjusted co-efficient of determination ($\overline{R}^2$) was used as the only criterion for the selection of the best representation of the shipping inflows. The results reflected the compilation methodology of that period according to which the key elements in the shipping inflows were shipowners' and the seafarers' remittances. Finally, Konstantopoulou (1976) makes only a rather short reference to the foreign exchange

[70] Appendix III.1 presents the estimated equations, their coefficients and their statistics as presented in Kontantopoulou (1976).

outflows from shipping limited to the ratio of outflows to inflows; although mentioning that at the beginning of 1960s that ratio was - on average - 12% increasing to 21% for 1973-1975, no attempt to investigate this increase or estimate a relationship for the shipping outflows was included.

However, Konstantopoulou (1976) identified an issue that had not been yet addressed: the absence of a Greek-shipping specific freight index that will closely follow the structure of the Greek-owned and Greek-controlled fleet as well as their freight revenues.

Tambakis (1984) examined the determinants of the Greek shipping inflows both at aggregated and at disaggregated level. In the disaggregated analysis, he attempted to estimate the determinants in 6 of the 7 categories previously presented, with the exclusion of ship-owners taxation. Tambakis (1984) used primarily the OLS methodology both in levels and in logarithms. In order to address the autocorrelation issue Cochrane-Orcutt technique was also employed; the results were similar though with improved R^2 and DW statistic, as expected. The sample period was 1958-1980 and thus the sample included 24 annual observations. The co-efficient of determination (R^2) and the Durbin–Watson (DW) statistic were used for the assessment of the estimated equations. In the analysis, Tambakis (1984) utilises 20 independent variables such as world trade, Greek merchant fleet, laid-up tonnage, number of seafarers, average wage and more. [71]

According to the Tambakis (1984) econometric results, the key equations were:

$$Y_T = \underset{}{-44.63} + \underset{(19.75)}{0.772\, X_1} + \underset{(6.19)}{0.010\, X_4} \qquad R^2 = 0.998 \qquad DW = 2.28 \qquad (5.1.2)$$
$$\qquad\quad (4.17)$$

$$\log Y_T = \underset{}{-2.79} + \underset{(7.96)}{0.73\, \log X_1} + \underset{(4.38)}{0.46\, \log X_4} \qquad R^2 = 0.981 \qquad DW = 0.91 \qquad (5.1.3)$$
$$\qquad\quad (5.55)$$

$$\log Y_T = \underset{}{-6.43} + 0.67\, \log X_1 + \underset{}{0.81\, \log X_5} \qquad R^2 = 0.990 \qquad (5.1.4)$$

[71] In each estimated equation, Tambakis (1984) used one or two of these independent variables. In addition, as he also pointed out a number of these variables were alternatives to others for example world trade (exports), world seaborne trade (in metric tons) and world seaborne trade (in ton-miles).

(5.59) (7.44) (5.02) DW=0.65

$$\log Y_1 = -11.77 + 0.47 \log X_1 + 1.31 \log X_4 \qquad R^2 = 0.961 \qquad (5.1.5)$$
(4.57) (2.32) (3.84) DW=0.43

$$\log Y_2 = -4.66 + 1.04 \log X_{11} \qquad R^2 = 0.895 \qquad (5.1.6)$$
(6.86) (13.36) DW=0.30

where:

Y_T : total shipping inflows (receipts)

Y_1 : shipowners remittances

Y_2 : seafarers transfers remittances

X_1 : world trade (exports)

X_4 : Greek merchant fleet (in grt)

X_5 : Greek-owned merchant fleet (in grt)

X_{11}: Greek seafarers income (derived as the weighted average of the number of Greek seafarers and their average wage by speciality)

Based on the estimated equations, Tambakis (1984) concluded that:

1. The total inflows from shipping depended on world trade (exports) and on the size of fleet (either Greek-flagged or Greek-owned) (see equation 5.1.2-5.1.4). Based on the logarithmic form, the elasticity of shipping inflows with respect to world trade was 0.73 (0.67) with the respective elasticity of the Greek-flagged (Greek-owned) fleet being 0.46 (0.81) (see equations 5.1.3 and 5.1.4).
2. Specifically, the shipowners remittances exhibited an elasticity of approx. 0.5 with respect to world trade (exports), while the seafarers remittances elasticity with respect to seafarers income was close to 1.0 (i.e. unit elasticity) (see equations 5.1.5 and 5.1.6).

3. The contributions to NAT equation exhibited a high elasticity with respect to seafarers' income of 1.66 and Tambakis (1984) claimed that this was expected as the percentage contribution to NAT were increasing as income increased.
4. As far as the other components of shipping inflows were concerned, he deduced that:
    a. freight inflows depended on freight index of dry cargo (from Norwegian Shipping News) and on value index of Greek exports;
    b. ship repairs inflows depended on world trade (exports) and
    c. passengers fares depended on GDP of OECD countries

The issues that are raised by the Tambakis (1984) research are similar to the ones discussed for Konstantopoulou (1976). Namely, the relatively small size of sample (23 observations), the use of a unique metric for the goodness of fit (R^2) and whether the variables are co-integrated (or stationary).[72] Turning to the results, Tambakis (1984) concluded that the world trade (exports) - a metric of world demand for sea transport services – and the Greek-flagged (or Greek-controlled) fleet - a metric of Greek supply of sea transport services - are the main determinants of the shipping inflows in Greece in the period 1958-1980. These results differentiate from those in Konstantopoulou (1976) as seafarers' income is not a determinant of the total shipping inflows in Tambakis (1984). One can though assume that in Tambakis (1984) the size of fleet indirectly proxied the number of Greek seafarers.[73] Although Tambakis (1984) did not use any freight index as an explanatory variable of the total shipping inflows (as it was the case with Konstantopoulou, 1976), one may infer that the significance of the demand and supply variable may indicate as well the significance of a freight rates' variable the latter being determined by the supply and demand of shipping services (Stopford, 2009).

Haralambides (1985) aimed at identifying the factors behind the fluctuation in the foreign exchange inflows from shipping and thus constructed their behavioral relationships.[74]

[72] Engle and Granger (1987).
[73] With the caveat, that flagging-out – which occurred massively after 1981 for the Greek-flag -can contribute to the decrease of Greek seafarers but not to the decrease of Greek-controlled fleet (see for instance, Thanopoulou, 1998).
[74] The model consisted of 17 equations, 14 behavioural and 3 identities. Moreover, 17 endogenous and 21 exogenous - including 9 lagged - dependent variables were used.

Although the aim of the Haralambides (1985) was to estimate the model as a system, the availability of data (i.e. 22 annual observations from 1960-1981) restricted him in employing single equations techniques rather than system ones with the research stating that parts of the complete system could be considered as sub-systems that could be estimated as such. Haralambides (1985) employed a variety of estimation techniques[75] and on the basis of the $\overline{R}^2$, the t-statistics of the estimated parameters and of the Durbin-Watson statistic, the best equation was selected.

Out of the 14 estimated equations (see Appendix III.2 for the whole system), two equations are of particular interest in the context of the present research:

1. OWN = 545 + 0.019 NI – 30.49 EXR + 0.016 LU + 7.45 CPI $\quad \overline{R}^2 = 0.91$ (5.1.7)[76]
(4.9) (3.7) (-7.3) (2.9) (21.2) DW = 2.40

2. SM = 266 + 0.17 Y – 12.1 EXR + 1.89 CPI $\quad \overline{R}^2 = 0.99$ (5.1.8)[77]
(3.0) (7.3) (-3.2) (3.6) DW = 1.560

where:

OWN: Shipowners remittances incl. taxation (mn USD).

SM: Seafarers remittances incl. contributions to social security and seafarers foreign exchange deposits at Greek banks (mn USD).

LU: Laid-up Greek-owned tonnage (thousand grt).

EXR: Greek Drachma/USD exchange rate. It is noted that the variability of the exchange rate started in 1975. Before that the parity was fixed at 30 GRD/USD.

[75] The estimation techniques included Ordinary Least Squares (OLS), Generalised Least Squares (GLS), Principal Components (PC), Instrument Variables (IV), Two Stage Least Squares (2SLS), Two Stage Least Squares with Autocorrelated Distrurbances (2SLSA) and Three stage Least Square (3SLS).

[76] Haralambides estimated 4 different versions of the ship-owners foreign exchange inflows. In the selected one, the LU variable was statistically significant compared to the one with the highest $\overline{R}^2$ (91% versus 98%). In all 4 versions the right-hand side variables were the same and the values used were either the original data collected, or the fitted values based on another system equations.

[77] Haralambides (1985) estimated 3 different versions of seafarers' related foreign exchange inflows. The first two were identical apart from the method used (3-step least squares versus 2-step least squares) and in the third one the Greek seafarers' income was substituted by its main constituents i.e. employment numbers (ED) and wage rate (W). The finally selected equation was the one estimated with the 3-step least squares method and the Greek seafarers' income.

NI: Net change in the Greek-owned fleet or net realized investment in shipping (thousand grt).

Y: Total monthly income of Greek seafarers (mn GRD).

CPI: Consumer Price Index.

Haralambides (1985) deduced that ship-owners foreign currency inflows (equation 5.1.7) reflected mainly the cost of the domestic resources (e.g. shore based employees, office rent, utilities) needed by the Greece-based shipping companies. He also argued that the profits stemming from the shipping operations did not enter to the shipping account and largely remained abroad. Against this background, the estimated relationship revealed that shipowners' remittances were positively related to a. the net change in Greek-owned fleet i.e., the greater the fleet - proxied by the number of Greece-based shipping companies - the higher the inflows required to cover their expenses, b. the laid-up tonnage (i.e. the greater the number of laid up vessels, the higher the inflows that were needed to be remitted to Greece to cover the laid up expenses) and c. the domestic CPI (i.e. the greater the CPI, the more inflows were required in order to cover the increased costs of the Greece-based operations).

On the other hand, the ship-owners' remittances were negatively related to the exchange rate (i.e. the stronger the USD against the GRD, the lesser amount in USD was required to be remitted to Greece). According to his findings, Haralambides concluded that the EXR, CPI and LU advocated "*the cost-based hypothesis of shipowners remittances"* (p. 273), while NI was considered as the main explanatory variable which reflected the Greece-based shipping operations.

Furthermore, he calculated the respective elasticities at the point of mean for each variable; the elasticity with respect to the net change in the Greek-owned fleet amounted to 0.1, with respect to laid-up tonnage at 0.08 and with respect to CPI and EXR at 2.2 and -2.9, respectively. Effectively, a 10% in the Greek-owned fleet was expected to increase shipowner remittances by 1%, while the effect from a change in the laid-up tonnage on the remittances was significant lower. As far as the co-efficients of the EXR and CPI are concerned, they should be also assessed in a combined approach as the benefit stemming

from the first, could be evaporated by the other.[78] To this end, Haralambides calculated the net elasticity (i.e. taking into account the reverse effect from the exchange rate) of ship-owners' remittances with respect to inflation at the mean point of the variables and amounted to 1.21, considerable lower that the initial elasticity.[79] In addition, the negative relationship between ship-owners' remittances and the EXR supported the view that currency depreciations negatively impact these remittances.

Turning to equation 5.1.8, seafarers' remittances were found to be positively related to seafarers total income and CPI and negatively – as in the case of ship-owners remittances – to the exchange rate. He also calculated the elasticities at the mean point of each variable and amounted to 0.73 with respect to seafarers' income, to 1.0 for CPI and to -2.1 for the exchange rate. The elasticity of seafarers' remittance with respect to their income indicated that a 10% increase in their income resulted in a 7.3% increase in remittances. It was also deduced that this was an indication that part of the seafarers earnings were saved abroad.

As it was previously discussed, Haralambides (1985) also calculated the net elasticity (i.e. taking into account the reverse effect from the exchange rate) of seafarers' remittances with respect to inflation at the mean point of the variables and amounted to 0.29. This indicated that any positive effect in inflows from inflation was cancelled out by the exchange rate adverse effect suggesting that seafarers' remittances to their families are inelastic to the changes in inflation after accounting for the exchange rate effect.[80]

As it was previously discussed in the case also of the previous two studies, Harambides (1985) used a small sized sample (22 annual observations) and he could not have tested whether the series are stationary (or co-integrated). Two issues should be emphasized:

1. Haralambides (1985) took the stance that shipowners remittances were not dependent on freight rates, and as a result their significance was not tested in shipowners remittances equation although it can be argued at this point that freight rates enter indirectly equation 5.1.7 though the laid-up (LU) and broken tonnage

[78] The reader is reminded of the Purchasing Power Parity theory which – in its simplest form – predicts that the CPI differential between two counties will be reflected to the exchange rate change over the same period.
[79] The simple elasticity at the point of means of the variables were -2.9 for EXR and 2.2 for CPI.
[80] The simple elasticity at the point of means of the variables were -2.1 for EXR and 1.0 for CPI. The latter result showed that seamen remittances closely followed CPI indicated their attempt to maintain their families standard of leaving.

that are included in the Net Investment (NI) variable. As it will be discussed later, Haralambides (1986) estimated a model that included freight rates as a determinant but the t-statistic in that model indicated that they were not statistically significant.

2. The EXR variation is expected to start following the un-pegging of the GRD from the USD after 1975 (as a result of the terminationof the Bretton Woods agreement in 1973), i.e. only in one-third of the sample time period he used creating some concerns on the explanatory power of the EXR variable.

A year later, Haralambides (1986) attempted to identify the determinants of shipping foreign exchange inflows with a special focus on comparing the impact of external (e.g. freight rates) versus internal (e.g. inflation) variables. His study was conducted within the context of the Economic and Social development plan 1983-1987 and assessed the validity of two research hypotheses: a) the stability of shipping foreign exchange inflows compared to other inflows such as tourism or goods' exports and b) the dependence of shipping foreign inflows to external, non-Greek determined, factors such as freight rates. On the first hypotheses, he compared the standard deviation of the annual percentage change among the shipping foreign exchange inflows and the other accounts in the balance of payments (e.g., exports of goods, exports of manufactured goods, tourism, Greek emigrants' remittances). For the period 1973-1981, shipping inflows (in annual percentage change) exhibited the lowest standard deviation against all other balance of payment account, with the exception of total exports of goods.[81]

The validity of the second hypothesis was assessed through the estimation of a series of equation for the determinants of shipping inflows both in aggregated and disaggregated level. The explanatory variables included international variables (i.e. freight rates) and Greek-specific ones (i.e. consumer price index and exchange rate GRD/USD). In this work, as well, the main metric for the selection of the best estimated model - and thus the main determinant(s) of shipping inflows – was the coefficient of determination (adjusted or non-adjusted). The main model specifications with respect to total shipping foreign exchange inflows that were estimated were the following:

[81] If the Coefficient of Variation (CV) was used instead of the standard deviation, shipping inflows (both in levels as well as in annual percentage changes) exhibit a higher value thus higher dispersion around their mean compared to all other account in the balance of goods and invisibles.

$$TSE = 80.81 + 5.91\ CIX + 0.83\ FRT \qquad \bar{R}^2 = 0.93 \quad (5.1.9)$$
(0.72) (9.18) (1.2) DW=1.24

$$TSE = 11131.9 + 10.92\ CIX - 45.72\ EXR \qquad \bar{R}^2 = 0.98 \quad (5.1.10)$$
(5.25) (10.5) (-4.69) DW=1.78

$$DTSE = -1.09 + 1.53\ DCIX - 1.29\ DEXR \qquad \bar{R}^2 = 0.62 \quad (5.1.11)$$
(-0.26) (3.52) (-2.14) DW=2.5

where:

TSE: Total Shipping foreign exchange inflows (in million USD)

CIX: Consumer price index (1970=100)

FRT: Freight index – General Council of British Shipping

DTSE: first difference of percentage changes of TSE

DCIX: first difference of percentage changes of CIX

DEXR: first difference of percentage changes of exchange rate GRD/USD.

Haralambides (1986) concluded that[82]:

1. Inflation (consumer price index) was more significant in explaining the shipping inflows compared to freight rates (see Equation 5.1.9). When, Haralambides (1986) estimated univariate equations with each one of the above explanatory variable, the model with freight rate as the explanatory variable had a lower R^2 compared to the corresponding one with consumer price index (0.31 versus 0.70).[83] This was another indication that Greek-related macroeconomic variables played an important role on shipping inflows.
2. The lower sensitivity of seafarers' inflows with respect to freight rates was attributed to the two main factors:
    a. Shipping inflows were covering the living expenses of seafarers' families.
    b. Labour incomes (wages) did not respond/adjust according to the freight rate movements (at least in the short-run).

[82] It is noted that Haralambides (1986) did not use fleet data. He claimed that such inclusion without the use of a system of equation could lead to a simultaneous equation bias.
[83] In the univariate models, the t-statistic for freight rates was just statistically significant at 5%, while for consumer price index was above the critical value and thus statistically significant.

3. Haralambides (1986) noted that the high level of R^2 in the estimated equation of shipping inflows and consumer price index may stem from the trended upward movement of both variables. Based on this observation and in order to address multi-collinearity, he also estimated a number of equations in first differences of annual percentage changes.[84] As in Equation 5.1.11, the shipping inflows exhibit a positive relation with inflation and a negative one with the GRD/USD exchange rate.

As in the case of the previous three research works, Haralambides (1986) used a small sized sample and he could not have tested whether the series were stationary (or co-integrated). However, he identified this issue (see point 3 above) and thus estimated a model in first differences (equation 5.1.11) to reveal as much as possible the relationship between domestic variables and shipping inflows. Finally, he had not used fleet statistics (Greek or Greek-owned) pointing to the potential presence of simultaneous equation bias. However, it can be noted that as the Greek (and the Greek controlled) fleet is part of the global fleet, when taking into account the competitive market structure of bulk cargo shipping, the effect from the supply of Greek (or Greek controlled) vessels on freight rates could have been small. In addition, the dependant variable (i.e., inflows) reflects the shipping companies' income. Therefore – at least in the short-term – it would be difficult to assume a reverse relationship from shipping inflows to the Greek (or Greek controlled) fleet, though such one could be present in the medium-term (i.e. financing the acquisition of vessels partly from operating income).

The majority of the pre-2000 studies on the determinants of sea transport inflows identified that the key determinants related to domestic variables (such as CPI, number of seafarers investment decisions of ship-owners); while freight rates did not seem to be a determinant in shipping inflows. In only one study (Tambakis, 1984) international variables - such as world trade - were directly included as explanatory ones. These results need to be directly linked to the sea transport compilation methodology followed by the Bank of Greece before 2000. These results endorsed the view that sea transport inflows were not separate from the

[84] Nowadays, this is proxied by the difference in natural logarithms of each variable. Assuming that the variables are I(1), this differentiation of the variables transforms them into I(0) i.e. stationary.

national economy. Specifically, the seafarers' income, an explanatory variable which was in a similar way estimated in many studies, exhibited a high pass through (elasticity) on total sea transport inflows of almost 0.81 (Konstantopoulou, 1976) or on seafarers' remittances of marginally higher than one (Tambakis,1984) and of 0.73 in Haralambides (1985).

From a technical point of view, the small size of the sample coupled with ambiguity over the integration order (or the co-integration) of the variables - as the respective econometric advancement had not been made available then - raises some concerns about related results. In any case, the majority of the pre-2000 studies advocated the strong link between the sea transport inflows and domestic variables.

Table 5.1: Summary of the pre-2000 research

Researcher	Estimated elasticity	Estimation period	Dependent variable	Method
Konstantopoulou (1976)	0.808: Seafarers' Income (in USD) 0.219: Greek Shipping Revenues	1960-1974 annual (15 obs)	Shipping foreign exchange Inflows	Ordinary Least Squares
Tambakis (1984)	Variant A: 0.73: world trade 0.46: Greek merchant fleet (in grt) Variant B: 0.67: world trade 0.81: Greek-owned merchant fleet (in grt)	1958-1980 annual (24 obs)	Shipping foreign exchange inflows	Ordinary Least Squares
	0.47: world trade 1.31: Greek merchant fleet (in grt)		Ship-owners remittances	
	1.04: Greek seafarers income		Seafarers remittances	
Haralambides (1985)	0.08: Laid-up Greek-owned tonnage (thousand grt) -2.9: Greek Drachma/USD exchange rate 0.10: Net change in the Greek-owned fleet 2.1: Consumer Price Index	1960-1981 annual (22 obs)	Ship-owners remittances	Two Stage Least Squares with Autocorrelated Distrurbances
	0.73: Total income of Greek seafarers (mn GRD) -2.1: Greek Drachma/USD exchange rate 1.0: Consumer Price Index		Seafarers remittances	Three stage Least Square
Haralambides (1986)	Coefficients based on ΔLog 1.53: Consumer Price Index. -1.29: Greek Drachma/USD exchange rate.		Shipping foreign exchange inflows	

Source: Adapted by the author based on Konstantopoulou (1976), Tambakis (1984), Haralambides (1985) and Haralambides (1986).

5.2 Post-2000 period

After the adoption of the new compilation methodology in the Balance of Payments in 2000 by the Bank of Greece, the first study on the determinants on sea transport inflows was by Bragoudakis and Panagiotou (2010). They used the cointegration methodology (Engle and Granger, 1987) and an Error Correction Model (ECM) to identify the determinants (long-run and short-run) of the sea transport inflows from cross-trading; the latter representing - on average - 97% of the total sea transport services in the 2002-2010 period. The stock of loans to shipping from the domestic banking system and ClarkSeaIndex were employed as explanatory variables. The former was used as a proxy of Greek-owned fleet which is the main pillar of the Greek maritime cluster due to the lack of Greek-controlled fleet data on a monthly basis; it was a key innovation and contribution of that study. As it will be discussed later, other researchers opted for the use of the Greek-flagged fleet as a proxy of the Greek-controlled one. ClarkSeaIndex was reflecting the freight rates in the international freight markets. Another contribution of the study was the use of modern econometric methods (cointegration and ECM), which were later employed by other researchers, too.

