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APPLICATION OF MULTI CRITERIA DECISION MAKING TECHNIQUES IN FINANCE: THE CASE OF THE GREEK COASTAL SHIPPING COMPANIES

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List of Abbreviations

AHP	Analytic Hierarchy Process
ANP	Analytic Network Process
ASE	Athens Stock Exchange
CAPM	Capital Asset Pricing Model
DEA	Data Envelopment Analysis
DSS	Decision Support System
EC	European Commission
ELECTRE	Elimination and Choice Translating Reality
EMH	Efficient Market Hypothesis
EU	European Union
FI	Financial Institution
GCS	Greek Coastal Shipping
IAS	International Accounting Standards
IRR	Internal Rate of Return
ISO	International Standardization Organization
LOS	Level of Service
MA	Multi-Criteria Analysis
MADM	Multi-Attribute Decision Making
MARAD	Maritime Administration – USA
MARPOL	Marine Pollution / International Convention
MCDM	Multi-Criteria Decision Making
MCDSS	Multi-Criteria Decision Support System

MMM	Minister (or Ministry) of Mercantile Marine
MODM	Multi-Objective Decision Making
MTO	Multi-modal Transport Operator
NPV	Net Present Value
NTUA	National Technical University of Athens
OECD	Organization for Economic Co-Operation and Development
PEST	Political-Economic-Social-Technical
SOLAS	Safety of Life at Sea / International Convention
SSS	Short Sea Shipping
STCW	Standard Training & Certification of Watchkeepers / International Convention
TEN	Trans-European Networks
TFN	Triangular Fuzzy Number
TOPSIS	Technique for Order Preference by Similarity to Ideal Solution
ULCC	Ultra-Large Crude Carrier
US-GAAP	US – Generally Accepted Accounting Principles
VLCC	Very-Large Crude Carrier
WPM	Weighted Product Method
WSM	Weighted Sum Method

Abstract

This thesis deals with the application of Multi-Criteria Decision Making (MCDM) techniques for the problem of the overall evaluation of the Greek Coastal Shipping (GCS) companies, and it focuses on the needs of lenders and investors. The importance of GCS is very high for the Greek society, as it demands regulation consistent also with European practices. It also demands efficient network operations for social and economic reasons and close financial monitoring as the important actors are listed at the Athens Stock Exchange (ASE). Lately, these companies have experienced growth, as a result of the partial deregulation of the industry, of the equity inflow from the ASE and the introduction of new vessels in service. In this thesis, it is also proven that the market is not concentrated, and is equally carved into niches for all actors in the market. The analysis period is extended from the fiscal year of 1997 up to 2002; this is a result of the availability of the data and their integrity check.

As revealed from the literature, there is no prior work on this issue, as well as there is no MCDM approach reported for the niche market of the GCS. Shipping finance literature is basically focused on time-series analyses and the lending (risk assessment) criteria are drafted in textbooks for many decades already. The literature on the GCS is considered as stagnant in the last years, as researchers with active presence in the mid-90s have not presented valuable new ideas in the academic community.

The selected MCDM method is the Analytic Hierarchy Process (AHP). This method was preferred from other established methodologies as it does not demand prior knowledge of the utility function, it is based on a hierarchy of criteria and attributes reflecting the understanding of the problem, and finally, because it allows relative and absolute

comparisons, thus making this method a very robust tool. AHP is adequately discussed and reviewed; the method allows combinations with other techniques, as well as, scenario analysis and simulation exercises. Last but not least, AHP allows group decision-making and is convenient in numerical handling.

The issue of the operational risk and of the risk assessment of the lenders is critical. Most of the capital gearing this industry is coming from lending financial institutions (FI); the capital inflow from ASE amounts only to less than 10% of the total liabilities of these companies. Taking as a basis the criteria and the risk structure as described in the textbooks, and by soliciting data by using questionnaires, a ranking model for the lending institution is derived. This model is based on simulations for the assignment of weights at the upper levels of the hierarchy and provides a mapping of the lenders' market according to basic attributes: quality of the lending portfolio, assurance required on the loans and marketing. This permit also further clustering of this market. It is also easy to add alternatives (lenders) as the model is based on absolute comparisons, in order to facilitate alterations of the mix of the lenders.

The main issue of evaluating the overall ranking of GCS companies is addressed with the construction of a rather expanded hierarchy. A hierarchy with four main levels of criteria is used; two major categories of criteria are considered: those referring to the internal and those referring to the external forces of the company. Under the 'internal' group fall the criteria of the fundamental accounting, of the logistics services offered, and of the management related ones. The criteria subsets of stock performance, market environment and of the competition fall under the 'external' group of criteria. Under these clusters almost seventy attributes are taken into account. A full justification for the selection as well as for the relative weighting is

provided. In most cases this was a result of the availability of data. For the upper levels of the criteria both scenario analyses and simulation exercises have been considered. The resulting ranking and indices provide a clear track of the course of the companies over the period of analysis (1997-2002). It is possible to monitor their course over time (overall index), as well as over partial attributes, such as the external and the internal criteria. A deeper degree of analysis is also possible but it cannot be visualized in planar graphs.

The model can be validated according to the shift-share calculations. In 60% of the cases, the shift-share analysis of the turnover data may explain the differences of the indices and in the rest cases there is a consistency with the shift-share calculations of the traffic. Apart from the overall ranking and monitoring over the years it is possible to use the same hierarchy or elements of the structure for practical problems, such as the corporate planning and mergers. In corporate planning it is possible to estimate the final position of the company if some tactical movements occur or to foresee the result of these movements, by using the same hierarchy and weights. In cases, where new actors or new parameters shall be taken into account, elements from the hierarchy may assist in the planning. This is also the case for the selection of the optimum merger-alternative. The model aims to have capabilities for practical use; nevertheless, it is consistent with the basic theory as described in the textbooks.

In all cases the consistency of the judgments remained under the limit of 10% as demanded from the theory, so there is confidence in the final numerical results. Different opinions or approximations may stem out of different sets of criteria. It is possible to include more alternatives and more criteria in the hierarchy as is but there is always the question over the availability and the integrity of the data for all companies in the set and for all years of the analysis.

Apart from suggestions for further development of the application as well as for further theoretical consideration, this manuscript includes large lists of indices, tables, figures and annexes aiming to assist the reader in understanding the depth of the analysis, the effort dedicated and in providing a solid data-base for these GCS companies.

The findings are also flourished with suggestions for further research and development of the prototype modeling. It is interesting to note that some applications may have different beneficiaries and may support more complex decisions.

The contribution of this thesis in the state of the art is evident. For the first time in the academic literature, a market analysis of the most significant actors in the GCS is provided. Furthermore, the analysis of their financial and operational course into sub-criteria reveals differences of their structure and their decisions. The classification of these companies according to a rational set of criteria comprises, also, a very powerful tool for managerial decisions. This tool may easily be used by the management of the company for comparison or planning reasons, as well as by academics and policy-makers as monitoring tool of the market. The tool is validated through a shift-share analysis of historical data, thus strengthening the belief that the appointed weights are reflecting actual conditions. Of course, an MCDM tool remains a subjective tool and the hierarchy reveals the understanding of the problem, as well as the indented goals. Further research and adjustments may easily be launched on the basis of this prototype. Last, but not least, the analysis of the lenders' market, as well as, side results of the analysis, such as the market concentration analysis appear for the first time in the academic and business literature.

Περίληψη

Η διατριβή έχει ως θέμα την εφαρμογή πολυκριτηριακών μεθόδων λήψης απόφασης στο πρόβλημα της συνολικής αξιολόγησης των ελληνικών ακτοπλοϊκών εταιρειών, και εστιάζεται στις ανάγκες των δανειστών και των επενδυτών. Η σημασία των ακτοπλοϊκών συγκοινωνιών (ΑΣ) είναι πολύ μεγάλη για την Ελληνική κοινωνία και απαιτεί κανονιστικά μέτρα σύμφωνα με τις Ευρωπαϊκές πρακτικές. Επίσης οι ΑΣ απαιτούν αποδοτικές λειτουργίες δικτύου για λόγους οικονομικούς και κοινωνικούς καθώς και στενή χρηματοοικονομική παρακολούθηση, διότι οι κυριότερες εταιρείες που δραστηριοποιούνται είναι εισηγμένες στο Χρηματιστήριο Αξιών Αθηνών (ΧΑΑ). Κατά τα τελευταία χρόνια, οι εταιρείες αυτές αναπτύχθηκαν δυναμικά, ως αποτέλεσμα της μερικής απελευθέρωσης της αγοράς και την εισαγωγή νέων πλοίων στις γραμμές. Αποδεικνύεται ότι η αγορά δεν είναι συγκεντρωμένη, και ότι είναι μοιρασμένη σε ίσα μερίδα για όλες τις σημαντικές εταιρείες. Η περίοδος ανάλυσης περιλαμβάνεις τις οικονομικές χρήσεις από το 1997 έως το 2002. Αυτό οφείλεται στα διαθέσιμα στοιχεία και τον έλεγχο ακεραιότητας τους.

Όπως προκύπτει από τη βιβλιογραφική αναζήτηση, δεν υπάρχει παρόμοια εργασία σε αυτό το πεδίο. Η βιβλιογραφία της ναυτιλιακής χρηματοδότησης εστιάζεται κυρίως σε θέματα ανάλυσης χρονοσειρών και σε θέματα κριτηρίων δανεισμού (αξιολόγηση κινδύνων) για πολλά έτη. Η βιβλιογραφική πρόοδος σε θέματα ΑΣ είναι μάλλον στάσιμη τα τελευταία έτη, αφού ερευνητές με ενεργή παρουσία στις αρχές της δεκαετίας 1990 δεν έχουν παρουσιάσει αξιόλογες νέες ιδέες στην ακαδημαϊκή κοινότητα.

Η επιλεγμένη πολυκριτηριακή μέθοδος είναι η Analytic Hierarchy Process (AHP). Η μέθοδος προτιμήθηκε από άλλες καθιερωμένες

μεθοδολογίες, διότι δεν απαιτεί πρότερη γνώση της συνάρτησης χρησιμότητας, βασίζεται σε ιεραρχικά δομημένα κριτήρια και χαρακτηριστικά, που αποκαλύπτουν την αντίληψη που έχει ο λήπτης της απόφασης για το πρόβλημα, και τελικά, γιατί επιτρέπει σχετικές και απόλυτες συγκρίσεις. Η AHP έχει συζητηθεί εκτεταμένα στη βιβλιογραφία και από ερευνητές. Η μέθοδος επιτρέπει τον συνδυασμό με άλλες τεχνικές, τη κατάστρωση σεναρίων καθώς και προσομοιώσεις. Κλείνοντας, η μέθοδος επιτρέπει συλλογική λήψη απόφασης και είναι ευέλικτη σε αριθμητικούς χειρισμούς.

Το ζήτημα του λειτουργικού κινδύνου (operational risk) και της αξιολόγησης κινδύνων από τους δανειστές είναι κρίσιμο. Το μεγαλύτερο ποσοστό των κεφαλαίων χρηματοδότησης των ΑΣ προέρχεται από τα πιστωτικά ιδρύματα. Η εισροή κεφαλαίων από το ΧΑΑ ανήλθε κατά τη περίοδο ανάλυσης μόλις στο 10% των συνολικών υποχρεώσεων (μακροπρόθεσμα δάνεια) των εταιρείων υπό μελέτη. Με βάση τα κριτήρια και τη δομή του κινδύνου όπως περιγράφεται στη βιβλιογραφία καθώς και με χρήση δεδομένων που παρήχθησαν από τη συμπλήρωση ερωτηματολογίων κατασκευάστηκε ένα μοντέλο ταξινόμησης των πιστωτικών ιδρυμάτων. Το μοντέλο βασίζεται σε προσομοιώσεις για την απόδοση βαρών στα κριτήρια των ανωτέρω τμημάτων της ιεραρχίας και παρέχει μια απεικόνιση της αγοράς των πιστωτών σύμφωνα με βασικά χαρακτηριστικά: η ποιότητα του χαρτοφυλακείου δανείων, εξασφαλίσεις επί των δανείων και marketing. Το μοντέλο επιτρέπει και περαιτέρω ταξινόμηση (clustering) της αγοράς. Είναι εύκολο να προστεθούν εναλλακτικές (πιστωτικά ιδρύματα δηλαδή) αφού το μοντέλο βασίζεται σε απόλυτες συγκρίσεις ούτως ώστε να μπορεί να διαχειρίζεται αλλαγές στο μείγμα των εναλλακτικών.

Το κύριο πρόβλημα της ταξινόμησης των ακτοπλοικών εταρειών αντιμετωπίζεται με την κατασκευή μιας αρκετά ανεπτυγμένης

ιεραρχίας. Χρησιμοποιείται μια ιεραρχία με τέσσερα διακριτά επίπεδα κριτηρίων. Δυο κύριες κατηγορίες κριτηρίων λαμβάνονται υπ'όψιν: η πρώτη αναφέρεται στις δυνάμεις του εσωτερικού περιβάλλοντος και η δεύτερη στου εξωτερικού. Κάτω από την κατηγορία 'εσωτερικού περιβάλλοντος' εμπίπτουν τα κριτήρια που σχετίζονται με τα θεμελιώδη λογιστικά μεγέθη, τις προσφερόμενες υπηρεσίες logistics, και τη διοίκηση της επιχείρησης. Τα κρίσιμα υποσύνολα κριτηρίων της απόδοσης της μετοχής, των συνθηκών της αγοράς και του ανταγωνισμού εμπίπτουν στη κατηγορία κριτηρίων του 'εξωτερικού περιβάλλοντος'. Σε αυτές τις κατηγορίες κριτηρίων αναφέρονται και χρησιμοποιούνται περίπου εβδομήντα διακριτά και ανεξάρτητα χαρακτηριστικά των εταιρείων. Πλήρης δικαιολόγηση για την επιλογή των κριτηρίων καθώς και τη σύγκριση μεταξύ τους παρέχεται όπου χρειάζεται. Τις περισσότερες φορές είναι αποτέλεσμα της διαθεσιμότητας και της ακεραιότητας των δεδομένων. Για τα ανώτερα επίπεδα της ιεραρχίας η απόδοση βαρών μεταξύ των κριτηρίων γίνεται και με ανάλυση σεναρίων και με προσομοίωση. Η καταληκτική ταξινόμηση και οι δείκτες παρέχουν καθαρή εικόνα για την πορεία των εταιρείων κατά την περίοδο ανάλυσης (1997 – 2002). Καθίσταται δυνατή η παρακολούθηση συνολικώς ή μερικώς, ήτοι η ανάλυση επιμέρους χαρακτηριστικών όπως τα κριτήρια εσωτερικού και εξωτερικού περιβάλλοντος. Βαθύτερη και περαιτέρω ανάλυση είναι δυνατή αλλά δεν μπορεί να αναπαρασταθεί σε επίπεδα διαγράμματα.

Το μοντέλο επιβεβαιώνεται από τα αποτελέσματα αναλύσης μεριδίων (shift-share analysis). Στο 60% των περιπτώσεων η ανάλυση των μεριδίων κύκλου εργασιών εξηγεί τις μεταβολές των δεικτών του μοντέλου και στις υπόλοιπες περιπτώσεις συμβαδίζει με ανάλυση μεριδίων του διακινούμενου μεταφορικού όγκου. Εκτός από την εφαρμογή ταξινόμησης και παρακολούθησης της πορείας των

εταιρείων κατά οικονομικές περιόδους είναι δυνατή η χρήση της ιεραρχίας ή στοιχείων της για την αντιμετώπιση πρακτικών προβλημάτων όπως είναι ο στρατηγικός σχεδιασμός και οι συγχωνεύσεις. Για τις ανάγκες στρατηγικού σχεδιασμού είναι δυνατή η εκτίμηση της θέσης της εταιρείας ως αποτέλεσμα τακτικών κινήσεων ή για ανάγκες πρόβλεψης, χρησιμοποιώντας την ίδια ιεραρχία και τα ίδια βάρη. Σε περιπτώσεις όπου νέες εναλλακτικές (εταιρείες) ή νέες παράμετροι (κριτήρια) πρέπει να ληφθούν υπ᾽όψιν στοιχεία της ιεραρχίας μπορούν να χρησιμοποιηθούν άμεσα για τις ανάγκες του σχεδιασμού. Αυτή είναι κιόλας η περίπτωση της επιλογής άλλης εταρείας στο πρόβλημα της βέλτιστης συγχώνευσης. Το μοντέλο σκοπεύει να έχει δυνατότητες πρακτικής εφαρμογής αλλά είναι και απολύτως σύμφωνο με την θεωρία όπως περιγράφεται στη βιβλιογραφία.

Σε όλες τις περιπτώσεις ο βαθμός συνέπειας (consistency ratio) διατηρείται κάτω από το όριο του 10%, όπως απαιτεί η θεωρία, έτσι ώστε να υπάρχει εμπιστοσύνη στο τελικό αποτέλεσμα. Διαφορετικές γνώμες ή προσεγγίσεις οφείλονται σε διαφορετικό σύνολο κριτηρίων ή διαφορετικές τεχνικές αξιολόγησης. Είναι δυνατό να εισαχθούν στο μοντέλο εναλλακτικές και κριτήρια αλλά πρέπει κανείς να επιλύσει πολλά επιμέρους προβλήματα διαθεσιμότητας και ακεραιότητας στοιχείων των εταρείων για όλα τα χρόνια της ανάλυσης.

Εκτός από τις προτάσεις για περαιτέρω ανάπτυξη της εφαρμογής καθώς και για θεωρητικές προσεγγίσεις, το κείμενο της διατριβής περιλαμβάνει μακρείς καταλόγους από δείκτες, πίνακες, διαγράμματα και παραρτήματα που στοχεύουν στην καλύτερη κατανόηση, στην βαθύτερη ανάλυση και την επενδεδυμένη προσπάθεια για μια σταθερή βάση αναφοράς στοιχείων των εταιρειών ΑΣ. Τα ευρήματα έχουν επενδυθεί με προτάσεις για την περαιτέρω ανάπτυξη του πρωτοτύπου. Είναι ενδιαφέρον ότι κάποιες

εφαρμογές του έχουν διαφορετικούς αποδέκτες – χρήστες και ότι μπορούν να υποστηρίξουν και πιο σύνθετες αποφάσεις.

Η συμβολή της διατριβής στην επιστημονική ανάλυση των ΑΣ είναι προφανής. Για πρώτη φορά στην ακαδημαική βιβλιογραφία παρέχεται εργαλείο για την εις βάθος ανάλυση της αγοράς ΑΣ και των σημαντικών συντελεστών της. Επίσης η ανάλυση των χρηματοοικονομικών και λειτουργικών παραμέτρων σε κατηγορίες κριτηρίων φανερώνει τις διαφορές στην δομή και στην πορεία των εταιρείων ΑΣ. Η ταξινόμηση των εταιρείων ΑΣ σύμφωνα με μια ορθολογική ιεραρχία κριτηρίων αποτελεί ισχυρό εργαλείο διοίκησης. Αυτό το εργαλείο μπορεί να χρησιμοποιηθεί για σχεδιασμό και συγκρίσεις καθώς και για τη δομημένη παρακολούθησης της αγοράς. Η επιβεβαίωση του μοντέλου μέσα από ανάλυση μεριδίων, δηλαδή μέσα από ιστορικά στοιχεία, ενδυναμώνει την πεποίθηση της ορθής απόδοσης βαρών μεταξύ κριτηρίων. Το μοντέλο αντικατοπτρίζει σε μεγάλο βαθμό τις πραγματικές συνθήκες. Φυσικά ένα πολυκριτηριακό εργαλείο παραμένει υποκειμενικό σε κάποιο βαθμό και η ιεραρχία των κριτηρίων αποκαλύπτει την κατανόηση και την εμπειρία επί του προβλήματος αλλά και υποδεικνύει τους στόχους που έχουν τεθεί. Περαιτέρω έρευνα και προσαρμογές επί την βάση του πρωτοτύπου είναι εύκολες και εφικτές τόσο για την ταξινόμηση των εταιρείων ΑΣ όσο και των πιστωτικών ιδρυμάτων εμφανίζονται για πρώτη φορά στη σχετική βιβλιογραφία.

1 Executive Summary

This thesis deals with the application of Multi-Criteria Decision Making (MCDM) techniques for the problem of the overall evaluation of the Greek Coastal Shipping (GCS) companies, and it focuses on the needs of lenders and investors. The importance of GCS is very high for Greek society, as it demands regulation consistent also with European practices. It also demands efficient network operations for social and economic reasons and close financial monitoring as the important actors are listed at the Athens Stock Exchange (ASE). Lately, these companies have experienced growth, as a result of the partial deregulation of the industry, of the equity inflow from the ASE and the introduction of new vessels in service. It is proven that the market is not concentrated, and is equally carved into niches for all actors in the market. The analysis period is extended from the fiscal year of 1997 up to 2002; this is a result of the availability of the data and their integrity check.

As revealed from the literature, there is no prior work on this issue. Some papers are dealing with the overall performance of shipping companies, yet only academically. These application of MCDM techniques in finance and risk assessment as conventional modeling, does not take into account subjective points of view (expert influence) and behavioral issues. Shipping finance literature is basically focused on time-series analyses and the lending (risk assessment) criteria are drafted in textbooks for many decades long. Although there are significant developments in the market, the basic risk assessment methodologies are heavily depended on the expertise of the officer in charge. The literature on the GCS is considered as stagnant in the last years, as researchers with active presence in the mid-90s have not presented valuable new ideas in the academic community.

The selected MCDM method is the Analytic Hierarchy Process (AHP). This method was preferred from other established methodologies as it does not demand prior knowledge of the utility function, it is based on a hierarchy of criteria and attributes reflecting the understanding of the problem and finally because it allows relative and absolute comparisons. AHP is adequately discussed and reviewed, where necessary, from researchers and allows combinations with other techniques as well as scenario analysis and simulation exercises. Last but not least, AHP allows group decision-making and is convenient in numerical handling. As there is no requirement for specialized software, the whole application was developed in common spreadsheets for sufficient control of the steps, supervision of the rationality of the judgments, and transparency reasons. Furthermore as the model is developed on spreadsheets it is easy to add or to test data; this function is very helpful in scenario analyses as well as in the case of introducing more data (even for companies not listed at ASE or not active in this market).

The issue of the operational risk and of the risk assessment of the lenders is critical. Most of the capital gearing this industry is coming from lending financial institutions; the capital inflow from ASE amounts only to less than 10% of the total liabilities of these companies. Taking as a basis the criteria and the risk structure as described in the textbooks, and by soliciting data by using questionnaires, a ranking model for the lending institution is derived. This model is based on simulations for the assignment of weights at the upper levels of the hierarchy and provides a mapping of the lenders' market according to basic attributes: quality of the lending portfolio, assurance required on the loans and marketing. This permit also further clustering of this market. It is also easy to add alternatives (lenders) as the model is based on absolute comparisons, in order to

facilitate alterations of the mix of the lenders. The names of the lenders are known to the researcher but are not revealed in this study due to disclosure agreements.

The main issue of evaluating the overall ranking of GCS companies is addressed with the construction of a rather expanded hierarchy. A hierarchy with four main levels of criteria is used; two major categories of criteria are considered: those referring to the internal and those referring to the external forces of the company. Under the 'internal' group fall the criteria of the fundamental accounting, of the logistics services offered, and of the management related ones. The criteria subsets of stock performance, market environment and of the competition fall under the 'external' group of criteria. Under these clusters almost seventy attributes are taken into account. A full justification for the selection as well as for the relative weighting is provided. In most cases this was a result of the availability of data. For the upper levels of the criteria both scenario analyses and simulation exercises have been considered. The resulting ranking and indices provide a clear track of the course of the companies over the period of analysis (1997-2002). It is possible to monitor their course over time (overall index) as well as over partial attributes, such as the external and the internal criteria. A deeper degree of analysis is also possible but it cannot be visualized in planar graphs.

The model can be validated according to the shift-share calculations. In 60% of the cases, the shift-share analysis of the turnover data may explain the differences of the indices and in the rest cases there is a consistency with the shift-share calculations of the traffic. Generally it is not possible to validate a MCDM ranking method as from the theory it is known that different methods may yield different results and in practice only experience and historical data may assist towards validation exercises. Apart from the overall ranking and monitoring

over the years it is possible to use the same hierarchy or elements of the structure for practical problems, such as the corporate planning and mergers. In corporate planning it is possible to estimate the final position of the company if some tactical movements occur or to foresee the result of these movements, by using the same hierarchy and weights. In cases, where new actors or new parameters shall be taken into account, elements from the hierarchy may assist in the planning. This is also the case for the selection of the optimum merger-alternative. The model aims to have capabilities for practical use; nevertheless, it is consistent with the basic theory as described in the textbooks.

In all cases the consistency of the judgments remained under the limit of 10% as demanded from the theory, so there is confidence in the final numerical results. Different opinions or approximations may stem out of different sets of criteria. It is possible to include more alternatives and more criteria in the hierarchy as is but there is always the question over the availability and the integrity of the data for all companies in the set and for all years of the analysis.

Apart from suggestions for further development of the application as well as for further theoretical consideration, this manuscript includes large lists of indices, tables, figures and annexes aiming to assist the reader in understanding the depth of the analysis, the effort dedicated and in providing a solid data-base for these GCS companies.

The structure of this Thesis is the following, considering this chapter – Executive Summary – as the first one:

1. In the second chapter, the problem is adequately defined. The background presentation includes an analysis of the forces and the characteristics of the GCS. The chapter concludes with a thorough literature review, broken down into three distinctive

parts: shipping finance, MCDM and GCS. These fields are not directly related, but for the needs and purposes of this thesis it is essential to present papers, books and work of specific interest. It is also necessary to note, that the presentation of the broad academic field of MCDM is limited to the needs of this work.

2. In the third chapter, the Greek Coastal System (GCS) is thoroughly presented. Special analysis of the institutional framework, novel market analysis including also scrutiny of concentration indices and shift-share analysis, and some technical aspects of the system comprise the main characteristics of interest. All these data are 'official' ones, i.e. these are the original ones presented to the stock-exchange authorities and the companies bear liabilities for negligence or errors in these data-sets.
3. A chapter on the methodology follows. In this chapter, the general MCDM problem is presented first. Then the AHP is discussed; the aim of this presentation is not to include all theoretic and practical issues discussed in the literature, but rather to present the AHP as a technique and a tool for the purposes of this thesis. Nevertheless, the critical issues of group decision-making and of the sensitivity analysis are presented in greater detail, as they determine simulation and sensitivity analyses goals and limitations.
4. Chapter 5 is devoted on the issue of the Operating Risk. This is a critical concern for the lending institutions as they have to implement new risk-assessment and management rules. Furthermore it was also required to map the Greek lending market. The collection of questionnaires was the first step, and

then the creation of information out of these data-sets was achieved through the use of AHP, based on absolute comparisons. The use of simulation techniques at the upper levels was necessary, since there was the goal of an unbiased final result. The analysis concludes with clustering of the lending institutions, as well as with a stressing of the importance of the lender's capitals in the GCS.

5. Chapter six deals with the main problem of evaluating a GCS company. Large part of this chapter is devoted to a thorough analysis of the hierarchy as well as of the respective criteria. Then follows the application of the methodology; the simulation and scenario-based outcomes are developed and presented. The chapter concludes with comments on theoretical issues as well as with the validation remarks.
6. A chapter on the application of the model follows. In the previous chapters the ranking problems have been numerically dealt, but in this one the focus lies with its wider applications. By taking parts of the hierarchy or by altering slightly the hierarchy it is possible to expand the capabilities of the tool. Nevertheless, a detailed analysis of its current capabilities as planning tool is presented. Finally, this chapter includes also some theoretical considerations. Although AHP is rather well-discussed method, one can seldom find MCDM considerations in the literature. Most of the work performed is on the numerical handling and on the soundness of specific steps. It was, therefore, necessary to consider some theoretical aspects of the method.
7. The thesis concludes with a chapter summarizing the conclusions and suggesting further research and applications.

References, annexes, questionnaires, data and calculations are also available for further research or justification of the work performed.

The main results of this research work are thoroughly analyzed in the respected chapter; however the following findings are considered as the most value adding ones:

1 Literature Review

1.1 There are many but out of date texts regarding the risk structure and the criteria for financing shipping ventures. None is specifically addressed to SSS and coastal shipping.

1.2 There is a lot of literature in the field of MCDM but no MCDSS tool or MA methodology relevant to the shipping company evaluation is reported. Some attempts in the literature are limited to relative comparisons or to academic purposes. The use of MCDM techniques as well as the academic interest in the risk related problems is increased lately.

1.3 The issue of GCS in the literature has not appeared lately. Only papers and studies of the mid-90s' are reported and set the basis for further research and elaboration. Most of them are presented by Greek research institutions.

2 The Greek Coastal System:

2.1 The GCS companies have benefited from their listing at the ASE and have experienced enormous growth during the period 1997-2002.

2.2 The market-shares based on turnover are shifted from the dominant Cretan companies MINOAN and ANEK in the 90s' to the group of companies of EPATT (Superfast Ferries and Blue Star Lines – STRINTZIS).

2.3 Most of the revenues are attributed to fares charged (approximately 87%) and are accrued in the Adriatic (approximately 70%), although this market represents almost 30% of the total passenger traffic reported, 40% of the total car traffic and 55% of the total truck traffic.

2.4 The market is not oligopolistic. According to HHI and Gini coefficient methodologies, the market is not concentrated to some carriers.

2.5 There are not many and important developments regarding the ports servicing the vessels of these companies.

3 Methodology

3.1 AHP has been selected on the following grounds:

3.1.1 in absolute comparison mechanisms it is not possible to experience rank-preservation problems;

3.1.2 the set of data is very large and the relative comparison of every alternative for every year available would increase the numerical and decisional burden exponentially;

3.1.3 it is easy to add alternatives (existing or dummy ones), to experiment with the sensitivity of parameters, or to estimate

the outcome of an action (element sensitivity);

3.1.4 the focal attention lies on the hierarchy, i.e. on the insights and on the parameters determining the phenomenon

3.1.5 AHP can be combined with other methods

3.1.6 AHP-required hierarchies can be further developed to networks and systems with dependencies and influences (commonly addressed by ANP)

3.2 The sensitivity analysis is critical and has been addressed on the basis of specialized research on the AHP, in order to proceed in the:

3.2.1 Determination of the most critical criterion,

3.2.2 Determination of the most critical element in the decision matrix.

4 The lenders' market

4.1 Financial Institutions have to face risks in a totally different way and specifically deal with the operational risk.

4.2 Financial Institutions with lending interests in shipping are reduced in number but the overall portfolio is expanded.

4.3 Shipping companies will experience consolidation in number and simultaneous increase of their size. This is partially the result of splitting the market in risk-tiers in accordance to the new lending rules and strategies.

4.4 The importance of the GCS sector to the lenders is rather limited, as it represents about 6% of the total portfolio available and about 9% of the Greek FI active in the market (€1.64bn in 2001 and €2.15bn in 2002). According to data provided by the ASE, the GCS listed companies have acquired 220bn GrD (€645m) from the market up to the end of 2002. Obviously bank lending is considered as the most important source of financing.

5 The shipping company evaluation model and its applications:

5.1 The developed model can yield an overall evaluation of GCS companies according to a criteria structure (hierarchy).

5.2 The most critical criterion, i.e. the one that can alter the ranking with the minimum relative change is the one of the fundamental data (for the base-year).

5.3 Both simulation and scenario analysis yield the same ranking practically, with slight differences for a specific year of analysis. This is an interesting validating point.

5.4 The resulting index can be explained from the shift-share analysis. From the available data for the turnover, almost 60% of all results can be explained. For the rest of the elements a conjoint analysis with the shift-share analysis for the traffic is required.

5.5 The model can be used as is for the determination of overall rankings, corporate planning ('what-if' scenarios) and comparison with other companies not included in the current sample (say companies from other markets and or not listed GCS companies)

5.6 The model after adjustment of its hierarchy may also assist in corporate planning and focused cases, such as merger between companies.

The above findings are also flourished with suggestions for further research and development of the prototype modeling. It is interesting to note that some applications may have different beneficiaries and may support more complex decisions.

The contribution of this thesis in the state of the art is evident. For the first time in the academic literature, a market analysis of the most significant actors is provided. Furthermore, the analysis of their financial and operational course into sub-criteria reveals differences of their structure and their decisions. The classification of these companies according to a rational set of criteria comprises, also, a very powerful tool for managerial decisions. This tool may easily be used by the management of the company for comparison or planning reasons, as well as by academics and policy-makers as monitoring tool of the market. The tool is validated through a shift-share analysis of historical data, thus strengthening the belief that the appointed weights are reflecting actual conditions. Of course, an MCDM tool remains a subjective tool and the hierarchy reveals the understanding of the problem, as well as the indented goals. Further research and adjustments may easily be launched on the basis of this prototype. Last, but not least, the analysis of the lenders' market, as well as, side results of the analysis, such as the market concentration analysis appear for the first time in the academic and business literature.

2 Introduction

2.1 Problem Definition

This study is focused on the application of multi-criteria decision making (MCDM) techniques on the complex problem of shipping finance. As the field of shipping finance is rather expanded, the research effort is devoted on the Greek Coastal System (GCS). GCS is very important for the Greek national economy and almost all of the important shipping operators are listed at the Athens Stock Exchange (ASE). With the help of similar MCDM modeling, the market of lenders has been analyzed and mapped as well. Both MCDM applications are considered as innovative as there is no such work referred in the literature.

2.2 Analysis Background

Financing industries, businesses and projects are very appealing operations and demand attention, cautiousness and deep understanding. Financing has been traditionally the core activity of banks and other lending institutions, such as state-operated financial institutions granting capitals for various purposes. In the waterborne transportation sector, the main sources of finance have been the commercial banks, private placements, stock-markets, State-agencies (for instance MARAD in the US) as well as international bodies (such as OECD) through a system of subsidies and grants.

Lately, financing has become more innovative. Operations or projects have been widely financed through equity rising at organized markets, and return-seeking sources, such as private placements, venture capitals, etc. This trend reveals only the need of modern businesses to get capitals and merely the inability or the reluctance of the banking system to support financially the whole market. The

shipping market is a good example for tracing the capabilities and the limitations of banks. From the very beginning of shipping, as it is in these days, it was and still is conceived as a high risk industry.

In the late 1950s the image of shipping changed; shipping was, and still is, a risky venture, but the financing of new vessels upon contracted transport commissions changed the pattern of business. This was also an effect of the 1959 Greek proposal to the wider shipping market on the tax regime that is more or less still valid as well as the growth of the Eurodollar market and of the increase of capital needs. More on the subject can be found in the classic textbooks, such as those of Rinman and Brodefors (1983, pp.112-117), and of Stokes (1992, pp 12-20).

