BANK OF GREECE
EUROSYSTEM

Economic Bulletin
ISSN 1105 - 9729 (print)
ISSN 2654 - 1904 (online)

DETERMINANTS OF THE RECEIPTS FROM SHIPPING SERVICES: THE CASE OF GREECE*

Zacharias Bragoudakis
Economic Research Department

Stelios Panagiotou
Economic Research Department

1 INTRODUCTION

Since the 1950s, the areas of international economics that have attracted significant empirical research include the foreign trade flows and the testing of trade theories which focus on the following questions:

(i) What goods do countries trade?

(ii) With whom do countries trade?

(iii) How much do countries trade?

In order to investigate these issues, MacDougall (1951, 1952) used the comparative labour cost of the Ricardo model, while Leontief (1954) that of the Hecksher-Ohlin model. Deardorff (1984) discussed the empirical testing of the trade theories and Goldstein and Khan (1985) estimated the income and price elasticities of trade flows and the policy implications of their findings. Their work focused exclusively on merchandise trade and its determinants.

However, as trade in services between developed countries started to take off and a first initiative for the liberalisation of services trade was undertaken by the USA,[1] academic literature turned to the determinants of trade in services. Kravis (1983) discussed the contribution and implications of services as much for the domestic economy as for international transactions. He concluded that services represent a relative growth factor for the domestic economies and that trade in both commodities and services had rapidly expanded over his research period (1960-1979).

It is evident though that, as an increasing proportion of the world's GDP is generated by services, their importance for international trade has increased as well. According to Karsenty (2000) almost a third of world trade is generated by services. One of the first attempts at modelling US trade in services was undertaken by Helkie and Stekler (1987). Hung and Viana (1995) employed the two-step approach suggested by Granger and Engle (1987) —cointegration and Error Correction Model (ECM)— in modelling US services trade flows. Their research though focused on tourism, other private services, royalty and license fees, and excluded military and transportation services. More recent work was undertaken by the University of Michigan (November 2000) in relation to the quarterly forecast of the US Trade in Services, which extended the model to also include transportation services in the services trade flow (see Hyman, Deardorft and Stern, 2000).

For Greece, an important component of trade in services is shipping. Therefore, in the present study we focus on the determininants of shipping receipts in the Greek economy by the use of an ECM. Our results reveal that both freight rates and the stock of credit granted by the Greek banking system to the shipping sector are statistically significant determinants of the shipping receipts recorded in the balance of payments. We also evaluate the forecasting ability of the estimated ECM in the short term. We compare its forecasting ability with that of alternative models (autoregressive models of

* The authors would like to thank Helen Thanopoulou, George Zombanakis and Heather Gibson for their constructive comments. The views expressed in this article do not necessarily reflect those of the Bank of Greece. A draft version of the paper was presented in July 2007 at the Annual Conference of the International Association of Maritime Economists in Athens.

1 In the early 1980s the Reagan Administration undertook a diplomatic initiative for removing the obstacles of services trading.

first and third order, and random walk), and we conclude that the selected ECM specification outperforms the alternative forecasting models.

The remainder of the paper is organised as follows: the following section reviews empirical work on the determinants of shipping receipts in the national economy. Section 3 discusses the methodology and the data used, and Section 4 presents the empirical evidence. Finally, Section 5 concludes.

2 LITERATURE REVIEW

To the best of our knowledge, the first attempt to determine and forecast foreign exchange inflows from shipping in the Greek economy by using regression analysis was made by Constantopoulou (1976), for the requirements of the 5-year development programme of the time (1976-1980). Her methodology is based on calculating the income of the "factors of shipping services production" (labour and capital) and their impact on the foreign exchange inflows from shipping. In that period, the respective shipping inflows in the balance of payments statistics were recorded under the following items:[2]

1. Freight – mainly related to imports/exports of goods to/from the country.

2. Seamen's remittances.

3. Shipowners' remittances.

4. Ship store and repairs etc.

5. Contribution to the Seamen's Pension Fund (NAT).

6. Shipowners' taxation.

7. Passenger tickets.

Although disaggregated data based on the above seven categories were available, Constantopoulou decides to use aggregated data for the shipping foreign exchange inflows, due to her worries about the credibility of the disaggregated ones. Following a regression analysis (based on a variety of equations) performed on annual data (1960-1974) she concludes that foreign exchange inflows associated with shipping depend on seamen's income and on the Greek-flagged fleet revenues.

Tambakis (1984) performs a similar regression analysis focusing on disaggregated items of foreign exchange inflows from shipping (see above), as well as on aggregate inflows. He concludes that total inflows from shipping depend primarily on world seaborne trade (representing the demand for shipping services) and on the size of the Greek fleet, i.e. the number of ships carrying a Greek flag (representing the Greek supply of shipping services). As Goulielmos (1997) points out, the statistical significance of these two variables could also indicate the importance of freight rates, which are determined by world supply of and demand for shipping services.

Haralambides (1986) investigates the interrelation between foreign exchange inflows from shipping and domestic macroeconomic factors in comparison to internationally related ones. His study is based both on aggregate and disaggregate data, as that of Tambakis (1984). He performs a series of single equation regressions using, among other things, total foreign exchange inflows from shipping, shipowners' remittances, seafarers' remittances, as well as their first differences as the dependant variable. Freight rates, the Greek consumer price index and the US dollar/drachma (USD/GDR) exchange rate serve as independent variables. Haralambides performs two sets of regression analysis. In the first set, he tests the hypothesis of a correlation between foreign exchange inflows and

2 Up to the end of 1998, the Bank of Greece followed the foreign exchange currency approach in the compilation of the Balance of Payments.

factors from shipping domestic determinants – i.e. variables related to the Greek economy, such as the exchange rate inflation. In the second set of regressions he investigates the relationship between shipping inflows and the general freight index compiled by the General Council of British Shipping (GCBS). As he attests, he does not employ the most advanced econometric techniques available then, as the cost of time would not have been compensated by a significant increase in the robustness of the results (due to the small sample and the short time series available).