The model had a log-log specification and the data (monthly) covered the period from January 2002 (2002:M1) to March 2010 (2010:M03). The above-mentioned three series found to be I(1) but cointegrated and the estimated long-run equation was:

$$\log(SR_t) = \underset{(-12.0)}{-2.95} + \underset{(21.32)}{0.44}\log(FR_t) + \underset{(31.21)}{0.64}\log(LS_t) \qquad (5.2.1)$$

$\bar{R}^2 = 0.95$

while the short-run or ECM equation was

$$\Delta\log(SR_t) = \underset{(4.10)}{0.05} - \underset{(-3.99)}{0.32}\,\Delta\log(SR)_{t-1} - \underset{(-1.74)}{0.13}\,\Delta\log(SR)_{t-2} + \underset{(2.31)}{0.17}\,\Delta\log(FR)_{t-1}$$

$$+\underset{(1.73)}{0.59}\,\Delta\log(LS)_t - \underset{(-2.51)}{0.18}\,DV038 - \underset{(-3.34)}{0.24}DV0510 - \underset{(-5.06)}{0.55}d_{t-1}$$

$\bar{R}^2 = 0.95$ F-statistic = 12.07 (5.2.2)

where:

SR: Receipts from sea transport – cross trade –services expressed in USD (Bank of Greece, in million USD)

FR: ClarkSeaIndex (in USD per day)

LS: Outstanding balances of credit to shipping companies granted by the domestic banking system through branches in Greece expressed in USD (Bank of Greece, in million USD)

Δ: denotes first differences and

DV: Impulse Dummies that improve the fitness of the model for August 2003 ($DV038$) and for October 2005 ($DV0510$).

From the long-run equation, it was shown that a 10% increase in freight rates (ClarkSeaIndex) would create a 4.4% increase in sea transport services receipts (in USD), while a 10% in the outstanding balance of loans would lead to a 6.4% increase in the receipts.

Turning to the short-run dynamics, the speed of adjustment was at 0.55 i.e. every month approx. 55% of the adjustment towards the long-term equilibrium takes place or – in other words – less than two (2) months are required for the adjustment back to the long-run after a shock.

Bragoudakis and Panagiotou (2010) recognized two sources of concern:

a) As the composition of the Greek-controlled/Greece-operated fleet might differ from that of the international fleet, the ClarkSeaIndex might not correctly represent the average earnings of Greek-controlled/Greece-operated fleet.
b) If Greece-based shipping companies were financed by the international (non-domestic) banking system, the respective freight revenues would be channeled to the shipping companies' operating accounts in non-Greek banking system.

Kasimati and Veranos (2011) employed the ECM methodology to estimate a model relating the receipts from shipping services to the fleet size and the freight rates. They used

quarterly data for the period 2001:Q3 to 2011:Q2. The size of the Greek-flagged fleet (in grt), as a proxy of the Greek-controlled fleet, and the ClarkSeaIndex was employed as explanatory variables. Their formal test on cointegration (Johansen test) indicated the existence of one (1) cointegrating equation. The estimated model was[85]:

$$\Delta SR_t = \underset{}{-0.1884}\ (SR_{t-1} - \underset{(-11.03)}{0.0000582}GRF_{t-1} - \underset{(-5.81)}{0.049}FR_{t-1}) + \underset{(2.75)}{0.0247}\Delta FR_t$$
$$\qquad\qquad (-1.98)$$

$\overline{R}^2 = 0.323$ F-statistic = 7.047 (5.2.3)

where:

SR: Receipts from shipping services (Bank of Greece, in million euros)

GRF: Greek-flagged fleet size (EL.STAT, in grt)

FR: ClarkSeaIndex (in USD per day)

As the equation was set in levels and not in log term, the respective parameters cannot be interpreted as elasticities. The representation within the parenthesis represented the long-term relationship and indicated that an increase by 1mn grt in Greek-flagged fleet would lead to an increase of 58.2 million euros in receipts (per quarter), while an increase of freight rates by 1,000 USD/day could result to an increase of 49 million euros (per quarter).

The speed of adjustment was at 0.1884, i.e. every quarter a bit less than 20% of the adjustment towards the long-term equilibrium takes place or – in other words – approx. five (5) quarters were required for the adjustment after a shock. It is of interest that although the freight index is express in USD (per day), the dependent variable – SR – is expressed in euros; this could imply that the co-efficient partly reflected the variability of the exchange rate (EUR/USD) as well.

Prandeka and Zarkos (2014) estimated the net receipts from shipping services as a function of the size of the Greek fleet and the freight rates, on a quarterly basis. As there was no data available on the size of the Greek-owned fleet in such time frequency, they employed Greek-flagged fleet (in grt) data. The ClarkSeaIndex was used as the freight rate variable.

[85] The coefficients of ΔGRF_{t-1} and ΔSR_{t-1} were not found statistically significant.

They employed a log-log specification and an ECM model,[86] while the estimation period was from 2003:Q1 to 2013:Q4. Their methodology is similar to the previous two research papers (Bragoudakis and Panagiotou, 2010; Kasimati and Veranos, 2011). The short-term equation, as estimated, were:

$$\log(NSR_t) = \underset{(-2.55)}{-7.16} + \underset{(9.71)}{0.58}\log(NSR_{t-1}) + \underset{(4.72)}{0.78}\log(GRF_t) + \underset{(6.67)}{0.26}\log(FR_t) \quad (5.2.4)$$

$\overline{R}^2 = 0.87$

where:

NSR: Net receipts from shipping services (Bank of Greece, in bn euros)

GRF: Greek-flagged fleet size (EL.STAT, in grt)

FR: ClarkSeaIndex (in USD per day)

The speed of adjustment could be calculated as (1-0.58) = 0.42, i.e. every quarter a bit less than 50% of the adjustment towards the long-term equilibrium takes place.

Although Prandeka and Zarkos (2014) did not provide the long-term equation, but rather the long-term elasticities, the following specification can be deduced (see Asteriou and Hall, 2011, p. 360-361).

$$\log(NSR_t) = -17.05 + 1.86\log(GRF_t) + 0.62\log(FR_t) \quad (5.2.5)$$

Namely, a 10% increase in freight rates will lead to a 6.2% increase in net shipping inflows, while a same increase in the Greek-flagged fleet will cause an 18.6% increase in net shipping inflows. As in the previous study (Kasimati and Veranos, 2011), the freight index is expressed in USD (per day) while the dependent variable – NSR – is expressed in euros; this could imply that the co-efficient partly reflected the effect of the exchange rate (EUR/USD) as well.

Bragoudakis, Panagiotou and Thanopoulou (2015) extended the Bragoudakis and Panagiotou (2010) work in relation to the ship-onwers investments as well as to sea

[86] Prandeka and Zarkos (2014) did not explicitly stated the use of an ECM model; their discussion though clearly pointed to it. In the same vein, they did not presented any formal tests on whether the series are I(1) or cointegrated; it is though assumed that these test were performed and the series were cointegrated.

transport payments.[87] In more detail, they estimated two models; one for inflows and another for outflows. In addition, both dependant variables (sea transport inflows/outflows) were hybrid in the sense that they were the sum of the sea transport services inflows and the exports of ships or the sea transport services outflows and the imports of ships, respectively. Finally, they constructed a Greek shipping Freight Index (GFI) based on fixed weights of three main sectors (dry bulk, oil tankers and containerships) of the Greek-controlled fleet (in dwt terms), attempting to address the concern previously raised by Bragoudakis and Panagiotou (2010) and much earlier by Konstantopoulou (1979). Bragoudakis et al (2015) found evidence that the hybrid shipping inflows variable depended mainly on freight rates, as its main element was sea transport service, while the hybrid shipping outflows variable depended on second-hand prices, as its main element was the import (i.e. purchases) of ships. Employing the two-step Engle-Granger ECM approach, a model was estimated for the period January 2002 (2002:M1) to June 2012 (2012:06) using three different estimation methods (OLS, FMOLS and DOLS).[88] The DOLS based estimation, which provided the best outcome (i.e. lowest Residual Sum of Squares - RSS) from an empirical point of view, is presented below::

$$\log(TSI_t) = \underset{(2.294)}{1.291} + \underset{(5.638)}{0.238}\log(GFI_t) + \underset{(5.717)}{0.222}\log(LS_t) + \underset{(4.548)}{0.462}\log(SHV_t) + \underset{(4.614)}{0.864}\log(EXR_t) \quad (5.2.6)$$

$\overline{R}^2 = 0.946$

$$\log(TSO_t) = \underset{(-8.904)}{-4.952} + \underset{(9.557)}{0.442}\log(LS_t) + \underset{(13.504)}{1.429}\log(SHV_t) \quad (5.2.7)$$

$\overline{R}^2 = 0.917$

where:

TSI/TSO: Total receipts/payment from shipping activities (exports of ships and receitps of sea transport services/imports of shipping and payments of sea transport services) expressed in USD (Bank of Greece, in mn USD).

GFI: Greek Freight Index.

[87] It is noted that since the change in the BoP methodology in recording purchases and sale of vessels, the series used in Bragoudakis, Panagiotou and Thanopoulou (2015) is not any more available for the post-2010 period.

[88] OLS: Ordinary Least Squares; FMOLS: Fully Modified OLS; DOLS: Dynamic OLS.

LS: Outstanding balances of credit to shipping companies granted by the domestic banking system through branches in Greece expressed in USD (Bank of Greece, in mn USD)

SHV: Second-hand vessels index.

EXR: USD/ EUR exchange rate.

In relation to shipping inflows, the long-run equation suggested that a 10% increase in freights (GFI) led to a 2.4% increase in inflows, while a 10% increase in the stock of loans (indicating the size of shipping cluster) led to a 2.2% increase in inflows. The second-hand vessel index and the exchange rate (USD/EUR) were also significant and had a positive impact on inflows. The shipping outflows model indicated the significance of the second-hand vessel index, as a 10% increase led to a 14.2% in outflows. An increase by 10% of the stock of loans, which indicated the supply of funds for vessels acquisition, created a 4.4% increase in outflows.

The respective short-run estimation (ECM) was:

$$\Delta\log(TSI_t) = -0.001 + 0.11\,\Delta\log(TSI)_{t-3} + 0.14\,\Delta\log(GFI)_{t-1}$$

(-0.29) (1.93) (3.26)

$$+0.17\,\Delta\log(LS)_t + 0.71\,\Delta\log(SHV)_{t-1} + 1.45\,\Delta\log(EXR)_t$$

(2.42) (3.93) (4.69)

$$-0.98\,\Delta\log(EXR)_{t-1} - 0.61 d1_{t-1}$$

(-3.48) (-8.02) (5.2.8)

$\bar{R}^2 = 0.595$ F-statistic = 19.28

where Δ: denotes first differences.

According to the short-run equation for inflows, the speed of adjustment was quite rapid (0.61) i.e. every month 61% of the adjustment towards the long-term equilibrium took place, thus the adjustment to the long-rum equilibrium would take less than two months after a shock.

$$\Delta\log(TSO_t) = -0.002 + 0.11\,\Delta\log(TSO)_{t-1} - 0.15\,\Delta\log(TSO)_{t-2}$$

(-0.25) (-2.66) (3.26)

$$+0.24\,\Delta\log(GFI)_{t-1} + 0.35\,\Delta\log(LS)_t + 0.81\,\Delta\log(SHV)_t$$

(3.32) (2.07) (1.78)

$$+1.095\,\Delta\log(EXR)_t - 0.27d2_{t-1}$$

(2.00) (-2.38) (5.2.8)

$\overline{R}^2 = 0.409$ F-statistic = 8.825

Turning to the outflows, the speed of adjustment was relatively sluggish (0.27), i.e. every month 25% of the adjustment towards the long-term equilibrium takes place; thus the adjustment to the long-rum equilibrium would take less than four months after a shock.

In addition, Bragoudakis et al (2015) splitted the estimation period into two sub-period before and after 2006, a break point that was supported by empirical evidence as well, in an attempt to investigate any changes in behaviour. In the case of sea inflows, the significance and magnitude of the stock of loans (a proxy of the Greek shipping finance cluster and of the shipping cluster in general) became more important compared in the 2006-2012 period compared to the previous one (2002-2005). In the case of sea outflows, the significance and magnitude of the second-hand vessel price index increased in the post-2006 period compared to the pre-2006 period. This finding supported the hypothesis that the Greek shipping companies did not follow a clear anti-cyclical pattern during that period, unlike what was observed in previous periods and indicated in previous studies (Thanopoulou, 1996).

Bragoudakis, Panagiotou and Thanopoulou (2021) extended their previous work and assessed also the presence of asymmetry in the adjustment in shipping inflows towards the equilibrium level. As in Bragoudakis et al (2015), they used the OLS, FMOLS and DOLS methodologies for estimating the long-term cointregrating relationship for the period January 2002 (2002:M1) to December 2014 (monthly data). Based on the level of Residual Sum of Squares (RSS), the DOLS estimation provided again more robust results and the corresponding estimation of the long-run relationship is:

$$\log(SR_t) = 1.43 + 0.36\log(FR_t) + 0.18\log(LS_t) + 1.09\log(EXR_t) + 0.04LIBOR_t + 0.20DVS087$$

(2.30) (8.86) (3.95) (5.06) (3.94) (2.57)

$\bar{R}^2 = 0.94$ RSS = 0.93. (5.2.9)

and the short-run:

$$\Delta\log(SR_t) = \underset{(0.24)}{0.001} \underset{(-3.72)}{- 0.16\,\Delta\log(SR)_{t-1}} + \underset{(4.31)}{0.21\,\Delta\log(FR)_t}$$

$$+ \underset{(5.10)}{0.36\,\Delta\log(LS)_t} \underset{(-2.59)}{- 0.002\,\Delta\log(Spread)_t} - \underset{(6.66)}{0.55 d_{t-1}}$$

$\bar{R}^2 = 0.34$ F-statistic = 15.79 (5.2.10)

where:

SR: Receipts from sea transport – cross trade –services expressed in USD (Bank of Greece, in million USD)

FR: ClarkSeaIndex (in USD per day)

LS: Outstanding balances of credit to shipping companies granted by the domestic banking system through branches in Greece expressed in USD (Bank of Greece, in mn USD)

$LIBOR$: The 3-month USD Libor rate.

$Spread$: The spread of the 10-year Greek bond over the German bund.

$DVS087$: dummy shift variable global financial crisis

Δ: denotes first differences.

Based on the long-run estimation (equation 5.2.9), a 10% increase in the freight rates led to a 3.6% in shipping inflows. The effect of the shipping loans stock is smaller compared to their previous work and amounted to 0.18 (i.e. a 10% increase in the stock of loans led to a 1.8% increase in shipping inflows). This change in the level of elasticities in the freight rates and in the stock of loans could be attributed to a number of reasons such as:

a) the longer sample employed (until end of 2014 compared to 2012 in the other studies)
b) the economic environment in Greece during the economic adjustment period and the fear of Grexit
c) the ability of Greece-based banks to maintain and expand their shipping finance portfolios.

Moreover, the coefficient of the exchange rate was close to 1 and the hypothesis that the coefficient was 1 cannot be rejected (Wald test).

According to the ECM (short-run) equation (5.2.10), the speed of adjustment was quite rapid (0.55) as it took less than two months to return to the equilibrium after a shock. In addition, the coefficient of the spread was found to be statistically significant in the short-run with negative sign, but its effect was quite small and there were no indication that it altered significantly during the Greek sovereign crisis. Turning to the presence of asymmetries, Bragoudakis et al (2021) estimated also an asymmetric error correction model (AECM) distinguishing the positive from the negative errors, i.e., positive and negative deviations from the long-run shipping inflows deviations. The coefficient of the ECM terms (positive or negative errors) were different (γ_1=-0.48 compared to γ_2=-0.54, respectively), which indicated that the speed of the downward adjustment was relatively slower than that of the upward adjustment. However, the Wald F-test on symmetric adjustment (i.e., $\gamma_1 = \gamma_2$) could not be rejected thus indicating the absence of asymmetry.

Specifically, in Bragoudakis and Panagiotou (2010) and Prandeka and Zarkos (2014), the sea transport inflows (total or net, respectively) exhibited a high elasticity with respect to freight rates (ClarkSeaIndex) of 0.44 and 0.62, respectively. In the same line, the elasticity with respect to the proxy variable for the shipping cluster (outstanding loans or Greek-flagged fleet, respectively) is also high and greater than the elasticity of the freight rates.[89] Bragoudakis et al (2021) confirmed the results of the previous studies despite the fact that both estimated elasticities had a lower value, especially with respect to the stock of loans; a proxy for the shipping cluster. It shall be noted that the post-2000 studies did not examine the presence of seasonality in the data used. This finding could stem from the fact that the freight rate variable, i.e. ClarkSeaIndex, is a composite index of all shipping sectors and thus any seasonality in one segment may be counterbalanced by seasonality in another segment or segments. This issue will be discussed further in Chapter 6.

Concluding the review of the post-2000 studies, the application of modern time series techniques (cointegration and ECM) to identify the determinants of sea transport inflows

[89] Kasimati and Veranos (2011) did not estimate elasticities, and Bragoudakis et al (2015) the dependent variable was a hybrid ships and shipping services account.

(and in some cases sea transport outflows) is noted. From a policy perspective, all the studies concluded that both international (e.g., freight rates) and domestically-determined variables (e.g. the size of cluster/fleet) constitute determinants of the sea transport inflows. Thus, the post-2000 studies extended the findings of the pre-2000 ones and advocated the significance of the domestically-related variables.

Table 5.2: Summary of the post-2000 research

Researchers	Estimated elasticity	Estimation period	Dependent variable	Method
Bragoudakis and Panagiotou (2010)	Long-term: 0.44: Freight index (Clarkseaindex) 0.64: Stock of loans to shipping by domestic banks	2002:M1 - 2010:M03 Monthly (99 observations)	Inflows from sea transport (cross-trade)	ECM
Kasimati and Veranos (2011)	Long-term (*coefficients in levels*): 58.2 x 10^{-6}: Greek-flagged fleet (in grt) 0.049: Freight index (Clarkseaindex)	Q3:2001 – Q2:2011 Quarterly (40 observations)	Inflows from sea transport	ECM
Prandeka and Zarkos (2014)	Long-term: 1.86: Greek-flagged fleet (in grt) 0.62: Freight index (Clarkseaindex)	Q1:2003 - Q4:2013 Quarterly (40 observations)	Net Inflows from sea transport	ECM (Ordinary Least Squares)
Bragoudakis, Panagiotou and Thanopoulou (2015)	Long-term: 0.24: Freight index 0.22: Stock of loans to shipping by domestic banks. 0.46: Second-hand vessels price index 0.86: Exchange rate Long-term: 0.44: Stock of loans to shipping by domestic banks. 1.43: Second-hand vessels price index	2002:M1 - 2012:M06 Monthly (126 observations)	Shipping inflows incl. vessels investments Shipping outflows incl. vessels investments	ECM - DOLS
Bragoudakis, Panagiotou and Thanopoulou (2021)	Long-term: 0.36: Freight index 0.18: Stock of loans to shipping by domestic banks. 1.09: Exchange rate 0.04: Libor	2002:M1-2014:12 Monthly (156 observations)	Inflows from sea transport	DOLS Symmetric ECM and Asymmetric ECM (AECM).

Source: Author based on Bragoudakis and Panagiotou (2010); Kasimati and Veranos (2011); Prandeka (2014); Bragoudakis, Panagiotou and Thanopoulou (2015); Bragoudakis, Panagiotou and Thanopoulou (2021).

5.3 Chapter 5 - Key takeaways

- The majority of the pre-2000 studies identified domestic variables (such as CPI, the number of seafarers, investment decisions of ship-owners) as the key determinants of sea transport inflows; freight rates did not seem to play a role as a determinant in shipping inflows These results endorsed the view that sea transport inflows were not separate from the national economy.

- The post-2000 studies were characterised for the application of modern time series techniques (cointegration and ECM) in identifying the determinants of sea transport inflows (and in some cases sea transport outflows). They concluded that both internationally (e.g. freight rates) and domestically-determined variables (e.g. the size of cluster/fleet) constituted determinants of the sea transport inflows.

CHAPTER 6: THEORETICAL FRAMEWORK, DATA DESCRIPTION AND TIME SERIES PROPERTIES

Chapter Summary: The chapter presents the theoretical framework on the key variables of the sea transport inflows that will be used in the empirical model. Then, the data series are presented along with their time series properties. As the data are monthly, the series were seasonally adjusted. In addition, the unit root tests indicated that none of the variable is explosive, a prerequisite by the ARDL bounds testing methodology.

6.1 Theoretical considerations

This section will take a closer look at the behaviour of shipping market participants with a special focus on the impact of their decisions on the Balance of Payments. Through this exposition, the key parameters that determine the inflows of shipping services in the BoP will be discussed. A macroeconomic approach of the determinants was already presented in Chapter 4 which discussed the BoP compilation methodology by the Bank of Greece. The following exposition follows a micro-founded approach on the basis of the market participants behaviour.