Financing has experienced sturdy progress due to theoretical advances and the blatant need to cover the needs of the financial institutions, the market and the States. Nevertheless, shipping finance has been wedged to a conventional form of business, based on the expertise of the bank officer and on a set of attributes of the loan-applicant: character , collateral, capacity and capital . More on these issues can be found in coming paragraphs (§5.2.2). So, despite the advances in the science and practice of finance, shipping finance remained a field with few research progress and all efforts have been focus on analyzing the market (see also §2.4.1). Evidently, the financial and research institutions invest in the market analysis, trying to get a better feeling of the trends as well as to model niches of the market, in order to rationalize their intuition. Towards such analysis, the book of Beenstock and Vergottis (1993) is invaluable, as it sums up all the efforts up to 1993 and the proposed modeling can be adjusted to the data streams banks own and retrieve.

In all forms of financing and in modern management, evaluation and benchmarking has become integral part in every-day decision making process. Whether financing comes from a financial institution, public or private placements, investors and creditors are primarily dealing with a multi-criteria decision making problem (MCDM) of discrete nature. Depending on the case, this problem is categorized as *choice of the better alternative, ranking of alternatives, classification or sorting* and as simple *description.* In the terminology of MCDM and in the case of financing, a specific company is understood as *alternative*. Problems of choice, ranking and classification lead to the evaluation of a set of alternatives. Furthermore, problems of choice and ranking are based on relative comparisons among alternatives, while classification on absolute ones. An interesting theoretical observation is that relative comparisons are dependent on the set of the alternatives, i.e. if it is changed, then the outcome of the procedure might alter, which is not the case in the absolute ones.

In the case of financing, absolute comparisons and classification problems may apply in larger sets of potential clients, such as in housing, and commercial loans. In these cases banks have a list of thousands and the task is to sort the customers into categories. Whether the customers are corporations, households or persons, it is irrelevant as the methodology is similar and what changes is the final sum of weights and attributes. Contrary to this 'mass' problem of classification, where usually the alternatives are thousands[1] financing industrial customers (including shipping) is a problem of ranking and selection of the better option. As stated before, in the former case the

[1] In a recent business exercise, a major Greek private bank elaborated about 75,000 personal loans, 18,000 housing loans and 110,000 credit cards.

formulation is based on absolute comparisons, and in the latter on relative ones. That means, the financial institution has a set of few customer' applications and has to select the best ones. This selection procedure does not only include data on the project, the financial standing of the customer and of the specific market but also bears marketing and strategic options of the lender. In many cases financial institutions undertake risks in order to penetrate markets or industries, aiming at the satisfaction of a customer. As a result the selection procedure is too relative, as it does not only include relative comparisons per attribute and per customers' pairs, but also subjective understandings, beliefs and intuitions of the decision-maker.

The trigger for this study was this very selection procedure; having spent a couple of years close to the final decision-makers of a large bank institution it became clear that the selection procedure was not always rational and in most cases non-uniform. Furthermore, there were too few supporting arguments for a selection and in most cases subjective perceptions determined the outcome. Nevertheless, big lending deals affect the loan-portfolio of the financial institution heavily and disastrous outcomes can very seldom be easily absorbed. The idea that the selection of alternatives was not a very sound one was amalgamated during careful attendance of shipping finance seminars abroad. There, it became evident that, the institutions invested heavily in the market analysis trying to rationalize their biases and to get armored with arguments and knowledge through observations. Contrary to the author's experiences and training, in the Greek market, personal relations were more important than any other factor and the 'business' should be furnished with the appropriate 'story'. This critique towards the Greek lenders would be easily characterized as biased, if only there were not so many articles in the

financial press over defaulted loans. Most of these loans were linked directly or indirectly with the Greek Coastal System (GCS) and politics were also involved in such a sensitive social issue. Therefore, the analysis and the in-depth understanding of the GCS companies is a subject of special academic and business interest.

This study had to deal with two separate subjects: the mapping of the GCS market in terms of sector analysis as well as the understanding of the Greek lender market, i.e. of the main supply of capitals. This mapping is understood also as a ranking analysis between alternatives on the basis of specific attributes. The focus on GCS companies listed at the Athens Stock Exchange Market (ASE) was compulsory as most of their data are of adequate quality and available freely in the various annual reports and information memoranda. The analysis of the lender market was possible only through questionnaires that were querying for information commonly discussed in academic textbooks but also referred as 'business practice'. It is not possible to get actual figures on customers, especially in such a specific market, that practically every financial movement is monitored by the press. For the ranking mechanism (selection tool) a MCDM approach was selected as international experience leads to these tools and techniques. The choice of a technique is often debatable but not the wider ideas of the MCDM field as such. It has to be highlighted that some Greek financial institutions are gradually introducing MCDM techniques but mainly for large classification problems. The chosen MCDM methodology, the Analytic Hierarchy Process (AHP) addressed practically all problems emerged during research.

Both problems, the mapping of a market and the selection procedure are of static nature, i.e. the outcome of the selection is valid for a given environment. In both cases there is a set of attributes per alternative

(either bank or customer) and the ranking mechanism draws data from the past. In order to surpass this problem at least, for the ranking mechanism of GCS-companies, the model runs for every company and for every fiscal year available. So there is a track recording and conclusions can be extracted. The same would have been an approach for the financial institutions, though changes are slower and less hastily. In that sense the ranking mechanism can also be used by the companies in order to improve their position given a set of weights (judgments over criteria) as they can estimate the changes for practically every action or procedure included in the model. So if the model includes as many as possible attributes of the company that correspond to procedures, actions or facts, then the management has a relatively easy-to-use but robust tool to estimate the outcome of decisions. Furthermore, the bank can also indicate to the customer what has to be changed in order to get a better ranking. Such services are very lucrative and build confidence between lenders and customers. In addition, one can also estimate the future standing of a company, thus predicting competition characteristics in a market.

In financing, as in other scientific fields, such as transportation, forecasting and predictions are subject to the parameters involved in the model and of their dynamic nature. As predictions and forecasting have to address a specific need, for example to predict the traffic in real time conditions and send the proper signaling to traffic lights, the system (or the algorithm) has to respond in a suitable time interval and within proper accuracy levels. So, in this example from the transportation science, the analyst has to take into account the dynamic nature of the data as well as the need for a rapid response. However, in financing the response time of lender to a request is only a matter of marketing to a customer's request, because what really matters is the unpredictability of the parameters. In academic texts

and in traditional bank spreadsheets, the estimation of running expenses, the financial outcome of the employment of the vessel are taken into account and a spreadsheet with normal project calculations is drafted; the capital, the operational and other extra expenses are taken into account, the revenues out of the employment are considered, and finally some criteria, such as NPV, IRR, payback period have to fall within a specific range. Nevertheless, the time frame is rather long, ten years and more are the usual amortization period, and many parameters can drastically change. The prediction of the ranges is a way to secure the results and the decisions, therefore, simulation techniques or sensitivity analysis complete the drafting of the calculations. However this is only a way to estimate the possibility of the final outcome with a priori given probabilities or distributions.

The value of perfect prediction in such systems is a very interesting subject and melts down to the very question, how much is it worth to have better information? Sussman links this issue with control methods. The spending of research resources is crucial for the prediction of the behavior of a system. Ultimately, Sussman suggests that this is a subjective issue as it depends on our best understanding (Sussman, 2000, p.345). In other words, it depends on the analysis and the assignment of weights among the criteria. That is also the main point of all MCDM techniques or the basic consideration for practical decision making.

2.3 Structure of the Document

In this chapter the very first sections were committed to the definition of the problem and the scope of the study.

The literature review section follows in order to set the limits of the research effort up today in this field. This review-section was split

into three distinct categories for research purposes. A thorough analysis of the shipping finance and investment risk review preceded the survey over the MCDM and the GCS. The MCDM literature review was focused on subjects and techniques relevant to the needs of the study; as the MCDM is a very wide and 'gray' academic zone it is quite impossible to monitor all papers, books and references of that field. The reader will find some references in other sections that are not reported in this appropriate section (2.4.2); these references are solely useful for the justification of numerical handling of the selected MCDM technique. A full reference of papers and works over the numerical handling is out of the purposes of this analysis and would demand a state-of-the-art-seeking effort that involves many scientific disciplines, such s mathematics and psychometric techniques. Finally, the review over the GCS aims to include only works with a significant impact on the academic evolution. Studies and other research efforts with a minimal add-value are excluded.

A chapter -3- on the Greek Coastal System follows; this presentation aims to outline the system for the non-familiar reader, as well as, to set the limits of the research and of the analysis. The market analysis and the calculations of concentration indices can be considered as pioneering work too, as there is no relevant work reported in the academic or business literature. Supplementary information on concentration indices and shift-share analyses is presented in the respective annex (Annex A: Concentration Indices).

The methodology of the analysis is presented in the next chapter -4-. The presentation of the Analytical Hierarchy Process (AHP) will be as thorough as necessary for the needs of the non-familiar reader, as there are many books and references over the fundamentals and the foundation of the methodology. Readers who may desire a more detailed, formal or strict development of the methodology are

directed to the literature. As AHP is known to the academic community since early 1980s' and international congresses are biannually held, it is therefore considered as a well-known and discussed methodology. This does not imply its universal application. The methodological analysis on the AHP includes also two very interesting subjects: the sensitivity analysis section as well as a brief discussion over the 'usual' methodological considerations. The sensitivity analysis is based on the work of Triantaphyllou (primarily) and of other researchers. All these papers are published in scientific journals in the US. The importance of sensitivity analysis is critical and therefore researchers provide basic definitions. This study adopts the definitions of the most critical criterion and of the most critical element when seeking a rank reversal. The issue of rank reversal and the 'fallacy' of preserving ranking when some initial conditions change are discussed in the coming section. This issue is a rather vehement subject among the MCDM academic community and is discussed in the respective paragraph (4.3).

In the fifth chapter - **The Challenge of Operating Risk –** follows a presentation of the modern operational pattern of banks due to the new rules and regulations regarding the risk management. The issue of operational risk gets focal attention. The effort concentrates on the qualitative aspects as it is not possible to apply the rules unless details of the loan-portfolio of the bank are available. The discussion proceeds with the basic aspects of risk structure in the shipping industry. Up to that point the presentation does not provide any insights of the Greek market. In the following paragraphs (§**5.2**), a thorough analysis of the Greek lenders market completes this chapter. As stated in the problem definition section (§2.1), the supply side analysis is limited to a mapping through questionnaires. The questionnaire is available as respective annex (**Annex B:**

Questionnaires to the Banks, p. 277). A survey to eleven lending institution could provide a solid basis for the development of a classification analysis. The results of the analysis (§**5.2.3**) provide a better understanding of the standing of each institution in the market. This could be materialized through sensitivity analysis, which highlighted different aspects of this issue.

As chapter -**5**- deals with the supply of money, the next chapter -6- deals with the ranking mechanism of the GCS active companies (only those listed at ASE). Based on the requirements of the AHP, a hierarchy addressing the problem is developed. This hierarchy consists of two distinct criteria sets: the internal and the external factors, as specified by all marketing and strategy textbooks. In a sense, it was necessary to split the business environment basically into two large sets as the number of criteria involved is rather expanded. Then every set of criteria is split into more categories, namely:

Internal Factors	**External Factors**
Fundamental Accounting Data	Stock Performance
Logistics Services Data	Market Environment
Management Related Data	Competition Data

Every respective criterion is thoroughly analyzed and supported by arguments stemming from literature of various fields. The model is of absolute comparison, which means that every single company is getting a rank through comparison of its attributes with a common scale, as well as through the very same system of weights. If the

model was based on relative comparisons then every alternative should have been compared with all the other ones. The absolute comparison method was selected for the following reasons:

1. in absolute comparison mechanisms, it is not possible to experience rank-preservation problems;
2. the set of data is very large and the relative comparison of every alternative for every year available would increase the numerical and decisional burden exponentially;
3. it is easy to add alternatives (existing or dummy ones), to experiment with the sensitivity of parameters, or to estimate the outcome of an action (element sensitivity);
4. the focal attention lies on the hierarchy, i.e. on the insights and on the parameters determining the phenomenon;

A sensitivity analysis, according to the findings and guidelines of researchers, is performed, in order to highlight the most critical elements and criteria. This chapter concludes with the presentation of the results of scenario based analysis and a simulation procedure. Data and calculations can be found in the respected annexes (pages 281 and 290 respectively).

The next chapter -7- deals with the application of the model. The interest lies with results that can be derived from the model as such (given the hierarchy drafted in chapter 6) as well as from its elements. There is clear intention to make this model useful to actual decision-makers and to expand their analytical capabilities for critical decisions, such as planning and mergers. This chapter concludes with some theoretic remarks; the quest for objectivity and the inherent capability of the AHP to produce results without a prior knowledge of the utility function are discussed in view of the classical theory of Keeney and Raiffa.

In the last chapter -8- the reader can find a sum-up of conclusions and suggestions for further research. Apart from the list of conclusions that offers interesting points for academic and practical discussion, the paragraphs on further research recommend, not only practical approaches to the problem, but also some methodological considerations. It is known to the MCDM community that the problem is not the handling of the data, but the way the decision is taken. To that perspective this study covenants to suggest ways mitigating errors or improving the outcome. Many annexes and supportive lists and indices are provided for validation of the input data, of the derived outcome, and for further research use.

2.4 Literature Review

2.4.1 Shipping Finance

Shipping has been traditionally considered a risky industry with relatively low profit margins. However, recent studies suggest that the systematic risk of the shipping industry is similar or lower than other industries, such as gas, electricity (utilities), trucks and air (transportation) and that its average returns appear to be higher than the average return of those industries (Kavussanos and Marcoulis, 1998). Under the basic assumption of unequivocal returns across the industry, such findings enhance the attractiveness of the industry but are limited within the microeconomic approach. Kavussanos and Marcoulis extended their approach considering macroeconomic factors (2000). From a mathematical point of view, this research has been based on the well-known Capital Asset Pricing Model (CAPM) and on Fama-MacBeth methodology for cross-industry regressions. The conclusions of the macroeconomic approach justify and quantify

the common belief that industrial production, interest rates, oil prices, consumption and inflation influence returns across sectors. At the same wavelength, Grammenos and Arkoulis attempt to link the above mentioned macroeconomic factors and laid-up tonnage to shipping stock returns (2002). Their findings are interesting given the sample, the used statistical techniques, yet they contradict basic figures; for example Grammenos suggests that oil-prices are negatively related to shipping stocks (p. 95 and 97), while Kavussanos' approach claims that oil-prices are positively related to returns (p. 246 and 250). Such disagreements may stem from differences in the sample and the formulation of the problem and do not deprive novelty from these efforts. Lately, Kavussanos has investigated also the sub-sectors of the maritime industry using similar methodological approach as in the previous works and observed that the β factors were significantly lower than that of the market (Kavussanos, et al, 2003). However, these papers are basically addressed to the academic community and take into account only listed companies. In most papers, the authors conclude with the suggestion to further collect data for many periods, with upturns and downturns of the market, so to achieve a better outcome.

A publication on the long run performance of shipping initial public offerings highlighted the underperformance of shipping shares to the local stock market of Athens, Oslo, New York, Stockholm and Hong Kong (Grammenos and Arkoulis, 1999). This very interesting empirical research validates the notion that the shipping industry is not attractive to investors. It is interesting to note that different markets displayed similar performance in the aftermarket and similar performance has been documented across different fleet compositions, at least in the first year. Gearing, fleet age, equity offered are only some of the factors analyzed in this paper and

provided some evidence of relation with the performance of the stock. Another interesting approach regarding listed shipping companies is that of Panayides and Gong on the reaction of stock markets to mergers and acquisition announcements (2002). Although the data-sample is limited to liner companies, the results of the investigation can be of particular importance to the shareholders, the investors and the management and the methodology can be adjusted so to offer a solid basis for investigation of the effects of industry or company specific events, such as emerging regulation or deal disclosure.

Though beta and returns comparisons as well as the behavior of stocks after perturbing information release are investigated to the benefit of investors and shareholders including creditors, bond financing has not been advocated enough. Within the five recent years, only Leggate has investigated the suitability of bond financing directed from the high financial requirements of the European shipping industry (2000). The rational of Leggate's work is that as European fleet grows older and needs renewal, the number of financial institutions active in the shipping finance market is shrinking, and the debt financing schemes will not be adequate or sufficient to cover the needs. Leggate discusses the issue of rating and links it with company performance. Although this is not a novel concept Leggate stimulates that financing will become more dynamic as it demands monitoring of the performance of the company. Commending this, every financing method takes into account the track record of the debtor or of the issuing company, but bonds and stocks are dynamically linked to performance; a banker monitors the debtor but enjoys mortgages and well-structured information. Leggate has also explored the exchange risk in the shipping industry (in 1999 and with Akatsuka in 2001). In both papers, where the Norwegian Krone and the Japanese Yen were examined against the

US dollar, the result is the equivalent: the exchange rate risk is a determinant factor of the corporate performance.

Almost simultaneously two papers on the assessment of efficient market hypothesis (EMH) appeared in the Journal Maritime Policy and Management; by using expectation theory Dikos and Papapostolou (2002) justified previous work of Kavussanos and demonstrated that the volatility of spot and time-charter freights of the VLCC and ULCC market segment is higher than of Handymax, Aframax and Suezmax (2002). Kavussanos and Alizadeh investigated the validity of EMH in asset play of the dry bulk sector (2002). The result of their statistical tests was more than appealing and with practical application; the assumption of EMH in the new-building and second-hand dry-bulk market shall be rejected due to time-varying risk premia, thus signaling arbitrage opportunities and formation of trading strategy. It is obvious that the investigation of the EMH is important for both academic and professional reasons.

Finally, a paper of Gilje et al. (2002) investigated the consolidation of crude carriers through financial criteria. The survey was based on questionnaires and revealed that long-term employment of the vessel(s) concerns all involved capital providers. However, debt-providers, the bankers, were more supportive of consolidation practices contrary to equity-providers, who seek opportunities for speculation and asset play. The authors support the idea that 'managerial experience' and balance sheet performance are among the primary considerations; although balance sheet performance implies a rather clear and straightforward set of quantitative criteria 'managerial performance' is not. This issue will be discussed thoroughly in latter sections (168).

Shipping finance is not a very alluring subject for authors; relatively only few books have been published on this very interesting subject both for shipping and banking. Stopford's *Maritime Economics* is a not a book solely dedicated to shipping finance, though it provides sound beginning for the basic knowledge acquisition: the supply and demand in the shipping industry, basic calculations and most importantly, the pattern of business (Stopford, 1995). Although it is not a book on finance, it is a book written by somebody active in this field, having renowned expertise and deep knowledge. At the same wavelength lies the book of Cheng too (1979). Cheng's book on the financial management of shipping is quite old and obsolete, with interesting structure and analysis. Cheng's book handles not only macroeconomic and microeconomic issues of the industry, but also provides basic insights and comparisons of the accounting and taxation systems in various legislations. It offers a unique ground for evaluation and understanding of several regimes. Last in this category, is the book of Evans and Marlow (1990) on quantitative methods in shipping. This book provides simple modeling of several examples and day-to-day operations and completes what is left of the previous books. These three books are complementary to each other and provide some tools to support decisions or to assess a case.

A very interesting book on shipping finance is the book of Stokes, which focuses on the history and basic mechanisms (Stokes, 1992). It is practically the only book focused on this subject without involving other fields or disciplines. Although it is almost 10 years old, the book offers a very interesting description of the facts and the drives behind the evolution of shipping finance. However, the résumé of the book is also that shipping finance has not been really evolved but changed or transformed as a relationship. New mechanisms and tools are

practical applications of other forms of finance dressed-up for the needs of the shipping industry.

Another very interesting book is the one on economic modeling of shipping by Beenstock and Vergottis (1993), which is a treatment of the basic micro-economic modeling of shipping combined with data streams. The authors provide very interesting description of the first attempts by Tinbergen and Koopmans, and others, as well as thorough methodological analysis of the each shipping market. It is a valuable tool for modeling the market, in deed, and along with adequate data such a modeling can assist in getting the insights of a wider market. However, such an approach could not be of real assistance in a problem structured as the GCS.

The book of Sloggett (1984) on shipping finance and the books of Gray (1986 and 1987) are considered outdated, but evidently unique, as no other book refers to shipping futures and other risk hedging instruments.

Finally, there are no texts on the financing of SSS and coastal shipping operations. In reality, there is no academic and practical interest as these issues are appropriately handled as corporate and project financing.

2.4.2 Multi-Criteria Decision Making

The literature on MCDM methods is very wide, as topics of MCDM can be found in fuzzy set applications, operations research methodological subjects and in pure mathematical books. Although there is a clear trend of using MCDM methods for financial decisions (Hallerbach et. all, 2002a and 2002b as well as Zopounidis et al., 2002), there were very few cases found associating MCDM with shipping or even transport related subjects. Lately, the works of Lirn et al. (2004), as well as of Dimitras et al. (2002), are using MCDM techniques for

the selection of transshipment hubs and for the evaluation of shipping loans respectively. As the quest for this research work is the setting-up of a mechanism adequate to support financial decisions for shipping companies, it is interesting to note that there are not many papers and sources in this field. Recently, only few authors have dealt with this issue: Chou and Liang have combined fuzzy-logic, the analytic hierarchy process (AHP) and the entropy techniques, in order to evaluate liner companies (2001). This paper is pioneering but it fails to address the real-world problem; the use of the AHP is not fully justified, although it is a very powerful method. However, research and academic debate has led to improved versions of this method; the use of the original version of the method denotes the importance of the results. Furthermore, the mixing of fuzzy-logic techniques makes possible to skip the problem of dealing with qualitative criteria in the evaluation procedure, though it is not the only way and complicates the algorithm. Finally, the authors suggest that three evaluators are getting involved and avoid discussing the issue of 'group decision' as it is commonly addressed in the jargon of the MCDM field. Panayides and Cullinane do not get into the MCDM techniques in order to assess the criteria used for third party ship management selection and evaluation (2002). They collect data on various criteria and perform simple statistical analysis. It is interesting to note, that at least in this paper, qualitative criteria, such as technical ability, reputation, competency, trustworthiness, etc, have only been dealt as attributes; the responses from the questionnaires were figures within a specific 1 to 5 scale. 'Gray' zones and intuitions were not really discussed; for example, there are gray zones in the competency criteria where experience, qualifications of the personnel and service quality has been identified. This paper provides though a very interesting insight of the ship management market. Finally, Mangan et al. (2001)

presented their work on discussing the variables in the modal choice problem in freight transportation. Their work is substantial as they present data of extended literature review and criticizes the various modeling approaches.

The issue of measuring company performance and credit-evaluating is not a new one in the literature. However, only one paper, that of Chou et al. (2001) focuses on shipping companies. Performance measurement is a rather common topic in the economic literature, and in journals, such as the International Journal of Business, one can find many articles. Indicatively, Yang and Shi presented lately a similar performance measurement mechanism in Chinese industries (2002). One can find other applications as well, but on waterborne transportation.

The issue of modeling risk and uncertainty with the help of MCDM techniques receives much attention in the decision-making literature. In most cases, the problem was restricted in states of nature (uncontrollable events) and their treatment from a methodology. Nevertheless, AHP was never used in such cases, despite its inherent capabilities in treating uncertainty through relative and scalar measurements. Regardless if AHP is used towards the elicitation of subjective probabilities or the estimation of outcomes, the method results measures on a ratio scales. This was also the main feature enabling the conjunction of the method with other decision-making techniques, such as linear and integer programming, data envelopment analysis (DEA), balanced scorecards, genetic algorithms and neural networks. Saaty has presented a technique dealing with risk through the construction of separate hierarchies dedicated to befits, costs and risks respectively (Saaty, 1994, pp. 164-166), but this technique has been thoroughly criticized, as unclear and not meaningful to the decision maker in the general case. In a recent

publication, AHP assists in modeling risk and uncertainty in four prototypical cases:

1. expected values with relative probabilities
2. decision trees and expected values
3. adjustment for variance, regret and risk aversion
4. risk as a criterion (Millet and Wedley, 2003)

Millet and Wedley also, dedicate some space in pointing out future research and necessary theoretical investigations before generalizing their approach, but having linked AHP with risk they shed light on some gray zones of risk analysis and decision support. This publication has to be evaluated in combination with the trends in risk analysis. For many years, the practice of risk analysis has been focused on financial issues, such as portfolio selection, credit analysis and relevant issues. Many researchers strive to fine-tune and combine methodologies using high-performance computing, methods and techniques of machine learning and soft computing and diverse classification (Leigh, et. al, 2002). Such research works try to put together as many techniques as necessary in order to fine-tune empirical methods, namely technical analysis, and to support decisions relative to portfolio management of any kind. Apart from the complexity of the approach and the necessary scientific effort, a huge stream of data is demanded, not always available in the market or in several archives and data-warehouses. On the other hand, credit risk measurements have been traditionally heavily depended upon accounting data and concepts, even in the last years, where logit modeling has also been applied. In Altman et al, it is stated that the practice of financial institutions (FI) was based on subjective analysis and more specifically on the 4 "Cs": character (reputation), capital (leverage), capacity (volatility of earnings) and collateral. The same

approach can still be found in the shipping finance literature (see, e.g. Grammenos and Xilas, 1997 and 1999). The same source reports that FIs themselves have increasingly moved away from subjective/expert systems over the past 20 years towards more objective systems. Then, accounting based credit-scoring systems have replaced the traditional subjective systems and four methodological approaches appeared: linear probability model, logit model, probit model and discrete models. Discrete and logit modeling have been widely applied yet there was the issue of failure/non-failure approach, i.e. the result was either negative or positive for the customer under investigation. Generally, the input-data were accounting parameters and ratios as there was no focus on a specific industry but on loan-categories (say housing) or other classification ranges. The models were empirical at a large extent and were based on bankruptcy criteria. The repayment of loan can fail even if the company does not go bankrupt. Altman, argues that credit risk modeling fails because it can not pick up the fast and subtle changes of borrowers conditions, as it takes into account only book value accounting data and the world is inherently non-linear (Altman et al, 1998). Finally, there is research in process aiming at dealing with classical problems, such as portfolio selection, by using MCDM procedures as they incorporate behavioral elements in contrast to the conventional ones, such as the theory of Markowitz (Bouri et. al, 2002).

Another set of papers, of direct interest for this study, are the methodological papers regarding the sensitivity analysis and the linkages with the fuzzy set theory. Getting back to the basics, MCDM and AHP are ideas and techniques within the wider family of solutions offered by operations research. Operations research is an application-driven filed, that means research is conducted in order to solve a specific problem. In a comprehensive survey of the purposes

of an encyclopedia, it is stated that sensitivity analysis is a fundamental concept. This idea originates from Dantzig, but has also been elaborated by other researchers. The interesting point is that sensitivity analysis in a MCDM problem is not solely focused on the response of the final result to input perturbations, but also focuses on the preservation of the ranking (Triantaphyllou et al., 1998, p. 182). Therefore, research has also included empirical approaches through tests and numerical experiments, in order not only to highlight differences and characteristics of the various MCDM approach, but also to set criteria. Triantaphyllou and Sánchez have expanded the work of others and have proposed four criteria, determining the most critical decision-criterion and element (Triantaphylou et al, 1997). Following this methodological discussion, issues of pairwise comparisons and of the numerical handling will be dealt within the sections on methodology (**4.2**), but it is important to mention the linking of MCDM problems with fuzzy set theory. The endeavor to quantify subjective notions is the main characteristic of both theories. Fuzzy set theory quantifies successfully linguistic variables and MCDM techniques, especially AHP, consider subjectivity over decision-criteria. Furthermore, group decision making is required in many practical cases and AHP incorporates it easily in the calculations. So by combining fuzzy-set theory and AHP, one can use fuzzy input (linguistic variables, such as tall-short, etc.) and then process them through AHP mechanisms with a certain degree of accuracy or certainty. Ben-Arieh et al classified equipment and items by using fuzzy-set input and then AHP (absolute measurements) for the final classification problem (Ben-Arieh et al, 1992). Tsaur et al have used similar methodologies for modal selection (Tsaur et al, 2002).

There are not many studies published in the related maritime economics literature on the issue of freight transport choice. There are some attempts to investigate the reasons why shippers choose a route or a port, mainly as a discrete choice analysis (Tiwari et al., 2003). Generally, the approach is qualitative and the quantification is commonly succeeded through dummy variables in a regression model. Last but not least, shipping and particularly passenger shipping has many commons and similarities with air-industry. The air industry attracts practical and theoretical interest as it represents almost 90% of the passenger market (US data but the international figures for intercity traveling is almost similar). Tsaur et al have recently evaluated airlines by using a mix of fuzzy techniques, AHP and TOPSIS, another MCDM method. The followed methodology aimed to bypass the inherent problems in clustering, which is the assignment of a relative weight of criteria. AHP was the key and the other tools, fuzzy techniques and TOPSIS assisted in collecting and inserting the data and then in the evaluation of the result.

2.4.3 Greek Coastal Shipping

The factual study of the Greek Coastal System (GCS) was initiated through a research grant to NTUA and Professor Psaraftis from the Hellenic Industrial Development Bank in 1992 (Psaraftis, 1993). The outcome of the study was not only a deliverable but a series of papers presented to the academic and policy making community during the first and second roundtable on short sea shipping (SSS) in Delft and Vouliagmeni (1992 and 1994 respectively). Results and findings have also been presented to other conferences and journals. The paper of Psaraftis (1994) is a direct outcome of the study while others have based arguments on it, such as that of Sturmey (1994). Earlier Psaraftis (1992) has presented a paper on the impact of new

technologies, mainly based on previous research initiatives (COST 310) and work of Professor Papanikolaou at the NTUA (see European Short Sea Shipping and FAST Conferences).

At the same time papers, have been presented by Goulielmos (1992) and (1994) of the University of Piraeus, mainly describing the structure of the market and some of the effects of the common European space. Interestingly enough in the 3rd roundtable in Bergen in 1996, no paper on the GCS was presented but generally only some on the Adriatic Corridor and SSS.

Within the academic and research framework of the Maritime Transport Laboratory at NTUA, various diploma theses have been conducted on this issue. Most of them were focused on the financial viability of routing innovative vessel designs in specific segments of the market. Methodologically there is no real deviation from the study of Psaraftis and there is an add-value to the researcher in terms of data collection.

Last but not least, the Greek State has financed a study on the new network operations, but apart from pieces of this study, the results are not known and clear to the author (ΣΕΘΑΜ study).

3 Greek Coastal System

The Greek Coastal Shipping (GCS) system is a very interesting case for research, not only within the Greek business pattern but also from a European perspective. The problem of the system is not solely of financial or transportation efficiency but embraces also a variety of interests of the State and of the society. The State and rest actors, such as carriers, local communities, and port authorities have to find an equilibrium that all partial interests can be merely satisfied and operate within a compromise pattern.

From a carrier perspective, the fleet has to serve ports with adequate traffic volumes. Furthermore, as the traffic is seasonal, a rational carrier would operate the fleet only during those months with adequate volumes. From a local community perspective, vessels have to connect their island with many other destinations for tourist-related purposes and to the mainland for commercial and social cohesion purposes. Local port authorities are the new players in the game and increase their significance steadily. Local ports have not only to serve the traffic but also to ensure funding from the State for local investments. Despite the fact that not all ports have been converted according to the Law 2932/2001 to corporations (Societe Anonyme), local interests participating in the management of the port (in most cases these are just harbors[2]) can seriously affect the operation of any fleet. Last but most important actor is the State expressed through the Minister of Mercantile Marine (MMM), the

[2] The quality of port infrastructure and facilities is critical for safety, operational, security and economic grounds. Although most of the facilities are treated as 'ports' by the Law, they only offer harboring and in some cases of a very low quality (e.g. in the Cycladic complex of islands).

Coast Guard and various other agencies, authorities, etc. that regulate or operate the system (e.g. for the construction of port infrastructure the Ministry of Public Works is also involved, for the lighting of ports, passages and corridors the Hellenic Navy, etc).

The interest for the GCS is really not new for the Greek State. After the Revolution and during the first period as independent State, a Decree of 1836 retains the privilege of cabotage to home shipping. Considering the status after the ending of the war periods 1912-13, 1916-18 and 1918-22 the Greek mainland was expanded to the west and the north but the new republic of Turkey seized the east. The traditional major trade centers to the major Greek islands of the eastern Aegean were now under Turkish rule; Lesbos and Chios were trading directly with Smyrna (Izmir) for centuries and now these islands are cut off from their natural markets in the nearby coast. On the other hand, these Greek islands had to establish adequate links with the major center of the State: Athens and the port of Piraeus. The new status in the Aegean forced new cohesion problems and the operation of GCS had to become more efficient, as travel distances were multiplied and it was vital to establish economic links among the islands and the mainland. The rules of the game were set in the amalgamative Law 6059/1934. Ever since, this Law has been in force and its provisos were also included in the Public Maritime Law (ΚΔΝΔ, § 165, 166, 187 of 1973).

After the turmoil of World War II and of the civil war, the GCS became even more centralized and Piraeus was connected to all major destinations directly. This was not the case before the war, as Syros and other islands, served a premature hub-and-spoke local system. The hub-and-spoke operations supported the local economies of the islands, as happened for centuries and enhanced social cohesion. The new centralized system forced even neighboring islands to isolation

as they were not properly connected. As transport infrastructure projects were commenced in the '50s GCS connections among various small mainland ports and the islands were abolished. For example, there was no connection of ports at the east side of Peloponnesus with the islands of the Saronic Gulf and of the central Aegean. Before the war, coastal links were necessary as the land infrastructure was not efficient. With the booming of the economy in the '60s the Aegean islands attracted also many tourists and therefore an immense seasonal traffic could lure private interests in the GCS. The entire above are valid for the total of the system though with exceptions of local nature. A distinct exception is the link of Crete with the mainland, due to the size and the importance of the island.

The implementation of EU Regulation 3577/92 on maritime cabotage aimed to liberalize the maritime services to the benefit of shipowners who have their ships registered and flying a flag of a Member State provided that their ships comply with the conditions for carrying out cabotage in the Aegean. It is interesting to note that Greece and other Mediterranean States have been granted temporal exception by means of derogation. Thus in 2004 the GCS should have been liberalized and the institutional framework harmonized with EU legislation. During these twelve years of grant-period too many things have been changed in the Greek economy and the GCS respectively. Last but not least, the changes did not resolve any problems of the past: the State has to find ways to ensure proper connection of the islands to the mainland and the carriers have to operate profitably in total, even when servicing destinations of no commercial interest.