Based on the econometric results of his research, the main conclusions can be summarised as follows:

- The breakdown of revenues from shipping services, used then by the Bank of Greece, was erroneous and could lead to misleading conclusions.

- Inflows to Greece from seafarers were ineleastic with respect to freight rates, given that they covered the daily expenditure of their families as well as the fact that salaries do not follow freight rates, as they are agreed in advance.

- Foreign exchange inflows from shipping are predominantly related to domestic macroeconomic conditions rather than external ones, such as freight rates or export demand. He found that the basic macroeconomic parameters that influenced inflows were the inflation rate and the USD/GRD exchange rate, both factors under the control of the monetary policy authorities.[3]

Haralambides finds that drachma devaluations had a negative effect on USD-denominated inflows; Goulielmos (1997) counters this view, arguing that it is the relationship between drachma devaluation and nominal drachma wage increases of the seamen that matters. Goulielmos concludes that in much of the 1980s, the USD-dominated wages of crews either fell or exhibited minor increases. All three previous studies —Constantopoulou (1976), Haralambides (1986) and Tambakis (1986)— share the same shortcoming in relation to the issues of unit roots and cointegration, since the seminal work of R.F. Engle and C.W.J. Granger on cointegration was only published in 1987.

Goulielmos (1993) discusses the impact of the adoption of open registries (known also as "flags of convenience") by the Greek fleet on the foreign exchange inflows from shipping in the period 1981-1991. His research focuses on the relationship between crew cost and foreign exchange inflows. Specifically, in the abovementioned period, the decline in foreign exchange inflows can be principally attributed to the non-utilisation of vessels (laid-up tonnage), and subsequently to the unemployment of seamen, and secondly to the adoption of flags of convenience and its impact on employment.

The laid-up tonnage, the loss of employment for Greek seamen and the adoption of flags of convenience by national vessels have been identified by Goulielmos (1996) as the main factors that contributed to lower foreign exchange inflows from shipping in the period of the 1981-1987 crisis. In the 1970s, the main factors determining the remittance of shipping-related earnings to the Greek economy were: state-related obligations (i.e. tonnage tax, social insurance contributions) and operating expenses (i.e. running costs of the shore-based shipping operations, remittances to the seamen's families, repair costs). His work is based on micro-data from 715 Greek shipping companies. He concludes that "laid-up tonnage and reduced crew employment were mainly responsible —to an amount up to 83% (42% + 41%)— for the reduction in inflows between 1980 and 1982-1984".

Until 1998, the Bank of Greece followed the foreign exchange currency approach to the

3 Haralambides (1996) – by the use of Input/Output Analysis methodology – attempted to estimate the economic impact of shipping on the national economy. Such analysis is beyond the scope of this paper.

compilation of the balance of payments. Since 1999, it uses the 5th edition of the IMF Balance of Payments Manual (IMF 1993), which is based on the distinction between residents and non-residents.[4] The above research effort —aside from the methodological issue of unit root testing it may suffer from— is undertaken on annual data compiled according to the old methodology. The current compilation approach offers the advantage of selecting the element of shipping service inflows / receipts that is closely related to the international shipping freight rates, as will be discussed in Section 3. Another significant change is related to the introduction of the euro, which became the legal tender in Greece (since 2002 in physical form). Finally, as our interest focuses on the short-term path of receipts from shipping services, monthly data are used.

Thus, the present study attempts to investigate the determinants of receipts from deep sea shipping by utilising advanced econometric methods that were not available at the time of previous research. The data used has been compiled according to the new methodology. In addition, the ability of the model to forecast is tested using the out-of-sample forecast performance of the selected ECM, providing evidence of its superiority compared to other time series benchmark models.

3 DATA AND METHODOLOGY

3.1 DATA

According to the IMF Balance of Payments Manual (BPM), the Balance of Payments (BoP) is defined as:

> "...a statistical statement that systematically summarises, for a specific time period, the economic transactions of an economy with the rest of the world. Transactions, for the most part between residents and non-residents, consist of those involving goods, services, and income; those involving financial claims on, and liabilities to, the rest of the world; and those (such as gifts) classified as transfers, which involve offsetting entries to balance —in an accounting sense— one-sided transactions".

The distinction between residents and non-residents has an important role in the BoP. The BPM states that an enterprise has a resident status when it is engaged in a significant amount of production of goods and/or services in the domestic country. However, this definition may cause a split between the legal entity of a company and its resident status. Namely, parts of the company (i.e. branches) that are operating in a particular economy are given the resident status of this economy and therefore any transactions between the resident (branch) and the non-resident (parent company) would constitute a BoP transaction.

The operation of mobile equipment —as the operations of vessels are referred to in the Balance of Payments Textbook (1996)— introduces more difficulties for the complier of the BoP. The decision as to whether a service provided by mobile equipment (such as vessels) has resident status is made on the basis of the resident status of the enterprise operating such equipment (vessels). Moreover, in order to decide on the territory of the operating enterprise, the focus should be on issues such as the location of the company directing enterprise operations. It can be inferred then that the Greek-owned fleet flying a non-Greek flag can fall under the criterion of the territory of the directing enterprise. Thus, both the Greek-flag fleet and the non-Greek-flag fleet can be regarded as resident from a BoP point of view.