At a first stage, a number of simplified – and simplifying - assumptions are made which will be relaxed later. Initially, it can be assumed that there is only one homogenous type of vessel that can be employed either on a voyage charter or on a time charter basis and – hence – market. In the voyage charter market (usually referred in the tanker market as spot market), a ship's remuneration is expressed in USD per ton of cargo, while in the time-charter market the vessel's remuneration is in USD per day, traditionally called hire. However, in the first type of chartering arrangement the shipowner incurs practically all transport costs while in the second one the shipowner incurs all with the clear exclusion of voyage costs (see Appendix IV.1). Therefore, vessel *i* revenues per day can be expressed as:

Voyage charter: $R_i^s = F^s/days$ of voyage

Time charter: $R_i^t = TC_i^t$

Where:

R_i^s: revenues per day for a vessel employed in voyage charter

F^s: freight income of a voyage charter

R_i^t: revenues per day for a vessel employed in time charter

TC_i^t: time charter rate per day

In order to transform the voyage charter earnings in a per day equivalent, the Time Charter Equivalent (TCE) concept will be employed. TCE is calculated from the voyage charter earning after deducting the voyage expenses and is expressed in USD per day. In short,

Time Charter Equivalent: $TCE_i^s = \frac{F^s - Voyage\ costs}{days} \cong \frac{F^s - Bunkers}{days} = R_i^s - \frac{Bunkers}{days}$

Or $R_i^s = TCE_i^s + \frac{Bunkers}{days} = TCE_i^s + BUNK$

At a given point in time and for the same duration of voyage and time charter, the TCE shall be same as the time charter rate if the element of market risk is neutral (Beenstock and Vergorris, 1989).[90]

Thus, $TC_i^t = TCE_i^s = TCE_i$

In summary, the daily revenues of a vessel can be described as:

Voyage charter	Time charter
$R_i^s = TCE_i + BUNK_i$	$R_i^t = TCE_i$

In a fleet of *n* homogenous vessels, there are *n-m* vessels operating in the time charter market while *m* vessels in the voyage market. Under these assumptions, the total revenues of a fleet (e.g national) per day can be expressed as:

$$TR = (n - m) \times TCE_i + m \times (TCE_i + BUNK_i) = n \times TCE_i + m \times BUNK_i$$

At a second stage, the assumption of a single homogenous vessel can be relaxed, by allowing K types of homogenous vessels, each one reflecting one of shipping segments

[90] Moreover, under the efficient market hypothesis, it is expected that the time-charter rates shall reflect the spot rates and the related voyage cost for the corresponding duration (Beenstock and Vergorris, 1989). It is noted that Kavussanos and Alizadeh (2002b) results were not supportive of the efficient expectation hypothesis of the term structure of the dry bulk freight rates for the 1980-1997 period. Moreover, Alizadeh and Nomikos (2011) found evidence that the volatility of the freight rates is related to the term structure of the freight market.

(e.g. dry bulk, oil tanker, containers etc). Therefore, the total revenues of a fleet (e.g national) per sector can be expressed as:

$$TR_K = \sum_{k=1}^{K} (\, n_k \times TCE_k + m_k \times BUNK_k) = \sum_{k=1}^{K} n_k \times TCE_k + \sum_{k=1}^{K} m_k \times BUNK_k$$

Taking into account that the Bunkering cost depends on the Price of Bunkers (P_b), it can be deduced that $BUNK_k = f(P_b)$.[91]

Moreover, the number of active vessels is a share of the number of vessels per sectors according to the capacity utilisation in each sector (cu).[92] Additionally, in reality there is a variety of sizes (i.e., vessel dwt capacity) within each sector rather than a homogenous vessel. Therefore, an adjustment for the different vessels' size (in dwt-terms) and thus of their respective earning capacity in each sector shall be made. Therefore, $n_k = f(cu, dwt, n_k^{total})$

Thus, total revenues are expected to depend on the following variables

$TR_K = f(TCE_k, n_k^{total}, cu, dwt, P_b)$.

Against this background and on the basis of the literature review of the post-2000 studies discussed in Chapter 5, the corresponding empirical model to be estimated - in its long-run form – will take the following form:

$$LREC_t = a_0 + a_1(LGSI_t) + a_2(LBUNK_t) + a_3(LFL_t) + \varepsilon_\tau$$

where:

REC: Sea transport receipts from the Balance of Payments

[91] The total cost of bunkers depends also on the speed of the vessel. However, the speed parameter is taken into account in the capacity utilization parameter, as higher speed will reflect also higher utilization of the fleet (through the performance of more ton-miles per year).

[92] It is noted that the capacity utilization reflects not only the carrying capacity of the active fleet but also the speed of the active fleet. An vessel sailing at slow steam can perform less ton-miles per year compared to a vessel sailing at higher speed.

GSI: The Greek Shipping Index. A freight index that reflects the average earning of the Greek-controlled fleet and it is calculated based on TCE (TCE_k) and the number of vessels (n_k^{total}) data.

$BUNK$: The cost of bunkers (P_b)

FL: The capacity utilisation adjusted Greek-controlled fleet. It is calculated based on the capacity utilisation level of the world fleet (cu) and the capacity of the Greek-controlled fleet (dwt).

6.2 Data

The following data series are included in the model:

a) Sea transport receipts in the BoP, old (pre-2015) and new (post-2015) methodology
b) The TCE in each sector that will be approximated by the respective sector earnings as per the Clarkson Research Services Database.
c) The number of vessels and the capacity (in dwt) in each sector are retrieved by the annual report of the Greek Shipping Cooperation Committee (GSCC) of the Greek Controlled fleet.
d) The price of bunkers which is collected from the Clarkson Research Services Database.
e) The capacity utilisation, a derived variable, is calculating according to the UNCTAD methodology (see later) on the basis of the ton-miles of world fleet and the capacity of Greek-controlled fleet (in dwt).
f) The calculation of the Greek Shipping Index uses both the TCE and the number of the Greek-controlled fleet.

6.2.1 Sea transport receipts

Data on receipts from the provision of sea transport services in million euro have been collected from Bank of Greece. The series was transformed in million USD using the monthly average EUR/USD reference exchange rate published by the European Central Bank (ECB). As we are interested in the Greek ocean-going shipping activities, the series

depicts the cross trade receipts from shipping, excluding transportation for persons etc., which - in any case – is an extremely small portion of total receipts.

6.2.2 Freight earnings

The earnings in each sector are calculated from the respective voyage freight rates and they are expressed in USD/day. Earnings are estimated for a number of routes and they are based on a standard – for each route – vessel. In broad terms, earnings are calculated as freight income - after commission - minus bunker costs and port expenses; the outcome is divided by the number of voyage days (Clarkson Research, 2021). The earnings act as a benchmark for the respective sector. The average earnings are weighted averages as the charter rates are weighted by the number of ships in different size ranges.

The following Freight earnings are used from the Clarkson Research Services (SIN) database:

- Average Weighted Bulker Earnings: for the dry bulk vessels (Series no.: 40966)
- Average Weighted Crude Tanker Earning: for the crude oil tankers (Series no: 546178)
- Average Weighted Product Tanker Earnings: for product tankers (Series no.: 546186)
- Clarksons Average Containership Earnings: for container vessels (Series no. 97738)
- Clarksons Average LPG Carrier Earnings - Historical Basket: for LPG carriers (series no. 547787)
- LNG 160K CBM 1 Year Timecharter Rate (series no. 532720): for LNG vessels. In the LNG sector, there is a limited number of series which cover a period spanning from 2005 onwards, which was used as the reference freight rate for the sector. Where needed, for the short period before 2004, changes in LPG earnings were used as an approximation for the development in the LNG time charter market.

6.2.3 Bunker price

Price of bunkers is calculated as the simple average price for HSFO 380cst (3.5% Sulphur) in the key bunkering ports of Rotterdam, Singapore and Fujairah expressed in USD/tonne with the original series as from the Shipping Inteligence Network (SIN) of Clarkson Research.

6.2.4 Number of vessels

The structure and the development of the Greek-controlled fleet can be found in various sources such as UNCTAD, Clarkson, Greek Shipping Co-operation Committee (GSCC) etc. In the context of the discussed model the Greek Shipping Co-operation Committee data were chosen on the basis of:

- Being a relatively longer time series starting from late 1990s; a feature that was not present in the Clarkson Research database.
- Providing detailed breakdown per sector; a feature not present in the UNCTAD database.

The GSCC fleet data are used twofold: first for the calculation of Greek Shipping Earning Index (number of vessels) and second for the calculation of the utilisation-weighted Greek controlled fleet (dwt). As the data were available only annually, a linear approximation is used for the calculation of the respective monthly figures.[93]

6.2.5 Seaborne trade

The annual seaborne trade in ton-miles per sector were collected from the Clarkson Research Services (SIN) database for the period 2000-2020. The data was used for the estimation of the capacity utilisation rate as will be discussed later in 6.2.8.

6.2.6 The series of credit to Greek shipping

This variable refers to the amount of outstanding loans to shipping companies in Greece (residents) from the Greek-based banking system. The series is available from September 2002, but there are two significant events (breaks) in the series: The first one, in June 2010 when there was a reclassification of loans amounting to 6.7 bn euros from non-residents to residents; this resulted to an equal increase of the outstanding loan amounts to Greece-based shipping companies. The second one was in March 2019 when the loans to shipping companies which have their registered office abroad, were no longer included in credit

[93] I avoided adjusting the number of the Greek-controlled fleet on the basis of the trend of the Greek-flagged fleet, which is available on the monthly basis. The key reason was that the trends in Greek-flagged fleet could be different, or even conflicting, with the respective trends in Greek-controlled fleet (see for instance Thanopoulou, 1998)

towards the domestic economy. This change resulted in a decrease by approx. 7bn euros of outstanding loans that represented almost 90% of the total credit to shipping. The June 2010 break was treated with the inclusion of a dummy in the estimation of the pre-2015 period model.

6.2.7 Greek Shipping Index (GSI)

The GSI is a derived variable and two variants of the Greek Shipping Index (GSI) were calculated; a broad and a narrow. The broad GSI is the weighted average of the freight earnings for all vessel types. The narrow one includes only the key sectors for Greek ocean shipping, i.e. dry bulk, crude oil tankers and product/chemical tankers. It is expressed in USD per day.

In both indices, the constituent freight earning were initially seasonally adjusted using the X-12 ARIMA method. There are two approaches in seasonal adjustment for aggregated timeeries; the direct and the indirect. In the direct one, the aggregate series is seasonally adjusted. In the indirect one, the aggregated series is calculated from the seasonally adjusted (i.e. direct method) constituent components. The former is preferred when the constituent series exhibit similar seasonality, while the latter when they exhibit different seasonality. As the freight earning in each sector exhibit different seasonality, I have opted for the indirect approach. Against this background, each earnings series was seasonality adjusted using the X-12 ARIMA methodology and then it was used for the calculation of the GSI.

6.2.8 Greek shipping capacity utilisation

The capacity utilisation is the second derived variable. The calculation of the capacity utilisation is based on Kalindaga (1990) which was employed also by UNCTAD. The concept of capacity output reflects the level of output when the factor input is fully employed at normal (long-run) intensity level. Therefore, capacity utilization measures the actual capacity employed versus its (long-run) capacity output. For each sector of the following 5 sectors dry bulk, crude oil, product oil, containers, liquid gases, I calculate the annual ratio ton-miles per dwt for the world fleet.[94] The ton-miles per dwt ratio is an indication of the productivity of the world fleet. The highest ratio for the period 2000-2020 is selected as the one that reflects the potential capacity output and it is then multiplied by the size of fleet (in dwt) in each sector to determine the potential output in ton-miles. Then, the deviation between the potential and the actual ton-miles reflect the unutilised capacity.

[94] The seaborne trade in tonmile was retrieved from Clarkson's SIN. The world fleet in dwt are from Lloyd's Register – Fairplay/IHS Markit.

Finally, the ratio of the unutilised capacity over the potential one provides us with a capacity utilisation rate.[95]

6.2.9 Capacity utilisation adjusted fleet (active fleet)

The capacity utilisation adjusted fleet (active fleet) variable reflects the level of the Greek-controlled fleet utilisation rate. The capacity of the Greek-controlled fleet (in dwt) per sector is multiplied with the capacity utilisation ratio for the respective sector. The total adjusted fleet is derived as the sum of the above-mentioned products and reflects the active capacity of the Greek-controlled fleet.

6.3 Data Analysis

As a first step, I examine the existence of seasonality in the series. Then, a set of unit root tests for the series is performed.

6.3.1 Seasonality

A time series that is collected more than once per year may exhibit seasonality and in general it can be decomposed – in principle - into three elements; (a) the trend, (b) the seasonal and (c) the irregular one (Eurostat, 2015; Ghysels and Osborn, 2001). The target of the seasonal adjustment is the removal of the seasonal component. [96, 97] The seasonal graphs for each variable as well as an estimation of the seasonality pattern for the freight rates are presented in the Appendix IV.2 and IV.3. Against this background, all the series, with the exemption of Credit to shipping, were seasonally adjusted following the X-12 ARIMA methodology.

6.4 Unit root tests

6.4.1 Unit root and stationarity tests: Background

The use of time series data raises undoubtedly the issue of stationarity in the data. The concept of stationarity used is the co-variance stationarity of the random variable x_t and involves that:

[95] The capacity utilization index is – by definition - capped at 100%.
[96] The X-12 ARIMA seasonal adjustment method belongs in the moving average class of methods. Specifically, it applies a centred moving average filters. It was originally developed by the U.S. Census Bureau as X-11.
[97] The initial series were adjusted with the X-12 ARIMA methodology selecting the multiplicative model without any ARIMA data transformation. In order to avoid the end-period problem, as X-12 is a centred moving average methodology, the estimation period was initiated after the t+6 period.

1. $E(x_t)$ is constant for all t
2. $Var(x_t)$ is constant for all t
3. $Cov(x_t, x_{t+k})$ is constant for all t and all k ≠ 0. i.e. it is only a function of the time distance and not on the actual point in time t.

which indicates that any shock in the series are temporary and the series will return to its long-run mean level (Harris and Sollis, 2003). On the contrary, non-stationary times series may not have a long-run mean to return to and the variance increases with time, thus becoming explosive. In its simple form of an order 1 autoregressive process – AR(1), a series y_t has a unit root if it follows a relation such as:

$y_t = \rho y_{t-1} + u_t$, where $\rho = 1$; in other words $y_t = y_{t-1} + u_t$.

If $|\rho| > 1$, then the series becomes explosive. Finally, if $|\rho| < 1$, then the series is stationary.

From the above AR(1) equation by subtracting y_{t-1} from both sides , the following representation is obtained:

$\Delta y_t = (\rho - 1) y_{t-1} + u_t$

Especially in the case of unit root series, $\rho - 1 = 0$ and $\Delta y_t = u_t$, and therefore Δy_t is stationary, as u_t is a white noise (stationary).

Therefore, it is important to test for unit roots. Especially in the ARDL methodological framework, the series can be either I(0) or I(1). Therefore, the unit root shall warrant that none of the variables have an integration order higher than one. The main unit root test employed here is the Phillips-Perron test (PP) and the analysis will be cross validated with the Augmented Dickey-Fuller test (ADF). Moreover, various specifications of the abovementioned test will be considered and presented

6.4.2 The Augmented Dickey-Fuller test (ADF)

The null hypothesis of the ADF test (Dickey and Fuller, 1981) is the existence of a unit root in the time series, which can be tested through the following equations depending on

the existence of a constant (stochastic trend) and/or a non-stochastic (deterministic) time trend:

$\Delta y_t = \gamma y_{t-1} + \sum_{i=1}^{p} \beta_i \Delta y_{t-i} + u_t$ (no constant and no linear trend)

$\Delta y_t = \alpha_0 + \gamma y_{t-1} + \sum_{i=1}^{p} \beta_i \Delta y_{t-i} + u_t$ (constant but no linear trend)

$\Delta y_t = \alpha_0 + \alpha_1 t + \gamma y_{t-1} + \sum_{i=1}^{p} \beta_i \Delta y_{t-i} + u_t$ (constant and linear trend)

The hypothesis is that :

H_0: $\gamma = 0$, the existence of a unit root as $\gamma = (\rho - 1)$

H_1: $\gamma < 0$

The advantage of the ADF test compared to the predecessor Dickey-Fuller test lays on the inclusion of the lagged difference of the dependent variable, correcting in this way for autocorrelation. The selection of the number of lags is usually based on the Akaike of the Schwarz information criteria. The critical values come from a non-standard t-distribution and the respective values used are those in MacKinnon (1991).

6.4.3 The Phillips-Perron test (PP)

The PP test is an alternative unit root test that can be regarded as a generalisation of the ADF test (Phillips and Perron, 1988). More specifically, instead of including lagged differences of the dependent variables, the t-statistic itself is adjusted for the autocorrelation in the residuals. As the asymptotic distribution of the PP t-statistics is the same as the respective one of the ADF, the MacKinnon (1991) critical values are used in this test as well.

The PP test as well as the ADF test indicated that the variables used in the estimation model do not have an integration rank above 1. The detailed results are presented in the Appendix IV.4.

6.5 Chapter 6 – Key takeaways

- The key variables to be employed in the empirical model are the Greek Shipping Index, which is a weighted average freight earning index for the Greek-controlled fleet; the cost of bunker and the active Greek-controlled fleet.

- The time series are seasonally adjusted as they are in monthly frequency.

- The unit root tests suggest that none of the time series is explosive (i.e. I(2) or above); a prerequisite for the application of the ARDL bounds testing methodology.

CHAPTER 7: METHODOLOGY OF RESEARCH

Chapter Summary: The size of the sample as well as the order of integration of the variables were key considerations in the process of the construction of the model in the context of the research. As it is argued at the start of this chapter. The ARDL bounds testing methodology exhibits advantages that address these considerations and warrant that the estimation of the coefficients and the hypothesis testing are reliable. A review of the ARDL methodology applications in Transport and Maritime economics research follows the discussion of the suitability of the ARDL bounds testing methodology for the model, while the chapter concludes with a discussion of the necessary checks for the use of this methodology in such a context.

7.1 Introduction: the selection of the econometric methodology

Granger and Newbold (1974) introduced the expression of *spurious regression* that describes the nonsense regression between uncorrelated non-stationary time series, which yields high R^2 and significant coefficients but low levels in the Durbin-Watson test for autocorrelation. Later, Granger (1981) introduced the idea of cointegration that was further developed by Engle and Granger (1987) seminal work that proposed the two-step estimation of error-correction equation and the cointegration test. However, their work had a number of short-comings such as:

1. The two-step methodology means that any errors introduced in the first step, i.e. in the estimation of residuals through a level long-run equation, are carried over to the second step, i.e. to the test of the integration order of the residuals.
2. The integration order of each variable has to be one I(1).
3. In the presence of more than two variables, there may be more than one cointegration relationship; in other words, there is not a provision for the number of cointegration relationships.
4. There is no clear-cut determination of which variable(s) is(are) the repressor(s) (Asteriou and Hall, 2011).

Johansen (1988), through the so-called *Johansen multiple equation approach to cointegration*, addressed to some extent the abovementioned shortcomings. Especially, more than two variables can be included in the model (multiple equations) and then the number of cointegrating relationships can be revealed with the use of the appropriate test (see Johansen (1988); Johansen and Juselius (1988)). In the Johansen methodology, it is preferable that the variables are of the same integration order and if possible I(1). Finally, as the multiple equations system is built as a Vector Autoregressive (VAR) model, there is a need for a long time-series.

In early 2000s, an old model in time-series econometrics, the Autoregressive Distributed Lag (ARDL), was reinvented for the estimation of cointegrating relationships with a number of desirable properties. These advantages – as it will be analysed later - led to the adoption of the ARDL bounds testing methodology in this study.

7.2 Cointegration and Error Correction: Background

A series y_t is *integrated of order d* ($y_t \sim I(d)$)), if it needs to be differenced *d* times before it becomes stationary, i.e. $\Delta^d_{y_t} \sim I(0)$. As it was mentioned in the introduction, the use of non-stationary variables could lead to spurious regression. However, by tacking the non-stationarity issue by the use of differenced variables, this restricts us on the development of short-run models. In general, the linear combination of two I(d) variables will also be I(d) i.e., their residuals will also be I(d). However, if there is a vector $\boldsymbol{\beta}$ so that the linear combination the I(d) variables leads to a disturbance term being integrated of a lower order i.e. I(d-b), where d≥b>0, then according to Engle and Granger (1987), the series are cointegrated of order d-b. For example, if the variables are I(1) and there is such vector $\boldsymbol{\beta}$ that gives a combination of the variables that is I(0), then the variables are *cointegrated* of order CI(1,1) and the vector *β is the cointegrating vector*.

An important element in the Granger Representation Theorem (Engle and Granger, 1987) is the existence of an error correction representation if the variables are cointegrated of order CI(1,1). For example, in the case of two variables, Y_t and X_t that are both I(1) and there is a vector $\beta = [a_0\ a_1]$ that provides that disturbance term is I(0), then the two variables are cointegrated CI(1,1) and their linear combination is not spurious. Thus:

In levels (long-run): $Y_t = a_0 + a_1 X_t + u_t$

Error correction model (short-run): $\Delta Y_t = \beta_0 + \beta_1 \Delta X_t - \pi\, u_{t-1} + \varepsilon_t$

7.3 Advantages of the ARDL bounds testing approach

The ARDL bounds testing procedure methodology exhibits a number of advantages compared to the other cointegration methodologies as in Engle and Granger (1987) and Johansen (1988); these advantages make it suitable for the empirical work in the context of the thesis. The main advantages of the ARDL methodology that make it the preferred methodology are:

1. *Mixture of I(0) and I(1) series*: The methodology can be used with regressors that are either I(0), I(1) or mutually cointegrated. Therefore, there is no need to take an *a priori* position whether the variables are I(0) or I(1). In this research, freight rates

are used as an explanatory variable. In many studies in maritime economics, freight rates were found to be non-stationary and this was also the case with studies discussed in the literature review in Chapter 5 of the thesis, which identified the series as I(1). However, there are studies such as Koekebakker et al (2006) that suggested that freight rates are non-linear stationary. The selection of the ARDL bounds testing methodology allows to test for cointegration, even if the regressors are either I(0) or I(1) or mutually cointegrated.