3.1.1 Institutional Framework

The right of cabotage is an outcome of protectionism in shipping. It is a privilege granted to home shipping operators to undertake exclusively, specific sea-transport services, such as trade and passenger traffic within the limits of the territory (Farthing, 1993, p. 139). The cabotage rules were dully supported by various Decrees and legal documents and the excuse for the state intervention was the social character of the service. The notion of *social character* was not innovative in the legal practice but was one of the very few instruments the State had to enforce the adequate service of the 'thin lines'[3].

The system was based on a license-granting procedure. There were various technical requirements for the ships to qualify the process of application of service a specific route under a given tariff structure. The master of the game was the Minister and a consultative body (Consultative Committee for Coastal Shipping - ΓΕΑΣ[4]) with representatives of various stakeholders: the Coast Guard, the MMM, the Hellenic Tourism Organization, the Ministry of Aegean, the Chamber of Shipping, etc. It is interesting to note that the application was not directly examined by this group of representatives and only the Minister could take the decision.

The Minister also had to determine the routes, the number of ports of call, the frequency and the schedule of the voyages. A shipping operator granted a license for a specific route had usually to serve a couple of islands that normally were not of commercial interest (thin-

[3] The literal translation of the Greek term *άγονες γραμμές* (infertile lines) is 'thin lines' according to Sturmey et al. (1994)

[4] The Greek term is *Γνωμοδοτική Επιτροπή Ακτοπλοϊκών Συγκοινωνιών*.

line islands). So the State secured a minimum connection of these islands to the system at no cost or budgetary outlay.

Apart from the fares of the first class passengers, the Minister determined also the fares of passengers, cars, trucks, mail and cargo on the ships servicing the GCS through a Decree. The State was interfering with the tariff structure with the excuse of the protection of the social interest, as carriers could form cartels or practice monopoly techniques.

Last, but also important, is the fact that among various technical requirements the vessels should be of age less than 35 years, fly the Greek Flag (thus making the operations more expensive) and operate for 10 months per annum. Furthermore, the State retained the right, through the Coast Guard, to preclude sailings due to bad weather conditions, although the ships had to remain within a range of 10 sea-miles from the coastline.

Although there is adequate literature (see §2.4.3, p. 56) where the researcher can go deeper in the definition and the aspects of the problem, it has to be clearly stated that the State through agencies and bodies had (and still has) a tremendous regulatory power. The power of the ship operator was the monopolistic right to serve a specific route. From a critical point of view, various technical requirements, such as the age of the vessel, the design of the routes, the manning of the vessels, the fare structure, and the schedules were not either appropriate or capable to maximize the utility out of the service. Some of them were not even adequately justified from a scientific point of view, such as the age limit of 35 years. Even the departure-bar, due to bad weather is not scientifically justified. However, the system operated for long at an adequate level of service despite problems experienced in peak times.

In 1992 a Regulation (3577/92) of the European Council brought into force the principle of freedom to provide transport services within a Member State. Before this act, several other acts based on the Treaty of Rome (1957), on decisions of the Court of Justice and of Council Regulations affected the maritime transport. The regulation provided the freedom to all ships registered in and flying the flag of Member State to provide services within a Member State. Passenger ro/ro vessels servicing the GCS were exempted up to December 31, 2003. The regulation provided the rights of a State to provide licenses and contracts or impose public service obligations but a non-discriminatory basis.

In 2001 the new Law (2932/2001) introduced many innovations that changed the structure of the system but basically the system was still regulated. This Law prescribed the institutional pattern of the GCS, as well as, established a Secretary for Ports and Port Policy in addition to the conversion of ten main ports to corporations following the model used for the Port Authorities of Piraeus and Thessaloniki. From a political point of view, there was a clear intention to balance the interests and needs for the harmonization according to the Regulation 3577/92. The Law provided the following:

1. the deregulation would occur on the 1st of January 2004, due to:
    a. the need of smooth transition of the system because of the Olympic Games in 2004 (according to the official Press Releases – see also egov.yen.gr/shipping/12-shmarit/02-law/)
    b. the need to update and improve the level of service
2. The principles of the Law are the protection of the social interest and the simultaneous encouragement of competition, so:

a. The State can secure the social and spatial cohesion

b. The competition could improve the level of service and encourage local interest to entrepreneurship.

3. A global network is considered that includes all ports and secures a minimum level of service for all ports (frequency of call).

4. The licenses are abolished.

5. The Minister can impose public interest requirements after consultation of a special body (Committee for Coastal Transportation), that affect mainly the ports of call, the frequency, the fares, the manning and the ability to provide services.

6. There are some requirements for the 'regular' routing, such as:

   a. Ability to provide transportation service

   b. The vessel can be accommodated to the ports of call

   c. The service begins on November 1st and has to be provided for a year long

   d. The mariners have to employed for ten months and shall have a certificate for their ability to communicate in Greek

   e. The maximum age of the vessels will become 30 years gradually up to 2008

   f. There are some 'free routing' services, i.e. services companies decide to provide and do not fall into the 'regular schedule' of the global network.

   g. The Minister can intervene the 'free' services when they destruct the 'regular' ones, in terms of port services

adequacy (not only to ships but also to the passengers and the access to the port), special conditions as well as of fare structure (expensive fare for coach seats).

h. Companies apply to the Ministry for 'regular' routes in January.

7. A Committee for the Coastal Transport Services will prescribe policies in the GCS -*Συμβούλιο Ακτοπλοϊκών Συγκοινωνιών*-.
8. A Secretary for Ports and Port Policy -*Γενική Γραμματεία Λιμένων και Λιμενικής Πολιτικής*- will concert all actions of various bodies of the Government[5].
9. An independent body of the regulation of the system will safeguard the terms of free competition (Regulatory Body for Coastal Shipping – *Ρυθμιστική Αρχή Θαλασσίων Ενδομεταφορών*[6]).
10. Major ports in the GSC, such as Rafina, Lavrio, Iraklio, Rhodes are legally transformed to corporations (among other ports). Although this decision is presented in a separate part of this Law, it is considered as an important development for the GCS. These ports along with Piraeus handle most of the volume of the system and serve many vessels. Furthermore it is a first step towards liberalization of the port industry as well as for erudite commercial management of these gateways. All

[5] This Secretariat has not concerted all governmental actions or decisions on ports up to today. The drafting and implementation of policies is still fragmented. However in the Press Release of the MMM it is clearly stated that this Secretariat concerts all governmental bodies.

[6] The Government abolished this Body in 2004, although the Law 2932 was not changed.

of them were not commercially managed; local Coast Guard authorities exercised the usual police and traffic-regulating duties.

The basic provisos of the system are currently in force, but the unfortunate event of the 'Express Samina' disaster forced the Minister to deregulate the market earlier to 2004. Nevertheless, companies and other actors were not satisfied from the provisos of the new Law. The most significant reaction came from Brussels. The Commission has warned the Greek government that the Law was not fully compatible with EC legislation (mainly with the Regulation 3577/92).

The main point of friction is no other than the framework the imposition of public interest requirements when the market (the companies) cannot provide adequate service. Companies also expressed their reservation of their rights for remuneration from the State (Press Releases February 4th, 2004). Furthermore, the certification of the ability of mariners to communicate in Greek is not consistent to the EU legislation. These are some of the point of friction emerged in the press. However, there are also some more points that could create friction in the future; a critical one is the adequacy of the port to handle simultaneously a vessel of a 'regular' and one of a 'free' route. Another one is the intervention of the Minister when the fare of a 'free' route is considered as excessively high. In a sense, there is no deregulation when a company cannot decide freely on the charged fares (and the services it provides) or on the ports it serves.

Setting apart the political friction that is presented in the press, Sturmey et al. (1994) have presented an interesting pattern of thinking although there was no consideration for the local forces. Nevertheless, there is the excuse that local forces could not directly express their interest back in 1994 and only the central government through the

MMM expressed all interests. Since 1994 many things have changed in the local communities in the Aegean and the system experienced frictions due to local interests (e.g. in the case of Santorini). Sturmey et al. concluded that what was basically necessary was a plan that should define the public service operations, the policy and the requirements for the operation in the system. There was also the idea in the paper about using 'slots' at ports, though there was no mentioning, who would decide and operate the slots: the central government as the one monitoring the whole network or the local authorities aiming to maximize the benefits for the local community. Furthermore, there is also an issue of pricing the slot; expensive slot plus necessary routing or call would create an exploding mix. Sturmey proceeded also in a very interesting analysis of the reaction of shipping operators from other Member States.

From an institutional point of view, the GCS is a very interesting and difficult problem to solve. In the author's opinion, the system can adopt practices from other transportation industries, such as the airlines, but it is necessary to take into account the degree of sophistication of technology at ports and in companies of the carriers. Furthermore, it is necessary to understand that the system is not easily brought into 'design' conditions as happens practically every night in the airborne transportation system of a region. Every night the airplanes, even the delayed ones, are grounded and the next day begins as planned. By using some of the ideas of Sussman on traveler transportation by air (2002, p. 409-11), one could consider the following operational and institutional issues:

- The hub-and-spoke system is probably the best one when optimizing the functions with a clear trade-off between cost and level of service (LOS). The LOS of direct connection is considerably higher than that with a stop (or more). However,

it is not really possible to establish a trunk line, say from Piraeus to Syros and then to serve this traffic with connecting services. There are no such facilities for the accommodation of passengers, cars and trucks, and most probably it is financially not a sound decision, due to the extreme seasonality of the service. In addition the GCS has currently a problem of capacity and such a design would exacerbate it, as more vessels would be necessary. This affects the size of the vessels and will increase high peak loads at ports. Currently, only the port of Piraeus experiences bunched arrivals and departures by 'design'.

- In the airline industry there is a network control. Authorities can hold to the ground a significant number of flights due to scheduling, weather conditions, safety and many other technical reasons. Every airport provides some support to the aircraft and every local control tower communicates adequately with a central network control, as well as, with the aircraft. The central control is not flawless but it keeps the system going sufficiently.

The stochastic nature of the system due to the weather, limits also the predictability of the time of arrival. The airborne industry has successfully integrated new technology and techniques in contrast to the GCS industry. A central network dynamic control of the schedules, as well as, of the slots could improve the system in total though there are destinations that would encounter problems. However, it is not easy to integrate many ports in a system that practically cannot offer even safe anchorage to the ships at all ports of call during all months of operation.

Another interesting point is social and economic cohesion of the country. Historically, there was no real social and economic cohesion of the Greek islands with the today mainland. Of course, there was national, ethnic and religious cohesion. The various complexes of islands were cohesive to each other and formed groups. From a political point of view, it would be more effective probably to encourage the deeper cohesion of the complexes than an artificial one with the capital of country. Then it would be critical for the development of the country to establish more connections to other ports in the mainland, such as Thessaloniki, Volos, Nafplion. Such public interest services could strengthen the cohesion of the whole country and reduce the loads at main ports. Financially, it is currently not wise but a system of subsidies, that can be justified under the 3577/92 regulation could alter the structure of the network.

The GCS services are directly linked with the tourist industry of Greece. Inadequate services would diminish any investment in tourism, and no tourism-related investment would diminish the revenues for the GCS operators. So it is necessary to take into account the peak times of the system. Although transportation planning is not based on peaks, in that respective case it is imperative to take into account peaks. The institutional framework shall allow operators to serve the peaks and prepare the ports in term of operations to handle the excess traffic.

Last but not least, deregulation shall serve the customers of the system who are primarily islanders. A deregulation of the fare structure would not necessarily raise the fares, but more possibly would lower them, as there is a large difference of available capacity and of the accrued income per capacity unit. The operators would seek ways to attract travelers and offer higher level of service, if only there are at least two operators servicing the same destination.

3.1.2 Market Analysis

As stated in a previous paragraph, this study is based on the listed coastal shipping companies, due to the lack of adequate data for the non-listed companies. From data provided to the public, the following tables and charts are induced. Most of these data will be taken into account in a coming chapter. The period of the analysis is the fiscal years 1997 – 2002.

The presentation is focused on the financial attributes of the listed GCS companies. The companies under evaluation are ANEK, MINOAN Lines, NEL, Strintzis Lines (Blue Star Ferries) and EPATT (Attica Enterprizes). It is interesting to note for the reader who is not familiar with the GCS, that ANEK and MINOAN are operators based on the island of Crete, enjoying dominant position in the lucrative Piraeus – Chania and Piraeus – Heraklion lines respectively. ANEK and MINOAN used to enjoy monopolistic status in these respective lines up to 2002. Furthermore, ANEK and MINOAN are powerful players in the Adriatic routes, as well as expand their interests to other sub-systems of the GCS. For simplicity reasons, one may distinct the GCS into the following sub-systems (see also the map):

1. Piraeus – Crete
2. Piraeus – Cycladic Islands
3. Piraeus – Dodecanese Islands
4. Piraeus – Eastern Aegean Islands
5. Piraeus – Northern Aegean Islands
6. Piraeus – Argosaronic Islands
7. Thessaloniki (and other northern ports) – various destinations in Central and South Aegean Sea (including Crete)
8. Ionian Islands (to/from Patras and Igoumenitsa)

Figure 1: The map of Greece

In the current study, all data concern the total market, and not a specific sub-system; only the routes between Piraeus and Crete are not as seasonal as the other entire are. Even the routes linking Piraeus with the main islands of Rhodes (Dodecanese) and Lesvos (North Aegean) and Samos (East Aegean) are seasonal (Psaraftis, 1993 as well as data provided by the operators). In that sense companies having the license to serve Crete have had an advantage over the others. The high seasonal attributes of the traffic forced also major players to pursue ventures in the Adriatic Corridor. The traffic over Adriatic is experiencing continuous growth and is fully deregulated as it is considered as international trade. The simultaneous deployment of vessels in the Adriatic and the Aegean is a difficult task but it was necessary for the companies aiming at the dominance of the market.

As a result, ANEK and MINOAN were active in both markets, but this did not prohibit other ambitious ventures in the Aegean niche-markets. ANEK has bought a stake in the NEL (dominating in the East and North Aegean links) and DANE (dominating then in the

market of Dedecanese); MINOAN has been pulling the strings behind the risky experiment of Hellas Flying Dolphins (HFD). The senior management of MINOAN took the control of many conventional but old vessels that used to serve various routes (mainly in the Cycladic sub-systems) with an aggressive buy-out spree in 1997 and 1998. Owners of these vessels exchanged their vessels with shares in HFD. HFD became a very big company controlled by MINOAN. Although there were many ambitious plans for the future of HFD, the 'Samina' disaster stalled the plans and the company encountered financial difficulties that affected also MINOAN.

Another major player in the market has been traditionally Strintzis Lines (currently Blue Star Ferries). Strintzis was, and still is, active in the Ionian and the central Cycladic sub-system. The company was also active in the Adriatic Corridor. In 1999 EPATT became the major shareholder of STRINTZIS and therefore its consolidated accounts include the figures of STRINTZIS from this point on. The background of EPATT is a very interesting one as it is not a shipping company (as all the above are) but it is a holding company. In 1991 EPATT bought out a 'shell-company' listed at ASE and in 1992 ordered new conventional but fast vessels for the Adriatic routes. EPATT through the shipping and shi management company SuperFast Ferries became and still is one of the major players in the Adriatic Corridor. The deregulation wind that was blowing in the whole EU allowed the management of various shipping companies to envisage a deregulated Aegean market. Taking into account all technical and institutional issues, as well as the relatively 'low' quality of service, many people considered that too many investment opportunities were to come up.

From a shareholders' perspective STRINTZIS and EPATT were listed first (in 1991) while the Cretan companies in 1997. NEL was listed in

1995. The issue of listing shipping companies is still an ardent subject among banks, owners, shareholders and stakeholders. Although the main point of concern is the transparency of operations and the dilution of the power of shipowner (who has to act as a Managing Director safeguarding the benefits of the shareholders and not as major shareholder seeking for his own benefit), many practitioners argue that capital markets cannot fit the cyclicality of the shipping market as well as provide the cash for shipping ventures. Although evidence support many arguments, pro and contra, listing shipping companies the Greek Law provided a listing-exception to companies active in coastal passenger ferry business. Generally, the shareholders have benefited from the listing of coastal shipping companies (see Figure 7, p. 78).

In summary the major players in every sub-system are:

Piraeus – Crete	ANEK, MINOAN and STRINTZIS (lately)
Piraeus – Dodecanese Islands	DANE (ANEK), NEL (lately)
Piraeus – Northern Aegean Islands	NEL (ANEK)
Piraeus – Cycladic Islands	STRINTZIS, HFD (MINOAN)
Piraeus – Eastern Aegean Islands	NEL
Ionian & Adriatic Sea	EPATT, STRINTZIS, MINOAN, ANEK
Thessaloniki (and other northern ports) – various destinations in Central and South Aegean Sea (including Crete)	ANEK, NEL

Table 1: Major Operators per sub-system in the Aegean

In the market of the Adriatic, three operators are dominating: ANEK, MINOAN and EPATT through SuperFast and STRINTZIS. Furthermore, one has to mention the ventures of EPATT in the lines connecting Finland and Germany (Baltic Sea) as well as between Scotland and Belgium (North Sea). Although the figures of these connections are not taken into account, unless noted explicitly in the analysis, it has to be evaluated that EPATT has deployed vessels in other markets as well and therefore expanded its portfolio of operations. As these new, fast, conventional vessels are very expensive and have not been depreciated they have to operate at adequate levels of utilization. Due to various factors the Aegean and the Adriatic market may not be able to provide adequate employment for all vessels of the EPATT group.

Taking into account only the figures provided by the companies to the ASE and the investors, the following information can initially be drawn out. All financial data have been converted to Greek Drachmae due to the fact that Greek Drachma was fluctuating against euros till 1999. From 1999 and on, the Greek Drachmae is pegged to euros. For simplicity reasons the term *industry* will be used for the indication of the sum of the respective figures of these five listed companies. The only significant player who is not taken into account here is HFD.

In terms of total assets, the industry has experienced tremendous growth of no less than 33,60% per annum. The industry had total assets of almost 250bn GrD in 1997, while in 2002 this figure was over 1340bn GrD. EPATT has experienced the highest growth rate surpassing 46% (see Figure 2 and Figure 3). All rest operators have experienced annual growth rates close to 30%, which are not negligible as well. These growth rates are attributed mainly to the introduction of new expensive vessels as fixed assets in their balance sheet (see Figure 5).

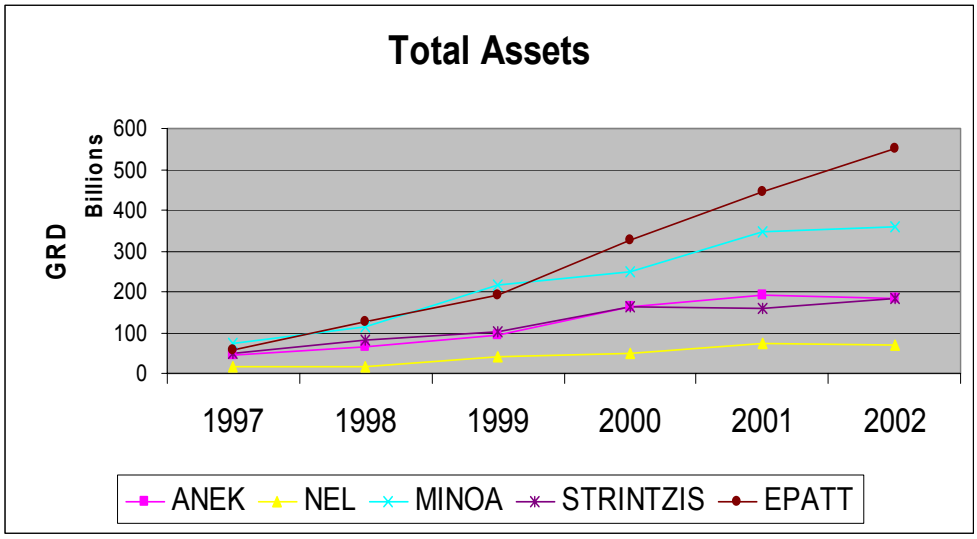
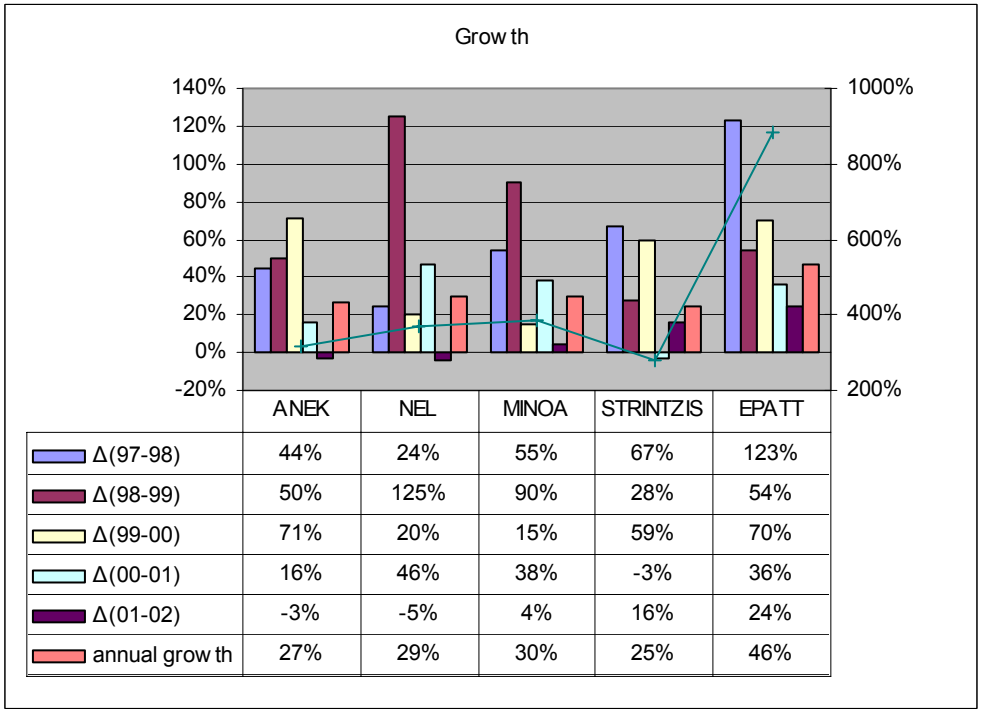


Figure 2: Total Assets in Greek Drachmae[7]



	ANEK	NEL	MINOA	STRINTZIS	EPATT
Δ(97-98)	44%	24%	55%	67%	123%
Δ(98-99)	50%	125%	90%	28%	54%
Δ(99-00)	71%	20%	15%	59%	70%
Δ(00-01)	16%	46%	38%	-3%	36%
Δ(01-02)	-3%	-5%	4%	16%	24%
annual grow th	27%	29%	30%	25%	46%

Figure 3: Growth Rates of Total Assets

[7] All graphs, figures and tables are based on official data provided by the companies to the ASE in their respective annual information memoranda.

In terms of market share the picture is more interesting. In 1997 the Cretan operators enjoyed a cumulative market share of almost 50%. In the 2002 this share was reduced to 40%. The gains were for the EPATT – STRINTZIS group. NEL enjoys a practically stable share of 5%. This is another factor indicating the dynamics in this market. The discussion over the market shares is not over; some data over the turnover will reveal the changes in the market.

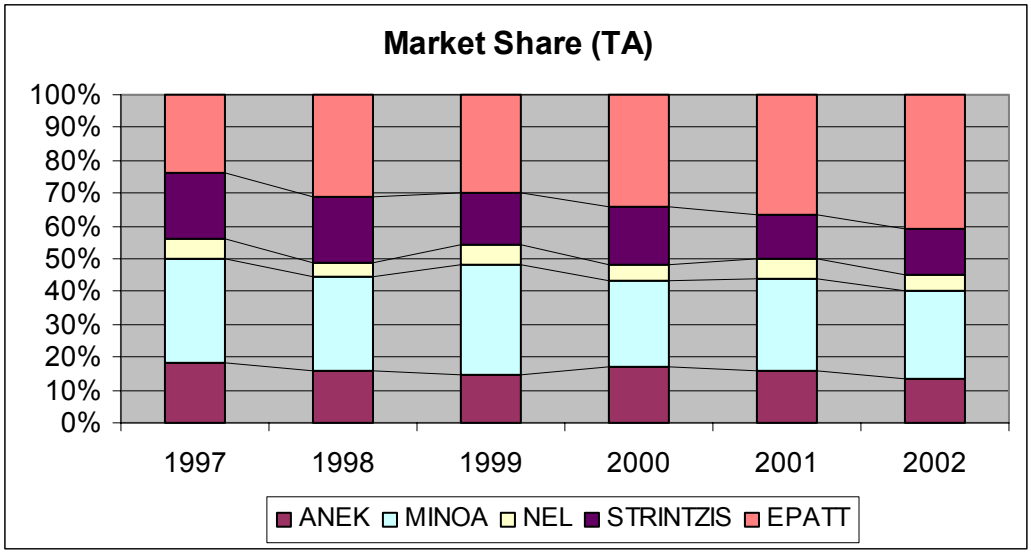


Figure 4: Market Share per Total Assets

It was stated above that the growth of the total assets of the companies was attributed to the introduction of new vessels in their fleet. Indeed EPATT own the youngest fleet (average age <4years!) and along with STRINTZIS has ordered many vessels. ANEK and MINOAN have also acquired new vessels, but have many merely depreciated vessels still in their balance sheets. The vessels (fixed assets) were worthy almost 194bn GrD in 1997; their value was 1178bn GrD in 2002 (see Figure 5)

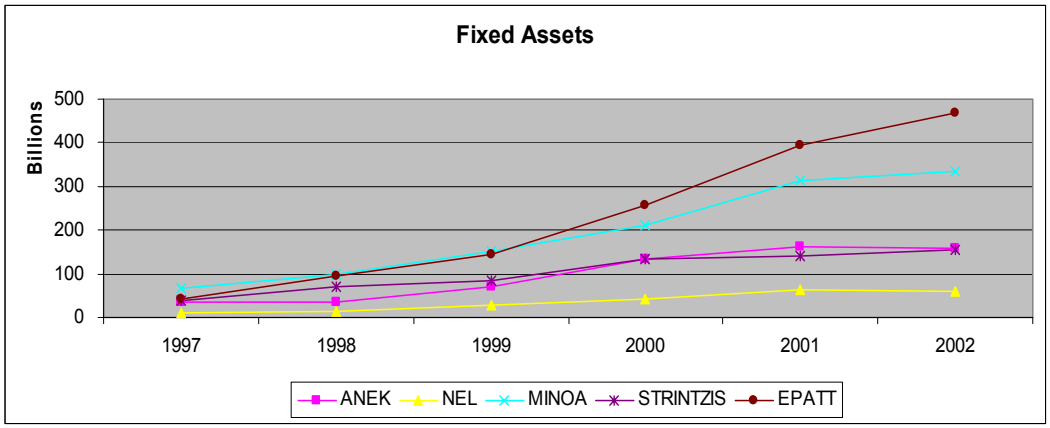


Figure 5: Fixed Assets in Greek Drachmae

By analyzing a little bit further the data and the graph, it is interesting to note that the Cretan vessels (ANEK and MINOAN) were the 52% of the whole, while the vessels of EPATT and STRINTZIS somewhat more than 20% respectively. In 2002 the vessels of EPATT and STRINTZIS represented more than 52% of the whole and the Cretan vessels about 42%. The picture was reversed. That was the result of the introduction of many new vessels; EPATT came with the new vessels and the Cretan had to follow. However, the critical ratio of fixed over total assets was over adequate limits ensuring investors for their solidity of the balance sheet (see Figure 6).

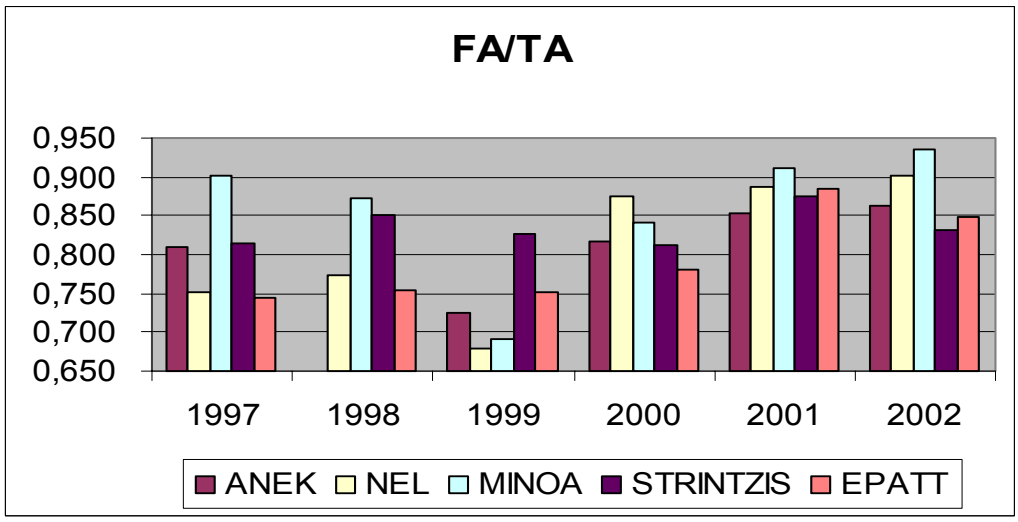


Figure 6: Ratio of Fixed Assets over Total Assets

The investors should have been relatively satisfied with the value of their equity (see Figure 7).

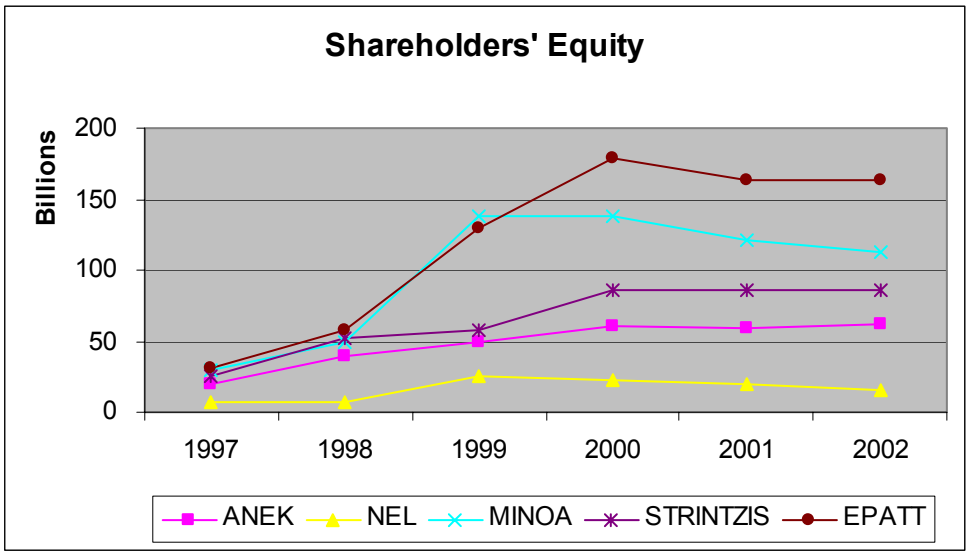


Figure 7: Shareholders Equity over the period 1997-2002 in GrD

The booming of the ASE assisted the companies to draw capitals for investments and improved arrangements of long term liabilities. These liabilities remained practically stable till 1999. Then the booming of the market enabled the companies to undertake adequate leverage in order to respond to the fierce competition. EPATT has been exposed to borrowed capitals more than any other company. In 2002, the total borrowed capitals were about €2.2bn (almost $2.2bn); given the data provided in the next chapter the total portfolio available for shipping was $16.3bn from all the financial institutions active in Piraeus in the 2001, so the lending of these companies reached 10% of the whole ($1.6bn in 2001). The long-term (LT) liabilities of every respective GCS company are presented below:

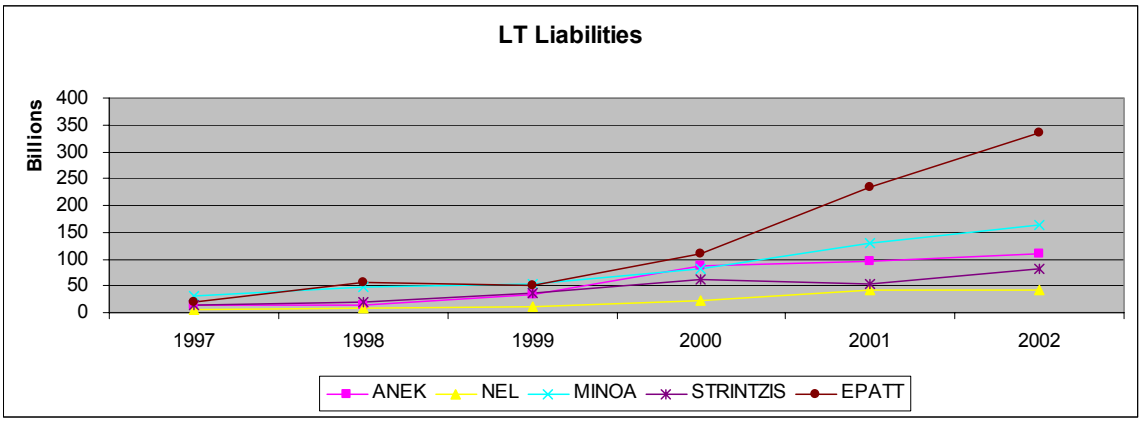


Figure 8: Long-term liabilities over the 1997-2002 period in GrD

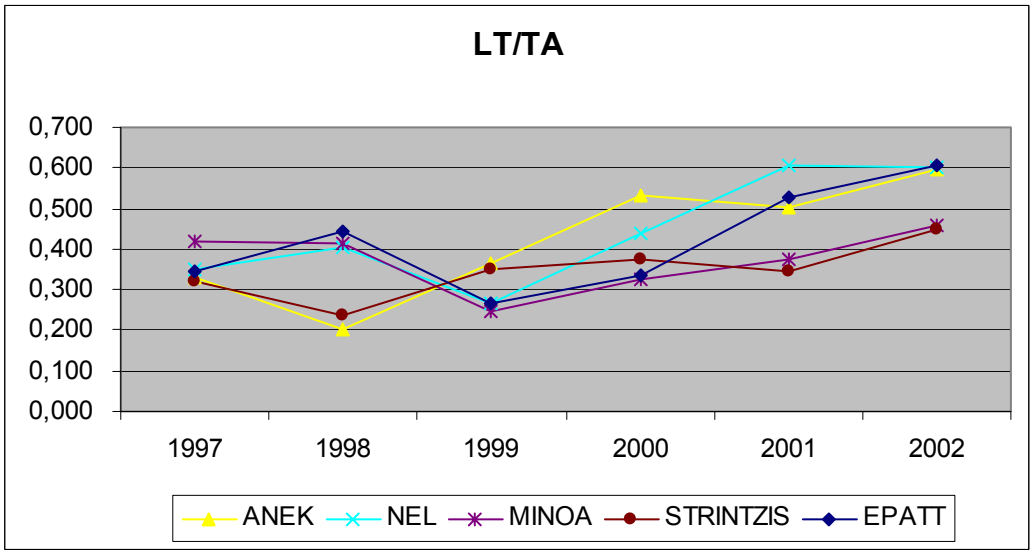


Figure 9: The ratio of long-term liabilities over total assets

The leverage ratio (long-term liabilities over total assets) remained in good levels. In most cases, the ratio was 0,3 and in specific cases over 0,5. It is reminded that values of the ratio below 0,3 are considered risky and dangerous and values up to 0,5 as warning ones. Values over 0,5 are considered adequate and acceptable.