The Bank of Greece has gradually introduced, since 1999, the implementation of the 5th edition of the BPM (1993) and the respective Compilation Guide (1995) published by the IMF. According to the BPM, each month's

4 See also Box VIII.1 of the Bank of Greece *Annual Report* 1998, and Pantelidis (1997).

receipts should be recorded in the monthly BoP. The Bank of Greece collects data from financial institutions based in Greece. The services from shipping transportation comprise the following categories:

1. Cross-trade transportation services.

2. Transportation of passengers.

3. Transportation of goods.

4. Other/auxiliary services.

Based on the data presented in Table 1, it is evident that cross-trade represents the category with the highest contribution to the shipping transportation element of the BoP, representing (on average) 97% of the total amount of receipts from shipping transportation services over the period 2002-2009. By definition, cross-trade services include those services provided by Greek companies for the transportation of goods between third countries. This is not at odds with what would be expected. Although Greek-owned vessels (usually managed by companies based in Greece) represent roughly 15% of the world fleet capacity (in dwt terms), the Greek economy does not possess the depth of domestically-produced exportable commodities to employ a considerable share of the Greek fleet.

As receipts from the provision of shipping services for cross-trade account for the bulk of shipping receipts, the estimated model focuses on them. These receipts are expected to be closely related to the internationally agreed freight rates and reflect the operations of the traditional Greek shipping companies.

The euro is a more liquid and tradable currency in international foreign exchange markets compared to the Greek drachma. In 2002, euro coins and banknotes were put in circulation in Greece. This fact may have prompted Greek-based shipowners to carry out a higher portion of their transactions through their local (Greek) banking system, as the local currency was then the euro. Thus, we have decided that our sample period should begin in January 2002, and not earlier. Importantly, the sample period includes also the financial turmoil of 2008, which had an enormous impact on the shipping industry and freight rates. The non-seasonally adjusted data are monthly time series and the sample covers the period from January 2002 to March 2010.

Receipts from the provision of shipping transportation services in cross-trade are hypothesised to depend on the international freight rates, the size of the Greek-based maritime cluster (i.e. ship management companies, financial services and companies that provide auxiliary services to shipping), and the carrying capacity of the Greek-owned fleet.

In our analysis, the ClarkSea Index (expressed in USD per day) is used as the index of international freight rates. It is a weighted average freight index of all main commercial vessels. Specifically, as described by Clarkson Research Studies in 'Sources and Methods for the Shipping Intelligence Weekly' (2009):

> "The ClarkSea Index is the only published weekly indicator of earnings for all the main commercial vessel types. It is weighted according to the number of vessels in each fleet sector. Clarksons Research collects rates direct from the Clarksons brokers on a daily and weekly basis and these are used to calculate the earnings taken into account to make up the ClarkSea Index. The sectors in the ClarkSea Index are oil tankers (VLCC, Suezmax, Aframax and clean product carriers), dry bulk carriers (Capesize, Panamax, Handymax and Handysize), gas carriers (VLGC) and fully cellular containerships" (see www.clarksons.net).

As the size of the Greek-based shipping cluster increases, shipowners tend to strengthen their banking relations with Greek-based shipping finance institutions. In addition, when ship owners receive a loan from a bank to

Tables I Receipts from shipping services

(in million USD)

	2002	2003	2004	2005	2006	2007	2008	2009	Year average (2002-2009)
Receipts from shipping services	**7,561.8**	**10,136.5**	**15,429.7**	**16,114.7**	**16,674.6**	**21,487.2**	**25,920.0**	**17,102.5**	**16,303.4**
Passengers	95.3	75.5	94.6	119.6	92.3	135.7	168.3	114.7	112.0
Goods	49.1	49.5	64.0	42.6	48.2	89.8	92.5	60.3	62.0
Cross-trading	6,919.8	9,556.1	14,713.6	15,790.0	16,359.7	21,095.0	25,478.0	16,749.5	15,832.7
Auxiliary services	497.5	455.3	557.5	162.4	174.4	166.4	181.2	178.0	296.6
Receipts as percentages	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**
Passengers	1.3	0.7	0.6	0.7	0.6	0.6	0.6	0.7	0.7
Goods	0.6	0.5	0.4	0.3	0.3	0.4	0.4	0.4	0.4
Cross-trading	91.5	94.3	95.4	98.0	98.1	98.2	98.3	97.9	97.1
Auxiliary services	6.6	4.5	3.6	1.0	1.0	0.8	0.7	1.0	1,8

Source: Bank of Greece.

acquire a vessel, they are also required to open an operating account for the financed vessel at the same bank, and perform all the vessel's trading transactions (including freight receipts) though this account. Therefore, the amount of outstanding loans (in USD) can play a dual role, as it can reveal, on the one hand the expansion of the fleet, and on the other the increase in the Greek-owned fleet. As it is almost impossible to collect monthly data on the size of the Greek maritime cluster and the Greek-owned fleet, outstanding balances of credit to shipping companies granted by the domestic banking system through branches in Greece can act as a proxy for these variables. It should be noted though that, based on the annual data provided by the Greek Shipping Cooperation Committee, the Greek-owned fleet has increased by approximately 3.2% per annum (or the equivalent of 0.26%) over the estimated period (2002:M1-2010:M3).

Even today, the USD is the predominant currency in shipping transactions. In order to avoid any distortion on our results due to fluctuations of the exchange rate of the US dollar against the euro, we decided to express all time series in USD, using the average monthly rate of the US dollar against the euro as published by the European Central Bank (ECB).