2. *Better small sample properties*: The ARDL bounds methodology exhibits reliable small sample properties and performs better in small samples (Pesaran and Shin, 1999). As our sample is relatively small (less than 70 observation), this methodology ensures that the estimation of the coefficient and the hypothesis testing can be reliable.
3. *Different lag length:* The ARDL methodology allows each variable to have a different number of lags, thus a flexible selection of the lag structure can be employed.
4. *Single equation set-up*: The ARDL methodology calls for the estimation of a single equation. The diagnostic tests are performed for the estimated equation and the long-run coefficients are estimated through its re-parameterization. This is an advantage over the Engle-Granger two-step methodology where any errors introduced in the first step (i.e., estimation of residuals through a level long-run equation) are carried over to the second step (i.e., test of the integration order of the residuals).
5. *Dummy variables*: The ARDL methodology framework allows the incorporation of dummy variables provided that the fraction of time that the dummy variable is non-zero tends to zero as the sample size increases.

7.4 Autoregressive Distributed Lag (ARDL) bounds testing methodology

This part broadly follows the presentation of the ARDL bounds testing paper by Pesaran, Shin and Smith (2001). In their work, they developed a cointegration test based on the ARDL model. In its general form, an ARDL model with *m* lags of the dependant variable

y and p exogenous variables extended up to n lags[98] (i.e. ARDL(m, q_1, …, q_p) can be presented as

$$y_t = a_0 + a_1 t + \sum_{i=1}^{m} \varphi_i \, y_{t-i} + \sum_{j=1}^{p} \sum_{i=0}^{n} \beta_{j,i} \, x_{j,t-i} + \varepsilon_t \qquad (7.1)$$

where:

a_0 = constant

a_1 = coefficient of a linear trend

φ_i= coefficient of the lags of y_t

$\beta_{j,i}$ = coefficient of the lags of the k repressors x_j and

$\varepsilon_t \sim iid(0, \sigma^2)$ = the residual (i.e. the usual innovation)

For example an ARDL(1,1,2), i.e. with two exogenous variables, can be presented as:

$$y_t = a_0 + a_1 t + \varphi_1 \, y_{t-1} + \beta_{1,0} x_{1,t} + \beta_{1,1} x_{1,t-1} + \beta_{2,0} x_{2,t} + \beta_{2,1} x_{2,t-1} + \beta_{2,2} x_{2,t-2} + \varepsilon_t$$

Pesaran et al (2001) starting point for the development of their cointegration test was a (k+1)-vector random process $\{\boldsymbol{z}_t\}_{t=1}^{\infty}$ that can be partitioned into $\boldsymbol{z}_t = (y_t, \boldsymbol{x}_t')'$. The target of their paper was "…*the conditional modelling of the scalar variable y_t given the k-vector $\boldsymbol{x}_t$ and the past values* $\{\boldsymbol{z}_{t-i}\}_{i=1}^{t-1}$ …".[99]

[98] Each of the p variables x_j can have a different number of lags up to n, which is the maximum lag (Banerjee et al, 1993).

[99] The cointegration test is further based on five assumptions such as that: (1) the elements of $\boldsymbol{z}_t$ to be I(1), I(0) or cointegrated; (2) the error process to be a conditional mean zero and homoscedastic; (3) the existence at most of one conditional level relationship between y_t and $\boldsymbol{x}_t$; (4) the maximal cointegrating rank and (5) on the maximal order of integration (Pesaran et al, 2001).

As an ARDL model can be also presented in an Error Correction form, where the latter exhibits an one-to-one correspondence with the initial ARDL model, the conditional model for Δy_t , called *conditional ECM,* is the following:

$$\Delta y_t = \alpha_0 + \alpha_1 t - \pi_{yy} y_{t-1} + \boldsymbol{\pi}_{yx,x} \boldsymbol{x}_{t-1} + \sum_{i=1}^{m-1} \psi'_{yi} \Delta y_{t-1} + \sum_{i=1}^{n-1} \boldsymbol{\psi}'_{xi} \Delta \boldsymbol{x}_{t-1} + \boldsymbol{\omega}' \Delta \boldsymbol{x}_t + \varepsilon_t \quad (7.2)$$

where:

π_{yy} and $\boldsymbol{\pi}_{yx,x}$ are the long-run coefficient or multiplier vector or matrix for y and x,

ψ'_{yi} and $\boldsymbol{\psi}'_{xi}$ are the short-run coefficient or multiplier vector or matrix,

c_0 is a drift (constant),

c_1 is the coefficient of the time trend t,

Δ is the first-difference operator,

ψ_{yi}, $\boldsymbol{\psi}_{xi}$ and $\boldsymbol{\omega}'$ are the coefficients of the lagged values of Δy_{t-i} Δx_{t-i} and Δx_t, respectively.

u_t the error term.

A *critical*, as characterized by Pesaran et al (2001) assumption (i.e., Assumption 3 in their work) is reflected in the derivation of equation 7.2. Specifically, the regressors **x** are long-run forcing for the vector of y_t, and thus there is no feedback from the level of y_t for $\boldsymbol{x_t}$, in equation 7.2. However, this does not imply a similar restriction on the short-run effect between of y_t and $\boldsymbol{x}_t$. Therefore, it can be assumed that there exists at most one conditional level relationship between y_t and $\boldsymbol{x}_t$.

According to how the deterministic components, i.e. the intercepts and the trends are specified in 7.2, Pesaran et al (2001) distinguished five cases.[100]

Case I: No intercepts and no trends, i.e. $\alpha_0 = 0$ and $\alpha_1 = 0$.

[100] The five cases resemble those in the Johansen multiple equation approach to cointegration.

Case II: Restrict the intercepts to be in the long-run relationship and no trends, i.e. $\alpha_0 = -(\pi_{yy}, \boldsymbol{\pi}_{yx,x})\boldsymbol{\mu}$ and $\alpha_1 = 0$. [101]

Case III: Unrestricted intercepts and no trends. i.e. $\alpha_0 \neq 0$ and $\alpha_1 = 0$. Intercepts do not enter in the long-run relationship as there is no restriction of $\alpha_0 = -(\pi_{yy}, \boldsymbol{\pi}_{yx,x})\boldsymbol{\mu}$ as in Case II.

Case IV: Unrestricted intercepts and restricted trends that enter in the the long-run relationship. Namely, $\alpha_0 \neq 0$ and $\alpha_1 = -(\pi_{yy}, \boldsymbol{\pi}_{yx,x})\boldsymbol{\gamma}$. [102]

Case V: Unrestricted intercepts and unrestricted trends, i.e. $\alpha_0 \neq 0$ and $\alpha_1 \neq 0$.

Pesaran et al (2001) emphasized on testing for the absence of level relationship between y_t and $\boldsymbol{x}_t$; namely the joint hypothesis that $\pi_{yy} = 0$ and $\boldsymbol{\pi}_{yx,x} = \mathbf{0}'$. The bounds testing is built on the null hypothesis for the *absence* of any level relationship among y_t and $\boldsymbol{x}_t$. To this end, the following hypothesis are formulated,

$$\begin{aligned} &H_o: \pi_{yy} = 0 \cap \pi_{yx,x} = \mathbf{0}' \\ &H_1: \pi_{yy} \neq 0 \cup \pi_{yx,x} \neq \mathbf{0}' \end{aligned} \qquad (7.3)$$

This hypothesis can be tested using the standard Wald test (and the corresponding F-statistic). However, the F-test has a non-standard distribution and depends upon: (i) whether the variables are I(0) or I(1), (ii) the number of repressors, (iii) whether ARDL includes an intercept and/or trend (according to the abovementioned cases) and (iv) the sample size. The critical values for this test were estimated via stochastic simulations for large samples (T=1000) by Pesaran et al (2001) and for small samples (ranging from 30 to 80 in increments of 5) by Narayan (2005). These critical values provide a lower and an upper bound value. If the computed F-statistic is higher than the upper bound, then the hypothesis H_o of no level relationship can be rejected, meaning that the variables are cointegrated, without prior knowledge of the degree of integration of the variables (I(0) or

[101] It is noted that $\boldsymbol{\mu}$ is the unknown (k+1) vectors of intercept coefficients.
[102] It is noted that $\boldsymbol{\gamma}$ is the unknown (k+1) vectors of trend coefficients.

I(1)). If the computed F-statistic is less than the lower bound, then H_o of no level relationship cannot be rejected, meaning that the variables are not cointegrated. Finally, if the computed F-statistic falls within the bounds, then the inference is inconclusive. Then, from equation (7.2), the long-run, the long-run and the ARDL model can be extracted.[103]

In more detail:

- If $F^{stat} > F_{low}^{crit} > F_{up}^{crit}$, Ho is not rejected. There is a conclusive result that there is no level relationships between y_t and $\boldsymbol{x}_t$.
- If $F_{low}^{crit} > F^{stat} > F_{up}^{crit}$, there is an inconclusive result, namely that it may or may not exist a level relationships between y_t and $\boldsymbol{x}_t$.
- If $F_{low}^{crit} > F_{up}^{crit} > F^{stat}$, Ho is rejected in favour of the althernative H_1

The rejection of H_o namely allowing to statistically accept H_1, could reflect the following alternative three cases about π_{yy} and $\pi_{yx,x}$:

Case 1: H_1: $\pi_{yy} \neq 0$ and $\pi_{yx,x} \neq 0'$.

This is the main case, which allows us to accept the level relationship among the variables.

However, there are two further alternatives that need to be assessed.

Case 2: H_1: $\pi_{yy} \neq 0$ and $\pi_{yx,x} = 0'$.

It indicates, according to 7.2, that Δy_t depends only on its own lagged values y_{t-1}. Therefore, x_{t-1} does not exercise any forcing effect on Δy_t and thus this relationship is degenerate in equilibrium.

Case 3: H_1: $\pi_{yy} = 0$ and $\pi_{yx,x} \neq 0'$.

This is the second degenerate case. It indicates that the Δy_t depends only on the lagged values of x_{t-1}. In this case, we would like to further test that $\pi_{yx,x} \neq \mathbf{0}'$.

Therefore, after the rejection of H_o in 7.3, it is advisable to identify the alternative, even though this can be formally performed only for π_{yy}. In this case, the following hypothesis testing is constructed

[103] Note that the long-run coefficients θ_k for the k-variables x_t are defined as $\theta \equiv -{}^{\pi_{yx,x}}/_{\pi_{yy}}$.

$$H_o: \pi_{yy} = 0 \qquad (7.4)$$
$$H_1: \pi_{yy} \neq 0$$

If the Ho is rejected, then we can also accept the level relationship among the variables assuming that $\pi_{yx,x} \neq \mathbf{0}'$. The test is performed through a t-test but as the respective distribution is non-standard, the critical values are also provided in Pesaran et al (2001).[104]

Concerning $\pi_{yx,x}$, there is no formal test. However, in empirical studies the significance of the x_{t-1}'s coefficients in 7.2 is employed as an indication for $\pi_{yx,x} \neq \mathbf{0}'$.[105]

Following the abovementioned formal tests and accepting the existence of a level relationship, the long-run relationship and the corresponding error-correction are derived as re-parameterization of equation 7.2.

$$\Delta y_t = \alpha_0 + \alpha_1 t - \pi_{yy}(y_{t-1} - \theta\, x_{t-1}) + \sum_{i=1}^{m-1} \psi'_{yi} \Delta y_{t-i} + \sum_{i=1}^{n-1} \psi'_{xi} \Delta x_{t-i} + \omega' \Delta x_t + \varepsilon_t \qquad (7.5)$$

Where $\theta \equiv -{}^{\pi_{yx,x}}/_{\pi_{yy}}$, i.e. the long-run coefficients θ_k for the k-variables x_t.

Two further points should be mentioned

a) Different lag lengths for the variables: The bounds test allows the inclusion of differential lag lengths on variables y_{t-i} and $\boldsymbol{x}_{t-i}$ in the ARDL, i.e. an ARDL(p, p_1, p_2, …,p_k) (Pesaran et el, 2001, page 299).
b) Inclusion of Dummy variables: The bounds testing theory is valid when dummy variables are included, provided that the non-zero observations of the dummy variables tend to zero as sample size increases; if not, then the asymptotic theory

[104] It noted that - although the Data Generating Processes (DGP) for Case II and Case III are different – Case II is subsumed by Case III as effectively the limiting distribution of the t-statistic are asymptotically the same. The same holds for Cases IV and V. This is discussed in both Banerjee et al (1996) and Pesaran et al (2001).
[105] See for instance, Goh and McNown (2015).

and the critical values of the bounds testing needs to be modified (Pesaran et el, 2001, page 307).

7.5 Step for the implementation of the bounds testing approach

The implementation of the bounds testing methodology is executed through the following steps.

Step 1: The time series of the model shall not be explosive. Therefore, they will be tested for unit roots so as to confirm that their order of integration is not equal or above 2 (i.e. not I(2)); effectively this means that they should be either I(0) or I(1). In the present thesis, the degree of integration is examined with the use of the main unit root tests; namely the Augmented Dickey-Fuller (ADF) and the Phillips-Perron (PP) (see Section 6.4).

Step 2: Build an ARDL model as *conditional (or unrestricted) ECM* as in equation 7.2. The selection of the appropriate lag length will be based on the Akaike Information Criterion (AIC). As the absence of serial correlation is essential in the ARDL model, the finally selected lag length shall warrant it. In addition, the typical diagnostics tests are performed (i.e. goodness of fit, heteroskedasticity, stability etc).

Step 3: Perform the bounds testing procedure as described previously. Provided that the level relationship is not rejected, then the long-run as well as the short-run coefficients can be estimated from the re-parameterization of the estimated model in the previous step.

7.6 Selection of the deterministic components: the 5 cases

As it was previously discussed, Pesaran et al (2001) distinguished 5 cases depending on the deterministic components and whether they enter in the long-run (cointregrating) relationship.

Case I assumes no intercepts and no trends in the data or in the cointegrating relationship. This is a quite restrictive and an unlike case in reality as a constant is needed to account for the different units of measurement in the variables.

Case II restricts the intercept to be in the long-run relationship and there is no trend. Effectively, the restricted intercept accounts for the different units of measurements of the variables.

Case III allows for an intercept in the short-run model and no trends. As the short-run model is built in first difference, the existence of an intercept indicates the presence of linear trends in the data. Therefore, if such trend is present, the use of the unrestricted trend is warranted. It is noted though that the intercept in the cointegrating relationship is assumed to be cancelled by the intercept in the short-run model, thus leaving only an intercept in the latter.

Case IV allows for an intercept in the short-run model but allows (restricts) the trend in the long-run relationship; in this case, a linear trend enters the cointegrating relationship.

Finally, Case V allows an unrestricted trend in the short-run model, which is built in first differences, indicating the existence of a quadratic trend in the data. However, such a case is not realistic in economic theory.

Therefore, the discussion is usually around which of the three cases - Case II, III or IV - shall be selected for modelling purposes. (Harris and Sollis; 2003; Asteriou and Hall, 2011)

In literature, there are a number of practical procedures for the selection of the model such as plotting the data in level and first-differences and examining the existence of any linear trends. From the examination of the data for the period 2015-2020, it seems that there is not a linear trend. Therefore, we have opted for the models without the inclusion of a trend. Moreover, as the data are expressed in different unit, we have also opted for the inclusion of the constant in the cointegrating equation. Thus, the estimation will be based on Case II; an intercept in the long-run relationship and without the existence of a trend.

7.7 ARDL application in transportation and maritime economics: a review

Since the publication of the Pesaran et al (2001) paper on ARDL methodology on cointegration until the end of 2021, there were close to 6,000 citations according to the publisher (John Wiley & Sons), more than 6,500 citations based on Dimensions database

and more than 17,000 citations according to Google Scholar. However, only a small number of papers were published in key academic journals in maritime transport.

Table 7.1: ARDL methodology in maritime economic academic journals

Journal	Maritime transport	Other Transport	Total
A. With ARDL papers			
Research in Transportation Economics	1	6	7
International Journal of Shipping and Transport Logistics	2	0	2
The Asian Journal of Shipping and Logistics	1	0	1
Transport Policy	2	5	7
Transportation Research Part A: Policy and Practice	1	1	2
Transportation Research Part D: Transport and Environment	0	1	1
Transportation Research Part E: Logistics and Transportation Review	0	1	1
B. Without ARDL papers			
Maritime Economics & Logistics			
Maritime Policy & Management	*		
Transport Reviews			
Transportation			
Transportation Research Part B: Methodological			
TOTAL	**7**	**14**	**21**

Source: Author.
* There is a reference on the ARDL methodology in a paper reviewing the green shipping research.
Note: Papers are presented in alphabetical order in each panel.

From the Web of Science/Clarivate *Master Journal List*, a number of academic journals that are listed in the *Transportation* category were selected. Furthermore, the list of the academic journals was further narrowed by focusing on journals that publish *inter alia* studies on maritime transport as well. The selection of the journals was further cross-validated with the list of papers that Shi and Li (2017) used in their review of the themes and tools in maritime transport. Therefore, a selection of 12 journals were considered with 35 papers that included the word "*ARDL*" been short-listed for consideration from 2001 -

when Pesaran et al (2001) original paper was published - until the end of 2021. Papers were carefully analysed to assess whether the time series ARDL methodology was employed in them. Out of the 35 papers, there were 21 that genuine used the ARDL methodology; almost 30% of them were in the field of maritime transport including port economics (Table 7.1). [106] Moreover, more than 11 papers (i.e. 50%) were published in the period 2019-2021 and another 8 (i.e. 40%) in the period 2016-2018 with the remainder (i.e. 2 papers) been published in 2013. Specifically, out of the 7 papers on maritime transport, six papers were published in 2016-2021, while there was just 1 in 2013. This is a clear indication that the ARDL methodology only recently started to find its way in the maritime and transport econometric studies.

[106] Papers that employed the panel data ARDL methodology are treated as different to the time series ARDL methodology of Pesaran et al (2001).

7.8 Chapter 7 – Key takeaways

- The ARDL bounds testing methodology has several advantages that better address the considerations of the empirical analysis. It can be used with regressors that are either I(0), I(1) or mutually cointegrated. Moreover, it exhibits reliable small sample properties and performs better in small samples.

- Only recently, the ARDL bounds methodology has found its way in the maritime economics literature.

CHAPTER 8: EMPIRICAL RESULTS

Chapter Summary: The determinants of the sea transport receipts in the Greek Balance of Payments are estimated on the basis of the ARDL bounds testing methodology. The estimation results indicate that the determinants and their magnitude in the pre- and post-2015 period share some similarities; however differences do exist. Aiming at identifying the existence of deviation between the two periods, a backcasting exercise for the period 2002-2014 was performed. Then the level of sea transport inflows based on the old methodology was compared to that of the backcasted one. This exercise revealed a deviation between the two periods, reflecting the different compilation methodologies; however, towards the end of the estimation period the two series exhibit signs of convergence.

8.1 Introduction

Both from an economic policy viewpoint and from an academic research one, it is important to evaluate whether the determinants of the sea transport inflows are the same and whether their significance has been altered between the old (pre-2015) and the new (post-2015) compilation methodology. To this end, the determinants of the sea transport inflows using the new compilation methodology data (post-2015) are identified using the ARDL bounds testing methodology. Then, the same exercise is performed with the old methodology data (pre-2015) which allows to reveal any changes in the determinants - and/or in their significance - on the sea transport inflows. As the empirical results indicates – despite the existence of some similarities - that there is indeed a difference in the determinants before and after 2015. Therefore, a backcasting exercise is performed, i.e. the estimation of the sea transport inflows for the 2002-2014 period on the basis of the new methodology estimation model.

The basic model for the post-2015 period sea transport receipt is presented at the beginning of the chapter. As the Greek-controlled fleet is mainly concentrated in the dry bulk and the tanker segments in terms of earning capacity of the fleet in dwt, a narrowed model focusing only on these sectors is estimated. The empirical findings further confirm the stability of the model as well as the significance of these sectors in the determination of the sea transport inflows in the BoP. The determinants of the sea transport inflows before and after 2015 are compared and on the basis of the empirical result a backcasting exercise is executed. The chapter concludes with the policy implications of the empirical results.

8.2 Empirical results and discussion[107]

Having ensured that none of the variables are I(2), we can proceed with the estimation of the model and the bounds test for the existence of cointegration among the variables.

[107] The estimations were performed with EViews12.

8.2.1 The Main Model

The conditional (or unrestricted[108]) ECM, which takes the following form, was estimated for the period 2015:M07-2020:M12[109]:

$$\Delta(LREC_t) = c_0 + a_1(LREC_{t-1}) + a_2(LGSI_{t-1}) + a_3(LBUNK_{t-1}) + a_4(LFL_{t-1}) + \sum_{i=1}^{p-1} \omega_i \Delta(LREC_{t-i}) + \sum_{j=0}^{q_1-1} \omega_{1j} \Delta(LGSI_{t-j}) + \sum_{j=0}^{q_2-1} \omega_{2j} \Delta(LBUN_{t-j}) + \sum_{j=0}^{q_3-1} \omega_{3j} \Delta(LFL_{t-j}) + u_t \quad (8.1)$$

where:

REC : Receipts for sea transport service in the Greek BoP

GSI: GreekShippingIndex

$BUNK$: Bunker price

FL: Active fleet

All variables are expressed in natural logarithms (L).

As the available sample consists of 66 observations and as the goal is to maintain the degrees of freedom at the level of 50, it is decided to start with 4 lags per variable. The selection of the lag structure follows the general-to-specific methodology proposed by Professor Henrdy and the best model is selected on the basis of the AIC[110] provided that no autocorrelation remained in the residuals. In this process, 500 models are evaluated and

[108] In the original paper, Pesaran et al (2001) call it conditional ECM, as the dependent variable y is conditional on the x variables. Alternatively, in the literature, it is referred as unrestricted ECM as the coefficients of the variables at t-1 (i.e. the cointegration element) are not defined. The respective ECM after the estimation of the level equation is then named restricted ECM.

[109] It is reminded that in order to avoid the start/end-period problem related to the X-12 centered moving average methodology, the estimation period was initiated after the t+6 period.