Another interesting chart is the following one presenting the sales revenues and the net income after tax over the period of the analysis.

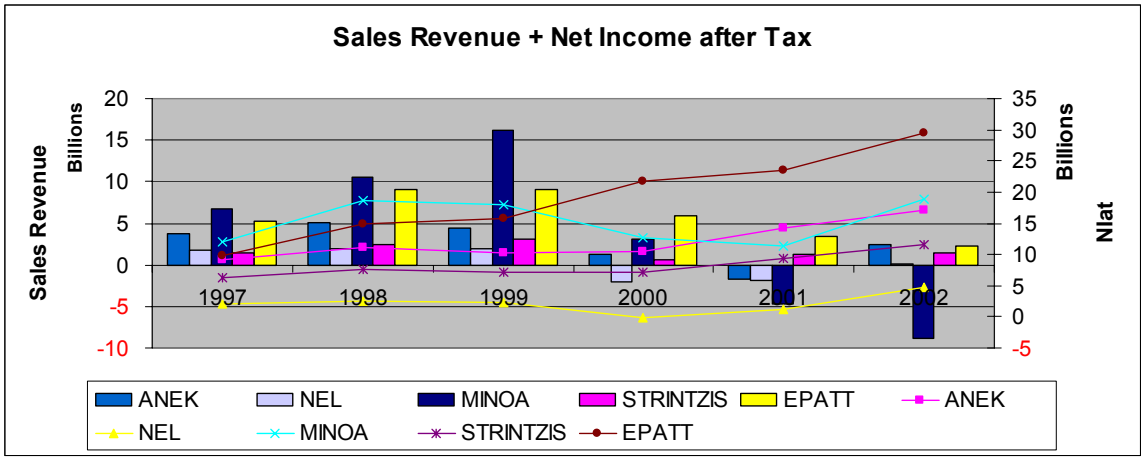


Figure 10: Sales Revenue and Net Income after Tax

In most cases the companies were profitable. Nevertheless, some years were not very profitable and the companies encountered red figures. NEL and MINOAN (and only once ANEK) experienced losses in the tough period of 2000-2002. The new vessels with their high levels of consumption and other expensive features drained the cash flow streams. In total, these companies have not experienced great losses (net income after tax) but only once (EPATT due to high depreciations).

As stated above the market shares, based on total assets, revealed interesting changes. In terms of turnover, the changes are even more acute (see Figure 11 and Figure 12). It is obvious that EPATT has experienced a considerably growth (almost 37%) in contrast to its competitors (with a growth rate close to 10-15%). This is attributed to the fast rate of growth in the Adriatic, as well as the buy-out of STRINTZIS and the deployment of vessels in other markets (Baltic and North Sea). EPATT and STRINTZIS were servicing almost 35% of the market in 1997 while in 2002 surpassed 50%. The Cretan operators were limited from almost 60% to 40%.

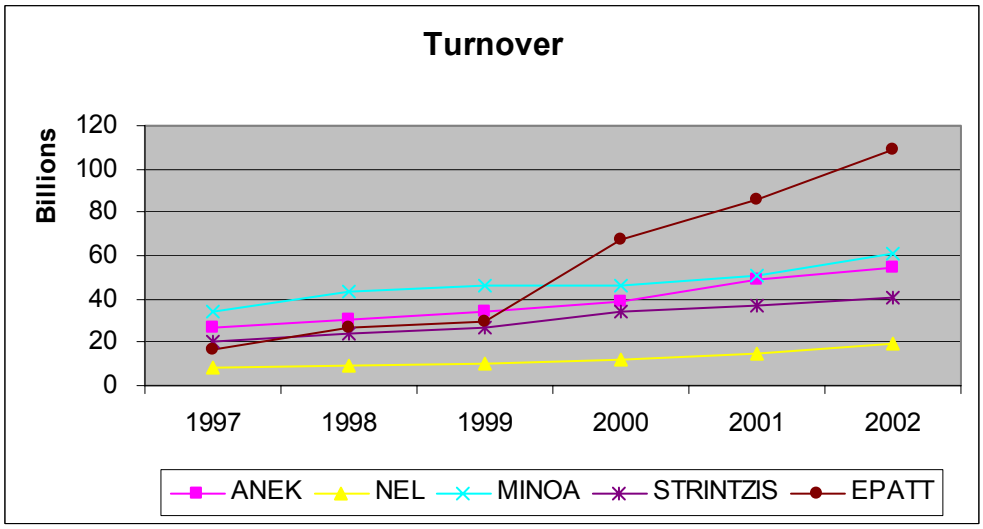


Figure 11: Turnover over the period of analysis

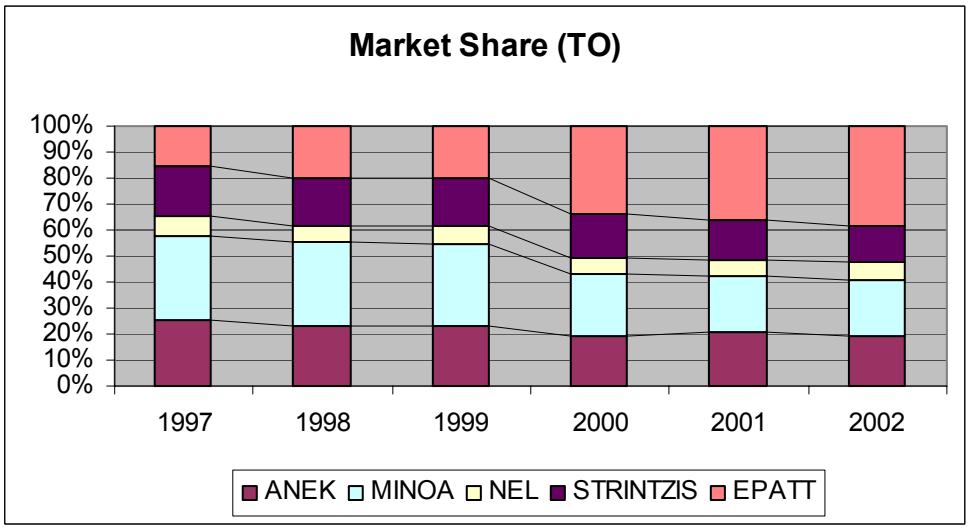


Figure 12: Market Shares based on Turnover Data

It is necessary to note also the analysis of the revenues. The fares and tickets are main source of income. A prevailing 85% of the income is attributed to the fares. The income from restaurant and bar services is not negligible, as it contributes almost 13%. The other sources of income are practically negligible.

	1997	1998	1999	2000	2001	2002	average
Fares	84,0%	83,9%	86,0%	87,4%	87,1%	86,5%	85,7%
Restaurant & bar services	14,8%	14,6%	12,2%	11,1%	11,9%	11,8%	12,9%
Casinos	0,3%	0,9%	1,0%	0,9%	0,7%	0,9%	0,8%
Cargoes	0,4%	0,2%	0,3%	0,3%	0,2%	0,2%	0,3%
Exchange, telecomms, etc	0,6%	0,4%	0,5%	0,4%	0,1%	0,7%	0,4%

Table 2: Revenues Classification

Another interesting observation is that most of the revenues are accrued in the Adriatic. There is an almost constant ratio over these years 2.3:1 suggesting that for every euro earned in the Aegean 2.3 are earned in Adriatic.

	1997	1998	1999	2000	2001	2002	annual growth
turnover (total bn GRD)	106	134	147	198	236	284	18%
Revenues (Aegean bn GRD)	35	40	47	73	77	76	14%
% Aegean	33%	30%	32%	37%	33%	27%	
Revenues (Adriatic bn GRD)	71	94	100	125	159	208	19%
% Adriatic	67%	70%	68%	63%	67%	73%	

Table 3: Breakdown of Revenues per Market

This observation is quite important for many reasons. Although the market in the Adriatic is relatively smaller for passengers and cars (see Table 4) the revenues are higher. The ratios for passengers are 1:3 and for the car traffic 1:1,5 (roughly) while more trucks are served in the Adriatic rather than the Aegean.

	1997	1998	1999	2000	2001	2002
pass – Aegean	3.752.267	3.915.142	4.268.356	5.163.183	5.702.349	6.621.103
pass – Adriatic	1.322.029	1.559.248	1.713.766	2.055.295	2.229.849	2.253.024
	26%	28%	29%	28%	28%	25%
cars – Aegean	469.398	489.066	558.003	690.008	707.155	839.356
cars – Adriatic	300.053	339.524	395.436	477.887	477.094	485.453
	39%	41%	41%	41%	40%	37%
trucks – Aegean	220.144	221.089	254.093	292.702	273.701	249.992
trucks – Adriatic	181.198	247.394	328.366	329.962	354.777	369.667
	45%	53%	56%	53%	56%	60%

Table 4: Total Volumes of Traffic Served by the Companies under Examination

Some arguments justifying this situation are the followings, although no exhaustive rational is provided. The first argument is that the Adriatic links are a year-round business for long hauls, i.e. there is a relatively continuous and adequate cash flow despite the seasonality of the Adriatic market (Schinas, 1994). Another argument is that the market is deregulated and there are no thin lines to serve. That is a very strong argument as the utilization ratio of many vessels in the

Aegean is very low even in the summer. The last argument is the very nature of the markets; while the Adriatic lines offer a viable alternative to the Greek trade and other flows through the Greek territory (inelastic up to a point market) and serves also Greek tourism (elastic up to a point), the Aegean lines serve highly seasonal tourist flows and compete with the aviation in main routes (Rhodes, Crete, Lesvos, Samos). All the above are prevailing causes.

A very interesting observation is that the measured concentration of the system is not leading to an oligopolistic perception of the market. Although there are various methodologies to estimate the concentration within an industry, the HHI and the Gini coefficient are widely used in transportation and logistics systems (Wang et al. 2004). In the respective annex the reader can find more information on the indices as well as their definitions and their formulas (see **Annex A: Concentration Indices**, p. 271).

		1997	1998	1999	2000	2001	2002
Turnover	**DI**	0,177	0,151	0,149	0,175	0,183	0,198
	Gini	0,032	0,024	0,022	0,160	0,162	0,183
	HHI	0,236	0,234	0,232	0,242	0,248	0,255
Passenger (Total)	**DI**	0,195	0,160	0,164	0,163	0,177	0,171
	Gini	0,099	0,080	0,068	0,032	0,037	0,050
	HHI	0,239	0,224	0,225	0,235	0,233	0,236
Cars (Total)	**DI**	0,221	0,189	0,180	0,186	0,203	0,203
	Gini	0,052	0,029	0,022	0,004	0,026	0,036
	HHI	0,244	0,232	0,229	0,235	0,238	0,242
Trucks (Total)	**DI**	0,163	0,116	0,128	0,138	0,129	0,137
	Gini	0,095	0,030	0,008	0,008	0,005	0,002
	HHI	0,225	0,215	0,218	0,220	0,220	0,226
Passenger (Adriatic)	**DI**	0,212	0,230	0,257	0,251	0,200	0,200
	Gini	0,094	0,186	0,230	0,231	0,161	0,137
	HHI	0,267	0,267	0,269	0,266	0,256	0,255
Cars (Adriatic)	**DI**	0,217	0,245	0,244	0,240	0,200	0,200
	Gini	0,036	0,109	0,165	0,166	0,096	0,067

	HHI	0,267	0,281	0,276	0,272	0,252	0,254
Trucks (Adriatic)	**DI**	0,200	0,224	0,216	0,200	0,200	0,216
	Gini	0,089	0,171	0,186	0,182	0,163	0,161
	HHI	0,253	0,266	0,263	0,257	0,259	0,262
Passenger (Aegean)	**DI**	0,200	0,200	0,200	0,238	0,211	0,204
	Gini	0,167	0,186	0,187	0,136	0,114	0,114
	HHI	0,253	0,252	0,257	0,275	0,268	0,271
Cars (Aegean)	**DI**	0,223	0,220	0,229	0,257	0,239	0,248
	Gini	0,108	0,125	0,154	0,122	0,108	0,096
	HHI	0,271	0,268	0,269	0,285	0,276	0,287
Trucks (Aegean)	**DI**	0,200	0,200	0,200	0,203	0,210	0,232
	Gini	0,246	0,255	0,259	0,222	0,222	0,245
	HHI	0,255	0,255	0,260	0,259	0,257	0,265

Table 5: Findings from the Application of Concentration Indices

Practically all dissimilarity indices are close to 1/5 (0.2) or to ¼ (0.25) as well as all Gini indices are low enough to support the idea that the market is not concentrated. This finding is consistent with the impression that the MMM divided all submarkets in 'equal' parts to satisfy all interests, and all 'interests' were satisfied with that arrangement.

Looking closer into the shift-share analysis of market shares per turnover (as product) it is interesting to note that EPATT are continuously gaining share against other actors. For all periods of analysis, EPATT is getting a lion's share even when adding the 'losses' from the STRINTZIS fleet. In absolute terms, STRINTZIS has not experienced reduction of its market share but the growth was not the expected one. The findings of these tables (**Table 35** to **Table 45**, pages from 274 to 276) will be discussed in the section regarding the validation of the model (see page 230).

The contribution of the non-listed companies is not negligible but also not as important as that of the listed ones. Unfortunately, HFD is the major player that has not been included in the analysis, as no

information has been provided at any stage of the research (see also p.74). Nevertheless another important actor G&A ferries provides a comparison basis. In terms of market share based on the total assets, G&A would only carve less than 5%of the total market. This percentage is decreasing in the last years as new vessels owned by listed companies enter the system. The fixed assets of G&A amount less than 10% of the average fixed assets of the listed companies (fiscal year 2002). The shareholders equity shrinks with an annual rate of almost 10% for the period of analysis 1999-2002, as the company reports losses every year. The long-term liabilities of G&A amount about 12% of the average long-term liabilities of the listed companies. However, in terms of sales revenues, G&A amounts around 80% of the average sales revenues of listed companies. By risking a generalization of the findings based only on G&A, it is obvious that the non-listed companies are contributing into the system in terms of sales, consequently in terms of services offered, but they cannot support their further growth. This is reflected in the delayed or stalled fleet-renewal, as well as in the reported losses every year.

3.1.3 Technical Aspects of the System

The vessels serving the system, as well as the port infrastructure, are considered as the hardware of the system. It is interesting to note that the operation of specific vessel types, as well as the design of the port facilities, is strongly inter-related. However, the improved operation of the system will not be solely attributed to new vessels and better ports but from the software of the system, either in the form of network control, or as knowledge-based elements (ticketing and relevant systems).

The fleet of the GCS had to be younger than 35 years and fulfill specific requirements, and then could be deployed in the Adriatic lines. This was the case up to the early 1990s' when the Adriatic corridor became an efficient sea-motorway. Then the old ships could not compete and only new fast and modern vessels could serve the market adequately. According to the available fleet data (all out the official information memoranda up to the fiscal year 2002) the following fleet features are produced:

1. The fleet belonging to the listed GCS companies consists of almost 65 vessels (new and old, conventional and non-conventional, deployed in the Aegean or the Adriatic) during the period of analysis. Almost 93% of them (60) are considered conventional. The vessels belonging to the listed GCS companies of the sample and were operating in 2002 are 48.
2. The average speed of the sample is around 24,6 knots. This figure is considered 'exaggerated' for the vessels deployed in the Aegean but close to reality for the vessels deployed in the Adriatic. A closer analysis suggests that the average speed for the conventional vessels is 24,4 knots and 37,6 knots for the non-conventional. Obviously this is the reported speed and not the actual operating one. It shall be noticed that most of these vessels are new ones (31 of them are less than 10 years old.)
3. The total capacity of passengers is around 93000 and the average around 1330. This figure reflects reality although the extracted statistics for bed, car and truck number do not. A rather not reliable statistic suggests that every ship offers around 390 beds, carries 330 private cars or a combination of 121 cars and 76 trucks. The measurement would be more accurate if only the available lane meters were known.

4. The average year the keel was laid is 1987; most of the old vessels have undergone extensive overhauls in the 1990s'. The following chart reveals the trend of the market for younger vessels:

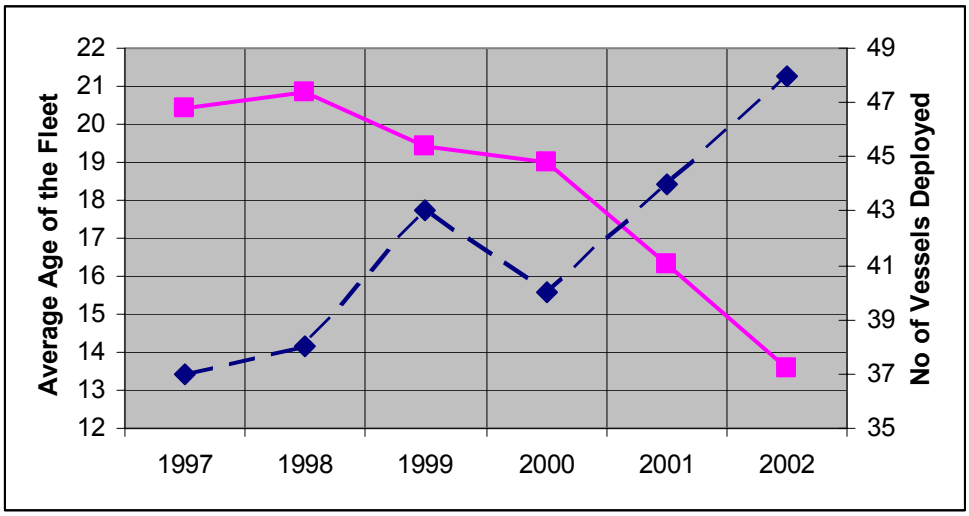


Figure 13: Average Age of the Fleet and number of Deployed Vessels

Obviously, more new vessels are deployed in the system. This is a very positive result of the financial boom of the 1997-2002 fiscal periods (see previous paragraph).

The issue of using modern and innovative ship designs in the system is not new; Psaraftis and Papanikolaou (e.g. 1992) have addressed this problem and various companies have routed non-conventional designs. In 2002 only 5 non-conventional vessels were deployed (3 vessels of NEL and 2 of Strintzis). HFD has also deployed non-conventional vessels but HFD is not a listed company and is not taken into account in the study. For clarity reasons, as non-conventional vessels are understood, mono-hull or twin-hull ships that are not designed on regular displacement principles.

While a lot of money has been invested by privates for the deployment of new vessels, the port infrastructure remains inadequate to handle the traffic and the needs of the islands.

Although no aggregate figures are available, only some major investments are worth-mentioning:

- In the Ionian Sea, the port of Igoumenitsa is experiencing extensive improvements as a result of the Egnatia axis and its increasing importance in the Trans-European Networks (TEN) (axis X). The port infrastructure at the ports of Patras and Igoumenitsa has been improved; no sophisticated intelligent system has been deployed in order to support 'smart' movements of the trailers carrying the cargo. The real development in the Greek mainland is the completion of the North-South road axis as well as of the East-West axis of Egnatia (not over yet) that connects the interesting and growing market of Istanbul with Thessalonica and Igoumenitsa. The completion of Egnatia axis will definitely encourage trucks from Bulgaria and Turkey to use the port of Igoumenitsa as a gateway. Experience shows that Turkish trucks have already exploited the new Greek road and air infrastructure, as well as Turkish families have used the old network to Igoumenitsa, as a gateway to Central Europe for tourism mainly. From press reports, it is known to the authors that almost 80,000 trucks of Turkish interests have used Igoumenitsa as gateway in 2002 and almost 1000 private cars per week in 2003. The figures are not negligible and the following graph highlights the increasing importance of Igoumenitsa at the Greek side (Figure 14):

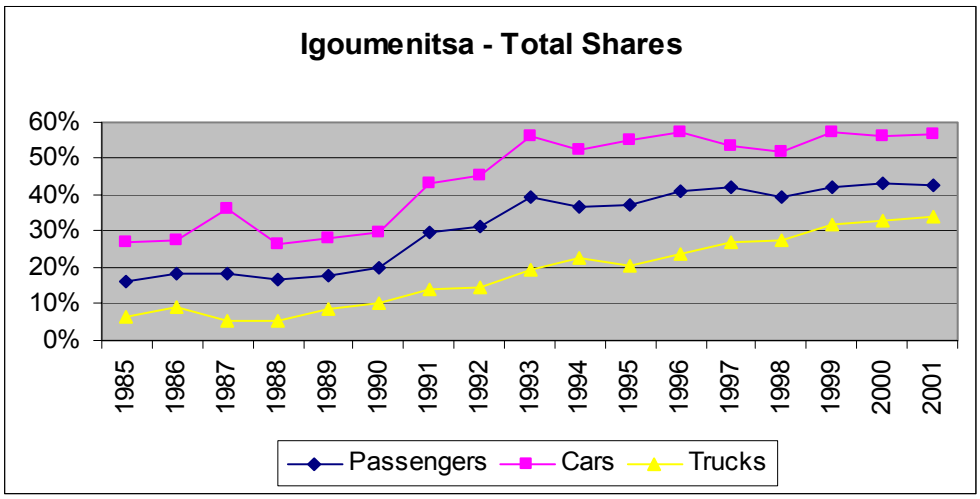


Figure 14: Shares enjoyed by the port of Igoumenitsa

- In the Aegean market, there are not so many developments. The main port, Piraeus, has dedicated the central harbor for the needs of the GCS. The city of Piraeus expands around this harbor and there is 'partially sufficient' land access and service from the public transportation means. This 'partially sufficient' characterization aims to highlight the fact that not all quays are sufficiently served by public means and in peak times (early in the morning or in cases of simultaneous arrivals in the summer) the users of the port facilities (passengers, cars and trucks) are not adequately served. There is no central passenger station and there is no sufficient bus service or traffic management in the port zone for the users. Coast Guard Authorities take care of these issues. Nevertheless, it reveals the general concept on port services. The same happens also in new facilities, such as the port of Lavrio and the port of Myconos, where the focus lies on the infrastructure rather than on the proper 'handling' of the users' needs and management of the traffic. Although many infrastructure improvements of minor significance are materialized, there is no worth-mentioning development.

It is necessary to mention that in the GCS complex of service, port facilities have never attracted the interest of investors and of operators. This is a result of the suffocating control of the State and of the design of the system. In very few and specific cases, operators expressed interest for the port facilities, as happened in the case of Patras. In that specific case, the poor port facilities were diminishing the advantages of the new vessels and therefore reducing the returns of their investment. In the Aegean complex, the interest of the operators was focused on the poor operational safety offered by the harbors. Furthermore, there was also the issue of the license; it was never sure that the same operator would serve the same line for a specific time period that would make the investment worthy.

As a result, it was rather impossible to introduce successful techniques and practices from other industries, such as advanced services for the users at ports, yield management for the perishable asset of the seats, the beds, the lane meters on board, advanced advertising, etc. These services are widely offered in the air-industry, as well as in other coastal systems, for instance in the Baltic Sea. The obsolete design and management approach from the State condemned the local port industry to poor services. Of course, not all ports could be benefited from the operators, but it is definite that some at least would, and at least they would raise the standards for the whole system. This question becomes even more interesting and acute as the new and innovatively designed vessels require better harboring and traffic management at the port zone in order to be efficient and competitive.

4 Methodology

4.1 The MCDM Formulation

In this section the interest lies in the general MCDM problem formulation and the fundamentals of the AHP.

The decision-making problems are classified into discrete and continuous ones. To the former category belong all problems dealing with a non-infinite set of alternatives (see also Table 6) and to the latter, all problems that cannot be adequately defined, but it is possible to limit them within a space, where all possible solutions lay (see Figure 15):

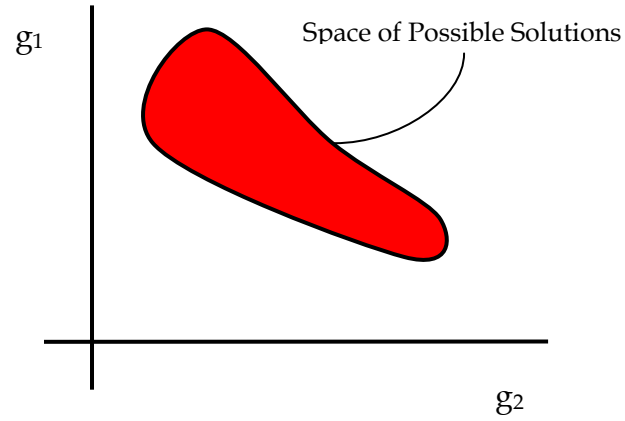


Figure 15: Continuous Decision Making Problems (g_1 and g_2 are criteria)

The problems dealt in this study are of discrete nature and fall into the ranking and classification category. More specifically the problem of clustering the Greek lenders is a pure classification one, while the valuation of the GCS companies a ranking one. Generally classification problems attract more academic and practitioners' interest. These problems are found in many fields, such as marketing, finance, pattern recognition, etc. The approaches towards such problems are many and can briefly be analyzed into the following scheme:

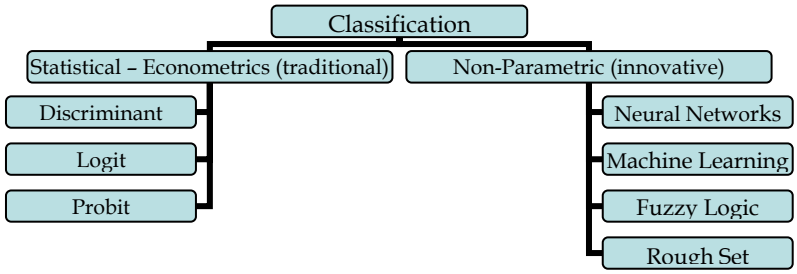


Figure 16: Classification Techniques

The super class of decision models is found in the literature as Multi-Criteria Decision Making (MCDM), which is a branch of general class of operations research (OR) models dealing with decision problems under the presence of a number of decision criteria. This class is divided into Multi-Objective Decision Making (MODM) and Multi-Attribute Decision Making (MADM). MODM studies decision problems of continuous space, and the Kuhn-Tucker approach, known as *vector-maximum* is most probably the very first attempt to solve such problems. In contrary, MADM techniques concentrate on problems of discrete nature. From this point and on, the terms MCDM and MADM will be referred indiscreetly. All MADM methods have some aspects in common. These are the notions of alternatives, and attributes (or criteria, goals) as described next (Triantaphyllou, 1998):

- **Alternatives**: Alternatives represent the different choices of action or entities available to the decision maker. Usually, the set of alternatives is assumed to be finite, ranging from several to hundreds. They are supposed to be screened, prioritized and eventually ranked.

- **Multiple attributes**: Each MADM problem is associated with multiple attributes. Attributes are also referred to as "goals" or "decision criteria" and are commonly understood as parameters or characteristics. Attributes represent the different dimensions from which the alternatives can be viewed. In cases in which the number of attributes is large (e.g., more than a few dozens), attributes may be arranged in a hierarchical manner. That is, some attributes may be major attributes. Each major attribute may be associated with several sub-attributes. Similarly, each sub-attribute may be associated with several sub-sub-attributes and so on. Although some MADM methods may explicitly consider a hierarchical structure in the attributes of a problem, most of them assume a single level of attributes (e.g., no hierarchical structure).
- **Conflict among attributes**: Since different attributes represent different dimensions of the alternatives, they may conflict with each other. For instance, cost may conflict with profit, etc.
- **Incommensurable units**: Different attributes may be associated with different units of measure. For instance, in the case of buying a used car, the attributes "cost" and "mileage" may be measured in terms of dollars and thousands of miles, respectively. It is this nature of having to consider different units which makes MADM to be intrinsically hard to solve.
- **Decision weights**: Most of the MADM methods require that the attributes be assigned weights of importance. Usually, these weights are normalized to add up to one.
- **Decision matrix**: An MADM problem can be easily expressed in matrix format. A decision matrix A is an (M × N) matrix in which element aij indicates the performance of alternative Ai

when it is evaluated in terms of decision criterion Cj, (for i = 1,2,3,..., M, and j = 1,2,3,..., N). It is also assumed that the decision maker has determined the weights of relative performance of the decision criteria (denoted as Wj, for j = 1,2,3,..., N). This information is best summarized in Table 6.

Given the previous definitions, then the general MADM problem can be defined as follows (Zimmermann, 1991):

Definition 1-1: *Let A = {A_i, for i = 1,2,3,... ,M} be a (finite) set of decision alternatives and G = {g_i , for j = 1,2,3,..., N} a (finite) set of goals according to which the desirability of an action is judged. Determine the optimal alternative A* with the highest degree of desirability with respect to all relevant goals g_i.*

		Criteria						
		C_1	**C_2**	**C_3**	**…**	**C_j**	**…**	**C_n**
	weights	w_1	w_2	w_3		w_i		w_n
Alternatives	A_1	a_{11}	a_{12}	A_{13}	…	a_{1j}	…	a_{1n}
	A_2	a_{21}	a_{22}	A_{23}	…	a_{2j}	…	a_{2n}
	A_3	a_{32}	a_{32}	A_{33}	…	a_{3j}	…	a_{3n}
	⋮					⋮		
	A_i	a_{i2}	a_{i2}	a_{i3}	…	a_{ij}	…	a_{in}
	⋮					⋮		
	A_m	a_{m2}	a_{m2}	a_{m3}	…	a_{mj}	…	a_{mn}

Table 6: Decision Matrix for a Discrete Decision-Making Problem

This tabular format implies a single hierarchy and is known as *decision matrix*. In this formulation:

let C_1, C_2, C_3, …, C_n be the decision criteria

let A_1, A_2, A_3, …, A_m be the decision alternatives

let w_i (for i = 1, 2, 3, …, n) be the weight of criterion C_i

let a_{ij} be the performance of alternative A_i when it is examined in terms of criterion C_j

The concealed meaning of the above formulation is that an MCDM problem, with a given decision matrix, is in essence a problem for a set of known alternatives and for a set of known criteria. Other alternatives and analysis under other criteria is not the case in the MCDM formulation and the decision-maker has to determine both alternatives and criteria before proceeding to further steps. The problem formulation goes through a three-phase procedure:

1. determination of the pertinent data
2. process of the data
3. interpretation of the results and the feedback mechanism

In the first phase, the decision maker has to evaluate the quality and the availability of data. Given or calculated data may be taken into account indifferently of their nature: stochastic – deterministic, qualitative – quantitative, stable – dynamic, etc. The second phase deals with the selection of the proper technique and the execution of the necessary calculations. It is interesting to note that there is no single method considered as the most suitable or the most acknowledged for the general problem. Furthermore, the results for a given set alternatives and attributes may significantly vary when comparing different methods. Popular MCDM methods, such as the weighted sum model (WSM), the weighted product model (WPM), the analytical hierarchy process (AHP) and its revisions or alterations, the family of techniques ELECTRE (Elimination Et Choix Traduisant la Realité), UTADIS, TOPSIS, etc may lead to different conclusions. This has also been proven in the MCDM literature (Triantaphyllou and Mann, 1989). Of course there are some criteria ensuring the stability of the final solution as well as the validity of both the mere decisions and the whole procedure, but this is not the case in the text. Finally, in the third phase, the decision maker has to interpret the

results and find the most critical criterion. The outcome of this phase is most commonly the results of a sensitivity analysis under specific rules.

The MCDM methods are classified according to the available data as well; so deterministic, stochastic and even fuzzy MCDM methods can be applied to various problems. Another common way to classify MCDM problems is the number of the decision makers involved in the process. Hence, if there is only one decision maker, then the method is called single and if there are more decision makers then it is called group MCMD method. Common deterministic, single MCDM methods are the Weighted Sum Method (WSM), the Weighted Product Method (WPM) AHP, Elimination and Choice Translating Reality (ELECTRE) and Technique for Order Preference by Similarity to Ideal Solution (TOPSIS). There are other ways to classify MCDM problems as well as other categories the above mentioned methods may fall into. For example, AHP can easily incorporate fuzzy data as well as assist in group decision making.

4.2 The Analytic Hierarchy Process Method

The analytic hierarchy process (AHP) is a relatively old method, developed and presented by Thomas L. Saaty in mid-1970s (Saaty, 1977). Then the method has been discussed and revised from various scientists in the world; the first collection of papers on the method along with the mathematical founding has been presented by Saaty in 1980 (Saaty, 1980). AHP works by developing priorities for alternatives and the criteria. Generally, the criteria are set by the decision-maker, who constructs the hierarchy. The subjective point of view of decision-maker consist a weakness for every methodology. Usually methodologies demand a certain level of expertise from the decision-maker. In some cases this necessary, as algorithms depend

on the first guess of the decision-maker for the soundness of the method or the easiness of extracting data. Such procedures are of heuristic type. In other cases, where relative comparisons are part of the procedure, the subjective point of view is critical for the outcome; the more subjective perception tends to objective acuity the better the outcome, assuming that objectivity is under quest. It has to be noted that decisions shall also reflect personal and subjective perceptions in many cases as well and objectivity is desired only when the decision-maker is neutral or indifferent, when selecting the alternative.

The hierarchy of the criteria reflects also the understanding of the decision-maker of the problem and of the parameters affecting the final judgment. A critical point for all MCDM methods is the combination of criteria measured on different scales; measurements of different scales cannot be directly combined. In AHP priorities between criteria are first extracted and then priorities for the performance of every alternative on each criterion are derived. These priorities are nothing but pair-wise assessments using judgment or ratios from a measurement scale, if one exists. There are many measurement scales available for decision-makers; Saaty has proposed a linear scale, well accepted in the academia and widely used in application. Lootsma has proposed another non-linear scale, and other researchers have based their scales primarily on psychological research. As a general comment, what Saaty has achieved with AHP is appealing: the decision-maker can combine criteria with different measurement scales, introduce qualitative criteria revealing biases and, last but not least, numerically is the transformation of multidimensional scaling problem to one-dimensional. This has also been achieved through the use of a common scale –the fundamental one-, proportionality and the introduction of ideal and distributive modeling.