3.2 ECONOMETRIC METHODOLOGY

The econometric methodology applied is described by the following stages.

First, the time series properties of all the variables are evaluated employing the Augmented Dickey-Fuller (1979) standard unit-root tests (ADF). Specifically, we examine the rank of integration I(d) for the logarithms of the ClarkSea Index (ind), outstanding credit balances to the shipping companies (ls), and receipts from the provision of shipping transportation services in cross-trade (sr).

At the second stage, we use an error correction framework in two steps as proposed by Engle and Granger (1987) to investigate the existence of a cointegration relationship between ind, ls and sr.

In a *first step*, if sr, ind and ls are I(1) and $d_t \sim$ I(1), the series would be cointegrated of order CI(1,1). This implies that if we wish to estimate the long-run relationship, it is only necessary to estimate the static model:

$$\log(sr)_t = \mu + \zeta \log(ind)_t + m \log(ls)_t + d_t \quad (1)$$

which implies that in the long run the endogenous variable of cross-trade shipping receipts (sr) is determined by the exogenous variables, the freight index (ind) and outstanding loans (ls).

The term μ is a constant; the parameters ζ and m denote the long-run elasticities of ind and ls; while dt are the long-run residuals. Estimating (1) using OLS achieves a consistent estimate of the long-run steady state relationship between the variables, while all dynamics and endogeneity issues can be ignored asymptotically. This arises because of what is termed the super-consistency property of the OLS estimator when the series are cointegrated (see Harris, 1995). To test the null hypothesis that shipping receipts and the exogenous variables ind and ls are not cointegrated we directly test whether $d_t \sim$ I(1) against the alternative that $d_t \sim$ I(0) by carrying out ADF tests and using the critical values provided by MacKinnon (1991).

In a *second step* we estimate an ECM, itself using the estimates of disequilibrium (d_{t-1}), to obtain information on the speed of adjustment to equilibrium. The ECM takes the following form:

$$\Delta log(sr)_t = \delta_0 + \sum_{i=1}^{m} \alpha_i \, \Delta log(sr)_{t-i} + \sum_{i=0}^{n} \beta_i \, \Delta log(ind)_{t-i} + \sum_{i=0}^{h} \varkappa_i \, \Delta log(ls)_{t-i} + \gamma d_{t-1} + \text{Sdummies} + \varepsilon_t \quad (2)$$

where Δ denotes first differences in logarithms;

$d_{t-1}=log(sr)_{t-1}-\zeta\, log(ind)_{t-1}-m\, log(ls)_{t-1}-\mu$ is the disequilibrium or the error correction term, tested to be stationary; and $\varepsilon_t \sim N(0, \sigma^2)$ are the residues from the estimation of model (2). If series *sr* and *ind* are both I(1), the stationarity of d_t is equivalent to *sr* and *ind* being cointegrated with a cointegration vector $x' = [1\text{-}\zeta\text{-}m\text{-}\mu]$ with ζ, m and μ being the parameters of the long-run relationship. Seasonal dummies (Sdummies) have been added in order to capture any seasonal pattern in shipping receipts. It should be noted that the Hendry (1995) type of 'general-to-specific' procedure is used to reduce the short-run ECM to its parsimonious form.

At the third stage, we present an evaluation of forecast performance between the selected parsimonious ECM and two benchmark time series models, random walk (RW) and autoregressive AR(k). A benchmark model is usually helpful in forming an idea about the relative forecasting performance of the different models. We use the Root Mean Square Error (RMSE) of recursive dynamic out-of-sample forecasts as the main criterion for the assessment, which is widely used in the literature (see e.g. Anderson, Hoffman and Rasche, 2002; Stock and Watson, 1999; Hoffman and Rasche, 1996; Clements and Hendry, 1993). Additionally, three measures of predictive accuracy —Mean Absolute Error (MAE), Mean Absolute Percentage Error (MAPE) and Theil's inequality coefficient[5]— are employed to evaluate the predictive performance of the ECM compared to the benchmark time series models. We use a rolling period of 3 months ahead to assess the forecast performance, i.e. the first out-of-sample exercise starts in 2009:M1 on the basis of the total sample 2002:M1 to 2010:M3. The sample is then extended sequentially by one month up to 2010:M3. The out-of-sample exercise covers a period of 15 months. Each time, the models are re-estimated and a set of dynamic forecasts is computed for up to 3 months ahead.

4 EMPIRICAL RESULTS

The hypothesis of a unit root in the logarithmic levels of ind, sr and ls cannot be rejected. In contrast, the hypothesis of a unit root in the first differences is rejected in all cases, in favour of the alternative of stationarity. These results suggest that all series are I(1) (see Table 2). The residuals of the long-run relationship (1) are also stationary in levels $d_t \sim I(0)$, and so we can conclude that the two series are cointegrated of order CI(1,1).

5 The MAPE and the Theil's inequality coefficient are scale invariant. The RMSE and the MAE depend on the scale of the dependent variable and should be used as relative measures to compare forecasts for the shipping receipts across ECM, AR(k) and RW.

Table 2 Augmented Dickey-Fuller Test Results

ADF Statistics	log(rs)	Δlog(rs)	log(ind)	Δlog(ind)	log(ls)	Δlog(ls)	Long -run Residuals (d)
Intercept	-2.10 (-3)	- 4.61* (-2)	-2.50 (-1)	- 6.75* (0)	-1.31 (0)	-8.57* (0)	-7.06* (0)
Trend and Intercept	-2.14 (-3)	- 4.74* (-2)	-2.33 (-1)	- 6.82* (0)	-0.62 (0)	-8.71* (0)	-7.02* (0)
None	1.05 (-3)	- 4.45* (-2)	0.23 (-1)	- 6.77* (0)	6.32 (0)	-2.14* (-3)	-7.10* (0)

* Denotes rejection of the null hypothesis at the 5% significance level.
Note: The numbers in the parentheses are the selected lag length for no serial correlation of the ADF residuals based on Swartz information criterion.