[110] According to Pesaran and Shin (1999), the ARDL estimators where AIC or SBC information criteria are used for the selection of the number of lags exhibit very similar small-sample performances.

the one yielding the best (i.e. lowest value) in terms of the Akaike Information Criterion (AIC) is selected (Table 8.1).

Table 8.1: Conditional ECM				
Dependent variable: ΔLREC Period **2015-2020**				
Variable:	**Coefficient**	**Standard Error**	**t-stat**	**Probability (p-value)**
Intercept	-14.308	3.368	-4.248	0.000
LREC(-1)	-0.496	0.076	-6.506	-/-*
LGSI(-1)	0.136	0.023	5.979	0.000
LBUNK(-1)	0.102	0.025	4.059	0.000
LFL(-1)	0.830	0.191	4.346	0.000
ΔLREC(-1)	-0.248	0.093	-2.666	0.010
ΔGSI	0.136	0.023	5.979	0.000
ΔLBUNK	0.117	0.038	3.098	0.003
ΔLBUNK(-1)	0.067	0.035	1.914	0.061
ΔLFL	-3.167	1.820	-1.740	0.087
*: t-value is incompatible with the usual t-distribution as the critical values of the bounds t-statistic estimated by Pesaran et al (2001) shall be used. In our case, the upper limit is close to -4.0, and therefore the coefficient of LREC(-1) is significant.				

The corresponding ARDL model, which is a reparemetrisation of the conditional ECM and on which all the diagnostic tests are performed, is an ARDL(2, 0, 2, 1) and is presented below (Table 8.2).[111]

[111] According to Pesaran and Shin (1999), the ARDL estimators where AIC or SBC information criteria are used for the selection of the number of lags exhibit very similar small-sample performances. In the case that the SBC criterion was used, the respective ARDL model would be ARDL(2, 0, 0, 0) while the Hannan-Quinn information criterion (HQ) would indicate an ARDL(2, 0, 0, 1).

Table 8.2: ARDL (2, 0, 2, 1)				
Dependent variable: LREC Period **2015-2020**				
Variable:	**Coefficient**	**Standard Error**	**t-stat**	**Probability (p-value)**
Intercept	-14.308	3.368	-4.248	0.000
LREC(-1)	0.256	0.113	2.261	0.028
LREC(-2)	0.248	0.093	2.666	0.010
LGSI	0.136	0.023	5.979	0.000
LBUNK	0.117	0.038	3.098	0.003
LBUNK(-1)	0.051	0.051	1.006	0.319
LBUNK(-2)	-0.067	0.035	-1.914	0.061
LFL	-3.167	1.820	-1.740	0.087
LFL(-1)	3.997	1.921	2.081	0.042
R^2- adjusted	0.971			
Standard Error	0.025			
F-stat (p-value)	272.063 (0.000)			

First, we test for the presence of serial correlation with the Breusch-Godfrey Lagrange multiplier test (Breusch, 1978; Godfey, 1978). As the data are monthly, we test for 12-order serial correlation (i.e. serial correlation up to the 12 lag)[112] and there is no evidence for the presence of serial correlation in the residuals. Then, the Breusch-Pagan-Godfrey (Breusch-Pagan, 1979; Godfrey, 1978) heteroskedasticity test is performed, and the null hypothesis for no heteroskedasticity cannot be rejected.[113] In addition, the ARCH test for autoregressive conditional heteroscedasticity (Engle, 1982) indicates that the null hypothesis - that there is no ARCH up to order 12 - cannot be rejected. The Jarque-Berra statistic is calculated and the respective normality test is performed, and again the null hypothesis of normality in residuals cannot be rejected.

[112] In the Breusch-Godfrey Lagrange multiplier test, the H_o is the presence of no serial correlation in the residuals up to the specified order, while the H_1 is the presence of serial correlation. The statistics under the null hypothesis follows χ^2 distribution.

[113] The result is confirmed with the White heteroscedasticity test as well.

Finally, the misspecification of the model is tested with the Ramsey (1969) RESET (**Re**gression **S**pecification **E**rror **T**est) and the null hypothesis of correct specification cannot be rejected. In addition, the parameters stability is tested with both the CUSUM and the CUSUM square test (Brown, Durbin, and Evans, 1975). In both cases, the respective CUSUM lines are within the 5% boundary indicating parameter and residual variance stability.

To sum up, the model passes all χ^2 diagnostics tests for the hypotheses of absence of serial correlation, of homoscedasticity, of normal distribution of residuals and of well specification (Table 8.3 and Graph 8.1).

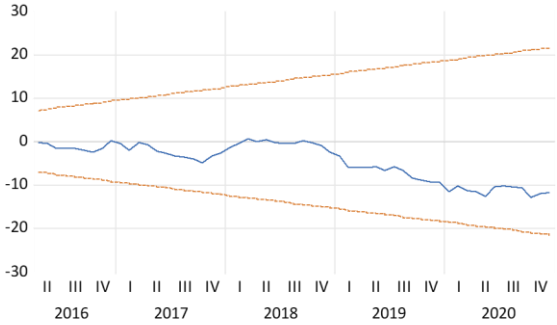
Table 8.3: Diagnostic tests

	2015 - 2020 ARDL(2, 0, 2, 1)	
Diagnostics	**Test statistics**	**Probability (p-value)**
$\boldsymbol{X^2_{SC}(12)}$	10.823	0.544
$\boldsymbol{X^2_{HET}}$	9.144	0.330
$\boldsymbol{X^2_{NORM}(2)}$	5.699	0.058
$\boldsymbol{F_{RESET}(1)}$ $\boldsymbol{F_{RESET}(2)}$	1.173 1.511	0.283 0.533
CUSUM and CUSUM of squares	within 5% bounds	

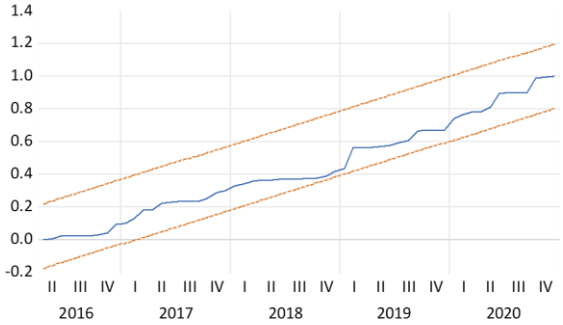
$\boldsymbol{X^2_{SC}}$, $\boldsymbol{X^2_{HET}}$ and $\boldsymbol{X^2_{NORM}}$ denote LM test for Serial Correlation (up to 12 lags), homoscedasticity (Breusch-Pagan-Godfrey test) and Normality (Jarque-Bera test) respectively and $\boldsymbol{F_{RESET}}$ denotes the Normality and Functional Form (Ramsey RESET).

Graph 8.1: Parameter Stability

CUSUM test



CUSUM of squares test



Source: Author's calculations

Following the estimation of equation 8.1 and ensuring that good fit of the model, we can proceed with the hypothesis testing on whether there is cointegration (level relationship) among the variables. The null and the alternative hypotheses are formulated as:

H_0: $\alpha_1 = \alpha_2 = \alpha_3 = \alpha_4 = =0$

H_1: $\alpha_1 \neq \alpha_2 \neq \alpha_3 \neq \alpha_4 \neq 0$

This is an F-test of the hypothesis that the coefficients of the lagged level variable are jointly not significant. In our case, the critical value for a finite sample (Narayan, 2005) are more relevant compared to the asymptotic one (Pesaran et al, 2001). In any case, the F-statistic exceeds the upper bound in both cases, revealing the presence of a level relationship (Table 8.4).

Table 8.4: Bounds testing

Critical value bound of the F statistics: intercept and no trend

		90% level		95% level		99% level	
Period: 2015-2020		I(0)	I(1)	I(0)	I(1)	I(0)	I(1)
F-stat = 13.550 (T=66 & k=3)	Asymptotic (n=1.000)	2.37	3.20	2.79	3.67	3.15	4.08
	Finite sample (n=70)	2.482	3.31	2.924	3.86	3.916	5.088

Note: Asymptotic refers to Pesaran et al (2001), while finite sample to Narayan (2005) critical values.

Moreover, with the aim to eliminate the probability of a degenerate case, the coefficient of LREC(-1) in the conditional ECM shall be significant. However, as the t-distribution is not the standard one, the asymptotic critical value bounds for the t-statistic that were estimated by Pesaran et al (2001) shall be used. The absolute value of the t-statistic (6.506) of the coefficient is above the absolute value of the upper bound (3.78 for k=3 at 95% confidence level); thus, the existence of level relationship is further confirmed.

Long-run relationship

Therefore, the level (long-run) relationship from the conditional ECM is presented below.

Table 8.5 Long-run (levels) equation				
Dependent variable: LREC Period **2015-2020**				
Variable:	**Coefficient**	**Standard Error**	**t-stat**	**Probability (p-value)**
Intercept	-28.822	5.248	-5.492	0.000
LGSI	0.275	0.038	7.274	0.000
LBUNK	0.205	0.058	3.541	0.001
LFL	1.673	0.279	5.998	0.000

The pass through of the GSI on the inflows from sea transport services amounts to 0.275 indicating that a 10% in the GSI earnings will result to a 2.75% increase in the inflows. Turning to bunker prices, the pass through is estimated at 0.205, meaning that a 10% increase in bunker price will result to a 2.05 increase in inflows. Finally, the pass through rate of a change in the active fleet is 1.673 indicating that a 10% increase in the fleet leads to a 16.73% in the sea transport inflows. The fact that the fleet elasticity is quite large and above unity could reflect the following situation:

a. The Greek-controlled active fleet is based on the capacity utilisation of the world fleet. If the capacity utilisation of the Greek controlled active fleet is higher than that of the world fleet, then the level of the coefficient can be again above unity.
b. The GSI is based on the earnings per sector which are earned by the average vessel in that sector. As it was showed in Section 2.4, the average size of the Greek-

controlled active fleet is larger than that of the world fleet, and therefore the coefficient could be above unity.

c. The Bank of Greece's Greek Shipping Estimation Model is built around the vessels that are commercially managed from Greece according to the criteria set by the Bank of Greece (see Section 4.3.2). To the extent that the number of these vessels is greater than of those included in the Greek-controlled fleet, the coefficient of the active fleet could be above unity.

Short-run relationship

The ECM (or the restricted ECM) can now be defined and the speed of adjustment can be estimated. Starting with the coefficient of the cointegration, which shows the speed of adjustment towards the long-run equilibrium, it is quite fast as it takes almost two (2) months to return to equilibrium. The GSI has only concurrent effects on the sea transport receipts. This finding is in line with the Bank of Greece's BoP compilation methodology which targets at representing the transactions at the time that the service is provided and not when the corresponding payment is concluded. However, the fact that GSI has only concurrent effects raise the issue of the treatment of the time-chartered vessels in the compilation methodology. In essence, if there were vessels employed in time-charter contracts, it would have been expected that the effect of the GSI would have been present in the short-run model as the time charter rate was agreed at a prior point in time, when market conditions may be different.

Table 8.6 Error Correction Model

Dependent variable: ΔLREC
Period **2015-2020**

Variable:	**Coefficient**	**Standard Error**	**t-stat**	**Probability (p-value)**
ΔLREC(-1)	-0.248	0.083	-2.998	0.004
ΔLBUNK	0.117	0.032	3.697	0.001
ΔLBUNK(-1)	0.067	0.031	2.127	0.038
ΔLFL	-3.167	0.802	-3.949	0.000
Coint(-1)	**-0.496**	0.058	-8.515	-/-

The significance of the Coint(-1) parameter is defined by the abovementioned bounds test.

8.2.2 Model for the key sectors of the Greek controlled fleet

As it was discussed in Chapter 2, the capacity of the Greek-controlled fleet is mainly in the dry bulk or the tanker sectors (crude or product). Against this background, the abovementioned model is re-estimated using only the freight rates and the fleet capacity of these sectors. Using the AIC for the selection of the lag structure, the preferred model is an ARDL(2, 0, 2, 1) as the previous model. In addition, the estimated model passes all the diagnostic tests (see Appendix V.3). The table below presents the level equation, while the ECM is presented in the Appendix V.3..

The narrow model based on the key sector of the Greek controlled shipping is similar to the previous one indicating the robustness and the stability of the main model (Table 8.7). There are though a number of interesting differences:

1. The pass-through rate of the narrow GSI is lower compared to the pass through rate of the broad GSI on the sea transport receipts. Apart from the fact that the two indices are different, it may also reflect the contribution that the other sectors make to the sea transport receipts.
2. The pass-through rate of the narrow active fleet is higher compared to the one of the broad active fleet. This evidence should have been expected as the former variable reflects a subset of the fleet.

Table 8.7 Long-run (levels) equation - Main sectors of Greek-controlled fleet

Dependent variable: LREC
Period **2015-2020**

Variable:	**Coefficient**	**Standard Error**	**t-stat**	**Probability (p-value)**
Intercept	-31.273	6.149	-5.086	0.000
LGSI_N	0.225	0.036	6.227	0.000
LBUNK	0.204	0.066	3.112	0.003
LFL_N	1.836	0.332	5.534	0.000

Finally, the speed of adjustment in the narrow model's ECM remains at a similar level (0.459) as in the broad one; it takes approx. 2 months to return to the equilibrium.

8.2.3 The main Model in the pre-2015 period

This section addresses the issue on whether the determinant of sea transport receipts are the same before and after the introduction of the new methodology in 2015. To this end, the corresponding equation 8.1 is estimated for the period 2002 – 2014 using as dependent variable the sea transport receipts before 2015. The long-run equation along with the bounds test are presented below (Table 8.8), while the respective diagnostic tests in Appendix V.4.

Table 8.8 Long-run (levels) equation

Dependent variable: LREC (old methodology)
Period **2002-2014**

Variable:	**Coefficient**	**Standard Error**	**t-stat**	**Probability (p-value)**
Intercept	-2.190	9.666	-0.227	0.821
LGSI	0.590	0.068	8.728	0.000
LBUNK	0.296	0.099	2.982	0.003
LFL	0.094	0.538	0.174	0.862

The bounds test indicates that there is a level relationship though at the 10% significance level (Table 8.9). Moreover, the coefficient of the fleet is not statistically significant for the 2002-2014 period. The model passes the diagnostic tests for the absence of serial correlation, for homoscedasticity, for normal distribution of residuals. However, the CUSUM test indicates that for the 2007-2012 the CUSUM line is outside the 5% boundary indicating a relative parameter instability.

Table 8.9 Critical value bound of the F statistics: intercept and no trend							
		90% level		95% level		99% level	
Period: 2002-2014		I(0)	I(1)	I(0)	I(1)	I(0)	I(1)
F-stat = 3.664 (T=156 & k=3)	Asymptotic (n=1.000)	2.37	3.20	2.79	3.67	3.15	4.08
	Finite sample (n=80)	2.474	3.312	2.920	3.838	3.908	5.044
Note: Asymptotic refers to Pesaran et al (2001), while finite sample to Narayan (2005) critical values.							

Moreover, comparing the econometric results before and after the methodology change, it can be deduced that:

1. The pass-through rate of the GSI is much stronger in the 2002-2014 period compared to the 2015-2020 period. In the former period, a 10% increase in the GSI led to a 5.9% increase in the sea transport receipts compared to 2.75% in the latter period.
2. The pass-through rate of the bunkering cost posts a small increase; this increase is significantly lower compared to that of the GSI.
3. The active fleet variable is not statistically significant in the pre-2015 period.
4. Finally, the speed of adjustment is relatively slow as 14.1% of the disequilibrium is corrected each month (i.e., it takes about 7 months to return to equilibrium).

The above findings indicate that the determinants and/or the level of their effects before and after the methodology change exhibit deviations. In more detail, the active fleet variable is not statistically significant and the effect of the GSI is almost double in the pre-2015 period compared to the post-2015 one.

8.2.4 Alternative Model for the pre-2015 period

In order to further support the aforementioned conclusion, a refined model is estimated where the active fleet variable is substituted for the credit to shipping companies as a proxy of the Greek-based shipping cluster. The use of the latter variable was made also in Bragoudakis and Panagiotou (2010), Bragoudakis et al (2015) and Bragoudakis et al (2021).

Indeed, the model where the active fleet is substituted for credit exhibits a better fit according to all information criteria (AIC, SIC and Hannan-Quinn). As there was a change in the methodology of the credit to shipping companies in 2010, a dummy was included in the model. The tables below present the bounds test and the long-run relationship while the ECM model and the model diagnostics are presented in the Appendix V.5.

The bounds test indicates that there is a level relationship as the F-stat is above the upper limit (Table 8.10).

Table 8.10 Critical value bound of the F statistics: intercept and no trend

		90% level		95% level		99% level	
Period: 2002-2014		I(0)	I(1)	I(0)	I(1)	I(0)	I(1)
F-stat = 15.687 (T=147 & k=3)	Asymptotic (n=1.000)	2.37	3.20	2.79	3.67	3.15	4.08
	Finite sample (n=80)	2.474	3.312	2.920	3.838	3.908	5.044

Note: Asymptotic refers to Pesaran et al (2001), while finite sample to Narayan (2005) critical values.

The level relationship supports – as it was discussed in Bragoudakis and Panagiotou (2010), Bragoudakis et al (2015) and Bragoudakis et al (2021) – the role of the freight rates and of the credit to shipping companies. The size of the coefficients for the GSI and for credit to shipping companies are comparable with the findings in the abovementioned studies.

Although the bunkers' cost is not significant in the long-run relationship, it is statistically significant in the short-run one. This finding indicates that - in the context of the old compilation methodology – bunker costs had a short-run effect in the sea transport receipts as they were part of the freight rate receipts from voyage charters. However, as bunkers represent a cost for the shipping company, they cannot have an effect in the long-run relationship in the receipts from sea transport services.

Finally, the speed of adjustment is also quite quick as it takes approx. 2 month to correct any deviations from the long-run relationship.

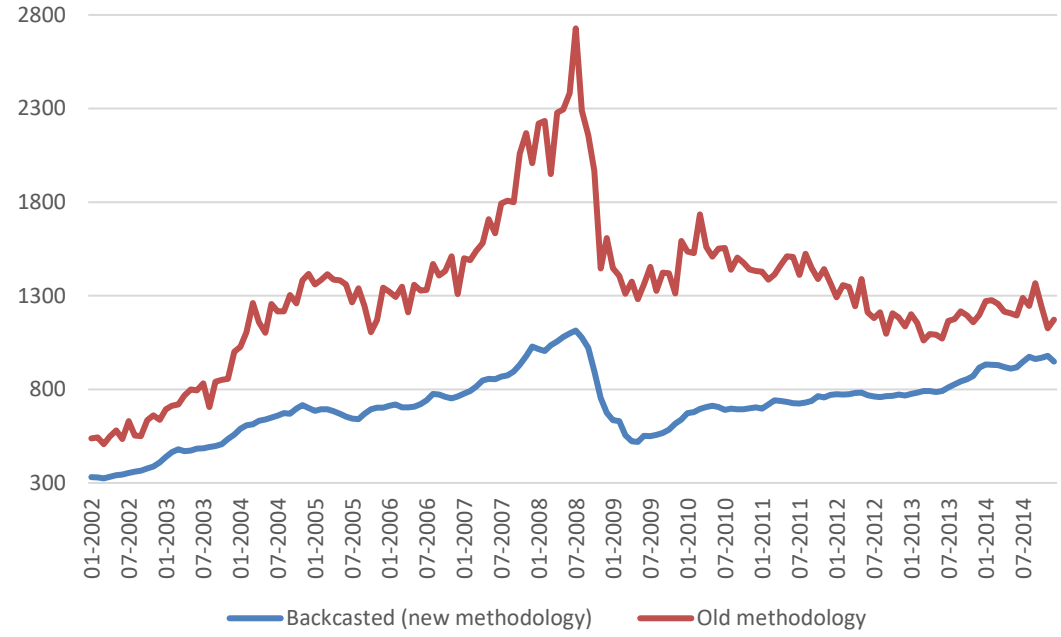
Table 8.11 Long-run (levels) equation				
Dependent variable: LREC (old methodology) Period **2002-2014**				
Variable:	**Coefficient**	**Standard Error**	**t-stat**	**Probability (p-value)**
Intercept	-2.074	0.381	-5.443	0.000
LGSI	0.501	0.031	16.034	0.000
LBUNK	0.069	0.050	1.382	0.169
LCREDIT	0.408	0.048	8.546	0.000

8.2.5 Backcasting

In the final step, the values of the sea transport inflows for the pre-2015 period are backcasted using the estimated ARDL(2, 0, 2, 1) model for the period 2015-2020. [114] The following graph shows the old methodology and the backcasted – based on the new methodology – data in USD million. For the whole period under examination, the backcasted sea transport receipts are below the corresponding ones estimated by the old methodology. However, towards the end of the estimation period, which coincides with the change in the compilation method, the two series start to converge. This finding could be explained through the credit to shipping companies. Specifically, Bragoudakis et al (2015) found evidence that the effect of the credit to shipping after 2006 was greater compared to the pre-2006 period. But then the compilation methodology (see Section 4.3.2) was based on the international transactions of Greece-based financial institutions. Around that time, these financial institutions started to increase their exposure to Greek shipping companies (Petrofin, 2021). However, in the aftermath of the Greek sovereign crisis, a number of Greece-based banks exited either the ship finance market or the even country. Therefore, the convergence that it is exhibited in the backcasting exercise could represent an overshooting in the provision of bank loans towards the end of the first decade of 2000, that was reversed during the Greek sovereign debt crisis, bringing the old methodology time series closer its trend.

[114] For the estimation of the backcasted, the initial values of sea transport receipts are needed. The number of initial values is the same as the number of lags required in the estimated model. In this case, the first two values of sea transport services are need as the model includes two lags for the dependent variable. As these value are not observable, they were calculated from the level equation, i.e. assuming that sea transport receipts were at their long-run level in 2001:M11 and 2001:M12.