A critical issue of all MCDM problems is the one of hierarchy; there are many sources suggesting that decision-making is a hierarchical process. All problems, from the simplest to the most complicated, can be represented in a multilevel structure, a hierarchy, whose first level is the goal followed by levels of factor, criteria, sub criteria and so on. Its representation can be used in order to describe how changes, at upper levels, can affect the priority at lower levels. Hierarchical representation gives a clear picture to the decision-maker about the structure and functions of the system in its lower levels and provides an overview of the actor and their purposes in the upper levels. Therefore, the main objective of a hierarchy is either to assess the impact of an element in levels higher than those that are characterized lower, or alternatively the contribution of elements in the lower levels to the importance of the elements in the upper level. This technique is based on the breaking down of a decision into smaller parts, from the goal to criteria, to sub criteria and so on. This procedure enables decision-makers to set up priorities and to create problem's model by developing a hierarchy decomposition representation. At the top of the hierarchy is the overall goal that is trying to fulfill. The lower levels represent the progressive decomposition of the problem. The decision-maker completes a pair-wise comparison of all elements in the next higher level of the hierarchy. The composition of all these elements determines the most relevant priority of elements in the lowest level in order to achieve the most objective. Therefore, one of the main objectives of AHP is the development of priorities for alternatives and of criteria that are used in order to judge the alternatives.

The method can also accommodate group decision making and judgments from various experts. The advantages of the method have been widely and sternly discussed and debated among academics.

The main point of friction is the extraction of the priority eigenvectors and other numerical issues. In conclusion, the AHP is based on seven pillars described briefly above and analyzed further in the following paragraphs:

1. Ratio Scales
2. Paired Comparisons
3. The establishment of priority vector
4. Alternative's Comparison
5. The establishment of priority vectors for alternatives
6. The achievement of the overall ranking
7. Group decision making

It shall be noted that AHP is a convenient and rather accurate tool when alternatives are not many, i.e. when the relative comparison between alternatives remains within a range humans can easily handle. Supposing that a decision-maker has to elicit the priorities or the weights of n entities (criteria or alternatives) then he has to elicit the value of n(n-1)/2 pairwise comparisons. In a generic form, with m alternatives and n criteria, then this number equals to $\frac{n\,(n-1)}{2} + \frac{n\,m\,(m-1)}{2}$, which can be a rather large number. For n=m=10 then the number of the required pairwise comparisons equals to 495; for n=10 and m=15 the number becomes 1095. This high number of comparisons can make the data elicitation procedure tedious and thus it may jeopardize the accuracy of the whole procedure. Small inaccuracies may become critical as numerical errors are diffused and have a magnified effect in the outcome. Researchers have attempted to skip certain comparisons (Harker, 1987) and Triantaphyllou has proposed lately an alternative approach by formulating a dual

problem (Triantaphyllou, 1999). This issue will not be discussed further as there is no relevant need. Yet the advantages of AHP in a small sample of alternatives over other methods were the main trigger for approaching the subject with this method. If the sample of the alternatives was bigger then AHP would be critically contrasted with other MCDM methods.

As it is known, a ratio is the relative value or a quotient of two quantities of the same kind and it is called *commensurate* if it is a rational number, otherwise it is *incommensurate*. A ratio is either the relative value or the quotient $\frac{a}{b}$ of two quantities *a* and *b* of the same kind. The statement of the equality of the equality of two ratios $\frac{a}{b}$ and $\frac{c}{d}$ is *proportionality*. A ratio scale is a set of numbers that is invariant under a similarity transformation. Ratio scales can be considered central to the generation and synthesis of priorities, as far as AHP is concerned, but also in any multi-criteria method that has to combine existing ratio scale measurements with its own scales. They are characterized as the only way that can be used to the generalization of a decision theory when the case of dependence and feedback is examined. The main reason is the ability of ratio scales to be both multiplied and added when they belong to the same scale. When two judges arrive at two different ratio scales for the same problem, the next step is the testing of their answer's compatibility in order either to accept or reject them.

Ratio scales may also be used to make decisions that follow a more general framework, which involves several hierarchies and by using a common criteria. Generally, the ratio of two numbers that belong to the same ratio scale is an absolute number and so, ratio scales create

the dominance numbers of an absolute scale, which can be weighted by other such numbers and of course, to be added.

If the readings from a ratio scale are aw_i^*, where i = 1,…,n, the standard form is given by $w_i = \frac{aw_i^*}{aw_i^*} = \frac{w_i^*}{w_i^*} = 1$, where i = 1,…,n and said to be normalized. So, it is no longer required to specify the units of the weights, as there is a standard ratio scale. The standard form is unit free and belongs to a scale of absolute numbers, commonly called *dominance numbers*. The relative ratio scale, which is obtained from a pair wise comparison matrix of judgments, is extracted by solving the following equations:

$$\sum_{j=1}^{n} a_{ij} w_i = \lambda_{max} w_i \qquad \sum_{i=1}^{n} w_i = 1$$

Where $a_{ji} = \frac{1}{a_{ij}}$ or $a_{ij}\, a_{ij} = 1$, if $a_{ij} > 0$ (reciprocal property, so matrix A is positive).

Let $A_1, A_2, \ldots, A_n$ be the activities. The quantified judgments on pairs of activities (A_i, A_j) are represented by an n-by-n matrix $A=(a_{ij})$ where i=1,2,…, n, which is consistent and its principal eigenvalue is equal to positive n. This exists if $a_{ij} = a_{ik}\, a_{kj}$ where i, j, k =1,2,…,n

The matrix A can be multiplied on the right by the interchange of the vector of weights $w=w_1, w_2, \ldots, w_n$. The result of this multiplication is n x w. The matrix of ratios A is consisted if and only if n is its principal eigenvalue and:

$\mathbf{Aw} = \mathbf{n} \times \mathbf{w} \Rightarrow \mathbf{Aw} - \mathbf{n} \times \mathbf{w} = \mathbf{0} \Rightarrow (\mathbf{A} - \mathbf{n} \times \mathbf{I}) \times \mathbf{w} = 0$

We may conclude that all eigenvalues except one are zero.

Paired comparisons allow the expression of comparisons in verbal term that are then translated in the corresponding numbers. Decision-makers synthesize the comparisons in order to get the dominance of each element in relation to other elements. The most structured way of doing this comparison is the preparation of a matrix whose factors have to be listed at the top and on the left. This comparison is based on surveyed information and on the resulting judgment of the decision-maker. The next step is the filling of the matrix with numerical values that indicate the factor's importance on the left, relative to the factor's importance on the top. Therefore, a high value means that the factor on the left is more important that the factor at the top. When the matrix has been filled out, the decision-maker can move to the next step.

Paired comparisons permit the expression of comparisons in verbal terms that are translated in the corresponding numbers. Decision-makers synthesize these comparisons in order to get the dominance of each element in relation to other elements. The most structured way of doing these comparisons is the preparation of a matrix whose factors have to be listed at the top and on the left. These comparisons are based on surveyed information and on the judgment of the decision-maker. The filling of the matrix with numerical values denotes the factor's importance on the left, relative to the factor's importance on the top. The high value of the factor on the left means, that it is more important than the factor at the top.

The matrix is consisted of numerical values. These numerical values can be denoted as w_i and w_j and their ratio w_i / w_j represents the relative importance of the i^{th} criterion over the j^{th} criterion. Instead of determining two numbers w_i and w_j and their ratio, decision-maker can select a single number taken out from the fundamental 1 - 9 scale of absolute numbers in order to represent the ratio (w_i / w_j) / 1. This

single number is consisted of the nearest approximation of the ratio w_i / w_j . The derived scale will expose what the w_i and w_j are. The following Table 7 shows the fundamental scale for pair wise comparison.

Verbal Value	**Numerical Values**
Equally important, likely or preferred	1
Moderately more important, likely or preferred	3
Strongly more important, likely or preferred	5
Very strongly more important, likely or preferred	7
Extremely more important, likely or preferred	9
Intermediate values to reflect compromise	2,4,6,8

Table 7: Fundamental Scale for Pair Wise Comparison

This number is the central factor of the relative measurement approach of the AHP and denotes the need for a fundamental scale.

In order to estimate the priority vector, there are various techniques. Following scientific discussions, Saaty accepted the 'revised' method proposed by other researchers, as his original one suffered numerically in some extreme cases. The revised method is based on the geometric mean instead of the arithmetic one. The geometric mean of the elements of a row is calculated and then the results are normalized (each one divided by their sum). The result is the priority vector; then from this vector the ideal vector is derived. A numerical example may clarify this approach:

	A	B	C	D	E	Geometric Means	Priority Vector	Idealized Vector
A	1	3	5	7	9	3,936283	0,510	1,000
B	1/3	1	3	5	7	2,036168	0,264	0,517
C	1/5	1/3	1	3	5	1	0,130	0,254
D	1/7	1/5	1/3	1	3	0,491119	0,064	0,125
E	1/9	1/7	1/5	1/3	1	0,254047	0,033	0,065
						7,717617		

The geometric mean of the first row, say, is estimated as:

$$\sqrt[5]{1*3*5*7*9} = \sqrt[5]{945} = 3,936283$$

The first element of the priority vector is estimated as:

3,936283/7,717617 = 0,510

where 7,717617 is the sum of all geometric means.

Then the first element of the idealized vector is calculated as the product of the division of the first element with the element with the highest value. In that case this is the first one, so the result is 1. All other values are derived accordingly.

Given these results it is also possible to estimate the consistency of the judgment. As stated above, a judgment is consistent if and only if $a_{ij}=a_{ik}a_{kj}$. By applying simple graph analysis, Saaty proved that when a matrix is consistent, any power of the matrix is equal to a constant times the matrix. In fact any power k of the matrix gives all paths of length k between two activities and is a constant n^{k-1} times the matrix, where n is the number of activities being compared. In the above case n=5 and k=2 so $n^{k-1}=5$. This is not the case for an inconsistent matrix. In order to measure the inconsistency there are available numerical techniques. The most stringent one is the one based on the extraction of the maximum eigenvalue. If this eigenvalue equals the rank of the matrix, then the matrix is consistent, else the rank is smaller than the maximum eigenvalue. Numerically, the technique is based on the product of the original matrix with the extracted priority vector. The

product is another vector [n×n]*[n×1]=[n×1]. By dividing its elements with the elements of the priority vector another vector is derived. The arithmetic average value of the elements is maximum eigenvalue. Then the consistency index is calculated:

$$CI = \frac{\lambda max\text{-}n}{n\text{-}1}$$

This ratio is then divided by a given figure, called random consistency (RC), depending on the size of the matrix and the consistency ratio is derived:

CR= CI/RC

If CR is less than 10% then the original judgments are considered consistent. If not then the decision-maker has to revaluate his/her judgment. This figure, RC, is estimated numerically and is given in the literature:

Size of the Matrix	1	2	3	4	5	…
Random Consistency	0.00	0.00	0.52	0.89	1.11	…

Table 8: Random Consistencies – Indicative sample

Given the numerical example considered above the consistency calculations are the following:

$$\begin{bmatrix} 1 & 3 & 5 & 7 & 9 \\ 1/3 & 1 & 3 & 5 & 7 \\ 1/5 & 1/3 & 1 & 3 & 5 \\ 1/7 & 1/5 & 1/3 & 1 & 3 \\ 1/9 & 1/7 & 1/5 & 1/3 & 1 \end{bmatrix} \begin{bmatrix} 0{,}510 \\ 0{,}264 \\ 0{,}130 \\ 0{,}064 \\ 0{,}033 \end{bmatrix} = \begin{bmatrix} 2{,}69112 \\ 1{,}37117 \\ 0{,}67502 \\ 0{,}33121 \\ 0{,}17441 \end{bmatrix}$$

$$\begin{bmatrix} 2{,}69112/0{,}510 \\ 1{,}37117/0{,}264 \\ 0{,}67502/0{,}130 \\ 0{,}33121/0{,}064 \\ 0{,}17441/0{,}033 \end{bmatrix} = \begin{bmatrix} 5{,}27631 \\ 5{,}19711 \\ 5{,}20957 \\ 5{,}20475 \\ 5{,}29823 \end{bmatrix}$$

Then the average of the elements of the vector is calculated as: (5,276307+5,197107+5,209569+5,204755+5,298233)/5 = 5,23719

By applying the formulas:

$$CI = \frac{\lambda max\text{-}n}{n\text{-}1} = \frac{5{,}23719\text{-}5}{5\text{-}1} = 0{,}05929 \approx 0{,}06$$

and

$CR = CI/RC = 0{,}06/1.11 \approx 5{,}3\%$

The original judgments are considered as sound enough to proceed to further elaboration.

These procedures are repeated for the comparison of all alternatives and weights. The final ranking of the alternatives is based on the formula:

$A_i = \Sigma w_j a_{ij}$

This linear formula conceals much theoretical information. The first one is that the attributes are independent and therefore it is possible to sum them numerically. Furthermore they bear no dimensions or units. Additive and rest assumptions are also held. Last, but not least, this linear also relation assumes linear utility functions. More details can be found in the literature (e.g. Keeney and Raiffa, Saaty, Pardalos) as well as in the coming chapter on the application of the model.

4.2.1 Group decision-making

In many cases, it is necessary to combine the judgments of many experts or to extract the judgment from of a team of persons. The issue of group judgment is not so easy, as it may seem to the inexperienced researcher, as the judgments have to satisfy the reciprocal properties. Group decision-making must be carefully designed and taking into account the experience and the knowledge

of persons that are involved in the decision-making, as well as by avoiding the need to use the classical ways such as voting.

Usually, group decision making comes up in two forms or types of problems: how to aggregate individual judgments and how to construct a group choice out of individual ones. Aczel and Roberts in 1989 proposed the conditions to produce meaningful statements from merged functions; the conditions are symmetry, linear homogeneity and agreement (Aczel, et al, 1989).

The symmetry axiom demands that the merging function does not change if the functions giving individual judgments are interchanged. The linear homogeneity specifies that if a group multiplies its preference by a constant *r*, then the resulting group preference is also multiplied by *r*. The agreement axiom specifies that if all individuals agree, then the group agrees with all individuals. As there is no specific interest in this issue in this document, there will be no mathematical justification of the above axioms or discussion over the soundness of this approach. However, it has to be highlighted that Saaty implies, in many of his documents, that in most cases arithmetic or geometric mean are the most usable and possible functions to cover such needs (Saaty, 2001b, p61). Saaty also discusses some qualitative issues in group decision making: the unequal power and expertise of the participants, the bargaining of votes or support on issues with specific interest (variability of preference), the change of preference due to external factors, and the unwillingness to reveal preferences (Saaty, 2001a).

AHP is used widely in group decision making situations through questionnaires. The implementation of such a technique demands some expertise from the researcher or the decision maker, and the issue of the merging function, may easily be bypassed with the use of

fuzzy techniques, such as by extracting the fuzzy average of judgments. Such ideas have also been presented in academic works (for instance in Chou et al, 2001). A mingling of techniques, such as a mixed use of TOPSIS, AHP, fuzzy systems, etc. may lead to robust algorithms addressing complex problems, as in the case of Tsaur et al. (2002) but there is a trade-off with the theoretical purity of the solution.

Group decision making numerical problems are commonly tackled through calculation of the geometric mean of the responses of the various decision-makers. Such techniques are used in cases of simulations and increased numerical input.

4.2.2 Sensitivity Analysis

Following a methodology originally supported by Triantaphyllou and Sanchez (1997) it is possible to identify the most 'sensitive' criterion. The authors consider two problems:

1. how to determine the most critical criterion,
2. how to determine the most critical element in the decision matrix.

Intuitively, one may think that the most critical criterion is the one that corresponds to the highest w_j. However, this notion of criticality may be misleading as the most critical criterion is defined in a different way:

> **Definition 1:** Let define $\delta_{k,i,j}$ ($1 \le i < j \le M$ and $1 \le k \le N$) denote the minimum change in the current weight W_k of criterion C_k such that the ranking of alternatives A_i and A_j will be reversed.
>
> **Definition 2:** Define $\delta'_{k,i,j} = \delta_{k,i,j} \frac{100}{W_k}$ ($1 \le i < j \le M$ and $1 \le k \le N$), that expresses changes in relative terms

Definition 3: The criticality degree of criterion C_k denoted as D'_k is the smallest percent amount by which the current value of W_k must change, such as that the existing ranking of the alternatives will change, i.e.:

$$D'_k = \min_{1 \le i < j \le M} \left\{ \left| \delta'_{k,i,j} \right| \right\}$$

for all $1 \le k \le N$

Definition 4: The sensitivity coefficient of criterion C_k denoted as $sens(C_k)$ is the reciprocal of its criticality degree. That is if only the following relation is true ($D'_k \neq 0$):

$$sens(C_k) = \frac{1}{D'_k} \text{ for all } 1 \le k \le N$$

In all above, definition M is the number of alternatives and K is the number of criteria. Considering the above definitions the authors have proved the following theorem that will support the following analysis:

When the WSM, AHP, or ideal AHP methods are used, the quantity $\delta'_{k,i,j}$ ($1 \le i < j \le M$ and $1 \le k \le N$), by which the current weight W_k of criterion C_k needs to be modified (after normalization) so that the ranking of alternatives A_i and A_j will be reversed, is given as follows:

$$\delta'_{k,i,j} < \frac{(P_j - P_i)}{(a_{jk} - a_{ik})} \frac{100}{W_k} \text{ if } a_{jk} > a_{ik} \text{ or}$$

$$\delta'_{k,i,j} > \frac{(P_j - P_i)}{(a_{jk} - a_{ik})} \frac{100}{W_k} \text{ if } a_{jk} < a_{ik}$$

Furthermore the following condition should also be satisfied for the value of $\delta'_{k,i,j}$ to be feasible:

$$\frac{(P_j - P_i)}{(a_{jk} - a_{ik})} \le W_k$$

From the above, it can be seen that if alternative A_i dominates alternative A_j (i.e. $a_{jk} < a_{ik}$ for all k = 1, 2, …, N) then it is impossible to make alternative A_j more preferred than alternative A_i by changing the weights of criteria. Furthermore, criterion C_k is a robust criterion if all $\delta'_{k,i,j}$ ($1 \le i < j \le M$ and $1 \le k \le N$) quantities associated with are infeasible. One should also observe that there are $\frac{N\,M\,(M-1)}{2}$ possible $\delta'_{k,i,j}$ quantities. The new weights are estimated as following:

$$W_1^{'} = \frac{W_1^*}{W_1^* + W_2 + \ldots + Wn}$$

$$W_2^{'} = \frac{W_2}{W_1^* + W_2 + \ldots + Wn}$$

$$\vdots$$

$$W_n^{'} = \frac{W_n}{W_1^* + W_2 + \ldots + Wn}$$

4.3 Methodology Selection Considerations

The selection of the AHP, instead of any other methodology was determined by several factors. AHP could be relatively easily processed with common spreadsheet applications, as the numerical handling of the data was easier than any other method. Furthermore, AHP proved to be a capable tool for both cases, i.e. the classification of Greek lenders and the ranking of the GCS-companies. Other methodologies could have been useful as well, but the data process would either be very complicated or it would be necessary to use special software.

At the beginning, the dilemma was not clear, but as research went on it became obvious that the selection was restricted between AHP and TOPSIS. TOPSIS as a member of the general class of ELECTRE (and UTADIS) techniques is based on the setting-up of the decision matrix

before the solution. In contrast AHP demanded a clear hierarchy, an analysis of the factors before proceeding to the formation of the matrix. Basically, this argument is not really accurate. When a decision-maker sets up a problem, then the formulation of the hierarchy is necessary and then follows the decision, which method shall be selected. Nevertheless in a research work like this, the structure of the hierarchy is neither clear from the beginning nor has the decision-maker the experience to direct the solution through a technique, so the most comprehensive way was selected. AHP is very comprehensive and there are too many textbooks and examples assisting in the understanding of its essence. As a result AHP was initially selected because it was more user-friendly at the beginning. Nevertheless, at latter research stages the method was tested and proved flexible enough.

Generally, TOPSIS and the other techniques of this family are based on quantitative and 'dummy' data per criterion. These techniques are capable of handling large matrices. Of course, it is possible to extract the weights of the criteria by using hierarchies and techniques similar to the AHP. However, it is necessary to mention that practically all rows of data are compared to each other in order to yield a result. For very large samples, comparisons among rows are theoretically and practically favored, while for smaller samples techniques, such as the AHP are preferred, mainly for rank preservation reasons. Saaty has provided many arguments on the fallacy of rank preservation, based on experiences and ideas of other researchers (2001b, p.41 and 361-8).

The next dilemma was whether to use AHP in combination with any other technique. In recent literature many scientists combine AHP with other methods. For the problems set in this study, AHP was combined only with fuzzy numbers, in order to improve the input procedure of the replies to the questionnaires (first case: the lenders

market). No other combination was really necessary due to the relatively small samples of alternatives. In the case that the sample of alternatives was considerably bigger, then TOPSIS would have refined the output, as AHP in ideal mode is numerically similar to WSM, i.e. considerably less sophisticated than TOPSIS.

The issue of combining techniques is not so simple. Fuzzy set theory provides researchers with capable tools for the quantification of qualitative and subjective data. So it is wise to design the questionnaires with a clear numerical scope. This theory may also assist researchers in gathering necessary data for the 'extraction' of utility functions; nevertheless, a repetitive procedure is usually required. Then AHP and other methods, such WSM, WPM, yield an index for every alternative, which is furthermore compared and ranked. The comparison is relative, i.e. an alternative is considered in comparison to the rest sample-members. There are cases where deviation from expected goals is required or preferred. This also introduces a notion of absolute measurement and refines the selection according to specific standards. That is the reason why parts of the TOPSIS algorithm are combined with other methods. The planar geometric representation of this method is also very helpful for the understanding of the rankings.

The research was faced with the above issues and it was obligatory to consider the actual facts of the inherent incapability of collecting questionnaires and proceed to repetitive procedures for the extraction of utility functions, as well as the relatively small sample under consideration. Last, but not least, it was necessary to build the methodology in such a way that scenarios and future or imaginary data could be taken into account.

It was stated that AHP requires no direct knowledge or assumption over the utility function. Therefore, it was selected and the attributes of the utility function would be clarified from the weights among criteria. In the case of the mapping of the lenders' market the questionnaires were necessary for the collection of the data, and not for the extraction of the utility function. In both cases the data-sets were gathered and 'translated' into relative grades in order to feed the model. The issue of 'relative grades' is very important for the understanding of the problem and the solution. From the available data there is information on the ranges of the values and the use of statistical functions make clustering as objective as possible. That means new data will only affect the sample if only they affect it limits and therefore the adjustment of grades will only happen in 'extreme' cases.

As the sample of the alternatives is rather small, it was possible to directly compare attributes per criterion. But the consideration of a scenario or future fiscal years would require a new loop of relative comparisons and would possibly recede previous ranking. Despite the theoretic approaches on ranking preservations (fallacy or not) it is necessary to base results and further steps on some data. It is not practical to change the pillar figures, results and foundations. So the consideration of absolute measurement, i.e. the appointment of grades per attribute was necessary in order to support scenarios and imaginary data (planning purposes). The objectivity of the technique is secured and the 'subjectivity' was taken into account as well as the sample could alter in extreme cases. Of course, it is possible for the decision-maker to exclude extreme values, yet the model can by default take them into account. A practical application of the above is the consideration of non-listed companies. Non-listed companies have normally lower values of the equity and of the shareholders'

capital than listed ones. In the case that non-listed companies should be taken into account, the decision-maker can easily adjust the sample and therefore the relative grades. It is a fine-tuning 'device' for the data-input of the model.

Two more issues shall be further considered here; the issue of weighting the criteria and the issue of the compatibility with wider and more popular or renowned theoretic approaches. The first issue is intertwined with the hierarchy and the selection of the criteria. Undoubtedly, the most critical weights are those in the upper levels, and for those levels it is wise to consider scenarios that better describe the reality the decision-maker feels, conceives and desires. That is the reason why scenario-analyses are taken into account in this study and the literature. Another approach would be to gather expert opinions (group decision-making). However, this was not possible in that case and it would create more theoretical difficulties on the response-gathering process, the weight of opinions, the dominance of an opinion, etc. A hidden assumption of that approach is that the decision-makers should primarily agree on the hierarchy and the criteria. Feedback from the management literature is discouraging for such ventures, unless there is an imminent goal and strong leadership of the team.

However, the group decision-making approach was not fully abandoned as it provides excellent data-input capabilities for simulation purposes. Random numbers (responses) can feed input formulas and therefore the input to the model can be as randomized as possible. This is also a technique used in the literature for mapping or predicting situations that are determined by a set of factors but their interrelationship is not known.

The criteria in the lower levels have been determined by the decision-maker (the author) in order to reduce numerical burdens, as well as to safeguard some rationality of the judgments. The issue was not really numerical but factual; hence, weights at these levels have been thoroughly discussed in the analysis.

Last but not least, AHP and its revisions are adequately discussed in the literature and are considered as 'classic' decision-making tools. Basic literature, such as papers and books of Keeney and Raiffa and others, discuss the issue of the utility function. Other methods also require some assumptions on the utility function. AHP with its inherent advantage not to require prior knowledge or assumption of the utility function, does not fall into the context of these renown approaches, although it satisfies their basic assumptions and statements. This is also the reason, why the academic community has launched specialized conferences, and congresses for conferring its developments.

5 The Challenge of Operating Risk

Banking is the business of managing risk. The recent trend in banking is the adoption of an offensive and proactive posture in which risks are actively managed at a firm-wide level in contrast to the obsolete defensive and reactive view of risk. That is an effect of the deregulation as well as of the globalization of financial markets. In order to manage risks financial institutions (FI) should adopt or establish:

- Clear management risk policies
- Proper rules and procedures
- Separation of execution and settlement functions
- Credible and independent risk management functions
- Credible and independent audit
- Appropriate incentive structures, and
- Appropriate risk controls and limits

A FI faces many risks that usually are classified as credit, market, liquidity, operational, regulatory and human-factor. Of course, it is possible to further analyze the risks into sub-categories, such as on- and off-balance sheet credit risk. Despite the different types of risks stemming out of totally different sources, generally, the decision-making process and risk management evolve in two stages as shown in the figure below:

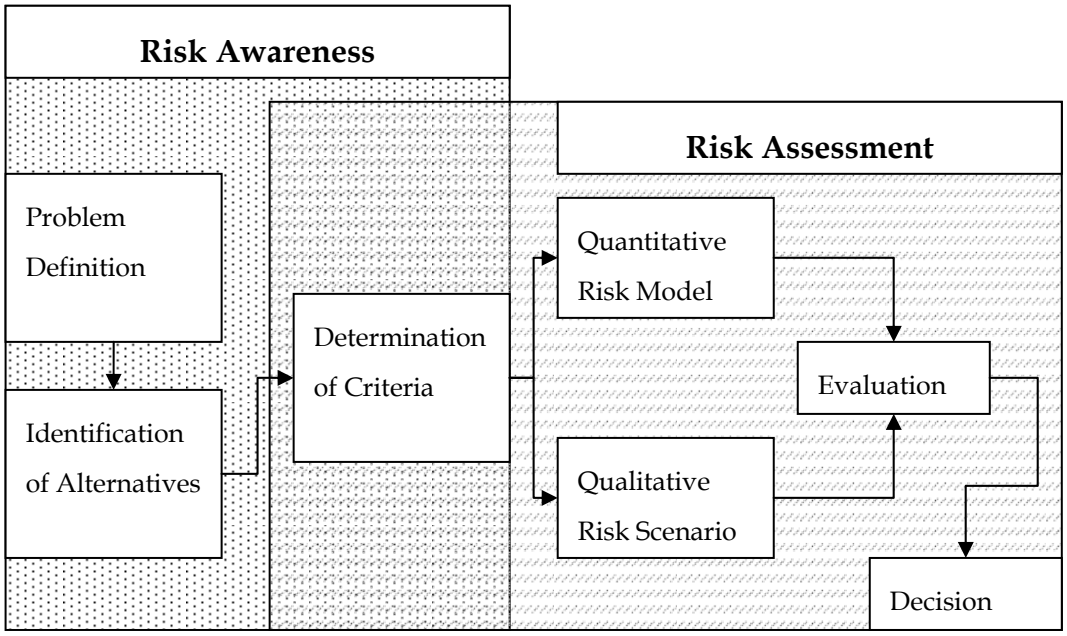


Figure 17: Decision-making process and risk management

In the contemporary pattern of operation FI have to deal with structural changes affecting the capital adequacy. Consequently a FI undertaking shipping risks has to conform to general capital adequacy rules in contrast to the past, when FI were more flexible. Although a default shipping loan would normally be considered as part of the credit risk, it has lately been considered as part of the operational risk. The idea behind it is that a mechanism of the FI failed to protect the risk system. The failure can be attributed to a risk analysis system or to officers. The FI has to develop an adequate mechanism protecting its risk portfolio; this will happen by adopting more adequate risk measurement systems, as well as, by reporting to the decision-makers valuable insights of the client.

5.1 Definition of Operational Risk

The operational risk can be defined as the risk of the loss caused by deficiencies in information systems, business processes or internal controls because of either internal or external events. Operational risk becomes a trendy term in the business world because of the Basel requirements for financial institutions – 'the accord' (BIS, 2001). Although operational risk

measurement and handling is currently constrained to financial services, the basic principles and axes of thinking can be transplanted into other businesses as well, due to the link of borrower-lender relationship. Historically, most financial services companies have concentrated their risk management efforts on credit and market risk. Today, most of the largest institutions have developed initiatives aimed at improving their management of operational risk—an exposure that few industry executives had given much attention in the recent past.

Although there is no formal definition of operational risk, it provides a broader concept, as operations risk is considered only as a subset of operational risk. Operations risk relates to the back-office activities generally performed by operations departments. Operational risk encompasses risks emanating from all areas of the organization, from the front office to the back office and support areas. Examples include systems failures, the faulty execution of a transaction, incorrect data entry, fraud, human errors, natural disasters and regulatory changes. Operational risk modeling, as defined by the accord, corresponds to the operations risk distribution in every company. In practice, this identification is of little value, as every bank or financial institution (and non-financial enterprise as well) clearly distinguishes between small and large losses. First, small losses are frequent in contrast to the very few large ones. This implies that financial institutions know a lot about the small losses and their causes but they have no real experience with large losses. Hence, typically, an efficient organization can tolerate small losses and no further modeling at all is practically necessary. Therefore, the value added to quantitative operational risk management for banks, lies in the domain of large losses (low intensity, high severity). This is the reason, why there is a differentiation between operations and operational risk.

Operational risks for a set of production processes are those operations risks associated with these processes which can be quantified and presented on a directed graph and which exceed a given threshold value. (Ebnöther et. al., 2001)

Though this definition seems a bit pedantic, it stresses the fact that analysis shall concentrate on well defined processes with resulting losses exceeding some minimal, preset values. Furthermore, it is interesting to note that this approach and definition may help other industries to improve. The transportation industry, in general, can be one case; it involves large amounts of invested money, deals with millions of consumers per day and has a relatively similar structure. A short PEST[8] analysis provides some evidence (more on PEST in paragraph 6.1.2, page 181):

- Barriers to Entry: low to high
- Buyer Power: medium to high
- Supplier Power: low to medium
- Substitutes: low
- Rivalry: high

Both financial and transportation service industries present the same attributes. The wide range in 'barriers to entry' reveals also the issue of relative size or segments in the market.

What is interesting to note, are the common drivers of change and therefore the importance of operational risk. While operational risk is not new, the increased recognition of such risks in executive suites is being driven by changes in the business, regulatory and operating environment. Financial and transport services experience some common trends affecting their risks:

[8] PEST: Political – Economical – Social – Technical

1. **E-commerce** has made business activities more transparent to the customer, while increasing the need to achieve speed to market with products and services, gain efficiencies in business processes, and allocate capital to activities that have a higher return/risk ratio. These changes are placing greater stress on infrastructure, increasing the level of exposure to operational risks, such as failures in product, process, and system design, new kinds of fraud, reputation risk, and customer service failures. E-commerce has direct effect on logistic services as well. As a more general conclusion, one could argue that this is the outcome of information dissemination and diffusion. The more freely information circulates, the more important such frictionless trading systems become.
2. **Mergers**, **acquisitions** and **consolidation**, with their related impact on people, processes, technology and overall organizational structure, are also creating operational risk and the need for better management information to improve decision-making. At the same time, the trend toward decentralization and employee empowerment, which results in more decisions being made by individual business-line managers, is increasing the need for management to understand the risk posed by these isolated decisions, to create transparency around decision-making processes, and to monitor the enterprise-wide exposure to risk.
3. **Financial modernization** and **market pressures** are accelerating the pace of convergence, creating pressures for companies to broaden product or service offerings, increasing competition, and forcing less-regulated entities toward more structured regulatory oversight that necessitates improved risk management and enhanced management information.

These factors are placing pressure on management to develop more dynamic and effective tools for identifying, measuring and managing

operational risk. Furthermore, there is an apprehension that operational risk management shall be introduced to clients of financial institutions who may turn out to big losses, if not handled properly. Shipping companies and ventures are steeped in history; big fortunes have been made and lost!

The interest in this study for the operational risk is actually twin-fold: as banks have to rationalize their operations and decisions, it is not easy to support an argument on the 'character' of a customer, say. It is necessary to quantify things, as clearly implied by the definition. Of course, banks have already, and for many years long, tried to quantify credit and market risk, but in the case of shipping finance, personal relations were always the issue. Nevertheless, banks have experienced great losses in the shipping sector, and lately the companies of GCS as customers of the Greek financial institutions have caused many troubles and worries. On the other hand, the focus on the operations in a financial institution creates a culture within the lending community that will be 'transplanted' to the customers as well. As a result, critical elements of today, such as accounting, employment, certification and experience parameters will not be the sole decision making parameters. The focus on the operations will also demand a considerably better understanding of the business of the respective industry (or niche market) as well as of the company as such.

The structure of risk in the shipping industry is not uniform across its segments, but some basic characteristics are common. Shipping deals primarily with the commercial control over tonnage and what is paid for it. The focus must be on the asset, i.e. the vessel, when analyzing a specific sector or a company. While there is a large variety of vessels of different sizes, purposes, capacity, etc. all vessels are similar from an economic point of view. First, all vessels are envisaged with a very high fixed cost. The cost of capital required for the acquisition or even charter-in of the vessel is high and influences all relevant calculations for 'breakeven' rates. Timing also affects the cost of capital. In general the return on capital, regardless of

the source, directs shipowners to offer a rate, most commonly, affixed to his minimum cash-flow requirements. When the market is low, shipowners may decide to operate at cash losses or even lay up tonnage, so to minimize the cash outflow. In case that the vessels are chartered-in operators enjoy access to profits without capital employment, but they lack the flexibility of the shipowner when the market is low, and may loose some cash until the contract expire. Another common aspect is that ships are long-lived assets with relatively low scrap values and exposed to value fluctuations.