The estimated long-run equation of shipping inflows is:

$$\log(sr) = \underset{(-12,0)}{-2.95} + \underset{(21,32)}{0,44}*\log(ind) + \underset{(31,21)}{0,64}*\log(ls)$$

$$R^2\text{-adj.} = 0,95 \qquad (3)$$

From the estimated long-term equation (3) it is obvious that both variables (freight index and outstanding loans) are statistically significant in explaining shipping receipts and (as was expected) they have a positive sign. The estimated cointegrating vector reveals a partial pass-through from the ClarkSea index to shipping receipts in the long-run, with the long-run parameter ζ estimated to be 0.44, which means that if the index increases by 10% in any month, shipping receipts will tend to rise by 4.4% only. This can be explained by the international nature of Greek shipping operations. Freight revenues can be deposited to bank accounts in major shipping centres such as London, New York and Piraeus. As a result, only part of the increased revenues passes into the Greek banking system and therefore to the data compiled by the Bank of Greece. Finally, when banks are granting loans to shipping companies, they also request the opening of a retention account which will be used for the loan repayment. Therefore, to the extent that Greek shipping companies are financed by non-Greek banks, freight revenues will be sourced in the international (non-Greek) banking system. In addition, the composition of the Greek fleet (focused predominantly on dry bulk and tanker vessels) is not necessarily the same as the composition of the world fleet. There could therefore be a mismatch between the weighting on the ClarkSea index and the composition of the Greek-controlled fleet.[6]

In the case of outstanding loans to shipping, the pass-through rate is estimated at 0.64, implying that a 10% increase in outstanding loans leads to 6.4% higher shipping inflows. The importance of outstanding loans —as was previously explained— is twofold. It represents the increase of the Greek-owned fleet, as well as the strengthening of the maritime cluster, since ship owners that receive a loan from a bank are also required to open an operational account for the financed vessel at the same bank, and to perform all the vessel's trading transactions (including freight receipts) though this account.

The parsimonious estimated ECM is the following:

$$\begin{aligned} d\log(sr) = {} & \underset{(4,10)}{0,05} - \underset{(-3,39)}{0,32}*d\log(sr)_{t-1} - \underset{(-1,74)}{0,13}*d\log(sr)_{t-2} \\ & + \underset{(2,31)}{0,17}*d\log(ind)_{t-1} + \underset{(1,73)}{0,59}*d\log(ls)_t \\ & - \underset{(-2,51)}{0,18}*DV038 - \underset{(-3,34)}{0,24}*DV0510 - \underset{(-5,06)}{0,55}*d_{t-1} \end{aligned}$$

$$R^2\text{-adj.} = 0,60 \qquad \text{F-statistic} = 12,07 \qquad (4)$$

Table 3 summarises the estimated parameters of equation (4).

Table 3 Results from the Error Correction Model

Shipping receipts (rs)	
[m,n,h]	[2,1,0]
δ_0	0.05* (4.10)
α_1	-0.32* (-3.39)
α_2	-0.13** (-1.74)
β_1	0.17* (2.31)
$\varkappa_o$	0.59** (1.73)
γ	-0.55* (-5.06)

* Denotes rejection of the null hypothesis at the 5% significance level.
** Denotes rejection of the null hypothesis at the 10% significance level.
Note: [m, n, h] are the maximum lags based on the Akaike (1973) and Schwarz (1978) information criteria.
The numbers in parentheses are t- statistics.

6 In Bragoudakis, Panagiotou and Thanopoulou (2010) an attempt is made to estimate a Greek Shipping freight index.

Table 4 Diagnostic Tests of ECM

R^2 - adj.	0.60
LM(1) [p-value]	0.82
LM(6) [p-value]	0.24
LM(12) [p-value]	0.68
ARCH(1) [p-value]	0.85
ARCH(2) [p-value]	0.78
Jarque-Bera [p-value]	0.35

In Table 4, the diagnostic tests of equation (4) are presented:

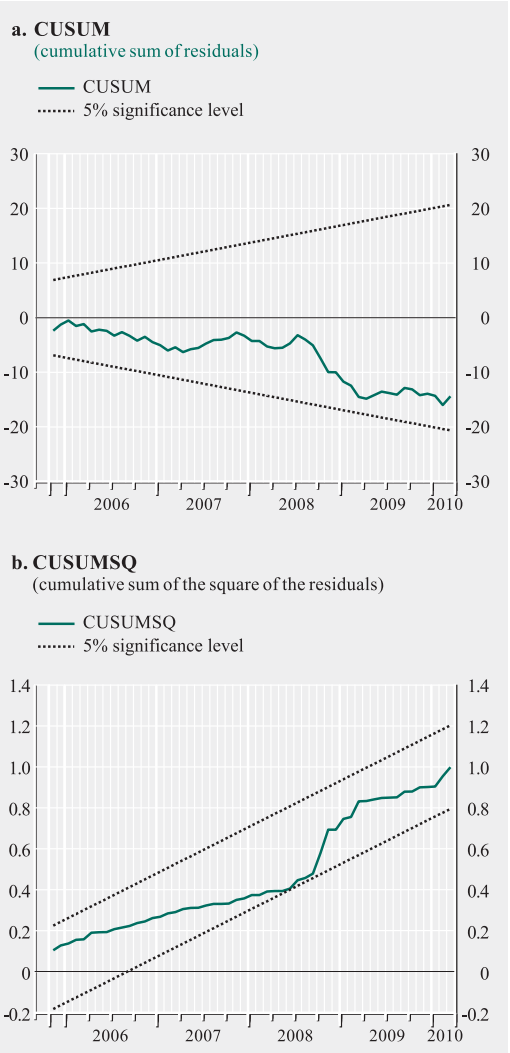
The estimated equation (4) shows good fitness and passes all diagnostic x^2 tests for the hypotheses that there is no serial correlation and autoregressive conditional heteroscedasticity and that the residuals follow the normal distribution. Furthermore, two impulse dummies that improve the fitness of the model —DV038 (August 2003) and DV0510 (October 2005)— were included.