Graph 8.2 Backcast sea transport services 2002-2014
(USD million)



Sources: Bank of Greece, author's calculations.

In any study, there are limitations that the researcher needs to balance. The limitations of the model are:

a) The number of observations for the sea transport receipts in the Greek BoP under the new methodology are available from 2015 onwards. Moreover, there are no granular data on the structure of the fleet used or the vessels' employment structure in the actual GSEM.

b) In the maritime economics literature, there is some statistical evidence for the existence of a two-tier freight market in the shipping. These two-tier freight market is differentiated by the "quality" parameter, which is usually approximated inter alia by the age, the flag, the size (Tamvakis, 1995; Tamvakis and Thanopoulou, 2000; Köhn and Thanopoulou, 2011). The GSI was based on the international prevailing freight rate earnings as there is a lack of detailed data on the freight earnings that the Greek shipping companies actually receive or the type of employment (time charter or voyage/spot) of their vessels. Therefore it is not feasible to assess the competitive advantages of the Greek-controlled fleet and any

possible premium (or discount) that it may receive due to its “quality” factors compared to world fleet.

c) The Greek-controlled fleet was used to approximate the actual fleet that is managed from Greece, as the exact size of the latter is not available in a systematic way. However, based on the available data by the GSCC and the Ministry of Maritime Affairs, there are indications that the two fleets have been converging. As it was discussed in the Chapter 2, the use of the Greek-flagged fleet was avoided as the latter exhibited different trends compared to the Greek-controlled one. Against this background, the role of the ship management cluster can only be estimated based on proxies and not on actual and granular time series.

8.3 Chapter 8 – Key takeaways

- In the long-run, the Greek Shipping Index, which is a composite freight index for the Greek controlled fleet, the price of bunkers and the active fleet are the determinants of the sea transport inflows in the Greek BoP.

- The empirical results confirm that the underlying determinants of the sea transport receipts before and after the compilation methodology change share similarities and at the same time significant differences.

- The backcasting exercise reveals that the old methodology and the estimated new methodology sea transport receipts differ in the 2002-2014 period. However, towards the end of the period and by the time of the new methodology implementation, the two series start to converge. This finding could stem from an overshooting in the provision of bank loans towards the end of the first decade of 2000 that was reversed during the Greek sovereign debt crisis; thus bringing the old methodology time series closer to its trend.

CHAPTER 9: CONCLUSIONS – FURTHER RESEARCH

Chapter Summary: The compilation methodology of the sea transport services receipts in the Greek BoP has undergone a number of methodological changes over the years and the most recent was in 2015. The new compilation methodology is based on a statistical model, the Greek Shipping Estimation Model. In the empirical analysis, the properties of the ARDL bounds testing methodology made it the preferred one for the empirical part of this thesis; the econometric results show that the determinants before and after the compilation methodology change in 2015 are not identical. Following the presentation of the thesis key findings, this final chapter discusses the the contribution of the thesis to the existent literature and the related policy implications.

9.1 Summary of findings

The receipts from exporting sea transport services, which almost exclusively relate to ocean-going shipping - have historically covered a significant part of Greece's perennial deficit in the trade of goods and in the current account. More than 40% of the total exports of services in the 2002-2020 period are attributed to sea transport, which – along with those from travel (tourism) – constitute the key extrovert services sectors of the Greek economy. It is notable that in relation to the total exports of goods and services, sea transport receipts represent a share of 25%. The specialisation of the Greek exports of goods and service to the sea transportation was evidenced in the thesis by the Revealed Comparative Advantage indices. They showed that both in services and in goods and services together, Greece has a comparative advantage in exporting sea transport services. This advantage is the highest compared to other sea nations and comparable only to that of Cyprus, Denmark, Norway and Singapore. In the period 2010-2020, the sea transport services receipts amounted to 6.8% of the Greek GDP compared to less than 1% for the EU-27 with only Cyprus and Denmark exhibiting a higher share in their GDP than Greece among the EU-27 countries.

This "Greek miracle" - as it has been dubbed - is reflected in the development of the Greek-controlled fleet and its leading position in world. Since the advent of the new millennium, the average age (dwt weighted) of the Greek-owned fleet has decreased significantly and in early 2010s, it was at par, or even marginally younger in some years, with both the world and the Greek-flagged fleet. Moreover, the Greek-owned fleet promptly followed the developments in the world fleet and it maintained a share of more than 16% of world fleet capacity. The Greek-controlled fleet exhibits a specialisation in the dry bulk and the oil tanker sector, while it was less specialised – compared to the composition of the world fleet – in containerships and liquid gas carriers. However, since the mid-2010s, the distance between the Greek-owned and the world fleet in those two sectors, especially in the liquid gas one, has started to narrow significantly.

Despite the increase in the capacity of the Greek-controlled fleet, the Greek-flagged one did not follow the same trajectory. In 2021, the Greek-flagged fleet (in dwt terms) accounted for 17.5% of the Greek-controlled one, having decreased by almost 14

percentage points since 2002. Compared to the Greek-controlled fleet, the Greek-flagged is more concentrated to the oil tanker rather than the dry bulk sector.

Already in late 1950s, there was a move of shipping companies to establish their headquarters in Piraeus and more recently in the wider Attica area. This development contributed to the creation of a ship-management and operations' cluster, which forms the central pillar of the wider Greek shipping cluster. This development is founded in two main legal pieces; the Legislative Decree 2687/1953 (art. 13) that governs the registration of vessels in the Greek flag and Law 27/1975 that specifies the tonnage tax regime and the legal framework for the ship-owning/ship-management and the other shipping-related enterprises. According to the available data, the number of vessels managed from Greece as well as the number of employees in the abovementioned companies have followed an upward trend and almost tripled between 1985 and 2020. In addition, the tonnage tax and the shipping related tax revenues have increased by a factor of 9, mainly during the economic adjustment programmes for Greece.

The importance of the Greek shipping industry is further reflected in the gross value added of Water Transport sector, which mainly reflects the activities of the ocean going shipping. It is the 11th most important sector and has contributed close to 3% of the total Greek GVA in the 2015-2020 period. However, the latest (published in 2022) input-output tables for 2015 show that close to 56% of the sector's total direct inputs are imported; while the import content of the sector's output (i.e. the direct and indirect imported inputs as share to output) stands at 0.48. The erosion of the domestic value added in the Water Transport sector was also confirmed by the OECD TiVA data. These findings indicate that there is ample scope for policies that could develop the use of domestically sourced inputs in the Water Transport sector and thus further increase its contribution to the national economy's value added.

The compilation of the sea transport services receipts in the Greek BoP has undergone a number of methodological changes over the years. The first one, which related to a profound change in the BoP methodology, was in late 1990s, and the second one, specific to the sea transportation accounts, in 2015. This latter change in the compilation methodology was dictated by the reduction in the inflows that were processed through the

Greek banking system in late June 2015, when capital controls were imposed. The new methodology was introduced in November 2018 but it was retroactively applied from January 2015. The previous (pre-2015) methodology was based on a Bank reporting system that the international transactions were used for the compilation of the Balance of Payments, including the sea transport accounts. The new (post-2015) approach is a statistical model - called the Greek Shipping Estimation Model (GSEM) - and utilises administrative data and data from international shipping databases for the estimation of the sea transport accounts. The international practice in other sea nations and especially those in the EU that were analysed in the thesis suggested that the survey method is the preferred one for the compilation of the BoP accounts. However, specific national circumstances may have led the selection of a statistical model in Greece rather than a survey based methodology.

The thesis then focused on revealing the determinants of the sea transport service receipts in the Greek BoP in the post-2015 period and to assess whether the determinants in the pre- and the post-2015 period remain unchanged. The assessment was based on the Autoregressive Distributed Lag (ARDL) bounds testing methodology - that was proposed by Pesaran et al (2001) - for the existence of cointegration between the variables. The ARDL bounds testing methodology is a relatively new one and has only recently found its way in the maritime economics empirical literature. The main advantages of the ARDL bounds testing methodology compared to other cointegration methodologies that made it the preferred one for the empirical application of the thesis are the flexibility to use I(0), I(1) or mutually cointegrated regressors, the better small sample properties; the single equation set-up and the ability to set different lag length for the regressors.

The empirical analysis showed that Greek Shipping Index (GSI), which is a Greek fleet specific freight revenue index, the cost of bunkers and the size of the active Greek-controlled fleet are the determinants of the sea transport receipts in the BoP in the post-2015 period. However, only the GSI and the bunker cost seem to be significant in the pre-2015 period. Moreover, the estimation of the model substituting the active fleet for the credit to shipping, a variable that it is not available anymore as it was discontinued, provided a better fit and provided results similar to those the pre-2015 empirical research

literature. These results indicated that the determinants before and after the compilation methodology are not the same though with the GSI remaining a significant determinant.

Then the thesis proceeded into backcasting the 2002-2014 period based on the post-2015 model with the aim to identify the existence of any variation or convergence. The results indicated that the backcasted series was consistently below the old methodology time series; however, towards the end of the backcasting period the two series started to converge.

9.2 Policy implications

The empirical results have revealed a number of elements that could attract the attention of policy makers as well as of researchers:

1. In the long-run, the wide Greek Shipping Index (GSI), a composite freight index for the Greek controlled fleet, the price of bunker and the active fleet are the determinants of the sea transport inflows in the Greek BoP.
    a. Freight rates and bunker costs are not determined by the Greek shipping companies, being determined in the respective international markets.
    b. However, the GSI takes into account the specialisation of the Greek-controlled fleet, which is determined by the investment decisions of the shipping companies.
    c. The pass-through rate of the active fleet is considerably above unity which may reflect operational advantages of the Greek-controlled fleet (e.g., better cost management or capacity utilisation compared to the world fleet) and of the Greek shipping cluster (e.g., management of also some non-Greek-controlled vessels from Greece).
2. The short-run model revealed that the GSI has only concurrent effect on the inflows. This is a desirable characteristic for the sea transport inflows compilation methodology as BoP compilation standards require that the transactions are reported when the service is provided and not when the cash settlement takes place.
3. The empirical results confirmed that the underlying determinants of the sea transport receipts before and after the change in the compilation methodology share similarities but at the same time significant differences.

a. As far as similarities are concerned, the GSI index is a significant determinant.
b. In terms of key differences, bunker prices is a long-run determinant in the post-2015, while it only plays a role in the short-run dynamic in the pre-2014.
c. The active fleet appears as a key determinant in the post-2015, while credit to the shipping companies is included in the key determinants in the pre-2015.

4. The long-term coefficients of the key repressors are different, which further supports the hypothesis that the impact of each determinant in the post-2015 period is also different compared to this of the 2002-2014 period.
5. The backcasting exercise has revealed that the estimated through the old methodology and the estimated by the new methodology sea transport receipts differ in the 2002-2014 period. However, towards the end of the period and by the time of the new methodology implementation, the two series started to converge indicating that the difference exhibited in the 2002-2014 period would have been eliminated in post-2015 period.[115]
6. Turning to the compilation methodology policy implications, the majority of key maritime nations have elected the survey method for the collection of sea transport data for the BoP, while Greece has opted for a statistical model, the GSEM.
    a. The advantages of the GSEM compared to a survey method can be summarised in the timely estimation of the sea transport receipts after the end of the reference period (month) and the lower, almost non-existent, administrative burden to the shipping companies.
    b. However, there are also a number of disadvantages. Firstly, the GSEM uses data available from international shipping databases that usually reflect, where available, market averages and not necessarily the actual revenues and expenses of the Greece-based shipping companies. Secondly, the

[115] In case that new methodology estimated values were to be used instead of the old ones for the 2002-2014 period, the impact on the current account and on national accounts (GDP) cannot be assessed as other items related to sea transport could have impacted.

GSEM is a data intensive and susceptible to exogenous developments in international shipping for instance the identification of scrubber and non-scrubber fitted vessels as well as the corresponding bunker cost.

c. Therefore, the introduction of a survey in the Greece-based shipping companies can significantly supplement the quality of the GSEM data is an additional policy implication. As a prerequisite, the design of the survey needs to be agreed with the shipping community and it can follow existing survey such as those in Cyprus or in the UK, ensuring at the same time that the administrative burden to the ship management companies will be minimised

9.3 Contribution to the existing literature - Further directions of action

This study was the first one to be conducted with sea transport receipts data based on the 2015 compilation methodology and revealed the determinants of the sea transport inflows as it is currently used. It also evidenced that the determinants of the sea transport receipts before and after 2015 share some similarities, mainly on the role of the freight rates but at the same time there are significant differences both in the determinants as well as in the magnitude of their effect on the sea transport receipts.

In view of the size of the sample of available data, the use of the ARDL bounds testing methodology - that exhibits better small sample properties compared to other cointegration methodologies - warrants the reliability of the empirical results. In addition, the bounds testing methodology has recently found its way in the maritime and transport economics applied research; therefore, this study contributes to use of a modern methodology in the literature on the determinants of sea transport receipts in the BoP.

Based on the estimated model, the sea transport services receipts time series - reflecting the new compilation methodology - was backcasted for the period 2002-2014. In this way, a long time-series for the sea transport receipts from 2002-2020 is available for researcher and policy analysts.

The study calculated and employed an average freight earnings index for the Greek-controlled fleet, the GreekShippingIndex. The index takes into account the structure of the Greek-controlled fleet at each point in time and therefore can follow best the developments on the average earnings of the Greek-controlled fleet.

Finally, the analysis of the compilation methodology of the sea transport service across key shipping nations revealed the extensive use of surveys for this purpose. Therefore, the currently used compilation methodology in Greece is rather an exception which may have been dictated by specific national circumstances and conditions that did not allow the development of a survey-based system.

Overall, this thesis aims to act as motivation for further refinement of the related compilation methodology, especially in key areas such as how time-chartered vessels are treated in the GSEM and how their respective earning are recorded. Furthermore, the enhancement of the GSEM's data quality through the introduction of a survey on ship-management companies similar to that already implemented in other countries is another ambition of the thesis. Some of the model limitations highlighted in Chapter 8 could be addressed if a survey on ship-management companies similar to that of other countries like Cyprus and UK is initiated.

In terms of further directions, the thesis aspiration is to set the future agenda for all shipping stakeholders, policy makers and statistical agencies regarding the implementation of a coherent statistical system worthy of the success of Greek shipping which has preserved its leading position in the world shipping industry for at least now half a century.

APPENDICES

Appendix I: The Greek Tonnage tax

In Greece, the tonnage tax is levied on ships flying the Greek flag in accordance with Law 27/1975 as amended. The calculation of the tonnage tax is based on the size of the vessel (grt) and its age. Firstly, the size of the vessel is multiplied in each bracket by the respective coefficients. The scale of the brackets is regressive (i.e. the larger the vessel, the smaller the coefficient in the bracket). Then, the outcome of step A is multiplied by the respective age rate which is expressed in USD/get (Step B). The younger vessels (up to 5 years) enjoy a significant discount under the Greek tonnage tax.

Table A-I.1: Summary table of Greek Tonnage tax rates and age adjustment rates (2020)

Step A		Step B	
Gross (registered) Tonnage (a)	**Co-efficient**	**Vessel Age**	**USD/grt (Age dependent)**
100-10,000	1.2	0-4	0.483
10,001-20,000	1.1	5-9	0.866
20,001-40,000	1.0	10-19	0.848
40,001-80,000	0.45	20-29	0.803
80,001+	0.20	30+	0.620

Note: GRT was the norm when the initial law was adopted.
Source: Panagiotou and Thanopoulou (2019) updated by the author.

Appendix II.1: Main sources used in the Greek Shipping Estimation Model

Source	Data provided	Comment
Administrative source		
Ministry of Merchant Shipping	Management companies and their managed vessels	
Shipping-related sources		
HIS Maritime and Trade	Vessels specifications	Data such as ownership, vessel characteristics
Lloyds List Intelligence	Vessels specifications and vessels movements	Additional to the above, port movements, speed draft etc.
Clarksons Shipping Intelligence Network	Freight data per type of vessel	
Drewry	Operating expenses per type of vessel	
Bunker Index	Bunkering costs	

Note: Data on port cost are collected by major port worldwide. Cross validation is performed among databases whenever they provide the same piece of information/data.
Sources: Papaspyrou and Petralias (2019) and Bank of Greece (2018a).

Appendix II.2: Comparison of data sources

Data Source / Criterion	Enterprise survey	ITRS	External (third-party) data
Coverage	(++) Covers major carriers in transport services. (++) General enterprise surveys to cover non-resident services. (++) Surveys on agents/branches of non-residents	(+) Covers settlements related to transactions. (-) No coverage of transactions below the value threshold (-) Possible difficulty on freight included in exports/imports. [116]	
Accuracy		(+) But attention on the definition of the partner country	(-) Changes in methodology of data collection.
Timeliness	(-) Usually quarterly	(+) Usually monthly	(+) If data are provided in timely and frequent manner
Relevance	(+) Need for good design	(-) Difficult to identify complex transactions.	
Burden and Data processing	(-) Reporting and processing	(-) Especially on bank reporting. (-) Aggregation of microdata	(-) Cost to access data (-) If estimation is needed.

[116] It is noted that freight cost up to the exporting economy's borders are assumed to be borne by the exporter; in the same token, the freight costs beyond the exporter's borders are assumed to be borne by the importer. Therefore, depending on the residency of the carrier/transporter an apportionment of the freight cost need to be done, where necessary.

		(+) Easy once the system is implemented.	(+) Easy once the system is implemented

Notes: Depending on national circumstances some sources may not be available or the best option.
(++) present the most advantages relative to other sources in relation to the coverage criterion.
(+) advantage / (-) disadvantage.
Source: United Nations Department of Economic and Social Affairs (2016), adapted by the author.

Appendix III.1: Konstantopoulou (1976) econometric results

1.a. $\log SR_t = -4.39 + 1.558 \log GCF_{t-1}$ [117] $\quad \bar{R}^2 = 0.965$
(19.6)

1.b. $SR_t = -99.0 + 0.037\ GFF_{t-1}$ [118] $\quad \bar{R}^2 = 0.976$
(23.6) $\quad$ DW = 1.2

2. $\log SR_t = 0.42 \log GFF_{t-1} + 0.65 \log SF_{t-1} + 0.79 \log SAs_t$ [119] $\quad \bar{R}^2 = 0.987$

3. $\log SR_t = 0.73 \log SR_{t-1} + 0.59 \log SAS_t$ $\quad \bar{R}^2 = 0.995$
(14.1) (6.2)

4. $SR_t = -1.75 + 0.000063\ GSR_t + 2.20\ SAS_t - 0.029\ I_t$ $\quad \bar{R}^2 = 0.991$
(5.5) (11.5) (-3.4)

4. b $SR_t = 103 + 0.000041\ GSR_t + 1.12\ SAS_t - 0.009\ I_t + 0.585\ SR_{t-1}$
(5.2) (11.5) (-1.5) (5.0) $\bar{R}^2 = 0.991$

5.a. $SR_t = -7 + 0.0000014\ SI_t + 0.000058\ GSR_t - 0.011\ I_t$ $\quad \bar{R}^2 = 0.987$
(9.0) (4.8) (-1.9) $\quad$ DW = 2.15

5.b. $SR_t = -16 + 0.00000062\ SI_t + 0.000043\ GSR_t - 0.006\ I_t + 0.64\ SR_{t-1}$
(2.7) (4.5) (-1.5) (3.6)
$\bar{R}^2 = 0.994$
DW = 1.16

6. $\log SR_t = -5.54 + 0.808 \log SI_t + 0.219 \log GSR_t$ $\quad \bar{R}^2 = 0.989$
(10.7) (3.4) $\quad$ DW = 1.80

6.b $\log SR_t = -3.5 + 0.49 \log SI_t + 0.17 \log GSR_t + 0.371 \log SR_{t-1}$ $\quad \bar{R}^2 = 0.993$
DW = 1.51

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[117] Konstantopoulou (1976) shows independent variable GCF_{t-1} in values and not in log terms. However, this can be considered to be most likely a typing error and the correct representation to be as above.

[118] Konstantopoulou (1976) pointed to the fact that the Greek-flagged fleet variable has a higher correlation with the inflows in a linear form, while the Greek-controlled fleet has a higher correlation with the inflows in a logarithmic form. Both of them are used with one period lag (t-1) as the stock of vessels at the end of the previous period seems to affect the inflows in the current period. The size of the fleet at period t-1 is expected to positively affect the foreign exchange receipts in period t, through three channels: increase in the seafarers income, increase in employment and increase in the shipping infrastructure.

[119] Konstantopoulou (1976) used the number of Seafarers variable with one period lag (t-1) as their number at the end of the previous period seems to affect the inflows in the current period.

where:

SR: Shipping foreign exchange Inflows (in mn USD). Source: Bank of Greece.

GFF: Greek flagged fleet in thousand grt. Source: EL.STAT (then ESYE).

GCF: Greek controlled fleet in thousand grt. Source: Naftika Chronika.

SF: Number of Seafarers, both on Greek-flagged and foreign-flagged vessels. Sources: ELSTAT and NAT (respectively).

SAS: Seafarers average salary. Source: Calculated by Konstantopoulou.

GSR: Greek Shipping Revenues. Thus, two derived variables were calculated that indicate the revenues of the fleet; one of the Greek flagged and one for the Greek controlled. The one based on the Greek-flag resulted in a higher R2=0.951 in the bivariate regression. Source: Calculated by Konstantopoulou (1976).

I: Investment in shipping (Greek-flagged fleet) in thousand grt. When Greek ship-owners purchase vessels abroad, it is expected that the inflows of foreign exchange would be less; thus a negative relationship. It was proxied by the change in the Greek fleet. On the bivariate analysis, the variable has a small positive relationship with the shipping inflows

SI: Seafarers' income. Source: Calculated by Konstantopoulou (1976).