The issue of risks in shipping is adequately dealt in many textbooks (e.g. those of Stokes, Stopford, Sloggett, etc.) However, there are two different kinds of risks involved: the risk of shipowner, and therefore of the rest investors owning the vessel(s) and consider it as an asset, and the risk of the operations, i.e. the vessel(s) as money-making instrument. In most cases shipowners are also the operators, as in the case of the GCS companies. These companies own and operate their vessels. However, there is a sturdy trend in the market for exclusive ship-management contracts and operations, revealing also the strategy for risk-fragmentation, for control purposes.

5.2 A Survey of the Greek Ship Finance Market

5.2.1 Analysis of the market

The Greek ship finance market is a very interesting one for three reasons. First of all, it attracts foreign interest as there are many foreign banks active in the market with or without physical presence in Greece (namely in Piraeus and Athens). Secondly it closely follows international practices, which is not common in a country like Greece, and the thirdly it experiences continuous increases of the lending portfolio. Most of the data

presented here are collected through the presentations of various speakers at recent last Lloyd's Shipping Finance Conferences[9].

During the last years, the ship finance sector has experienced a dramatic consolidation (see Figure 18). In 1997 there were 77 active financial institutions (FI) while in 2003 were only 30. That is a decrease of more than 50%! Although this fact is clear and extends to Greek and foreign FI, it does not reflect the whole picture. The decline can be attributed to the international trend of mergers and acquisitions, which was also vigorous in Greece as well. Furthermore, some FI have left the market, due to strategic decisions, such as focus on other markets, bad experiences (loan losses) or even geographical orientation. Nevertheless, what really matters is the ship finance capacity, i.e. the portfolio available for the Greek shipping market. It is estimated an increase of almost 17.9% per annum of the totally available portfolio (from \$9bn in 1996 to \$28.51bn in 2003), which reflects also the importance and the activity in the sector. From the same sources, it is also admitted that this is not the accurate picture as foreign FI dedicate and commit more capitals under the form of syndication.

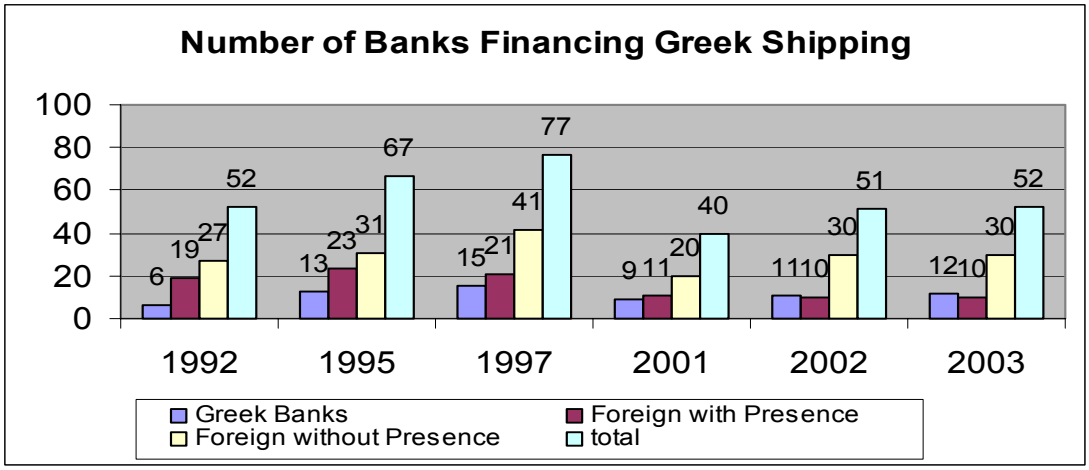


Figure 18: Number of Banks Financing Greek Shipping (2003)

[9] It has to be noted that most of the statistical data has been gathered from the presentations of Ted Petropoulos of PETROFIN SA, which has also been compiled to other sources as well.

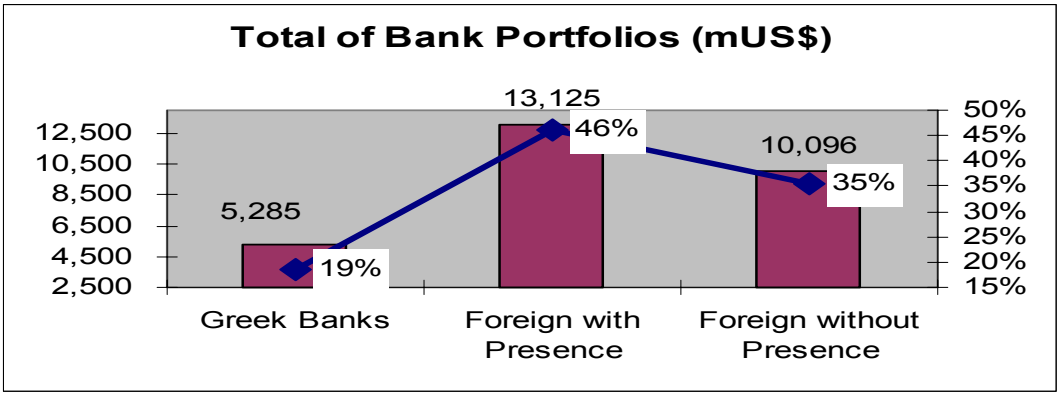


Figure 19: Bank portfolio per bank category (2003)

Given the figures from the charts above for the year 2003, it is easy to estimate that the average portfolio dedicated to shipping from a Greek bank is about $440m; of course there are some precursors with portfolios of $900m and almost $800m, such as the National Bank of Greece and Alpha Bank, as well as some small players with their portfolios not exceeding $100m (Egnatia Bank, Bank of Cyprus). The foreign banks with presence in Greece devote almost $1300m on average with Royal Bank of Scotland being the most important actor. Foreign banks without presence are more cautious dedicating about $336m on average with Deutsche Shiffsbank on top.

Despite the reduction of the number of FI active in the Greek shipping finance market, the portfolios have not been reduced, as most of them have been undertaken by the remaining actors in the market. The remaining FI have followed a strategy of trenching and expansion through buy-outs, in order to exploit economies of scale, acquired expertise and market insight. Nevertheless, they have also shifted to specific niches of the market, thus putting some thresholds (tiers).

There are practically two tiers in the market. The main tier clients are of large size (over 10-15 vessels), of low average age, proven management, clear strategy and marketing goals, and of course the use of non-credit services of the bank. These are characteristics of customers, who can create add-value to the bank because of their relationship. In other words, this tier

is for shipping 'corporations'; the term applies also for the management structure. The other tier consists of small and medium shipping enterprises that actually do not possess the characteristics of a 'corporation' but of a relatively small and closely held or managed house. Nevertheless the market is full of such companies, while shipping corporations are few; this is logical as the pyramid of organizational development is only for few at the top and for too many at the bottom.

In the next charts it becomes clear that almost 83% of the total number of potential customers are considered as not top-tier clients, while only 7% are clearly top-tier ones. There is also a gray zone of 9%. Additionally these 83% of small and medium shipping companies will need financing in the coming years as ≈70% of their fleet is over of 20 years old.

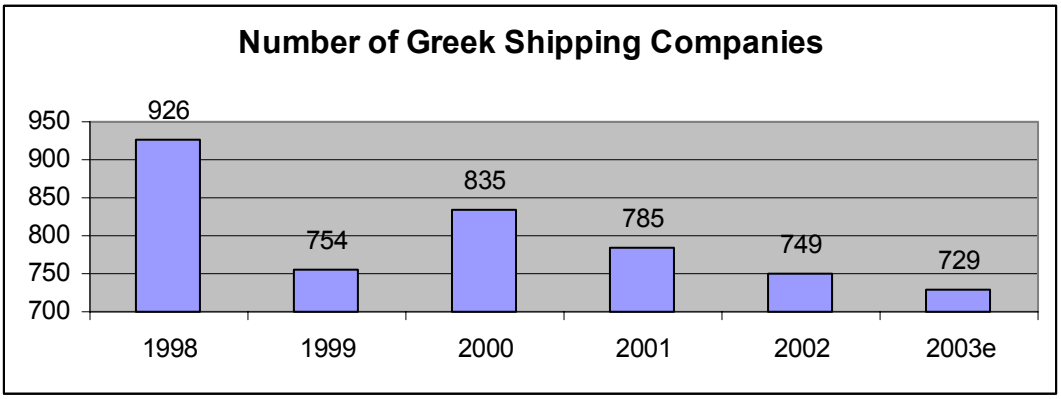


Figure 20: Number of Greek Shipping Companies (2003)

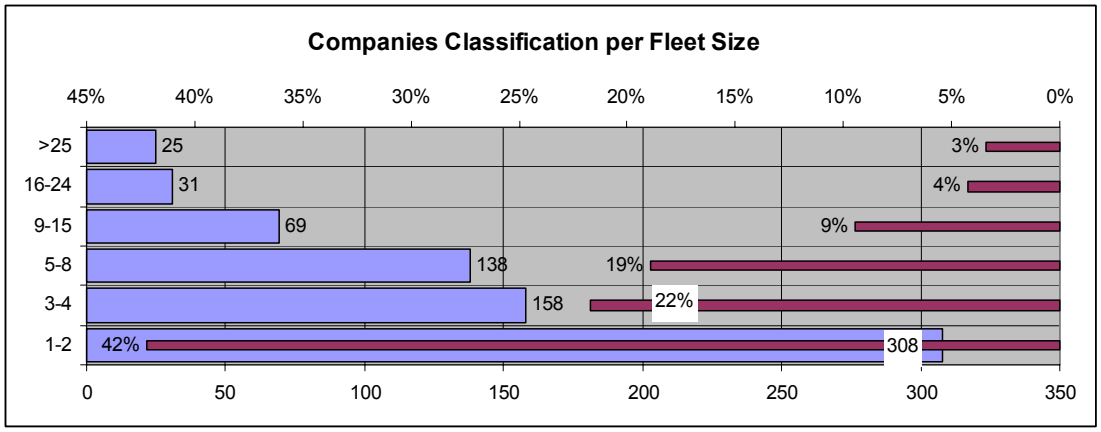


Figure 21: Breakdown per Operated Vessels (2003)

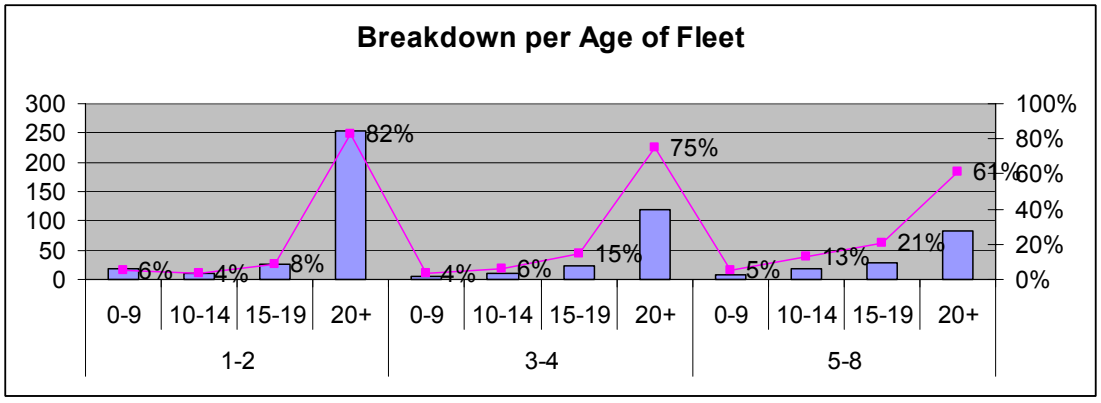


Figure 22: Breakdown per Age-range (2003)

The consolidation in the shipping market has not only affected the FI; evidently shipping companies have also been merged or disappeared from the market. The total number has drastically been reduced over the last year at a pace of 4% pa. However, banks have adopted a 'fight for quality, size and young age' policy, leaving these small companies outside of their direct interest.

At a first glance, it seems absurd that FI are reluctant to look at the largest portion of the market. Nevertheless, experts of this market do not justify their reluctance on high risks but on the developments in the international markets. Vergottis outlines the 'hell' of the small private shipping; the first point is that multinational companies, most commonly the first class shippers and charterers challenge directly sovereigns. In the contemporary market, environment multinational companies have a size, sometimes larger than that of a State, and can practically impose rules and desires. Some years ago, it would be also the 'habitation' of the vacuum left from disappearing public companies, but currently this seems more than an effort to streamline and harmonize national practices to international ones. In such an environment a small company cannot 'hide' under a flag of a State. The other major point Vergottis is making is the differentiation strategy stemming out of the use of technology and more specifically out of Information Technology (IT). The point is that IT and e-commerce totally displaces agents and brokers, thus minimizing the friction cost of a

transaction and consolidating ship ownership. It is also a means to rationalize processes under the umbrella of total logistics concept. Last, but not least, is that even a banker, someone with a strong focus on the returns and the risks, highlights the equal significance of non-financial parameters for business success (Vergottis, 2002):

- client-oriented / brand differentiation
- R&D – Innovation in product and technology
- Corporate culture and employee motivation
- Top management skills and motivation
- Management specialization and focus
- Scale (quoted from Vergottis, 2002, slide 9)

It is interesting to note that from the same source we get information on the perception of the GCS-listed companies; by estimating the ratio of enterprise value[10] relative to fleet value, it becomes clear that most of them are weak operators.

The shifting to more technological-promoted shipping is not only a trend. Banks and institutional investors seek for higher returns either on the employed capital or directly as dividends. Therefore, the option of mergers is many times favored; there is usually an added-value in the mergers especially when dealing with listed companies. In successful structures, the outcome of the merger exceeds the sum of the two units (*1+1=3*). Nevertheless, a successful structure depends on the real business, and contemporary business depends on the degree of the adoption of technology within an organization. Especially as e-commerce demands, it

[10] The Enterprise Value (EV) equals to the capitalization plus debt minus cash and peripherals. The ratio EV to Fleet Value of 100% means that capital markets value the business at parity to its liquidation value; a ratio above/below 100% implies valuation at premium/discount to liquidation value

is expected that logistics needs will boost, and therefore, inflate the annual ton-miles. The same applies also for people, as there is a clear trend for expanded mobility world-wide. The logistics nightmare is similar to the last-mile problem in the telecommunication and as shipping lines serve trunk routes of various sizes, they feel the effect of limited 'capacity' at distribution networks. Modern IT technology can easily assist in B2B situation, thus implying cooperation and flexibility with other parties. This rule does not only apply in the container market but in practically every shipping niche. In the discussions about GCS the idea of hub-and-spoke subsystems has also been raised; however, there are no adequate port facilities, reliable connections and there is an obvious decrease of the LOS. It is expected, though, that some IT technologies related to tickets and marketing will allow users to enjoy more flexible connections and services of local nature, thus making the whole service more attractive.

This is also the interest of venture capitalists, who invest heavily in e-logistics and similar applications. Shipping companies have to get into 'transactional business' in order to find a place in the future business patterns. So if venture capitals are into this kind of business after a time-lag, this will also become a stream at stock-markets and investment banking, and it is remained to be gradually observed.

5.2.2 Identification of the Risk Perception – Hierarchy Structure

As the ultimate goal is to map the Greek shipping finance market, this will be approached by soliciting responses from the banks on their attributes. The questionnaires will include all possible aspects reported in various textbooks and sources, thus extracting directly the ruling ideas of lenders. The questionnaires are structured in such a way, permitting both the identification of the risk, i.e. replies from the banks, as well as a ranking of the FI, given a set of criteria, potential customers would use.

For analysis purposes, as well as for the enabling of the use of AHP, it is necessary to draft a hierarchy that will highlight all aspects of this issue.

The hierarchy structured for this problem consists of four levels; the alternatives, i.e. the responses from the bank officers (elements a_{ij}, see Table 6: Decision Matrix for a Discrete Decision-Making Problem, page 94) by using a quantification technique per question of interest. This quantification is widely used in the literature and will be explained on a latter stage. Given the hierarchy, some basic criteria weight assignment follows (w_j), with a rather indifferent approach, despite some 'coloring' from experiences gained at seminars, conferences and the praxis. Nevertheless, the approach is as neutral as possible. Then at the highest level of the hierarchy, a Monte Carlo simulation procedure[11], will produce the outcome, i.e. the ranking and clustering of banks into categories. This is necessary in order to diffuse subjectivity from the selection.

As stated, the hierarchy consists of four levels that include many and different in nature criteria. These criteria are found in the literature and correspond to groups of attributes a client must have or a bank seeks into a customer or a bank has to take into account, such as generic risk attributes.

Level I Initially, the objective or the overall goal of the decision is presented at the top level of hierarchy. Specifically, the overall goal of this application is to assign a total value that ranks the alternative and highlights the clusters.

Level II The second level represents the three major goals of a FI. Specifically a FI aims to maintain adequate levels of *assurance* and *quality* of the portfolio and to exercise strategies or techniques for *marketing*. The weights as well as the side-goals reflect also the importance a FI assigns to each one characteristic. An illustrative set of charts provides also a better understanding and insight

[11] Precisely it is a tabular iterative Monte Carlo two-input and multiple output procedure.

of every cluster.

Level III At this level the three main goals of a FI are broken down to subsets of criteria. Namely *assurance* is broken down to criteria related to the customer and to the venture (project). Similarly the *marketing* goal is broken into *internal decisions* and *competition-driven* ones. The last goal of *quality* breaks into *ship & company* attributes and *general risk concepts*. The formation of these six sets of sub-criteria offers a better control over the criteria falling under a goal and assists in comprehensive decision-making as the criteria are of similar type.

Level IV At this level 24 factors (criteria) are taken into account. These criteria are directly reflected in the questionnaire submitted to the FI.

Level V At this level the linguistic replies from the questionnaires are transformed into numerical values (a_{ij})

Level VI At this lowest level the responses from the questionnaires are entered (linguistic values)

With a top to down analysis, the first level, i.e. the index consists of three main elements: assurance and quality of the portfolio, as well as marketing. These are the three main issues concerning a bank. Obviously assurances and the quality of the portfolio are the primary concerns of a FI, but there are not few cases in the literature and in the praxis, where FI exceeded their limits and capacities in order to serve a customer or to expand into a market. Nevertheless, with the recent provisos of the accord, a FI cannot exceed its capabilities and rules stemming out the credit and risk management systems shall govern the decision-making process. Furthermore, a FI has to expand in a market, as much as possible, and

prudent, thus including the number of customers, their size and other differentiating features.

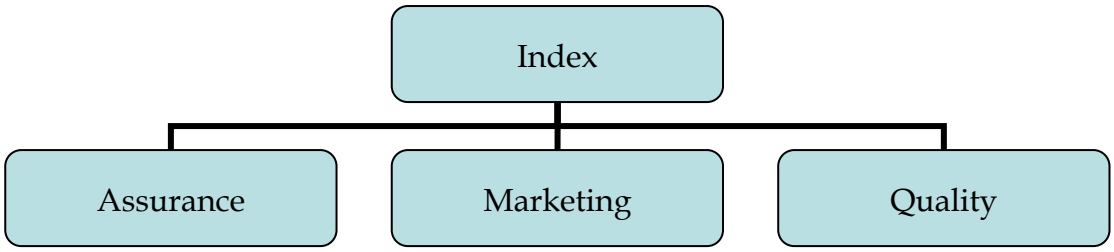


Figure 23: Level I and Level II analysis

The set of criteria used at level II, can be further analyzed to the following groups of criteria (Figure 24, Figure 25, and Figure 26).

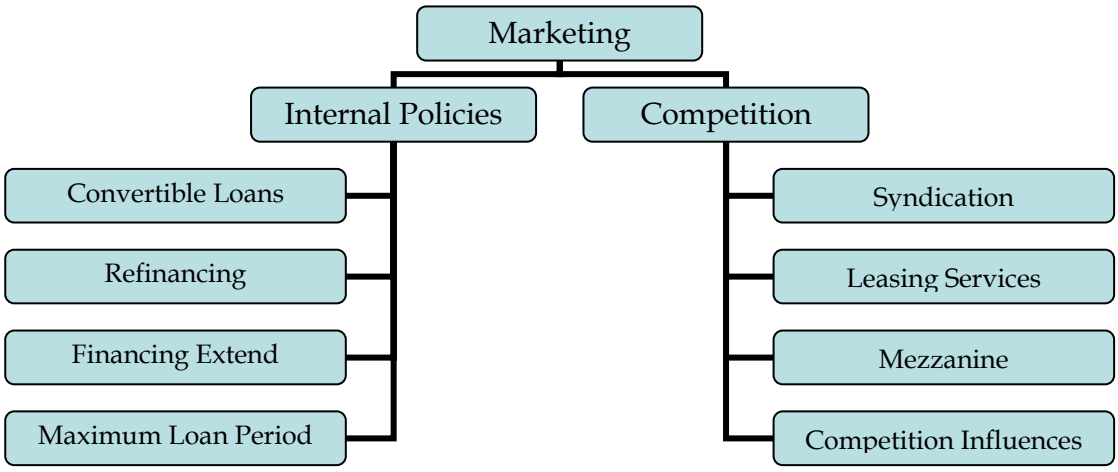


Figure 24: Level II (marketing), Level III and Level IV analysis – 1st branch

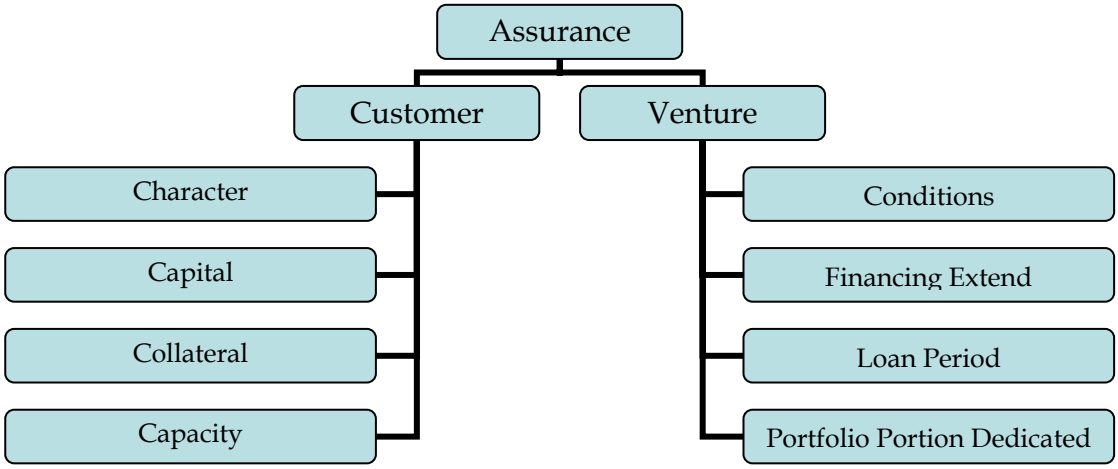


Figure 25: Level II (assurance), Level III and Level IV analysis – 2nd branch

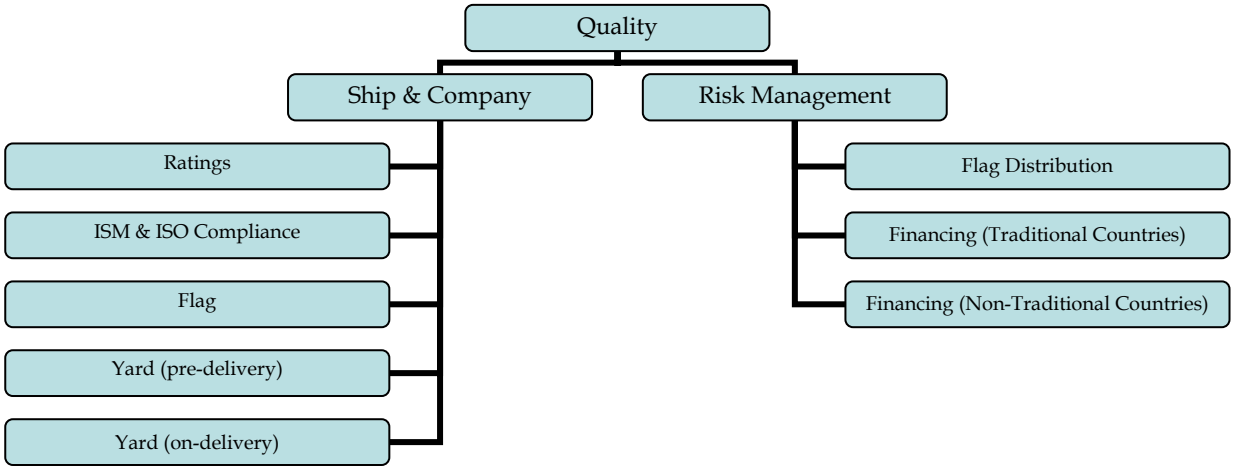


Figure 26: Level II (quality), Level III and Level IV analysis – 3rd branch

The breakdown of marketing criteria into the groups of *internal policies* and *competition* is identical to the common breakdown of marketing forces into internal and external ones. It is not really necessary to analyze further this point, although there is a brief discussion in a coming chapter (see page 189). In order to approach the internal and external forces it is necessary to identify the actions of a bank. Practically the selling of money has three attributes: the extend of financing, the interest and the loan period. This is common knowledge, but more information can be found in any risk

management textbook. However, money is not solely sold for a specific development purpose, say a project, but also for the repayment of other debts (refinancing). The risk involved in project refinancing is considerably different than that of a start-up one. The same problem comes up when loans can possibly be converted to preferred stock. However, these are problems that are addressed by the internal risk management system. In this decision structure –hierarchy - there is no mentioning to the interest, as this is considered very sensitive information. Generally, the interest is estimated as premium upon LIBOR[12] or a similar basis, such as EURIBOR. The premium depends strongly on the customer and the project and it varies a lot from customer to customer, project to project and period to period. In the general literature one can find many sources referring to these issues (e.g. Grammenos et al., 1999, p. 9/13).

As external influences a bank usually faces the case of syndication and mezzanine. When it comes to syndication, a financial institution faces a dilemma: another FI has accepted the project but wishes to split the risk, mainly because of the financing extent and the involved risk. That means, the case is prominent but not so attractive to undertake the whole risk. Usually syndication is established on 'best-effort' basis. Naturally, concerns over the quality and the viability of the project come up, as well as over the decision of the leading bank to split the risk. The continuous or systematic or a priori refusal of syndication suggests that customers seeking relatively large amounts of money will avoid this bank and direct their interest to a bolder FI. The same applies to mezzanine structures, while the case is usually clearer: it is clear approval-rejection decision as there is a small portion of risk for the bank to undertake, but the collateral is degraded. In both cases it is a decision largely based on the risk management and risk

[12] LIBOR: London Interbank Borrowing Rate

perception of the leading FI, but a bank has to follow the market and risk a portion of its portfolio seeking high yields.

At the opposite direction of risk management lays the issue of leasing services. In that case a FI is primarily acting as financial and legal consultant aiming to find the best off-balance-sheet solution for the project of customer. In that kind of business there is not only a single goal but a set of goals depending the customer and the investors. The most common case is tax-evasion and increase of bank assurances. The scheme shall minimize the tax-burden to the client and save the assets of the bank in case of failure of the project. Often such schemes include non-shipping assets, such asset portfolios in tax-havens or personal guarantees. Also, such schemes boil down to networks of legal ties between off-shore companies creating accounting and legal hassle to auditors and controllers. In any case, the bank does not only profit from traditional business, i.e. by selling money but also by offering very expensive services. As stated above, contemporary banking aims to the maximum utilization of the global network of FI. In other cases, where leasing schemes aim to protect the investors, banks undertake, primarily, a role of custodian. Custody is another niche market of banking with different risk attributes from lending, but in any case it surely involves some risk.

Last but not least, a parameter taken into account in the structure and the questionnaire is the influence of competition. Banks are private firms as well and have to profit within a specific market. Therefore, if another bank launches a strategy affecting the share or the clientele of a respective FI, then this FI has to respond. In Greece, the banking market was not so sophisticated and in most cases it was driven by 'example'. A perpetual customer running a specific fleet, say bulkers, has also strong interests in another market, say passenger shipping. A bank would like to get a link with the customer for the bulk market but the chance is only given for the passenger. The bank may decide to risk some money in order to satisfy the

customer and get into the club of 'his bankers'. This kind of personal relationship was most commonly the trigger.

Nevertheless, as ship-finance departments belong to wider financial organizations, strategies and marketing evolve and the game becomes more complicated. So a bank that had a 'permanent' position against refinancing, say, may have to reevaluate its position given the conditions in the market and not because of its risk profile. Syndication and leasing services are the most common cases.

As far as it concerns the analysis of *marketing* –related set of criteria, there will be no further breakdown. The other two elements at the same level of the decision structure, the *assurance* and the *quality* closely intertwined. The issue of assurance and quality of the loan portfolio fails under the category of credit analysis problems. In general, this credit analysis distinguishes the elements related to the ship and the company (or directly to the beneficiary owner as in the case of Greek shipping), to the venture as such and the risk attributes of the portfolio. The attributes of the customer are commonly called as '4Cs', namely character, capacity, capital and collateral. In Grammenos and Xilas (1999) one can find a detailed analysis of these attributes (Chapter 10). Nevertheless, these attributes are highly subjective or quite thorny to be quantified. Therefore, there are some sub-criteria for all Cs' but for character. In the same source there is a reference to the conditions[13]. The conditions in this analysis are treated separately. A further analysis of the term *conditions* shall include all elements that may affect the credit elements, whether these are macro-economic affecting the country-risk or micro-economic, such as availability of the personal wealth

[13] Grammenos and Xilas are referring to the '5Cs' as they include 'conditions'. However conditions are not related to the customer but to the market generally. The same analysis can be found in many other textbooks and the most completed one in the book of Cheng (1979).

of the shipowner. This term has an 'umbrella' meaning in this structure as it would be impossible to include all these aspects in the questionnaire due to differences between clients and conditions within the very same loan portfolio.

As all other aspects, financing extend, conditions and the '4Cs' can be found in any textbook of financing and not only of ship-finance, it is interesting to highlight the importance of some shipping focused ones. First of all, quality in shipping is widely accepted to be measured through certificates. The more quality certificates a company holds the better quality perception for this company is. A company that does not only hold the necessary ISM certificate but operates under well-known quality assurance standards is considered as a better counter-party for any transaction. So FI ask for relevant certification.

In ship-finance there was always a concern over the experience of the customer and the yard constructing the ship. These issues are very well-known to the shipping community, and deviations from traditional paths leads often to increase of the bank premium as there is an increase of the country risk or the risk related to the construction (see also Grammenos et al, 1998 and 1999, as well as Stopford, 1995). Last, but not least is the issue of the distribution of 'flags' in the portfolio. While it is generally known that there is no clear and linear relationship of a flag (with some distinct exceptions) to the quality of a ship and her seaworthiness, banks try to invest in ships flying flags of higher standards. In most cases the issue of flag is closer linked to the crew, in terms of quality and quantity, rather than to the vessel as such, which usually has been certified by a perpetual classification society. Although flag distribution is not an adequate measure for the risk involved in a portfolio, banks seek to get customers flying a 'good' flag or at least keeping some minimum standards, even if there is no such requirement from the Flag State.

The issue of rating is a very appealing one. As shipping and mainly Greek shipping was opaque to others, inside information and personal relationships were very important. However, as the amounts of money increase significantly local banks cannot cover all needs and solicitations in the international market shall be accompanied by independent assessors. The rating issue goes along with the 'globalization' procedure of the company or its services. Shipping has been traditionally a global business and often highlighted in policy issues. Nevertheless, shipping was not really a global industry from a financial point of view, as only few large corporations had either the need for global capital or the profile of a global customer. The gradual integration of national capital markets into a global one, as well as technological and political breakthrough (securitization, deregulation, IT revolution) converge the international markets (assets, bonds, currency, etc.)

The rating, either of a bond issuance or of the credit ability of a company goes through internationally renowned institutes[14]. One of the very first facts an investor (or a lender) interested in a company is its ability to meet its payment obligations. Investors should know that creditworthiness varies greatly among cases and these professional institutes offer their impartial judgments. Until recently most companies and their bonds were not rated and the creditworthiness was based on similar securities issues (or loans) in their domestic markets were used as guides. Needless to say, credit agencies are not of the reach of criticism but they offer good services generally. The first step towards rating is not only the opening-up of accounting books but also the presentation of the management structure and of the decision-making procedure to the officers of the rating. In a sense these officers are the ears and the eyes of investors. It is common to

[14] Practically there are only three: Standards & Poor's, Moody's and FITCH

call lenders as 'investors' as in many cases the loans are secured with financial assets.

In various sources (e.g. Grammenos et al, Vergottis, Petropoulos) the issue of rating of the shipping companies is linked to the size of the loan. Petropoulos suggests also that as the market will experience consolidation and only 300 companies out of 750, will survive the consolidation and corporatization, these companies will have to get rated in order to raise capitals through innovative structures. In the current analysis, rating is considered a very important issue, not only for the ability of a company to raise capitals but also for following reasons:

- A company, which has been rated, acknowledges that modern corporate governance principles, that increase transparency and managerial quality, can be applied successfully and there is an effort to adopt them.
- A company that allows third parties to scrutiny accounting books and procedures is committed to transparency and the rate will offer a benchmark for further improvement.
- By getting rated a company enters a global financial market and shipping experience or excellence of the lender is not necessary; the company can seek money from practically every source available and not only in the domestic market.
- The cost of money will in most cases decrease as there is no reason for FI to impose further risk premiums.

Last but not least, shipping companies have had experiences with ratings in the past. The issue of 'junk-bonds' or 'high-risk – high-yield' bonds is an old one in shipping. There are many success and disastrous cases in the past, but these were exceptions in the generally conceived relationship of lenders and borrowers. As the markets go global and the banks seek quality, rating is the only means towards this direction.

5.2.3 Clustering of the Greek Banking Market

The hierarchy can offer a quite interesting perspective of the market if only it can be combined with a simulation procedure. The complexity of real-world problems, as the one of mapping a market, can easily create an analytical nightmare when many uncertainties are involved. As many parameters are involved in the above hierarchy, it is useful to proceed with a simple simulation. As sampling method for the simulation was selected the Latin Hypercube; the sample size for correlation was 500. Latin Hypercube Sampling is generally more precise for producing random samples than conventional Monte Carlo Sampling because the full range of the distribution is sampled in a more even and consistent manner. Thus, with Latin Hypercube Sampling, a smaller number of trials is required to achieve the same accuracy. The added expense of this method is the extra memory required to hold each assumption's sample while the simulation is running, but this is not a burden with contemporary home-PCs. When all the values from each sample have been used, a new batch of samples is generated. For this reason, the simulation will appear to stop while the PC calculates the new samples.