One remaining problem concerns the stability of the estimated parameters of model (4) due to the relatively small sample. The CUSUM and CUSUM Square test was applied to the whole sample 2002:M2 to 2010:M3.

As Chart 1 shows, the null hypothesis of the parameter stability over the sample period cannot be rejected at the 5% significance level.

In the short run, the ClarkSea index with one-month time lag affects the inflow of receipts from shipping. The parameter β_1=0.17 —which represents the short-dynamic effect of the ClarkSea index on shipping receipts— measures the impact of the one-month lagged value of the freight index on the shipping inflows and generates an elasticity of 1.7%. Effectively, the modalities of freight collection imply that any payments will be recorded in the Greek BoP on average about a month later,[7] which is in accordance with the shipping practice.

Chart 1 CUSUM and CUSUMSQ test of the error correction model coefficients



Note: When the departures of the cumulative sum of residuals (CUSUM) and of the cumulative sum of the square of the residuals (CUSUMSQ) from their expected values lie within the upper and lower limits, this means that the null hypothesis that the coefficients remain constant at a 5% significance level can be accepted.

Parameter γ=-0.55 (adjustment coefficient) reveals the speed of adjustment to the equilibrium steady state and implies a relatively quick return to the long-run level. Finally, the negative coefficients α_1=-0.32 and α2=-0.13 of ship-

7 As confirmed by ship-broking sources (see Bragoudakis, Panagiotou and Thanopoulou, 2010).

Table 5 Recursive dynamic (3 months ahead) out-of-sample results

Models	ECM	AR(3)	AR(1)	RW
Forecast period	**RMSE**	**RMSE**	**RMSE**	**RMSE**
2009M1-2009M3	0.119	0.076	0.105	0.159
2009M2-2009M4	0.089	0.067	0.08	0.08
2009M3-2009M5	0.103	0.083	0.05	0.112
2009M4-2009M6	0.041	0.109	0.062	0.165
2009M5-2009M7	0.041	0.093	0.07	0.155
2009M6-2009M8	0.037	0.079	0.064	0.138
2009M7-2009M9	0.062	0.052	0.083	0.092
2009M8-2009M10	0.069	0.038	0.058	0.103
2009M9-2009M11	0.078	0.048	0.071	0.101
2009M10-2009M12	0.054	0.094	0.127	0.154
2009M11-2010M1	0.06	0.108	0.15	0.207
2009M12-2010M2	0.075	0.082	0.115	0.204
2010M1-2010M3	0.122	0.055	0.111	0.192
Average	**0.073**	**0.076**	**0.088**	**0.143**

ECM: Error Correction Model
AR(3): Autoregressive model of order 3
AR(1): Autoregressive model of order 1
RW: Random walk model
RMSE: Root mean square error

ping inflows with one- and two-month time lags respectively, indicate the corrective actions that companies may undertake in order to balance their overshooting behaviour. When inflows (revenues) for freight in one month are quite high, Greek-based shipping companies decide to reduce (in the following months) the freight revenues that charters remit to their accounts. Freight revenues are used, predominately, for bank loan servicing (interest and capital payments) and to cover ship management companies' operating expenses. This is an indication that each shipping company has a "target" account balance that it prefers to maintain, and any deviations are corrected.

The results of the recursive dynamic (3-months ahead) out-of-sample exercise based on equation (4) are presented in Table 5, and in more detail in the Appendix. The findings support the conclusion that the parsimonious estimated ECM outperforms the AR(3), AR(1) and random walk (RW) models. The average RMSE over the forecasting period 2009:M1-2010:M3 is lower for the ECM compared to the various benchmark time series models, thus the ECM produces more accurate estimations.

These findings are further supported by the results with respect to the MAE, MAPE and Theil's inequality coefficient statistics, as presented in the Appendix.[8] To conclude, the forecasting ability test of the proposed ECM provides evidence that this could be a useful tool for short-term projections of shipping receipts in the Greek economy. In addition, the discussed ECM —due to its structural specification— can be utilised for simulations analysis regarding the short-term response of shipping receipts to exogenous parameters related to

8 RMSE, MAE, MAPE and the Theil's inequality coefficient all favour the estimated ECM's forecasting ability. The only exception being the AR(1) model which —only according to the MAPE statistic— outperforms the ECM.

the freight rate index or the financing conditions in shipping.

5 SUMMARY AND CONCLUSIONS

Receipts from the provision of shipping services play a pivotal role in covering the Greek current account deficit. In the 1970s and 1980s, a number of researchers have explored the determinants of shipping receipts. However, since the change in the methodology used to compile the BoP and the changeover from the drachma to the euro, there has been no relevant research to the best of our knowledge.