Appendix III.2: Haralambides (1985) econometric results

	Method	Equation	$\bar{R}^2$	DW
1.	2SLSA	OWN = 545 + 0.019 NI – 30.49 EXR + 0.016 LU + 7.45 CPI (4.9) (3.7) (-7.3) (2.9) (21.2)	0.91	2.40
2.	3SLS	SM = 266 + 0.17 Y – 12.1 EXR + 1.89 CPI (3.0) (7.3) (-3.2) (3.6)	0.99	1.56
3.	PC	DIS = -92 + 0.31 XV + 0.53 MV + 0.44 PRF (0.99) (0.95) (0.92)	0.84	1.33
4.	PC	FGP = -164.4 + 0.3 XV + 0.57 MV + 0.69 FR + 0.01 ARR (0.98) (0.97) (0.80) (0.95)	0.90	1.91
5.	IV	$T = 1969 + 1.92\ WTR + 0.38\ T_{t-1}$ (1.86) (10.9) (7.2)	0.99	2.01
6.	2SLSA	$LU = 2222 + 10.03\ W - 16.3\ FR + 0.09\ LU_{t-1} - 7.1\ W_{t-1}$ (2.8) (2.6) (-2.6) (0.46) (-1.76)	0.49	1.85
7.	2SLS	ED = 60063 – 66.9 W + 2.5 T – 2.4 LU – 7292ZG (6.8) (-3.8) (14.6) (-1.5) (-4.1)	0.94	1.53
8.	2SLS	ES = -69318 + 210.8 W – 5.01 WS + 6170 AG (-1.27) (3.4) (-3.1) (2.2)	0.91	0.99
9.	GLS	EXR = 20 + 0.12 CPI (6.5) (8.8)	0.75	1.20
10.	OLS	$TB = 3008 + 0.14\ WTR_{t-1} - 560\ PR_{t-1}$ (3.35) (2.93) (-3.46)	0.61	2.16
11.	OLS	$TS = -5885 + 0.069\ T_{t-1} + 303.4\ PR + 259.4\ AG$ (-3.13) (6.98) (2.3) (2.4)	0.78	2.10
12.	GLS	$BR = 604 + 0.95\ BR_{t-1} - 4.61\ FR$ (2.5) (8.7) (-2.01)	0.80	2.08
13.	GLS	$ORD = -2082 + 46.8\ FR + 1.11\ ORD_{t-1} - 0.89\ ORD_{t-2}$ (-1.13) (2.7) (5.6) (-2.07)	0.83	1.96

14.	OLS	$D = 459 + 0.144\ ORD_{t-1} + 0.097\ ORD_{t-2}$	0.81	2.50
		(2.6) (3.2) (2.2)		
15.	Identity	NI = D + TB –TS – BR - L		
16.	Identity	Y = ED W		n/a
17.	Identity	ED = ES		

Note: t-statistics in parenthesis with the exception of PC estimation, where the factor loading of the normalized variables are presented.

Source: Haralambides (1985), p. 261 for estimated equations and p. 206 for identities.

where:

Endogenous variables:

OWN: Ship-owner inflows incl. taxation (mn USD).

SM: Seafarer inflows incl. contributions to social security and seafarers' foreign exchange deposits at Greek banks (million USD).

DIS: Port disbursements (million USD).

FGP: Freight on goods and passengers (million USD).

T: Greek-owned tonnage (thousand GRT).

LU: Laid-up Greek-owned tonnage (thousand GRT).

ED/ES: Demand/Supply of sea-going labour of Greek seafarers on Greek-owned fleet. It is the same series for supply and demand (number of persons).

EXR: Greek Drachma/USD exchange rate. It is noted that the variable exchange rate dates since 1975. Before that the parity was fixed at 30 GRD/USD.

TB: Second-hand tonnage bought by Greek interests (thousand GRT).

TS: Greek-owned ships sold to foreign interests (thousand GRT).

BR: Greek-owned ship broken-up (thousand GRT).

ORD: The Greek orderbook (thousand GRT).

D: Deliveries of new tonnage (thousand GRT).

NI: Net change in the Greek-owned fleet or net realized investment in shipping (thousand GRT).

W: Weighted (based on various ranking) average of the basic wage rates according to the collective agreements for Greek seafarers (USD).

Y: Total monthly income of Greek seafarers (million GRD).

Predetermined variables:

CPI: Consumer Price Index.

XV: Export volume index.

MV: Import volume index.

PRF: Price of fuel oil (USD/tonne).

FR: Freight rate index as a weighted average of dry cargo trip charter and tanker voyage charter.

ARR: Arrivals of foreign tourists (thousand persons).

WTR: World seaborne trade (thousand million ton-miles).

ZG: Average size of Greek ships (GRT).

WS: Wage rate ashore (GRD).

AG: Average age of Greek ship (years).

PR: Second-hand ship price (million USD)

L: Tonnage lost (thousand GRT).

Appendix IV.1: Cost structure in different vessel employment

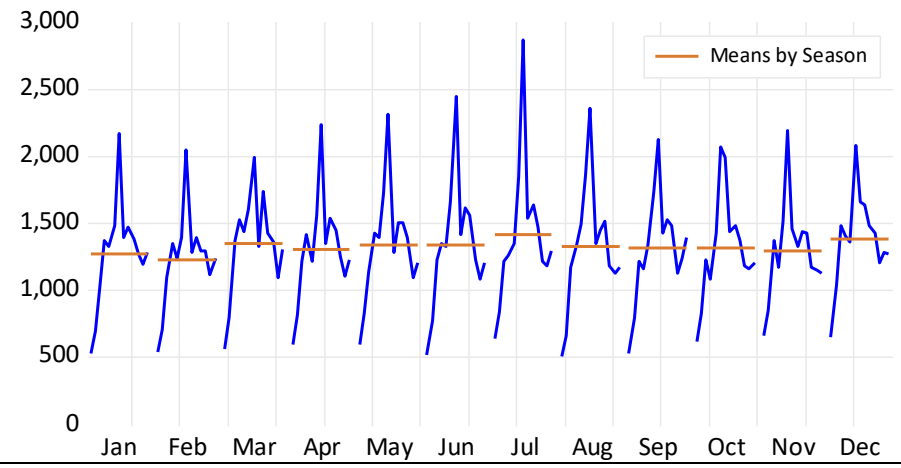
Cost element	***Voyage Charter***	***Time charter***
Operating cost such as: • Crew wages • Stores and Maintenance • Lubricants • Insurance	Shipowner	Shipowner
Voyage costs such as: • Fuel • Canal dues • Port charges	Shipowner	Charterer
Periodic Maintenance	Shipowner	Shipowner
Cargo handing cost	Shipowner or Charter	Charterer
Capital/Financial cost	Shipowner	Shipowner

Appendix IV.2: Seasonal Graphs

A1.1 Sea transport receipts

The seasonal graph provides indication for seasonality in the series, especially in July and December (above average) and in February (below average).

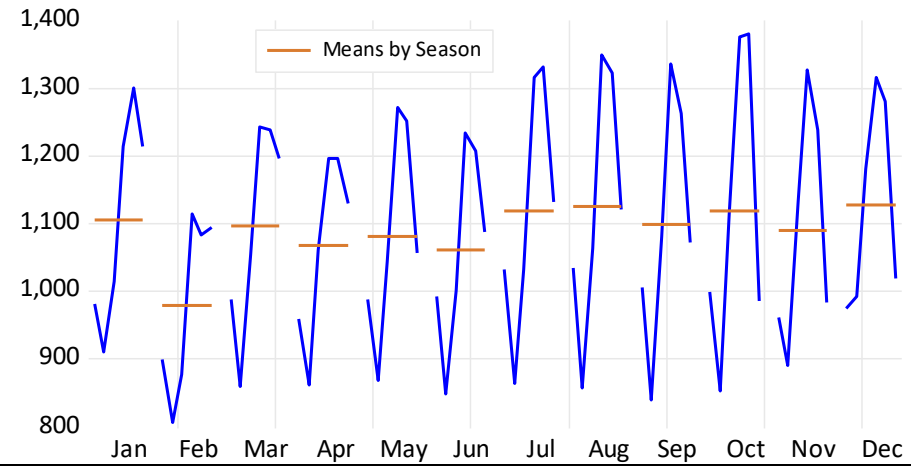
Seasonal Graph of Sea transport receipts
(2002-2014)



Source: Bank of Greece.

Under the new methodology, the seasonality seems to be even stronger, with February being significantly below the average and July, August and December above the average.

Seasonal Graph of Sea transport receipts – New methodology
(2015-2020)



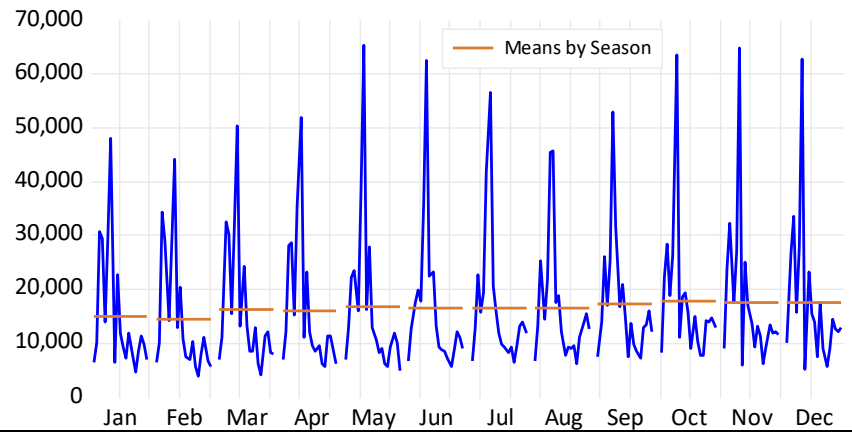
Source: Bank of Greece.

A1.2 Freight earnings – Seasonal graphs

Average Bulker Earnings:

The seasonal graph indicates the existence of seasonality, which is above the average towards the end of the year (October to December) and below average in January-February.

Seasonal Graph: Bulker Earnings
(2002-2020)

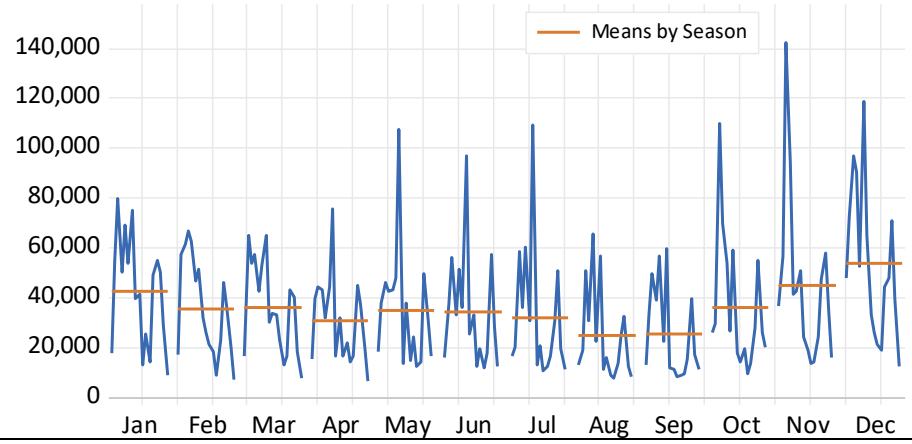


Source: Clarkson Research.

Average Crude Tanker Earning:

The seasonal graph indicated that there are significant increases – above the mean - towards the end of the year (November and December), while a decline is registered at the beginning of the year (especially in February, toward the end of the winter season).

Seasonal Graph: Crude Tanker Earnings
(2002-2020)

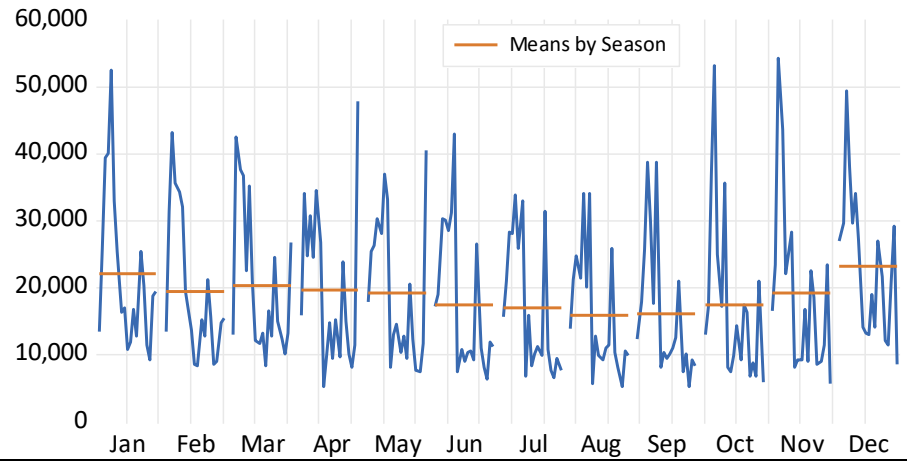


Source: Clarkson Research.

Average Product Tanker Earnings:

The product market freight market exhibits a similar seasonal pattern as the crude oil one, as there is an increase in freight rate – above the mean - towards the end of the year (especially in November and December).

Seasonal Graph: Product Tanker Earnings
(2002-2020)

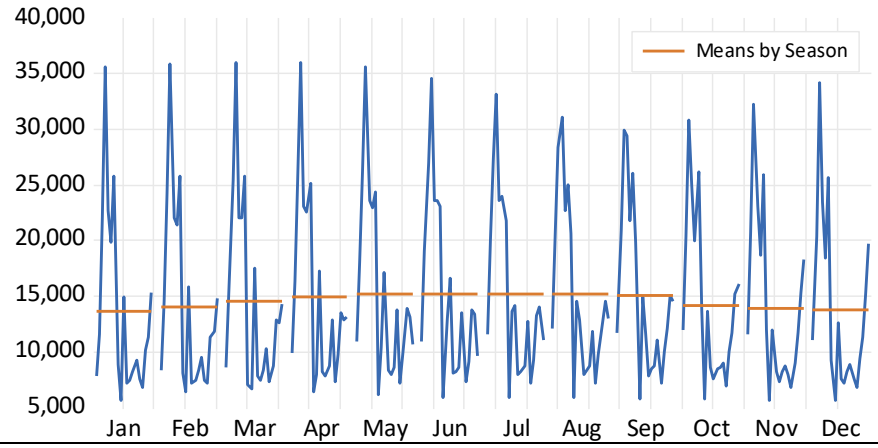


Source: Clarkson Research.

Average containership earnings:

Containership time-charter freight markets seem to decrease below the average at the end of the year, something that propagates into the first months of the following year (especially in November, December and January). This could reflect that due to the high pre-seasonal activity in main routes before end-year festivities, additional capacity has to be secured already by then for the transportation of goods ahead of the season holidays.

Seasonal Graph: Containership Earnings
(2002-2020)

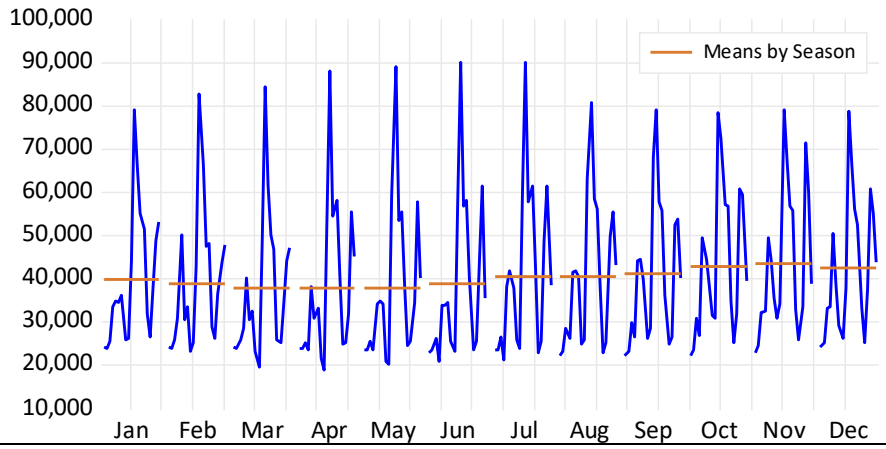


Source: Clarkson Research.

Average LPG and LNG earnings:

From the following graph, it can be shown that gas carriers freight rates are above average the average towards the end of the year (especially in the October and November) when the cold season starts in the Northern hemisphere.

Seasonal Graph: LPG and LNG Earnings
(2002-2020)

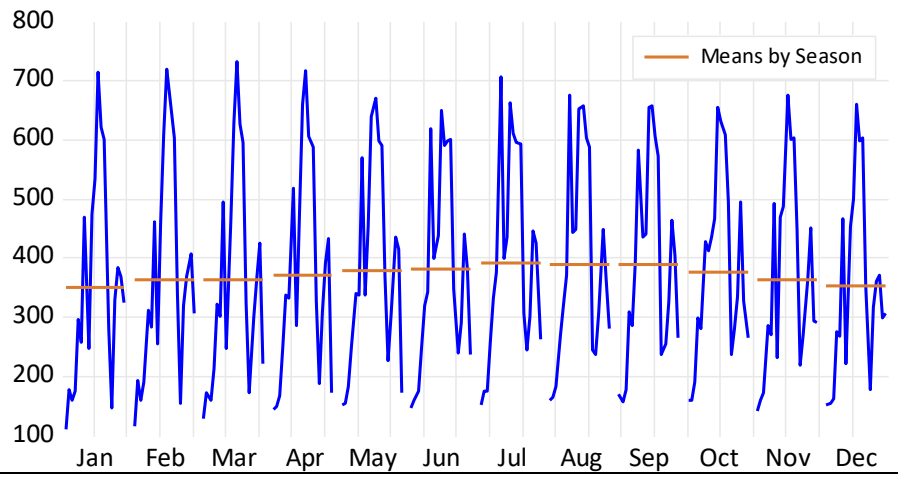


Source: Clarkson Research.

A1.3 Bunker prices

Towards the middle of the year (July-September), the price of bunkers is – on average – higher that the corresponding prices at the end and the beginning of the year (November to February) but in recent years these have also been the best freight market months in the the large bulk market segment.

Seasonal Graph: Bunker prices
(2002-2020)



Source: Clarkson Research.

Appendix IV.3: Seasonality patterns in freight rates

Following the methodology employed in Kavussanos and Alizadeh (2001), the seasonal patterns across the 5 sectors were explored. The changes in freight earnings (expressed in natural logarithms) were regressed against a constant (i.e., the mean month on month change) and 11 seasonal dummy variables (i.e., relative dummy variables against January).

Initially, the series were tested for the presence of stochastic seasonality using the Hylleberg, Engle, Granger and Yoo (1990) (HEGY) test allowing for seasonal dummies, constant and trend. There were no indications for the presence of stochastic seasonality.

The, the following equation is estimated:

$$\Delta FR_t = \beta_0 + \sum_{i=2}^{12} \beta_i D_{it} + \varepsilon_t,$$

Where:

ΔFR_t: The monthly change is the respective freight rate

β_0: the monthly average change

β_i: the seasonal effect compared to the average, if the respective coefficient is statistically significant

ε_t: the error term

The standard errors, where needed, were corrected for heteroskedasticity and autocorrelation (HAC) by using the Newey-West method. The following table presents the estimation results that support the existence of seasonality in freight rates. In more detail:

In the dry bulk sector, the significance of the coefficients in many months is related to the strong and significantly negative effect in January, which could be attributed to the Chinese holidays (lunar new year). Then, there is a strong rebound in March followed with significant increases in July and September. Kavussanos and Alizadeh (2001) investigated the nature of seasonality in dry bulk market (monthly data, 1980-1996) and they found that during the spring months there was an increase in spot freight rate for all types of dry bulk cargo that they examined (Handysize, Panamax and Capasize while, there was a fall in all types of vessels in summer. In addition, they also found that for Panamax vessels, there

was a further increase in October and November. These trends were explained on demand-related factors such as harvest seasons or holiday periods. Our analysis indicates the existence of seasonality, which is significantly above average towards the end of the year (October to December) and significant in the summer, while it is below average in January-February. The former finding is broadly in line the finding of Kavussanos and Alizadeh (2001) for the Panamax sector. The latter finding seems to relate to the Chinese holidays, as China emerged as a key dry bulk importer at the advent of the new millennium, which was beyond the sample period of Kavussanos and Alizadeh (2001).

In the crude tanker sector, there are significant positive effects towards the end of the year. A similar pattern is also evident in the product tankers. Kavussanos and Alizadeh (2002), who investigated the nature of seasonality in tanker market for the period 1978-1996 (monthly data), revealed the existence of seasonality. In particular, there were increases in all vessel types' freight rates (VLCC, Suezmax, Aframax and Handysise) towards the end of the year, ahead of winter (especially in November), while a decline was registered at the beginning of the year (especially in February, toward the end of the winter season) for the first three types of vessels. This pattern is also confirmed in the current analysis.