The distributions used were discrete ones with an equal possibility of occurrence (1/9, 1/7,…, 7, 9). This simulation is only a process that generates random number inputs for uncertain values but within a specific range as implied by the pairwise comparisons (see 4.2, page 103). These random numbers are processed in the mathematical model, i.e. the hierarchy, and produce a set of outcomes. The whole structure has been developed on MS-Excel spreadsheets with the help of built-in functions[15]. The analysis of the model is based on the following flowchart:

[15] The whole procedure could easily be developed as a Visual Basic® program or of a similar application.

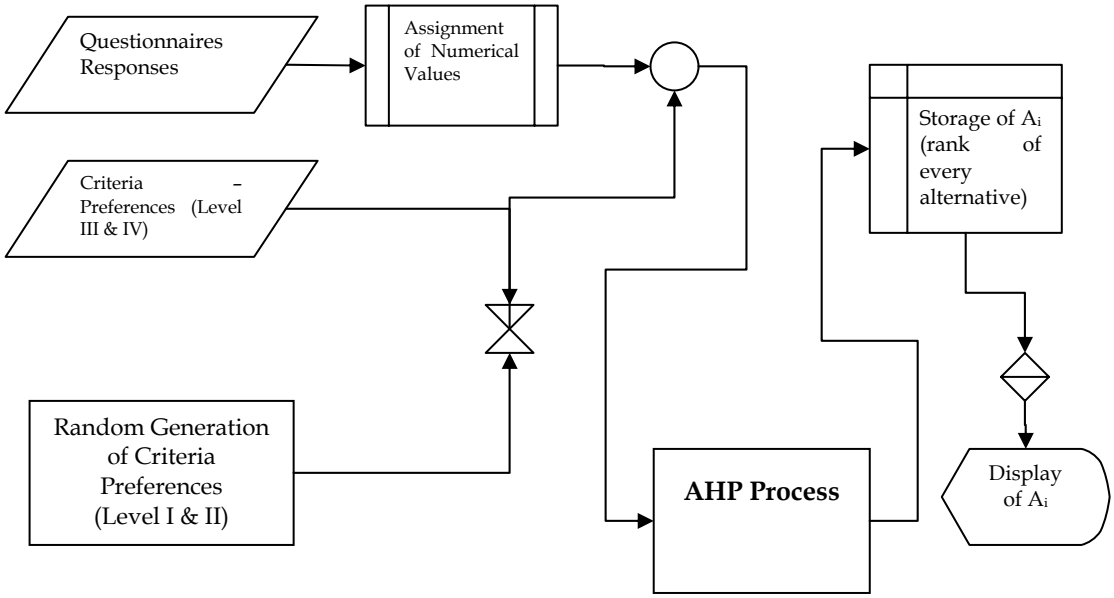


Figure 27: Flowchart of the Mapping Process

The responses of the bank officers to the questionnaires are considered as linguistic input. This input has to be 'translated' into numerical values. This is achieved through a five-point rating (Liberatore et al., 1992; Liberatore, 1987). This approach is introduced into this model and lies at the fifth level of the hierarchy. For example in the 16th sub-criterion (Level IV, see also page 280 of Annex B: Questionnaires to the Banks) on the maximum loan period, the 5-point rating table is the following:

	1-3 yrs	6-9 yrs	12-15 yrs	18-21 yrs	24-27 yrs
1-3 yrs	1	1/3	1/5	1/7	1/9
6-9 yrs	3	1	1/3	1/5	1/7
12-15 yrs	5	3	1	1/3	1/5
18-21 yrs	7	5	3	1	1/3
24-27 yrs	9	7	5	3	1

Table 9: 5-point rating (sample table)

The eigenvalues of this table are calculated and then normalized; the normalized values feed the model with bank-related input (a_{ij}). In this case the normalized values are 0.065 for 1-3 years loan period, 0.125 for 6-9 years, 0.254 for 12-15 years, 0.517 for 18-21 years and 1.000 for 24-27 years loan period. This implies that the longer a loan period is the better it is, given the specific pattern of the criteria in this model. The intervals have been structured in such a way reflecting the most common practices

wherever possible, and in case of mid-values, say the case 21-24 years, and then the assigned value is estimated as the average value 0,759.

This procedure is not considered as innovative, neither in the literature, nor in applications. The use of AHP in combination with questionnaires is widely applied and referred to any relative textbook. Most commonly the issue is focused on the structure of the questionnaire and not on the AHP methodology. It shall be mentioned that the 5-point rating of Liberatore, is considered as a rather obsolete method, since the wide application of fuzzy numbers in questionnaires (see also next chapter). A very interesting example can be found in Tsaur et al, where questionnaire responses are processed through a simple defuzzication procedure of fuzzy numbers corresponding to linguistic values.

As far as it concerns the criteria weights, two separate procedures are followed: for the sub-criteria (level IV) the weights are assigned and for the upper levels (level II and III) the weights are randomly generated within a specific range of values (namely 1/9, 1/8, 1/7,…,0,…, 7, 8, 9). The assignment of values for the sub-criteria was not really necessary from a numerical point of view; however it was necessary to direct the model towards acceptable consistency ranges. The assignment of weight-values for the level IV was a relative easy task as it depends on experience, textbooks and discussions with officers. The overall weighting seems rather impartial and aims to reveal differences on the upper level, where random numbers differentiate the outcome.

The criteria weights at level II and III reflect the differences in strategy, risk perception and marketing of banks, therefore the weights are randomly assigned. The generation of random numbers is made through a function in MS-Excel. The function selects one of the following numbers {1/9, 1/8, 1/7,…,0,…, 7, 8, 9}, that are evenly distributed, i.e. there is an equal possibility of 5.88%to be selected. These numbers feed the decision-tables at level II and III. Five (5) respected weights are randomly inserted; 2 for

the decision table at level II and 3 for the decision-tables at level III. The following tables clarify the structure:

	assurances	Marketing	quality
assurances	1	w_{12}	w_{13}
marketing	$1/w_{12}$	1	$w_{23} = \frac{w_{13}}{w_{12}}$
quality	$1/w_{13}$	$1/w_{23}$	1

Table 10: Decision table at level II

The structure of the above matrix reflects the basic principles of the AHP. The upper triangle of the matrix is the one with the preferences; the values in the lower triangle are the reciprocals of the upper ones. The values w_{12} and w_{13} are randomly selected within the specific range that stems out the fundamental scale (see Table 7). In order to achieve acceptable levels of consistency, it is necessary w_{23} value to conform with the basic consistency rule:

$$w_{ij} = w_{ik}\, w_{kj} \Rightarrow w_{13} = w_{12}\, w_{23} \Rightarrow w_{23} = \frac{w_{13}}{w_{12}}$$

In order to secure the soundness of the result, the value of w_{23} is determined through a simple if – then command:

If	**remarks**
$\frac{w_{13}}{w_{12}} > 9$ *OR* $\frac{w_{13}}{w_{12}} < 1/9$	*is the ratio within the range of the fundamental scale?*
Then	
$w_{23} = K$	*if the ratio is out of the range of the fundamental scale then assign a large value (that diminishes the consistency of the decision table)*
Else	
$w_{23} = \frac{w_{13}}{w_{12}}$	*if the ratio is within the range then assign the value of the ratio*

All relevant tables are attached as Annex C: Data and Calculations (in page 281. The numerical trick is simple: since MS-Excel can easily handle iterative processes, it is easy to run an 'if-then' command. If the outcome is within the range of the fundamental scale then the outcome of the table, i.e.

the eigenvalues and the priority vector are recorded, even if the table is finally not consistent. There is a filter at a latter stage. If the ratio (outcome of the random nominator and denominator) is not within the range, then a large numerical value is assigned that totally diminishes the consistency table. That is a first numerical filter (acceptance-rejection approach).

That is the numerical mechanism at level II; at level III the problem is considerably easier as these tables are of 2×2 dimension and only one random value is used as input and it does not harm the consistency at all, as it is always within the range of the fundamental scale.

	internal	competition
internal	1	w
competition	1/w	1

Table 11: Decision table at level III (sample of the marketing criterion)

The numerical values of the questionnaire responses plus the assigned weights of sub-criteria (level IV) and the random weights at level II and III, are fed into the AHP model and for every set of random values (the five random numbers) a set of ranking values is stored for the alternatives (the banks). The table with all the random values and the ranking values of the alternatives is filtered through the total consistency ratio; if a set of random numbers violates the condition of 10% consistency, then it is excluded from further elaboration. In the final table one can find only the ranking values of alternatives that comply also with the consistency requirements.

By running the simulation procedure for 3000 iterations, the final table resulted into 2228 consistent sets of ranking values and 971 not consistent ones. The latter are totally excluded from any further elaboration.

Out of 19 banks with physical presence in the Greek market (see Figure 18, page 123) only 9 have responded to the questionnaire[16]. Practically all Greek FI, but two of minor importance, have responded to the questionnaire and two foreign banks of major importance. The names of the banks are known but cannot be revealed due to disclosure purposes. So for simplicity reasons the FI will get a X_i tag $\{X_1, X_2, \ldots, X_9\}$. In general, the sampling procedure is regarded as highly successful, as it is known from experience that many Greek and foreign financial houses are seeking their opaqueness in their market. Nevertheless, the sample is considered as capable to support decisions; the Greek FI included in the sample represent 82% of the total portfolio (US$2960m[17]) and 62.5% of the total number. The foreign FI with a physical presence in the Greek market, included in the sample, represent 22% of the total loan portfolio and 20% in terms of numbers.

The results of the simulation model are rather interesting. The stored outcomes of the AHP process is filtered in order to keep only the sets of ranking under a specific consistency range. Then with the help of a simple average function the mere values of *assurance, marketing, quality* and *total index* are extracted. These values produce the following charts:

[16] The collection of the questionnaires could not have been achieved without the help of Alex Orfanidis, who was preparing his diploma thesis on this subject and within the research goals of this doctoral thesis.

[17] See also Figure 18, Figure 19, and Figure 20, pages 123, 124, and 125 respectively

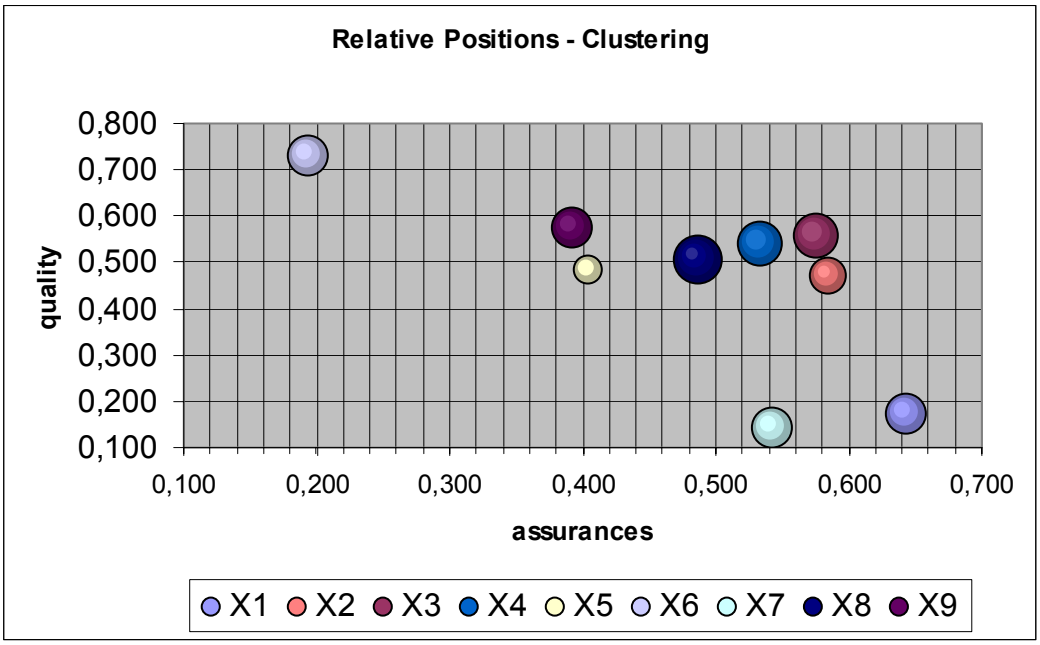


Figure 28: Relative position of FI in the market (quality – assurances)

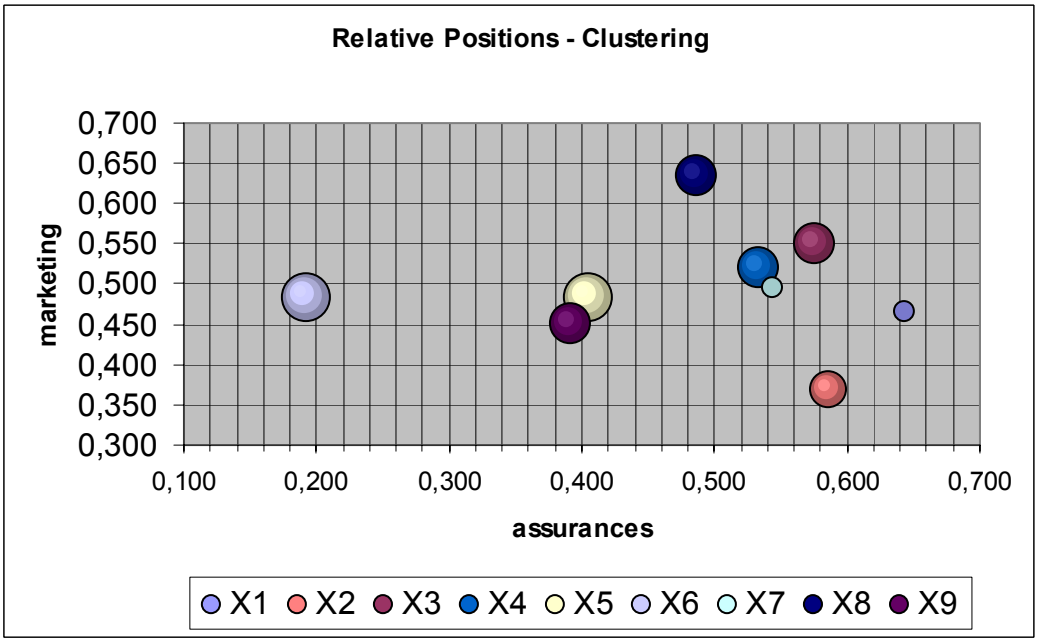


Figure 29: Relative position of FI in the market (marketing-assurances)

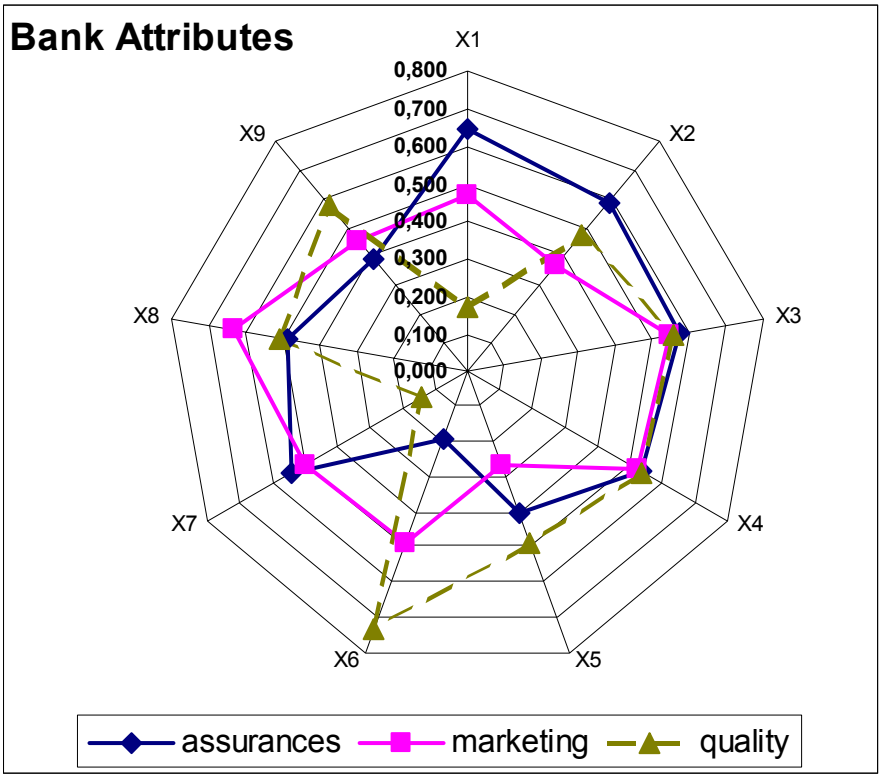


Figure 30: Radar Chart indicating the attributes of FI

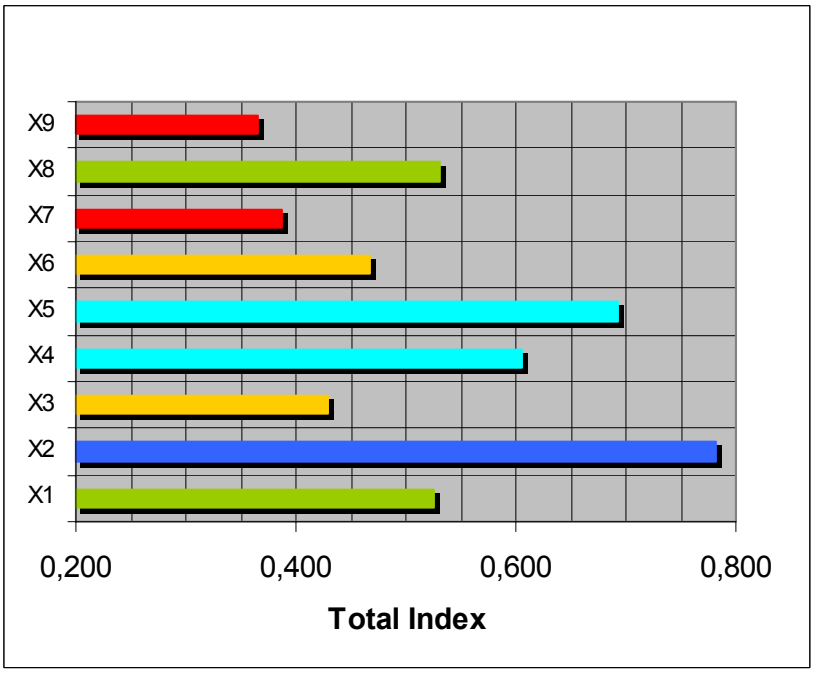


Figure 31: Simple clustering of FI (color-related)

The first and second charts (Figure 28 and Figure 29) aim to clarify the relative position of a FI in the market. The two vertical axes place the center of the circle that represents a specific FI; the range of the circle is estimated

through the third value. So a FI that lies as far as possible to the right and to the top, having also the largest size, is better positioned than the others. In the second chart (Figure 29) the two vertical axes are *assurance* and *marketing* while in the first chart (Figure 28) the axes are *assurance* and *quality*. Evidently the second chart focuses on the portfolio, while the first one provides a mixed picture.

The next chart (Figure 30) offers much information to the reader. First of all it is easy to distinct the attributes of banks and to understand their ranges. Steep lines connecting points indicate a sharp difference between these institutions. Furthermore, it is easy to select a FI expressing preferences over specific attribute. Last, in the Figure 31, the clustering of the FI is provided by using different colors. The clustering of the FI is based on the quartiles of the results. Given the following results:

FI	Total Index	Rank	Cluster
X1	0,525	5	c
X2	0,782	1	e
X3	0,429	7	b
X4	0,606	3	d
X5	0,692	2	d
X6	0,467	6	b
X7	0,387	8	a
X8	0,531	4	c
X9	0,365	9	a

the quartiles are the following {0.429, 0.525, 0.606, 0.782}. So if a value is less than 0.429, then it is clustered under category "a", if it lies between 0.429 and 0.525 then it clustered as "b" and so on.

The above results have been extracted from averaging simulation data (mean values), and provide a mapping of the market. For example, bank X2 gets the highest ranking. The relative position of a FI in the above charts indicates the performance of the bank per criteria set; the better position is to the upper right part of the chart. The same analysis procedure can be applied to every FI participating in the sample. Noticeably, if more banks are added in the sample, the model can easily accommodate them. It is also

interesting to note that the model can also work for inside managerial action. Looking at the model from one direction, a customer or a specific interest can easily understand this market and its actors, in combination with manifested accounting figures available to the public, such as the total loan portfolio, the total assets of the bank, etc. Such data are provided in summary at the beginning of this section (Analysis of the market). This might theoretically guide the customer or the interest to a specific group of FI. On the other hand, if the management of a bank would like to alter its relative position in the market and the model can assist in keeping a specific course.

The simulation data can also provide more information; a simple analysis suggests that the following institutions will get the following placement in the market (total index) by estimating the objective probability. The term objective probability links the frequency of an outcome to a long sequence of events ($\frac{\text{number of events X}}{\text{number of possible events Y}}$). However, it is also possible to estimate errors and deviations from the simulation outcomes that should lead to similar results.

5.2.4 The Importance of GCS companies for the Greek Lenders

From data, available through the various information memoranda of the GCS companies, it is possible to get a picture of the total amount of money they borrow from lenders or raise from the ASE capital market.

Considering the data presented above, as well as the data available for the companies, the significance of the GCS sector to the lending market in Greece is rather limited. By dividing the total long-term liabilities of the companies with the available portfolios in 2001, the significance of the GCS is estimated close to 6% when taking into account all FI (with and without a presence in Greece). Although there is no evidence that the GCS deal only with FI with a presence in Greece, it is interesting to note that this ratio rises up to 9% when considering only FI with a presence.

According to data provided by the ASE, the GCS listed companies have acquired 220bn GrD (€645m) from the market up to the end of 2002 (see table below):

ANEK	28.656.000.000	13%
NEL	17.050.000.000	8%
MINOAN	77.381.000.000	35%
STRINTZIS	29.673.891.200	14%
EPATT	66.939.648.000	30%
Total	**219.700.539.200**	

Table 12: Capitals drawn from ASE up to 2002 (in GrD)

It is interesting to note that EPATT and MINOAN have drawn the largest sums of capitals during the last years. All companies have financed their growth by renewing or building new vessels as well as by lowering their long-term liabilities. As long-term liabilities of all companies are close to 560bn GrD in 2001 it seems that the GCS companies finance their growth primarily through the lender's market, although the amounts drawn from ASE are in no case negligible. As pointed out by many researchers, professionals and academics, despite the growth of capital markets, are not capable of financing shipping ventures. The limited liquidity of capital markets during periods of recession, the underperformance of shipping stocks are some of the reasons. Nevertheless, it is considered that public equity will follow if only large private placements emerge that will lock investors in.

6 Evaluating a shipping company

In most cases the evaluation of any company is solely based on financial ratios as well as on the 'story' behind the company. Although financial ratios offer a quantitative yet incomplete approach, this 'story' notion encompasses a rather vague and duly qualitative set of attributes of the company under scrutiny. These attributes are usually some of the following, although the list is not exhaustive:

- Capabilities and track-record of the top management team
- Sector perspectives
- Perspectives of the company within this sector
- Business strategy
- Market perception - image
- Familiarity with the investors

In the shipping market these attributes are commonly discussed among investors, lenders and borrowers, as both keep a very close track of the respective market. In cases of a public offering these are the critical points for an underwriter to communicate with the investors, who are not really aware or do not monitor this sector.

In the modern business environment, financial ratios and relevant analyses are not reflecting the whole picture; statements, structures and financial instruments are very complicated as companies expand operations to several institutional, legal and tax settings. Furthermore, the use of options and other off-balance-sheet risk tools may easily hide the actual risk exposure and financial status of the company. Nevertheless, financial ratios are important elements for the analyst to take into account but not the sole ones.

The 'story' set of attributes is extremely vague and is in no case uniform. 'Good' and 'bad' are very subjective notions. Furthermore, it is very difficult

to quantify the above mentioned attributes, although there are some ideas and approaches for some of them.

As shipping is a cyclical market, financiers are monitoring the cycles and trying to predict future prices of indices or time-charter rates. The market is classified into several niches and modeling based on time-series is performed. This approach may provide a basis for further discussion on the demand as well as on the supply side, yet it can highlight only some aspects of the problem. Financiers translate the market and the company data into a risk figure that will feed a risk management system and yield a result suggesting the acceptance or the rejection of the project or provide the basis for a sensitivity analysis and guidance to the client.

The evaluation of a company is of pure multi-criteria analysis (MA) nature. Pardalos stresses the importance of development of multi-criteria decision support systems (MCDSS) as a future direction. A MCDSS is defined as a decision support system (DSS) that helps to implement MCDM methods (1995, p. xvi). In that sense what Chou and Liang have theoretically presented is an MCDSS (2001). The same applies for the evaluation model developed here. It is interesting to note that apart from any theoretical classification, MCDSS aim to include as many as possible parameters bearing information, while the traditional approaches disaggregate the problem into a set of quantitative elements, (financial and risk related ones) as well as, of qualitative attributes ('good' management team, perspectives, strategy). Any MCDSS quantifies the problem and therefore it harmonizes the approach and draws attention to other elements not included in the analysis yet. The added-value from any MCDSS is the foundation of knowledge, as the criteria and the hierarchies used underline our understanding; redundant elements are eliminated and new elements are entered in order to explain deviations and gray zones.

6.1 Hierarchy of the Criteria

The most creative part of decision making and the most critical one is the structuring of the hierarchy. This process has a significant effect on the outcome of the model as well as on explaining the phenomenon under scrutiny. Saaty (2001b, p. 58) proposes a basic principle in the form of a question: *can I compare elements on a lower level meaningfully in terms of some or all of the elements of the next higher level?* Then Saaty proposes a set of suggestions for the design of the hierarchy; some of them are applicable to this case and are presented as well as commented on the basis of the structure used for the evaluation of coastal companies (2001b, p.59):

1 *Identify an overall goal. What are you trying to accomplish? What is the main goal?*

The main goal is to extract an index of annual performance for every coastal company, thus enabling a classification based on quantified data.

2 *Identify subgoals of the overall goal. If relevant, identify time horizons that affect the decision.*

There are subgoals; the major ones are to monitor the performance of the company per annum as well as to extract 'what if scenarios'. Furthermore, there is another subgoal to use subsets of data as input to other models for further elaboration. There is a need for quantified data required for running other models. The issue of time horizon is critical in this decision-making process as well. The approach is static, i.e. independent of time. There are some reasons justifying this approach. First of all the criteria used are time-enduring; fundamental and all the rest data-sets are used for many years long and there is no sign of not using them in the future. There is information available to fill the necessary vectors, too. By implementing time-element in the criteria-set the complexity of the problem would increase exponentially. There would be no hierarchy but

a network aiming to model the problem. A hierarchy concerns the distribution of a property (the goal) among the elements being compared, to judge which one more influences the property. Networks concern the distribution of the influence with respect to a given property. A network would respond to a question of dominance of influence among alternatives with respect to a criterion. In that case, the Analytic Network Process method would be used.

3 Identify criteria and subcriteria.

The criteria and the subcriteria are thoroughly analyzed below.

It is interesting to note that the issue of building hierarchies is not largely discussed in the literature; in a sense the decision-maker is 'uncontrolled' from any expert or academic guidance in structuring a hierarchy. In the book of Keeney and Raiffa there is a brief discussion on this issue (1993, p. 41). They base their comments on an essay of Manheim and Hall (1969), who prompted the issue of specification and means. By *specification*, one understands the subdivision of an objective into lower-level objectives or more details, thus clarifying the intended meaning of the general objective (goal). These lower-level objectives are considered as *means to the end*, thus by identifying them to very precise objectives, one can build the whole hierarchy up to the highest level. Keeney and Raiffa highlight also the importance of setting a sound and achievable overall goal, so to point the upper end of the hierarchy. A vague goal such as 'the good life' is not a very successful example for further elaboration. However they suggest going down the hierarchy as long as the advantages of doing so are more than the disadvantages. Complexity and data availability are the most common disadvantages. Regarding the formalization of the problem, Keeney and Raiffa discuss also the 'test of importance' of Ellis (1970). Ellis suggests before adding any objective (sub-criterion according to Saaty's terminology) into the hierarchy to consider whether this would change the course of action. This

approach offers a basis for eliminating or including criteria into the hierarchy, yet it is not necessarily correct. It is possible to include criteria that fail the test of importance separately but collectively they are important. Last but not least, hierarchies for a specific problem are not unique. Their differences may be attributed to the degree of formalization as well as the point of view (subjectivity) of the decision-maker. In the case of the Greek coastal shipping it is possible (if not certain) that investors and financiers have a totally different structure of criteria from the users of the GCS services; even between them there would be a different structure between the residents of the islands and the tourists. In this context the interest lies currently with the financiers and the investors.

Before proceeding to the analysis of the hierarchy and of its criteria, it is important to note the approach of other sciences to the field of MCDM. Plous (1993) presents many different aspects of decision making that differ from the 'rational' and normative approach of engineers and scientists. The paradoxes violate the principles of rationality and question normative approaches. The paradoxes of Allais and Ellsberg, intransitivity and preference reversals are some of the cases where rationality (and in these cases the expected utility theory) is violated. Plous quoting other psychologists suggests that people's decisions are not unreasonable and there is no clear link between 'rational' and 'logical' always. It is very interesting to note also the structure of questions, when asking for feedback as well as considering qualitative data. In responding to this issue in this hierarchy there were no 'qualitative' data required. As there is no requirement for the estimation of a utility function, there is no point in discussing any further the issue of qualitative versus quantitative approach.

It was stated in a previous section (§4.3) that the reasons for the selection of AHP were the following:

1 in absolute comparison mechanisms it is not possible to experience rank-preservation problems;

2 the set of data is very large and the relative comparison of every alternative for every year available would increase the numerical and decisional burden exponentially;

3 it is easy to add alternatives (existing or dummy ones), to experiment with the sensitivity of parameters, or to estimate the outcome of an action (element sensitivity);

4 the focal attention lies on the hierarchy, i.e. on the insights and on the parameters determining the phenomenon

5 there is no need to estimate a utility function (or marginal utilities)

6 AHP can be combined with other methods

7 AHP-required hierarchies can be further developed to networks and systems with dependencies and influences (commonly addressed by ANP)

For the purposes of evaluating the coastal shipping companies the following hierarchy is considered. The overall index is estimated on the basis of two distinct sets of criteria: the internal and the external forces (see paragraph 4.1.1, p. 106 and paragraph 4.1.2, p. 128 respectively). As internal forces are considered attributes that are determined by the management of the company and more specifically in this case, all attributes related to the fundamental, the logistics services offered and the management. The criteria are presented below (see Figure 32, Figure 33, and Figure 34 respectively) and discussed thoroughly in coming paragraphs (see pages 159, 166 and 168 respectively). The criteria-sets that are not directly controlled by the management are considered as external forces. The stock-performance, the market environment as well as the competition fall into that category. The subcriteria are presented below (see Figure 36, Figure 37 and Figure 38) and discussed in coming paragraphs (see pages 184, 189 and 193 respectively).