This study explored the relationship between receipts from the provision of shipping services (cross-trade), freight rates, and outstanding loans to the shipping sector. Its empirical findings revealed the existence of a stable long-run relationship between the ClarkSea index, the outstanding loans and the inflows of shipping receipts.

It also detected evidence of a limited pass-through of 44% from freight rates and of 64% from outstanding loans to the shipping inflow. These results are closely related to the international nature of the Greek shipping business model and the increasing significance of Greek shipping and shipping cluster (including the shipping finance sector). Finally, the out-of-sample forecast performance exercise revealed that the selected ECM is more efficient (lower RMSE) than some "benchmark" selected time series models.

Recursive dynamic (3-months ahead) out-of-sample results

Models	ECM				AR(3)				AR(1)				RW			
Frecast period	RMSE	MAE	MAPE	Theil	RMSE	MAE	MAPE	Theil	RMSE	MAE	MAPE	Theil	RMSE	MAE	MAPE	Theil
2009M1-2009M3	0.119	0.099	177.891	0.526	0.076	0.071	124.184	0.345	0.105	0.083	69.021	0.783	0.159	0.116	55.636	0.657
2009M2-2009M4	0.089	0.076	210.715	0.573	0.067	0.057	211.278	0.454	0.080	0.053	78.666	0.892	0.080	0.068	447.368	0.456
2009M3-2009M5	0.103	0.087	254.617	0.605	0.083	0.082	257.948	0.743	0.050	0.040	96.382	0.645	0.112	0.106	498.866	0.642
2009M4-2009M6	0.041	0.039	86.584	0.285	0.109	0.101	198.741	0.983	0.062	0.050	74.849	0.690	0.165	0.159	531.004	0.861
2009M5-2009M7	0.041	0.040	58.353	0.226	0.093	0.075	95.344	0.719	0.070	0.070	98.007	0.670	0.155	0.144	277.698	0.959
2009M6-2009M8	0.037	0.034	35.658	0.182	0.079	0.062	62.223	0.452	0.064	0.063	63.008	0.434	0.138	0.119	221.329	0.553
2009M7-2009M9	0.062	0.047	76.416	0.334	0.052	0.050	60.218	0.370	0.083	0.083	106.669	0.649	0.092	0.088	195.991	0.354
2009M8-2009M10	0.069	0.061	586.451	0.445	0.038	0.036	539.899	0.261	0.058	0.055	417.768	0.437	0.103	0.100	104.573	0.396
2009M9-2009M11	0.078	0.076	614.473	0.798	0.048	0.042	501.327	0.499	0.071	0.065	385.080	0.884	0.101	0.096	115.287	0.589
2009M10-2009M12	0.054	0.048	233.683	0.232	0.094	0.085	484.860	0.510	0.127	0.104	191.897	0.815	0.154	0.134	120.586	0.660
2009M11-2010M1	0.060	0.057	54.303	0.24	0.108	0.103	80.560	0.574	0.150	0.146	117.806	0.863	0.207	0.185	75.040	0.668
2009M12-2010M2	0.075	0.060	93.444	0.279	0.082	0.066	45.311	0.400	0.115	0.099	75.758	0.635	0.204	0.168	56.387	0.650
2010M1-2010M3	0.122	0.108	115.082	0.587	0.055	0.047	42.025	0.240	0.111	0.094	73.592	0.638	0.192	0.158	57.735	0.627
Average	**0.073**	**0.064**	**199.821**	**0.409**	**0.076**	**0.067**	**207.994**	**0.504**	**0.088**	**0.077**	**142.193**	**0.695**	**0.143**	**0.126**	**212.115**	**0.621**

ECM: Error Correction Model
AR(3): Autoregressive model of order 3
AR(1): Autoregressive model of order 1
RW: Random walk model
RMSE: Root mean square error
MAE: Mean absolute error
MAPE: Mean absolute percentage error
Theil: Theil's inequality coefficient

REFERENCES

Akaike, H. (1973), "Information theory and an extension of the maximum likelihood principle", in Petrov, B.N. and F. Csaki (eds), 2nd International Symposium of Information Theory, Akademiai Kiado, Budapest.

Anderson, R.G., D.L. Hoffman and R.H. Rasche (2002), "A vector error-correction forecasting model of the US economy", *Journal of Macroeconomics* 24(4), 569-98.

Bank of Greece (1999), *Annual Report 1998*, Chapter VIII, Box VIII.1.

Bragoudakis, Z., St. Panagiotou and H. Thanopoulou (2010), "Investment strategy and Greek shipping earnings: exploring the pre & post 'ordering-frenzy' period", Proceedings of the International Association of Maritime Economists Conference, July, Lisbon.

Charlafti, J., I. Theotoka and H. Thanopoulou (2009) [in Greek], "Το παρόν και το μέλλον της ελληνικής ναυτιλίας" ["The present and the future of Greek shipping"], Papers of the Athens Academy Economic Studies Office (scientific responsible: K. Drakatos): Paper 10, Academy of Athens.

Clarkson Research Services (2009), *Sources & Methods for the Shipping Intelligence Weekly*. Updated: May 2009, www.clarksons.net.

Clarkson Research Services (2010), *Shipping Intelligence Network*, www.clarksons.net.

Clements, M.P. and D.F. Hendry (1993), "On the limitations of comparing mean square forecast errors", *Journal of Forecasting*, 617-37.

Constantopoulou, M. (1976) [in Greek], "Ναυτιλιακό Συνάλλαγμα: Οικονομετρική Ανάλυση και Προβλέψεις για την πενταετία του προγράμματος ανάπτυξης 1976-1980" ["Shipping exchange inflows: econometric analysis and projections for the 5-year duration of the growth programme 1976-1980"], Center of Planning and Economic Research (KEPE) Athens.