Table A-IV.3: Seasonality patterns in freight rates

	Dry Bulk	Crude	Product	Container	LPG/LNG
Constant	**-0.144**	**-0.193**	-0.086	0.023	-0.035
	(-3.2088)	(-2.8968)	(-1.7988)	(1.9183)	(-1.3364)
January	**-1.766**	**-2.283**	-1.012	0.233	-0.448
	(-3.4839)	(-2.9821)	(-1.7885)	(1.6199)	(-1.493)
February	0.089	-0.054	-0.052	0.015	0.003
	(1.9354)	(-0.4761)	(-0.8438)	(0.9313)	(0.1094)
March	**0.284**	**0.296**	0.138	0.014	-0.002
	(4.9402)	(2.7338)	(1.6902)	(0.7828)	(-0.0547)
April	**0.124**	0.021	0.010	0.017	0.019
	(2.2834)	(0.2531)	(0.1213)	(0.7981)	(0.521)
May	**0.162**	**0.177**	0.086	-0.005	0.037
	(2.8676)	(1.9955)	(1.329)	(-0.219)	(1.2243)
June	**0.165**	0.173	-0.032	-0.022	0.061
	(2.6171)	(1.8554)	(-0.3498)	(-1.1442)	(1.8395)
July	**0.183**	0.065	0.057	-0.023	**0.079**
	(3.0729)	(0.6582)	(0.91)	(-1.2506)	(2.7162)
August	**0.157**	-0.008	0.037	-0.019	0.045
	(3.0171)	(-0.0954)	(0.6222)	(-1.0471)	(1.3629)
September	**0.207**	**0.220**	0.078	-0.027	0.053
	(3.4956)	(2.3787)	(1.1578)	(-1.7005)	(1.895)
October	**0.163**	**0.606**	0.134	**-0.087**	**0.080**
	(1.9795)	(5.3085)	(1.5772)	(-3.1182)	(2.4298)
November	**0.095**	**0.371**	**0.207**	**-0.057**	0.055
	(1.5288)	(3.7051)	(2.9864)	(-2.7965)	(1.8848)
December	**0.136**	**0.417**	**0.350**	**-0.038**	0.017
	(2.375)	(4.7342)	(5.4944)	(-2.3882)	(0.6101)
R^2-adj	0.083	0.260	0.147	0.104	0.057
Wald-test (Feb.-Dec.)	40.736	120.764	73.225	19.684	25.382
(p-value)	(0.000)	(0.000)	(0.000)	(0.0499)	(0.008)

t-statistic in parenthesis. Coefficients in bold indicate significance at 5%.
The standard errors were corrected for heteroskedasticity and autocorrelation (HAC) by using the Newey-West method.
The coefficient for the January dummy and the respective standards errors were calculated according to Kavussanos and Alizadeh (2001). The coefficient b_1 for January as $b_1 = -(b_2 + b_3 + \ldots + b_{12})$ and the standard error from the estimated Variance-Covariance matrix.
Wald-test for the joint significance of the seasonal dummies coefficients.

Appendix IV.4: Unit Root tests

Augmented Dickey-Fuller (ADF)								
	LREC(new)	ΔLREC(new)	LREC(old)	ΔLREC(old)	LREC(new)	ΔLREC(new)	LREC(old)	ΔLREC(old)
	Constant				Trend and Constant			
t-statistic	-1.0561	-8.5136**	-2.8562	-5.2237**	-0.7605	-8.5209**	-2.1459	-5.6317**
p=value	0.7281	0.0000	0.0530	0.0000	0.9637	0.0000	0.5159	0.0000
Time lags	0	0	3	2	0	0	3	2
Phillips-Perron								
	LREC(new)	ΔLREC(new)	LREC(old)	ΔLREC(old)	LREC(new)	ΔLREC(new)	LREC(old)	ΔLREC(old)
	Constant				Trend and Constant			
t-statistic	-1.1285	-8.5084**	-2.7837	-17.1169**	-0.8886	-8.5149**	-2.0678	-17.7061**
p=value	0.6997	0.0000	0.0629	0.0000	0.9509	0.0000	0.5592	0.0000
Bandwith	3	3	8	2	3	3	10	2

Notes:
All variables in logarithmic form. *,** denotes significance at 10% and 5% level and the rejection of the null hypothesis of non-stationarity.
Lag lengths in parenthesis. For ADF determined by the Schwarz Information Criterion (SIC). For PP, the lag truncation for Bartlett kernel according to Newey-West's (1987) suggestion.

Augmented Dickey-Fuller (ADF)								
	LGSI	ΔLGSI	LGSI_N	ΔLGSI_N	LGSI	ΔLGSI	LGSI_N	ΔLGSI_N
	Constant				Trend and Constant			
t-statistic	-2.4663	-13.4307**	-2.4139	-13.7580**	-3.2170	-13.4552**	-3.2521	-13.7858
p=value	0.1251	0.0000	0.1390	0.0000	0.0837	0.0000	0.0771	0.0000
Time lags	1	0	0	0	0	0	0	0
Phillips-Perron								
	LGSI	ΔLGSI	LGSI_N	ΔLGSI_N	LGSI	ΔLGSI	LGSI_N	ΔLGSI_N
	Constant				Trend and Constant			
t-statistic	-2.5658	-13.3437**	-2.4887	-13.7178**	-3.2907	-13.3721**	-3.2838	-13.7641**
p=value	0.1017	0.0000	0.1195	0.0000	0.0704	0.0000	0.0716	0.0000
Bandwith	2	7	3	8	3	7	4	9

Notes:
All variables in logarithmic form. *,** denotes significance at 10% and 5% level and the rejection of the null hypothesis of non-stationarity.
Lag lengths in parenthesis. For ADF determined by the Schwarz Information Criterion (SIC). For PP, the lag truncation for Bartlett kernel according to Newey-West's (1987) suggestion.

Augmented Dickey-Fuller (ADF)								
	LBUNK	ΔLBUNK	LCREDIT	Δ LCREDIT	LBUNK	ΔLBUNK	LCREDIT	Δ LCREDIT
	Constant				Trend and Constant			
t-statistic	-2.5130	-10.8168**	-2.0126	-11.0615**	-2.3596	-10.8386**	-0.5652	-11.2475**
p=value	0.1137	0.0000	0.2813	0.0000	0.3998	0.0000	0.9793	0.0000
Time lags	1	0	0	0	1	0	0	0
Phillips-Perron								
	LBUNK	ΔLBUNK	LCREDIT	Δ LCREDIT	LBUNK	ΔLBUNK	LCREDIT	Δ LCREDIT
	Constant				Trend and Constant			
t-statistic	-2.3909	-10.4910**	-1.9683	-11.0611**	-2.1113	-10.4292**	-0.6395	-11.2486**
p=value	0.1454	0.0000	0.3006	0.0000	0.5363	0.0000	0.9749	0.0000
Bandwith	2	11	3	3	2	12	2	1

Notes:
All variables in logarithmic form. *,** denotes significance at 10% and 5% level and the rejection of the null hypothesis of non-stationarity.
Lag lengths in parenthesis. For ADF determined by the Schwarz Information Criterion (SIC). For PP, the lag truncation for Bartlett kernel according to Newey-West's (1987) suggestion.

Augmented Dickey-Fuller (ADF)								
	LFL	ΔLFL	LFL_N	ΔLFL_N	LFL	ΔLFL	LFL_N	ΔLFL_N
	Constant				Trend and Constant			
t-statistic	-1.3793	-3.2356**	-1.5936	-3.2529**	-2.8377	-3.2556*	-2.8968	-3.2878*
p=value	0.5921	0.0192	0.4842	0.0183	0.1854	0.0765	0.1655	0.0709
Time lags	1	0	1	0	1	0	1	0
Phillips-Perron								
	LFL	ΔLFL	LFL_N	ΔLFL_N	LFL	ΔLFL	LFL_N	ΔLFL_N
	Constant				Trend and Constant			
t-statistic	-1.0900	-3.4372**	-1.2497	-3.4563**	-1.6182	-3.4604**	-1.6507	-3.4947**
p=value	0.7201	0.0107	0.6529	0.0101	0.7831	0.0462	0.7696	0.0423
Bandwith	11	4	11	4	11	4	11	4

Notes:
All variables in logarithmic form. *,** denotes significance at 10% and 5% level and the rejection of the null hypothesis of non-stationarity.
Lag lengths in parenthesis. For ADF determined by the Schwarz Information Criterion (SIC). For PP, the lag truncation for Bartlett kernel according to Newey-West's (1987) suggestion.

Appendix V.1: Summary of data series

Variable	Description	Unit	Source
REC	Receipts from the provision of sea transport services. As the original data are in euros, the average monthly exchange rate of EUR/USD was used to transform them in USD.	USD million	Bank of Greece European Central Bank
GSI GSI_N	The weighted – with the number of vessels – average earning of the Greek controlled fleet. The narrow index (GSI_N) includes only the main sectors i.e. Dry bulk and tankers (crude and products).	USD/day Number of vessels	Clarkson Research Services Greek Shipping Co-operation Committee
BUN	The simple average of the HSFO 380cst Bunker Prices (3.5% Sulphur) at the ports of Rotterdam, Singapore and Fujairah, which are the key bunking places.	USD/tonne	Clarkson Research Services
FL and FL_N	A capacity utilization (CU) adjusted Greek-controlled fleet in dwt.	Dwt	Greek Shipping Co-operation Committee
CU	The capacity utilization of the world fleet based on the seaborne ton-miles.	Seaborne trade ton-miles	Clarkson Research Services
CREDIT	The stock of credit provided to the domestic shipping sector at the end of each month. As the original data are in euros, the last working date exchange rate of EUR/USD was used to transform them in USD.	USD million	Bank of Greece European Central Bank

Appendix V.2: Main Model Selection – The top-10 models according to AIC

Model Specification	AIC*	SIC	HQ
ARDL(2, 0, 2, 1)	**-4.446**	-4.147	-4.328
ARDL(2, 0, 0, 1)	-4.440	-4.208	**-4.348**
ARDL(2, 0, 3, 1)	-4.427	-4.095	-4.296
ARDL(2, 0, 2, 2)	-4.418	-4.086	-4.287
ARDL(3, 0, 2, 1)	-4.418	-4.086	-4.287
ARDL(2, 1, 2, 1)	-4.416	-4.084	-4.285
ARDL(2, 1, 0, 1)	-4.415	-4.150	-4.310
ARDL(2, 0, 1, 1)	-4.414	-4.148	-4.309
ARDL(2, 0, 0, 0)	-4.413	**-4.214**	-4.334
ARDL(2, 0, 0, 2)	-4.413	-4.148	-4.308

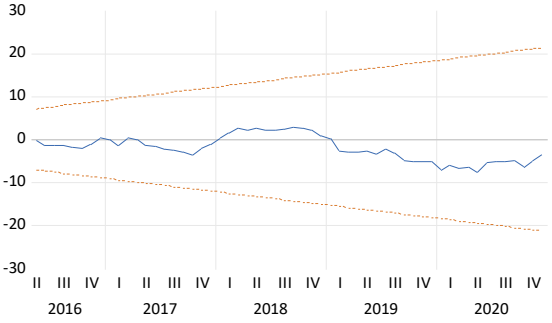
Source: Author.

Appendix V.3: Diagnostics of the main sectors of the Greek controlled fleet

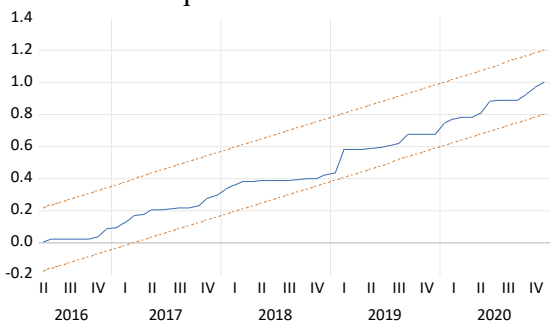
Table A-V3.1: Diagnostics of the main sectors of the Greek controlled fleet		
Main sectors of Greek controlled fleet	2015 - 2020 ARDL(2, 0, 2, 1)	
Diagnostics	**Test statistics**	**Probability (p-value)**
$\boldsymbol{X^2_{SC}(12)}$	10.775	0.548
$\boldsymbol{X^2_{HET}}$	9.955	0.268
$\boldsymbol{X^2_{NORM}(2)}$	4.482	0.106
$\boldsymbol{F_{RESET}(1)}$ $\boldsymbol{F_{RESET}(2)}$	1.379 0.688	0.245 0.442
CUSUM and CUSUM of squares	within 5% bounds	
$\boldsymbol{X^2_{SC}}$, $\boldsymbol{X^2_{HET}}$ and $\boldsymbol{X^2_{NORM}}$ denote LM test for Serial Correlation (up to 12 lags), homoscedasticity (Breusch-Pagan-Godfrey test) and Normality (Jarque-Bera test) respectively and $\boldsymbol{F_{RESET}}$ denotes the Normality and Functional Form (Ramsey RESET).		

Graph A-V.3-1: Parameter Stability - main sectors of the Greek controlled fleet

CUSUM test



CUSUM of squares test



Source: Author.

Dependent variable: ΔLREC						
Period: **2015-2020**	**Unrestricted (Conditional) ECM**			**Restricted ECM**		
Variable:	**Coefficient**	**t-stat**	**p-value**	**Coefficient**	**t-stat**	**p-value**
Intercept	-14.308	-4.248	0.000			
LREC(-1)	-0.496	-6.506	-/-*			
LGSI(-1)	0.136	5.979	0.000			
LBUNK(-1)	0.102	4.059	0.000			
LFL(-1)	0.830	4.346	0.000			
ΔLREC(-1)	-0.248	-2.666	0.010	-0.260	-3.085	0.003
ΔGSI	0.136	5.320	0.000			
ΔLBUNK	0.117	3.098	0.003	0.115	3.552	0.001
ΔLBUNK(-1)	0.067	1.914	0.061	0.082	2.604	0.012
ΔLFL	-3.167	-1.740	0.087	-3.856	-4.323	0.000
Coint(-1)				**-0.459**	**-8.280**	**-/-****

*: t-value is incompatible with the usual t-distribution as the critical values of the bounds t-statistic estimated by Pesaran et al (2001) shall be used. In our case, the upper limit is close to -4.0, and therefore the coefficient of LREC(-1) is significant.

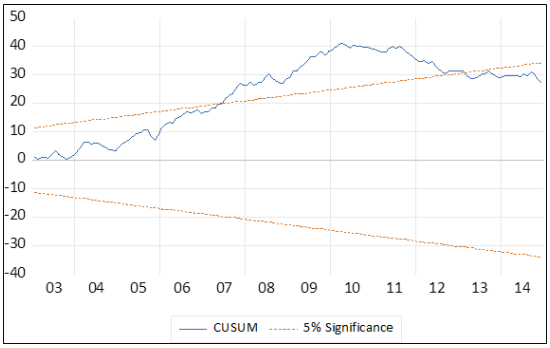
**: The significance of the Coint(-1) parameter is defined by the bounds test.

Appendix V.4: Diagnostics of the basic model in the pre-2015 period

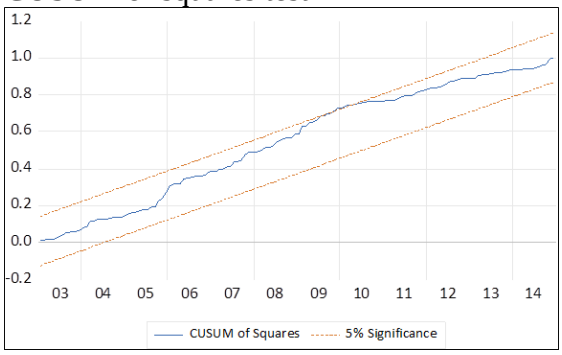
Table A-V.4-1: Diagnostics of the basic model in the pre-2015 period		
Main model in the pre-2015 period	2002 - 2015 ARDL(4, 3, 1, 0)	
Diagnostics	**Test statistics**	**Probability (p-value)**
$\boldsymbol{X^2_{SC}(12)}$	8.611	0.736
$\boldsymbol{X^2_{HET}}$	17.143	0.104
$\boldsymbol{X^2_{NORM}(2)}$	2.761	0.251
$\boldsymbol{F_{RESET}(1)}$	0.067	0.796
$\boldsymbol{F_{RESET}(2)}$	0.416	0.634
CUSUM and CUSUM of squares	Partly outside 5% bounds within 5% bounds	
$\boldsymbol{X^2_{SC}}$, $\boldsymbol{X^2_{HET}}$ and $\boldsymbol{X^2_{NORM}}$ denote LM test for Serial Correlation (up to 12 lags), homoscedasticity (Breusch-Pagan-Godfrey test) and Normality (Jarque-Bera test) respectively and $\boldsymbol{F_{RESET}}$ denotes the Normality and Functional Form (Ramsey RESET).		

Graph A-V.4-1: Parameter Stability - basic model in the pre-2015 period

CUSUM test



CUSUM of squares test



Source: Author.

Dependent variable: ΔLREC Period: **2002-2014**						
	Unrestricted (Conditional) ECM			**Restricted ECM**		
Variable:	**Coefficient**	**t-stat**	**p-value**	**Coefficient**	**t-stat**	**p-value**
Intercept	-0.308	-0.230	0.819			
LREC(-1)	-0.141	-3.146	0.002			
LGSI(-1)	0.083	3.219	0.002			
LBUNK(-1)	0.042	1.641	0.103			
LFL(-1)	0.013	0.177	0.860			
ΔLREC(-1)	-0.551	-7.783	0.000	-0.551	-8.190	0.000
ΔLREC(-2)	-0.296	-3.938	0.000	-0.296	-4.082	0.000
ΔLREC(-3)	0.197	2.794	0.006	0.197	2.885	0.005
ΔGSI	0.094	2.353	0.020	0.094	2.453	0.015
ΔGSI(-1)	0.093	2.229	0.027	0.093	2.352	0.020
ΔGSI(-2)	0.123	2.860	0.005	0.123	3.028	0.003
ΔLBUNK	0.287	4.719	0.000			
ΔLFL	0.013					
Coint(-1)				**-0.141**	**-4.339**	**-/-****

*: t-value is incompatible with the usual t-distribution as the critical values of the bounds t-statistic estimated by Pesaran et al (2001) shall be used. In our case, the upper limit is close to -4.0, and therefore the coefficient of LREC(-1) is significant.

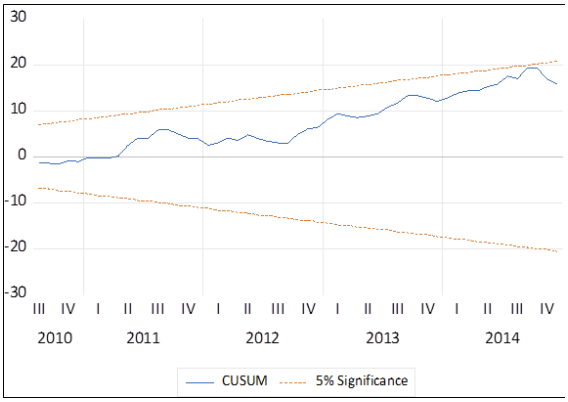
**: The significance of the Coint(-1) parameter is defined by the bounds test.

Appendix V.5: Diagnostics of the alternative model in the pre-2015 period.

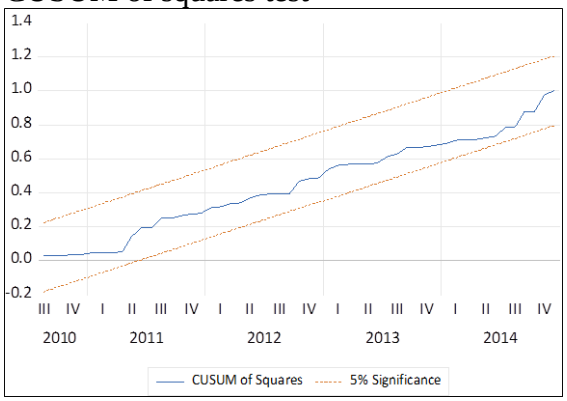
Table A-V.5-1: Diagnostics of the alternative model in the pre-2015 period		
Alternative model for the pre-2015 period.	2002 - 2015 ARDL(4, 3, 1, 0)	
Diagnostics	**Test statistics**	**Probability (p-value)**
$\boldsymbol{X^2_{SC}(12)}$	10.882	0.539
$\boldsymbol{X^2_{HET}}$	14.754	0.141
$\boldsymbol{X^2_{NORM}(2)}$	2.862	0.239
$\boldsymbol{F_{RESET}(1)}$	1.358	0.246
$\boldsymbol{F_{RESET}(2)}$	0.830	0.438
CUSUM and CUSUM of squares	Within 5% bounds	
$\boldsymbol{X^2_{SC}}$, $\boldsymbol{X^2_{HET}}$ and $\boldsymbol{X^2_{NORM}}$ denote LM test for Serial Correlation (up to 12 lags), homoscedasticity (Breusch-Pagan-Godfrey test) and Normality (Jarque-Bera test) respectively and $\boldsymbol{F_{RESET}}$ denotes the Normality and Functional Form (Ramsey RESET).		

Graph A-V.5-1: Parameter Stability - alternative model in the pre-2015 period

CUSUM test



CUSUM of squares test



Source: Author.

Note: As a dummy has been used for the change in the Credit to Shipping methodology, the CUMUM tests are from 2010 onwards.

Dependent variable: ΔLREC Period: **2002-2014**						
	Unrestricted (Conditional) ECM			**Restricted ECM**		
Variable:	**Coefficient**	**t-stat**	**p-value**	**Coefficient**	**t-stat**	**p-value**
Intercept	-1.003	-4.398	0.000			
LREC(-1)	-0.484	-8.365	0.000			
LGSI(-1)	0.242	7.908	0.000			
LBUNK(-1)	0.034	1.368	0.174			
LCREDIT(-1)	0.197	5.505	0.000			
ΔLREC(-1)	-0.318	-4.907	0.000	-0.318	-5.394	0.000
ΔLREC(-2)	-0.201	-2.853	0.005	-0.201	-3.125	0.002
ΔLREC(-3)	0.188	2.804	0.006	0.188	2.990	0.003
ΔGSI	0.106	2.802	0.006	0.106	3.061	0.003
ΔLBUNK	0.295	5.159	0.000	0.295	5.485	0.000
ΔLCREDIT	0.197	5.505	0.000			
DUMMY_CREDIT	0.085	3.876	0.000	0.085	8.327	0.000
Coint(-1)				**-0.484**	-8.986	**-/-****

*: t-value is incompatible with the usual t-distribution as the critical values of the bounds t-statistic estimated by Pesaran et al (2001) shall be used. In our case, the upper limit is close to -4.0, and therefore the coefficient of LREC(-1) is significant.

**: The significance of the Coint(-1) parameter is defined by the bounds test.

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