Deardorff, A.V. (1984), "Testing trade theories and predicting trade flows", in Jones R.W. and P.B. Kenen (eds), *Handbook of International Economics*, Vol. I.

Dickey, D.A. and W.A. Fuller (1981), "Likelihood ratio statistics for autoregressive time series with a unit root", *Econometrica* 49, 1057-72.

Engle, R.F. and C.W.J. Granger (1987), "Cointegration and error-correction: representation, estimation and testing", *Econometrica* 55, 251-76.

Goldstein, M. and M.S. Khan (1985), "Income and price effects in foreign trade", in Jones R.W. and P.B. Kenen (eds), Handbook of International Economics, Vol. II.

Goulielmos, A.M. (1993), "The behaviour of the state, of ship owners and of the Greek shipping foreign exchange inflow during 1981-1991", in *Volume of essays in memory of Prof. Fr. A. Letsas*, University of Piraeus.

Goulielmos, A.M. (1997), "The factors determining the foreign exchange inflows from shipping", in the *Volume of essays in honour and memory of late Professor Emeritus of Maritime Economics Dr. B.N. Metaxas*, University of Piraeus, Department of Maritime Studies, 567-87.

Grammenos, C.Th. (2002) (ed.), *The Handbook of Maritime Economics and Business*, Lloyd's of London Press, London.

GSCC (various years), *Greek Controlled Shipping*, Greek Shipping Cooperation Committee.

Haralambides, H.E. (1986) [in Greek], "Ναυτιλία και οικονομική ανάπτυξη" ["Shipping and economic growth"], *Themata Programmatismou*, 30, Center of Planning and Economic Research (KEPE), Athens.

Haralambides, H.E. (1990), "Shipping transactions in the balance of payments statistics: A tabular approach", *Marine Policy Reports*, Vol. I, no 2.

Haralambides, H.E. (1996), "The economic impact of shipping on the national economy", Proceedings of the International Conference on Shipping, Ports and Logistics Services: Solutions for Global Issues, International Association of Maritime Economists, Vancouver.

Harris, R. (1995), *Using Cointegration Analysis in Econometric Modelling*, Prentice Hall, London, chapter 4, 52-72.

Helkie, W. and L. Stekler (1987), "Modeling investment income and other services in the US International Transactions Accounts", *International Finance Discussion Paper* no 319, Federal Reserve Board.
Hendry, David F. (1995), *Dynamic Econometrics*, Oxford University Press, Oxford.
Hoffman, D.L. and R.H. Rasche (1996), "Assessing forecast performance in a cointegrated system", *Journal of Applied Econometrics* 11, 495-517.
Hung, J.H. and S. Viana (1995), "Modelling US Services Trade Flows: a Cointegration-ECM approach", Federal Reserve Bank of New York Research Paper, no. 9518.
Hymans, S.H., A.V. Deardorff and R.M. Stern (2000), *A quarterly forecast of the US trade in services and the current account, 2000-2003*, University of Michigan.
IMF (1995), *Balance of Payments Compilation Guide*, International Monetary Fund, Washington, D.C.
IMF (1996), *Balance of Payments Textbook*, International Monetary Fund, Washington D.C.
Karsenty, G. (2000), "Assessing trade in services by mode of supply", in Suave P. and R. Stern (eds), GATS 2000: *New Directions in Services Trade Liberalization*, Brookings Institution, Washington D.C., 487-508.
Kravis, I.B. (1983), "Services in the domestic economy and in world transactions", NBER Working Paper no. 1124, National Bureau of Economic Research.
Leontief, W. (1954), "Domestic production and foreign trade: the American capital position reexamined", *Economia Internazionale* 7, February, 3-32.
MacDougall, G.D.A. (1951), "British and American export: a study suggested by the theory of comparative costs, Part I", *Economic Journal* 61, December, 697-724.
MacDougall, G.D.A. (1952), "British and American export: a study suggested by the theory of comparative costs, Part II", *Economic Journal* 62, September, 487-521.
MacKinnon, J.G. (1991), "Critical Values for Cointegration Test", in Engle R.F. and C.W.J. Granger (eds), *Long-Run Economic Relationships. Readings in Cointegration*, Oxford University Press, New York, 266-76.
Panagiotou, St. and Z. Bragoudakis (2010) [in Greek], "Κεφάλαιο 2.5 Θαλάσσιες μεταφορές – ποντοπόρος ναυτιλία" ["Chapter 2.5 Sea transport – ocean shipping"] in Γ. Οικονόμου, Ι. Σαμπεθάι και Γ. Συμιγιάννης (eds), *Ισοζύγιο τρεχουσών συναλλαγών της Ελλάδος: αιτίες ανισορροπιών και προτάσεις πολιτικής*, Bank of Greece.
Pantelidis, E.Th. (1997), "The new methodology of the Bank of Greece for compiling the balance of payments", Bank of Greece, *Economic Bulletin* 9.
Schwarz, G. (1978), "Estimating the dimension of a model", *Annals of Statistics* 6, 461-64.
Stock, J.H. and M.W. Watson (1999), "Forecasting Inflation", NBER Working Paper no. 7023, March, National Bureau of Economic Research.
Tambakis, D. (1984), "An econometric analysis of the factors affecting shipping in Greece", *Maritime Policy & Management*, Vol. 11:1, 21-33.
Thanopoulou, H.A. (2007), "A fleet for the 21st century: modern Greek shipping", in Pallis A.A. (ed.), *Maritime Transport: the Greek Paradigm*, Elsevier, Oxford.