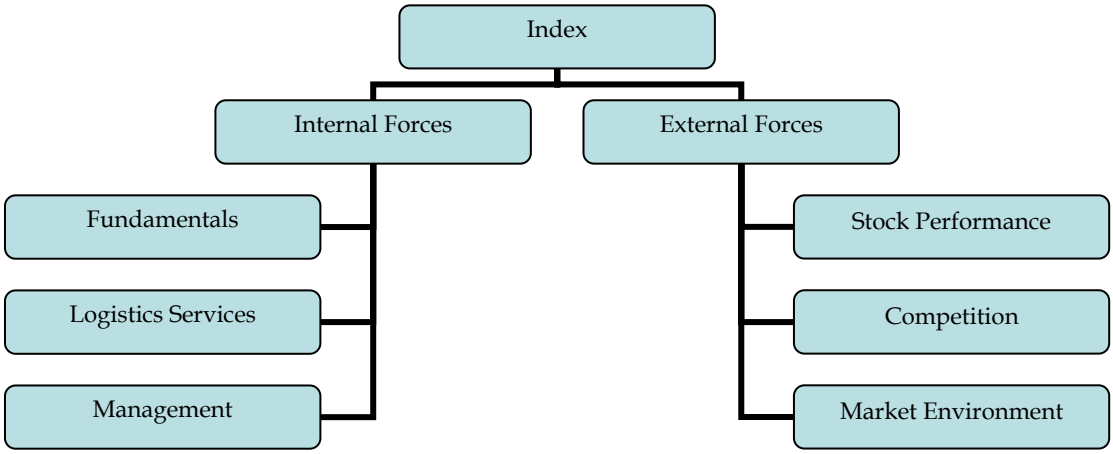


Figure 32: Levels I, II and III of the hierarchy

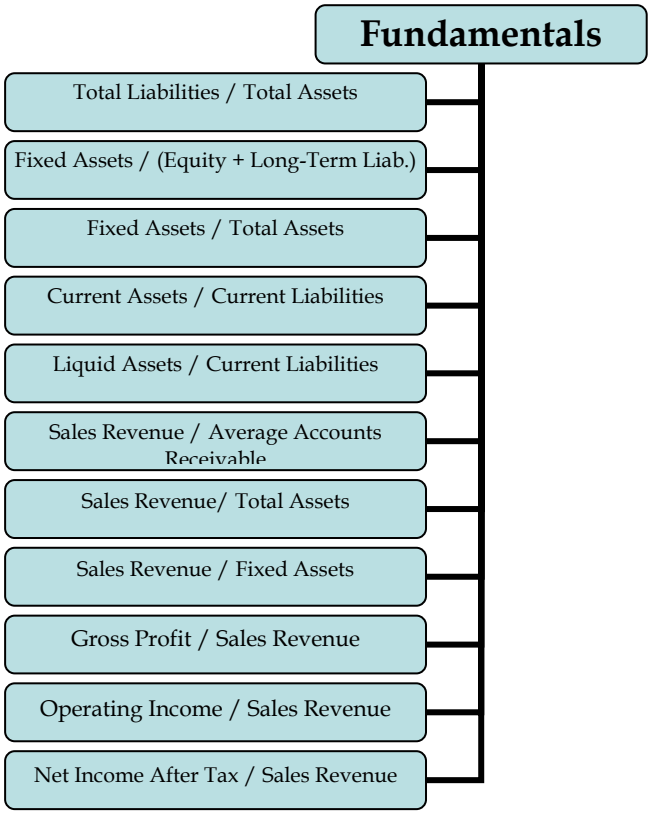


Figure 33: Level IV – Fundamental Data

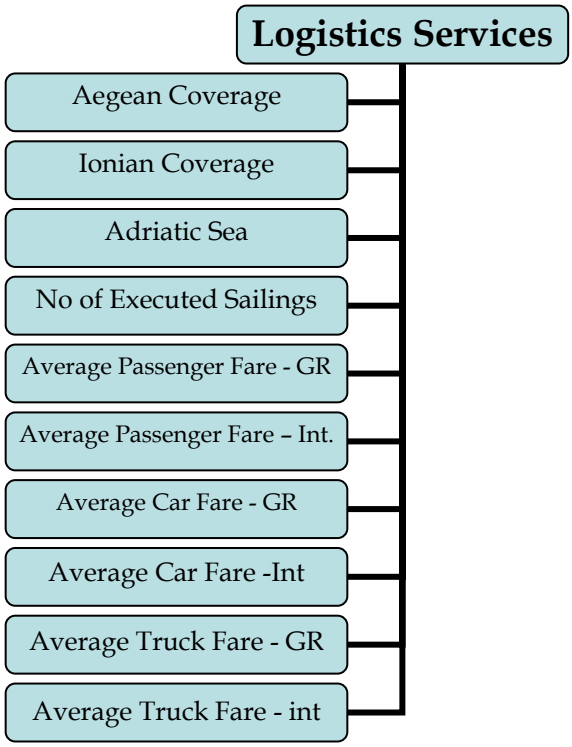


Figure 34: Level IV – Logistics Service Data

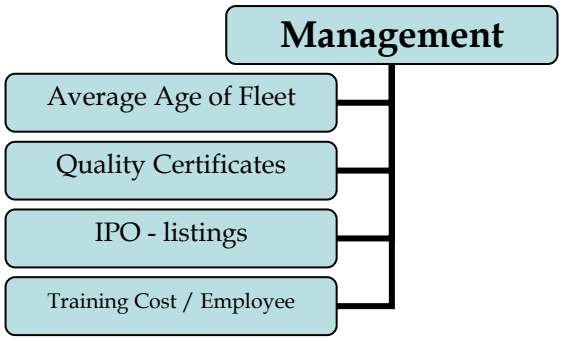


Figure 35: Level IV – Management Data

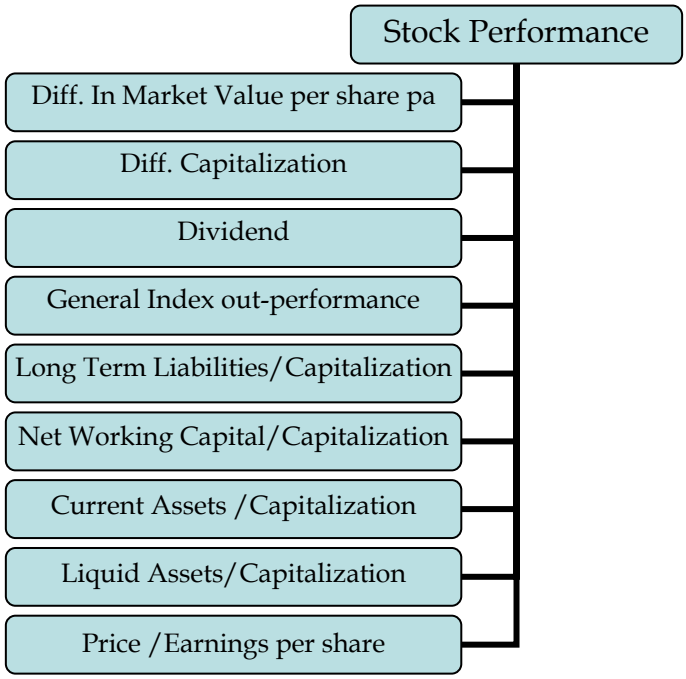


Figure 36: Level IV – Stock Performance Data

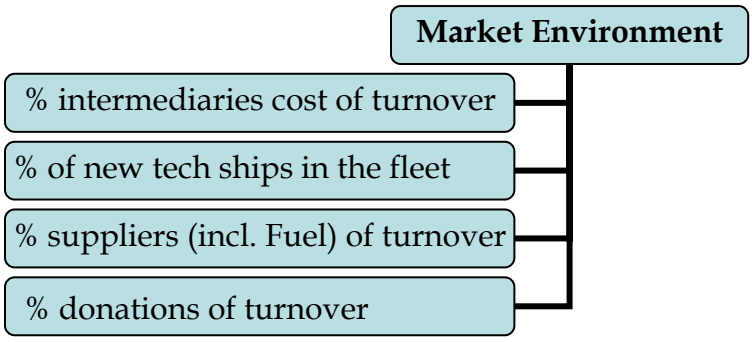


Figure 37: Level IV – Market Environment Data

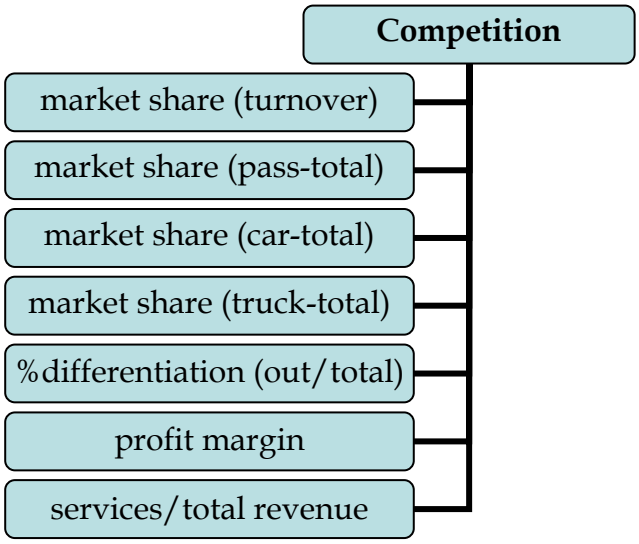


Figure 38: Level IV – Competition Data

6.1.1 Internal Factors

Parameters and attributes solely related to the company are considered as internal factors. Such characteristics are considered the fundamental accounting data, the management and the logistics services offered. Of course these characteristics are subject to interaction with the rest of the market, the competition and the general condition of the economy, yet the primarily decisions taken within the company affect them unequivocally.

6.1.1.1 Fundamental Data

The fundamental data of the company reflect its financial status and with the assistance of various ratios offer a tracking and decision-support tool. The

information extracted from financial reporting is vital for the communication between the management, the shareholders, investors and debtors. However, a balance sheet is only a static picture of the status at a given data, and profit and loss (P&L) statement justifies the change of the relative position between the dates the balance sheet is drafted, without any further details on the course between these two points. Lately, interim reports and cash flow analysis have been widely adopted, and have undeniably improved the quality and the quantity of information. In the cyclical business of shipping there are arguments against and for, basically as a resistance or support to change towards corporate practice.

Although information is a crucial parameter for transparency purposes as well as for the participation of shareholders in the decision-making process, there is an issue with its limitations. A critical approach takes under consideration the content and the obsolescence of the data provided (latest update). In fact, accounting information demands also an understanding and some basic knowledge of the accounting principles, otherwise, decision-makers and shareholders can easily be lured. Usually, managers possess basic accounting skills while small-stake investors most commonly do not. The diffusion of business information theoretically leads to an improvement of market efficiency yet there is the question of information interpretation.

Accounting reports, including balance-sheets, profit and loss statements, as well as sources and uses of capitals, aim to inform the management and the investors in order to make rational decisions. Fundamentally, there are two principles behind reporting: relevance and verifiability. Under the principle of relevance, there is a link between data and needs. All data are relevant and all data are provided in order to reflect better the standing of the company. Information is relevant when it is important, in other words, when induced decisions can be rationally justified. Thus information shall be updated and on-time. Furthermore, the principle of verifiability implies that analysts and accountants using the same data will conclude to the same information.

Before analyzing some of issues of the accounting report content that may mislead investors, it is interesting to note that in literature, accounting reporting is considered as the sole source for external audit (Breton and Taffer, 1995). Furthermore, the high corporate disclosure quality influences leverage and protects the company during hard times or uncertainty (Sengpurta, 1998). The use of financial ratios, as well as the synthesis from accounting data by analysts, strengthens these ideas. Ratios such as of earnings to book value reveal the use of capitals and its productivity.

As markets evolve, the issue of the content of accounting reports becomes more important. The issue of adequacy of accounting rules, as well as the provided information on market values, is the first point of concern. Another one is the ability to predict situation through these data. The prediction of cash-flows is necessary and essential in valuating the company. Furthermore, the publication time is an issue. Quarterly and interim reporting becomes necessary for listed companies (Rogdaki and Kazantzis, 1999).

Referring to the content the most common misunderstanding lies in the reckoning and understanding of earnings, as calculated through accounting rules, and economic income. Balance-sheets reveal accounting earnings based on historical cost, thus presenting the difference in value of accrued transactions. Analysts seek to find the economic income, which is the difference of the value of the company. Economic income does not always equal to the dividends. This issue affects also other book values and their role in influencing market values. Good news stemming out of the publication of earnings and well-being of the company influence only some investors and a relatively moderate correlation of reported earnings and market value of shares is reported in the literature (Francis and Shipper, 1999). Every day practice justifies this correlation, as good news is 'incorporated' in the market value before the publication of the accounting results. Today's markets benefit from the available information wealth. Relevant issues are considered the historical cost principle, the allocation of

inflows and derivatives. The historical cost principle provides the basis for comparison and verification of the data, yet presenting values of the past but during the fiscal period. The commonly discussed issues of inventory and liquid assets, say deposits and bonds, are thoroughly analyzed in the literature. The allocation of inflows is relevant with the mix of inputs necessary for the production or the delivery of the final product or service to the client. There is always the question that a different mix of resources could lead to an economically better result. Inventory and fixed asset management are also discussed, while analysts and investors may demand more clarification information apart from the final numbers. Finally, derivatives and their effect in the balance sheet are under discussion and consideration. Most analysts and investors cannot really handle that kind of information as rules are vague and companies are not obliged to follow a specific pattern of reporting. Academic and professional literature, as well as market experience, agrees that external analysts cannot understand the risk levels or critically examine decisions taken or predict the outcome of the actions taken, as derivatives are off-balance sheet risk management instruments and deviate from accounting orthodoxy.

As information is time dependent, three issues are risen in most cases of interpretation and conflict: the historic character of data, the lag between book and market values, and the matching of inflows and outflows during reengineering or relevant processes. The most debatable issue among these is the historic character of data. Non-accountants claim that the mission of accounting is to provide information about the future of the company. This breaches the principle of verifiability and in no case is possible to draft general rules for the future-prediction procedure. It shall be reminded that balance sheets reflect only a specific snapshot of the financial status of the company. It resembles the pictures taken by physicists when studying the course and track of a moving body in time. The lag between the observed point and the current point is common in science yet accounting reporting is not only addressed to scientists. The handling of such lags in science has also

led to complicated theories and modeling, which is not the case in business reporting. Rapid changes of the business environment, irrelevant if attributed to competition, suppliers, entrants or customers are not reflected in the balance sheet. In best cases, they are merely reflected in the profit and loss statements or in the notes underneath. This problem becomes even more unconcealed, when the company undergoes a major or minor reengineering process. Even the training of employees affects the fiscal outcome, as it is considered resource improvement. Nevertheless, such investments accrued during this period, as R&D projects, training, reengineering, etc. will mature in the coming fiscal periods. Accounting reporting cannot grasp their importance and quantify the actual or potential benefit. Such information remains subjective in nature and is interpreted in a different way from investors.

Last but no least, in the international environment, where capitals freely flow, there is an issue with the lack of uniformity in reporting. Although the US-GAAP and IAS standards have been adopted by stock markets and large multinational enterprises, the vast majority of companies follow the national standards, thus hampering the understanding of financial reports. In addition, several accounting standards offer options in handling specific issues; consequently, the same or similar action may be carried differently on the balance sheet.

The interesting development while market matures and information flushes is the use of non-financial measures, the discussions on the internal corporate structure and the allocation of resources. Non-financial measures, such as background information, historical results, non-financial statistics (say the market share), various analyses (say inventory management) are used as feedback in traditional multivariable decision matrices as the 'balanced score card'. This kind of tools uses various data as input and commonly offer a subjective perspective as there is no objective relationship. If there was any

then accounting techniques could incorporate this information in traditional reporting.

Furthermore, the analyses and discussions on internal organizational structures, managerial levels, and techniques, as well as, the use and allocation of resources, provide the basis for further thinking and consideration on the future of the company. As investment risks are spread among more people, such discussions flourish and investors become more educated and aware. Case studies, presentations, newspaper information are consolidating knowledge and awake reflects. Accounting cannot become so popular and massive.

For the purposes of this modeling the evaluation criteria will be ratios defined by the Joint Credit Information Centre and used by other researchers in the field of maritime economics as well (e.g. Shim et al., 1986 and Chou et al., 2001, p. 383). These are the following:

	Evaluation Ratio	Index Character	Comment
1	Total Liabilities / Total Assets	Financial Structure	The less the debt ratio is the better for the financial standing of the company. The ratio implies that most of the capital structure of the company is shareholders equity, thus the cost of capital is at lowest level.
2	Fixed Assets / (Equity + Long-Term Liab.)	Financial Structure	The importance of fixed assets in the balance-sheet is considered as very important to investors. Especially in shipping where company valuations are frequently based on the Net-Asset-Value (NAV), i.e. on the value of the ships. The importance of fixed

			assets is merely linked also to the issue of liquidity; capitals committed to vessels are illiquid but in case of financial distress or bankruptcy investors will regain part of their capital. Generally the higher the ratio is the better for the investors.
3	Fixed Assets / Total Assets	Financial Structure	The same comment as above.
4	Current Assets / Current Liabilities	Debt Payment Ability	The current ratio measures the ability of the company to meet the current liabilities out of current assets. A high ratio is needed when the firm has difficulty borrowing on short notice.
5	Liquid Assets / Current Liabilities	Debt Payment Ability	The quick ratio, also known as acid-test is a stringent test of liquidity.
6	Sales Revenue / Average Accounts Receivable	Operational Efficiency	This ratio is a measurement of the number of times accounts receivable are collected during a year. In general the higher the ratio is the better since the company collects more quickly from the customers.
7	Sales Revenue/ Total Assets	Operational Efficiency	This ratio is helpful in evaluating the company's ability to use its asset base efficiently to generate revenue.
8	Sales Revenue / Fixed Assets	Profit-making Ability	This ratio is similar to the previous one, but it measures the ability to use the vessels (main fixed assets)

			to generate revenues.
9	Gross Profit / Sales Revenue	Profit-making Ability	The ratio reveals the percentage of each euro (or dollar) left after the business has paid for its goods.
10	Operating Income / Sales Revenue	Profit-making Ability	The ratio measures the operating performance of the business, and provides clues to a company's pricing, cost structure and production efficiency.
11	Net Income After Tax / Sales Revenue	Profit-making Ability	The ratio is actually a refined version of the previous one as taxation is also taken into account. It is a crucial index for investors as dividends are paid after settling out tax obligations.

Table 11: Financial Performance Evaluation Criteria

These ratios will be evaluated for all GCS companies listed at ASE and will then measure the performance of the companies on an absolute basis.

6.1.1.2 Logistics Services

It is very difficult to model logistics services in a shipping market that combines passenger and private car transportation, tourism and trucking. These are three different niches with different logistics services attributes. Generally, one can consider the following parameters, when dealing with logistics services: time, cost and comfort. For simplicity reasons, lets define *comfort* as the set of attributes that cannot directly or easily be measured, such as biases, frequency of connections, traveling comfort, security, safety, entering and leaving of the terminals (port facilities), and so on. In a typical econometric approach comfort would be either a dummy variable drawing values out of a specific range or it would be a vector of other weighted dummy variables.

Nevertheless, passenger and car transportation has a different set of characteristics from tourism and trucking. It practically lies between the two; tourism is at the one end and trucking is at the other. The difference lies with the value of time, the on-board services, the proximity of locations to the terminals, as well as on many other aspects. Furthermore, these attributes are totally different between routes. Obviously the Cretan routes do not have the same attributes with those of the Cyclades, etc. So, in order to extract a common set of attributes, given also the restrictions and limitations stemming out of the availability of data, it is decided to use the following criteria:

1. Aegean network coverage
2. Ionian network coverage
3. Adriatic Sea network coverage
4. number of executed sailings
5. average pass fare - GCS
6. average pass fare – International routes
7. average car fare - GCS
8. average car fare - International routes
9. average truck fare - GCS
10. average truck fare - International routes

The criteria 1 to 3 aim to reveal the coverage of the network a company offers. The larger the coverage is, the better to the customer. The number of executed sailings is directly linked to the frequency of the service. Lastly, criteria 5 to 10 reveal the average cost. This average cost is estimated and provided by the companies, by combining traffic and revenue data per geographical area and per niche (passengers, cars, trucks).

This set of criteria provides a macroscopic analysis of the logistics services offered in the system. In order to cover all respected aspects one should have data or devote time and efforts in the following:

1. cost, time, correspondent links and frequency per route and port;
2. comfort and other qualitative factors per route and port; and
3. customer satisfaction index per route and port

Then it is necessary for the researcher to find a way to quantify all these data. This point needs further research (see paragraph 8.2, p. 253), although there are some notions of using fuzzy calculus. In this study, the coverage of the network is estimated through simple calculations: this company has served these ports in this geographical area, so this is the percentage of network coverage. This is a naive approach as it does not reveal any connections and frequencies between the ports. Nevertheless, it is still a first order approximation. Regarding the cost element, the average cost per geographical area is enough to extract conclusions on an aggregated base.

6.1.1.3 Management Related Criteria

This set of criteria aims to highlight issues closely related to the management of the company. Although the issue of management in the shipping industry has been widely considered as a differentiation factor with other industries, due to the fact that shipping companies are commonly closely held by the owner and his relatives, in the case of the Greek Coastal Shipping (GCS), this is not true. The biggest players in the market have already been listed at the Athens Stock Exchange (ASE) market as they were seeking for capitals for the acquisition of new vessels, so to respond to the deregulation imposed by national and European policies. Furthermore, to the listing and to the ability to draw capitals from the market, diverting from the traditional lending institutions, this has also brought a revolutionary set of obligations to the upper management regarding the corporate governance. The issue of

corporate governance is of high importance and will be addressed in greater detail in latter paragraphs.

As the shipping industry evolves, more quality criteria are coming up; most of them stem out of international conventions, such as the SOLAS, MARPOL, and STCW, as well as from the classification bodies and other authorities. The protection of the environment is not only an issue for tankers, as fuel oil storage and carriage engulfs the danger of leakages, and therefore the creation of oil-spills; in the current environmental context air emissions, anti-fouling protection, ballast control, etc are in the agenda. Additionally as these GCS companies may be considered as short-sea shipping (SSS) operators, they have to defend their ambiguous competitive advantage and marketing catch of environmental friendly transport option. Last but not least, the GCS vessels serve primarily tourism-attractive destinations and therefore, even a limited incident may be disastrous for the image of the company, of the industry and for the local economy. This environmental profile is not limited to criteria as consumption per transported ton, but has to include also other aspects regarding emissions, garbage management, etc. For the safe operation, as well as for the safeguarding of the environmental sensitivities, employees ashore and the mariners have to be adequately trained and aware of procedures and perils.

According to the analysis above, the criteria used in the model are the following ones:

Average Age of Fleet	The average age of the fleet is calculated on the basis of the date the keel was laid; according to the Greek Law, the GCS vessels had to be less than 35 years old. After the 'Samina' disaster this limit was reduced to 30 years (Law 2932). The management of the company is evaluated according to the average age of the fleet; lower

	average age leads to higher 'marking'. However it is debatable from a financial point of view that a young fleet is a good attribute for a company; young fleets have usually not been amortized and depreciated, thus bearing high capital costs. Considerably lower expenses for maintenance, operation (consumption) do not cover adequate part of the capital expenses. Business and market experience suggests that a mix of ages of vessels is the best practice with increased financial capability. This sounds normal as the company spreads risks of various kinds. In the context of GCS system, the average age of the fleet as a distinct criterion will not jeopardize the soundness of the model; most companies were operating old vessels and during the last period have acquired new vessels and extensively maintained the old ones. This criterion is usually used by groups exercising pressures to the Ministry and related to the quality of services customers enjoy.
Quality Certificates	The issue of quality in shipping is one of the most crucial and highlighted one. Safety and quality have been closely intertwined in legal documents; the issue of seaworthiness extensively treated in the Hague, Hague-Visby and Hamburg Rules, limits the liability of the company regarding the cargo and other damages. The IMO Convention of SOLAS

	aimed from the very beginning to set basic standards for the technical seaworthiness of the vessel; MARPOL aims indirectly the same as it is focused on environmental issues and STCW aims to cover the human element aspects. The ISM Code bridges in a sense operations afloat and ashore, aiming at a higher level of managerial tracking of actions, procedures, etc. Authorities and clients increase their pressure on shipping companies to provide proof of their quality of management and organization. In the literature and in the business practice, various authors and organizations have come up with systems enabling the integration of various standards, e.g. of the ISM and STCW with ISO9002 (Chauvel, 1998, pp 115-6). Others try to explore the effects of this trend in legal practices. Theotokas and Alexopoulos argue that the major effect of these quality systems is not the commercial aspects and the awareness of the shipping community, but the attack of fundamental branches of the shipping law. The implications of these quality standards with nationally imposed regulations, such as the US-Oil Pollution Act, or with insurance practices as stated in the Marine Insurance Act of 1906, may alter the capabilities of the companies to limit their liabilities and have a direct impact on the duties of officers ashore and onboard (Theotokas and Alexopoulos, 1998, pp 96-7).

	For the 'marking' of the GCS company, the following certificates and internal policies are taken into account: ISO 900x, ISM, any Environmental Certificate (such as ISO 14000), Drug & Alcohol Policy, other quality standards (such as DNV-SEP), ballast management plan, garbage management plan, TBT-antifouling paints, incinerators plans for the burning of PVC-PCB, Halon fire extinguishing systems.
IPO-listing	The listing of a company at any organized and regulated market comes along with changes in the corporate governance. The issue of corporate governance is discussed in this paragraph, as OECD has adopted new strategy for the safeguarding of shareholders and the deepening of international economic relations. In this context the companies are evaluated according to the number of years listed in an organized market, and specifically at ASE. The longer a company is listed the higher the mark will be, as this reflects a better corporate culture and communication with the shareholders. Of course, this criterion is debatable, yet it offers a basis for further elaboration.
Training cost per employee	The annual cost of training per employee offers a basis for further discussion on the commitment of the management to the training of mariners and employees. The annual expenses for training, as reported in the annual

	report and accounts to the shareholders, is divided by the total number of employees (ashore and onboard), thus providing a measurement of the per employee cost.

Table 13: Management-related criteria

In the above analysis of the management related criteria, the issue of corporate governance came up. This is, in deed, a very sensitive issue for almost every company in the waterborne transport sector, either terminal or carrier or forwarder or multi-modal transport operator (MTO), is corporate governance. Under the term corporate governance nothing really complicated or extraordinary is hidden; it is only a term for describing the operational pattern for companies and most commonly responds to indirect but very sensitive and important subjects, such as:

1. What is the role of the Board of Director (BoD)?
2. Who shall participate in the BoD?
3. What is the role of the Chief Executive Officer (CEO)?
4. What is the order of power in the senior management level?
5. What is the actual goal of the company?
6. Is there any evaluation procedure for the senior management and is it linked to their fees and wages?

These questions are very often in a company, yet they get a special meaning when the company has gone public or simply evaluated for financing in the credit procedure of a prudent bank. In the case of shipping companies all these questions can melt down to the phrases 'who is at the helm' and 'who knows the true course of the ship', though both apply to almost every company.

Under an OECD instruction all listed companied in Stock Exchange Market shall comply specific managerial criteria for the protection of their

shareholders and the reputation of the market as well as of the institutions of the free market system (OECD, 2004). So, OECD defines corporate governance as a system of corporate structures and procedures, leading and controlling the company while defending and protecting the interests and rights of the shareholders.

The same source identifies also BoD as the main governance body. Experience and practice induce three types of BoD:

1. 'Watchdog' boards
2. Trustee boards
3. Pilot boards

'Watchdog' boards identify themselves as guards of the investors' rights and benefits. The members of the board exercise mainly control tasks and participate seldom actively in the strategic planning or decision making of the company. Their role is considered as more passive as they have a posteriori approach. At the same direction but with a different focus, trustee boards exercise 'custody' over the assets of the investors. This scheme appears frequently in corporations of the financial sector or state controlled enterprises. The assets in many cases are not tangible or financial, but also of social interest, and therefore representatives of State or local authorities participate in the BoD, as in the case of ports. In both cases, CEOs usually suggest or propose subjects for discussion to the BoD and their deeds are under scrutiny at the end of the fiscal year. The role is promoted under the circumstances, but there is always the handicap of protracted procedures and in many cases, incompetent and/or inexperienced members impede the sequence of necessary decisions and actions.

The third kind of BoD is the most interesting one, as their members participate actively in the decision making procedure and CEO's role is demoted; CEOs have to analyze and convince the members about the suggested policy or action. Despite the fact that CEOs have to discuss and

justify almost everything, they are faced with a group of experts and qualified people guarding the interests of their representatives but at the same time understanding the subject matter. That is very relieving for the CEO, as this splits his/her share of responsibility to the members of the board as well. This is also the case with the other types of BoD, but as this type of BoD consists of 'experts' then responsibility get a character of collectivity.

The board itself commonly decides the type of BoD. There is a trend to act advisory to the CEO and the President of the board as well offers interaction by discussing the subjects suggested by the President and the CEO. At this point, a crucial relationship has to be defined for every case respectively, that of the President and the CEO. In many cases, and more frequently when there is a gap of experience and knowledge between the President and the CEO, CEOs are not willing to discuss subjects at the BoD. They prefer not to waste time and act fast, while other members of the BoD and the President need more time to compromise the contrary interests of their representatives.

It becomes obvious that the character, the skills and the personality of the CEO as a decisive factor towards the necessary balance and equilibrium of power in any organization. The other factor is the capabilities and skills of the members of the BoD. In many cases, the selection of a member does not lie on the rational approach of skills and knowledge, but on trust and social acknowledgement. Generally, a crucial parameter determining the behavior of the BoD is the existence of prescribed skills and experiences for the member of board as well as for the CEO. This becomes obvious in companies closely held by families or state-owned ones, where personal, political and subjective criteria dominate.

Last but not least is the intertwined issue of transparency and of small-shareholders' participation in the corporate life. Before briefly examining the basic facts, it shall be understood that a country's institutional corporate governance framework can be described by the following main elements:

1. Statutory law and regulations
2. Voluntary standard contracts and self-regulation
3. Implicit rules, social norms and business culture.

Statutory laws and regulations belong to the public policy domain and in that context corporate governance in generally regarded a mean advancing private sector returns and relations towards the benefit of the wider society. Corporate governance as day-to-day corporate practice stems out of a credible and enforceable legal environment. This legal foundation outlines the basic rights and responsibilities of different parties, clarifies the operation of the law and assures compliance. Most commonly, these arrangements are provisos of the company law. Although there are issues making the distinction between civil law and common law countries, such as the flexibility and the rigidity in many legal instances, regulators try to find shortcuts or to compromise situations favoring new business and initiatives.

The second element in corporate governance is the voluntary adoption of norms and self-regulation. This is most common in listed companies, where 'going public' means that the company shall comply with a rather long list of criteria and perform specific internal-audit and reporting operations. Since listing is not mandatory, the 'going public' decision can be seen as entering a voluntary standard contract.

Finally, as corporations and investors always form part of a wider social context their interactions are always influenced by prevailing implicit rules, social norms and business culture. While the immediate and exact impact of such value-systems may be hard to measure, their importance for evolving corporate governance practices is increasingly recognized. Their existence may in fact be an important explanation why technically similar legal frameworks may result in quite different corporate governance outcomes. An often referred to example is the public perception of the mission of the corporation. In some countries, corporations are often expected to serve a range of social functions that in other countries has become the responsibility

of the public sector. Such implicit commitments may concern job tenure, education and training. Implicit liabilities are sometimes expected to go also outside the actual workforce and include such services as providing for apprenticeship positions

Under the influence of increased market and global competition, financial markets and OECD countries have experienced a range of initiatives aiming to improve corporate governance practices. These initiatives have aimed at both the insider model and the outsider model. The main objective in insider oriented countries has been to reconcile the strengths of traditional governance practices with the recognized economic advantages that stem from corporate access to developed equity markets. In countries that primarily have relied on the outside approach, the ambition has been to overcome the incentive and collective action problems related to disperse ownership by promoting shareholder visibility and participation.

While shareholder supremacy has been seen as the hallmark of the outsider model, the reality is that the emergence of much dispersed ownership structures usually left them with little influence over corporate affairs. The profound separation of ownership from control gave increasing discretionary power to hired management that could not always be expected to act in the best interest of the company and its shareholders. Although this development was widely recognized as a genuine problem, it was also assumed that the lack of direct shareholder monitoring through voting and board representation, could be compensated by the stock market's ability to discipline management behavior. This argument builds on the assumption that if management can take care of the company, strict disclosure requirements in combination with liquid stock markets will take care of the stock. If shareholders are able to trade a company's stock on the basis of high quality information, they will also be able to evaluate and sanction management performance. If there is reason to believe that management is underperforming, shareholders will sell their stock; the price will fall and

eventually pave the way for a take-over bid aiming to realize the fundamental values of the company. Such takeovers, which are triggered, when management is not able to make the best possible use of company assets, will typically result in a change of management and therefore serve as an ultimate check on their ability to equivocate. The best protection for managers against this fate would be to keep stock prices up by running the company in the interest of the shareholders. This notion engulfs confusions; it is important to maximize the company value and not the company equity.

Exclusive reliance on the exit mechanism as a disciplining factor has also been mitigated by the presence of large institutional investors that hold a large portion of their assets in the form of indexed portfolios. Such an investment strategy often makes investors less flexible when it comes to selling the shares of an individual company. This has in turn triggered the search for alternative corporate governance strategies among several large institutions, notably the US public pension funds. With limited possibilities to exit specific companies, the principal governance-avenue has been to "move the herd" or "lift all boats". The main tool to achieve this has been to identify a set of governance safeguards, which are assumed to minimize the risk of abuse, waste and moral hazard, and then request all portfolio companies to comply with these pre-established standards. Common elements of such standards include board practices, disclosure provisions and the character of compensation schemes. To gain additional leverage, some institutional investors also publish "black-lists" of companies that lag in performance and acceptable corporate governance practices.

In addition, or rather as an alternative, to pre-established governance standards in individual companies, some large institutions, notably in the UK, describe their ownership strategy as relational investing. These investors (still holding fairly small stakes in individual companies) prefer to influence the company through direct and informal discussions with the directors or the management. For investors with large and diversified portfolios such a

strategy may indeed be very time consuming and for this reason it may become the case that such focused ownership will be carried out by specialized departments or subsidiaries.

During the last decade, market oriented countries have also experience a surge in more "hands on" governance strategies designed to deal with specific information, monitoring and incentive problems. Such strategies are typically pursued by an intermediary owner, which pools capital from various sources in order to acquire large ownership stakes in a limited number of companies. Private equity partnerships and buy-out funds are examples of such specialized governance owners. In their search for competitive rates of return, many large institutional investors, including major US pension funds, have over the last years substantially increased their participation in such targeted and less liquid investment ventures.

The intermediary governance owner operates in active and ad-hoc collaboration with the entrepreneur and other insiders. The strategy focuses on maximizing shareholder returns via customized contracts aiming at a more complete sharing of risks and better alignment of interests among the participants. This governance technique should not be confused with the traditional insider approach. Ownership structures and fiduciary obligations are clearly defined and the contractual rights, including exit possibilities, of different parties are thoroughly elaborated and explicit.

Traditionally used in small and mid-size companies in the high-tech industry, increased familiarity with more "hands on" governance techniques has made it an interesting strategy for ownership also in larger companies, not least as an efficient tool during restructuring. Commitment to this ownership strategy typically requires practical business experience, which is then transferred to the company in very concrete forms. The owners will certainly provide competent candidates for the board of directors, select the executive and if necessary form part of the management team. When carried out across borders, this ownership strategy does not only include transfer of

financial capital but also of industrial know-how, management skills and business networks.

While much attention has been given to corporate governance in the market based system, companies, stock exchanges, regulators and controlling investors are seriously beginning to tackle those aspects of the insider model that creates obstacles to outside investment or hamper corporate dynamism. Unlike in the outsider model, the central problem in the insider model is not the separation of ownership from control. The main areas of concern are instead:

1. Effective protection of minority shareholder's rights
2. More transparent corporate structures, and
3. Market access to high quality financial information

This analysis proves the complexity of the issue of the corporate governance, and the difficulties to quantify such attributes. A way to include several criteria or sub-criteria into an analysis would be to use fuzzy-logic techniques, which easily transform linguistic judgments to figures. This issue will be discussed in a coming paragraph (page 217). However, it would not add sufficient accuracy to this model, unless there was inside information and extended solicitation of opinions from shareholders and potential investors. Therefore, the criteria used for the evaluation of the management have been limited to the ones described and analyzed above.

It is interesting to note that some first attempts to quantify the results of management styles and corporate governance have already appeared in the literature. Recently, Randøy et al. have published a paper over the corporate governance and the effectiveness of the board taking as example Nordic experiences (Randøy et al., 2003). In Greece, no relevant approach or attempt has been noted and as induced from paragraph 3.1.2 -Market Analysis- in page 70, in Greece there are many shipping companies of various sizes and

risk profiles, so it would be interesting from an analytical point of view to get a picture.

In the case of the listed GCS companies it would be interesting to include a criterion related to the corporate governance. Nevertheless, as the market is currently structured this would have a very limited contribution to the estimation of the overall index. According to the test of importance (see p. 100) the inclusion of a criterion over the governance of the company can be excluded as it would not affect the overall ranking due to the fact that all BoD are controlled by major shareholders and the members do not have executive power unless they are shareholders too. The only exception to the rule of the 'uniform' governance style is ANEK; ANEK is a company of 'popular base', i.e. the shares are dispersed among many shareholders. However, the power of a shareholder's group that includes the local Orthodox Church is profound and indisputable. As there is lack of diverse data to feed the model, the relevant criteria are not taken into account. However, researchers are suggested to conduct research in this field (paragraph 8.2.2).

6.1.2 External Factors

Opposite to the internal factors, where the company can basically affect them through its decision-making mechanisms, external factors are practically independent from the decisions of the management. In this modeling, the external factors are broken down to the following set of criteria: stock performance, market environment and the competition.

As expected and as in the case of internal factors, these groups of attributes may raise debates over the interaction of the decisions of the company with this external environment. One can easily argue that stock performance is based on the fundamentals and that competition is affected from the actions of one sole player in this high concentrated market. The truth is that in small markets and segmented sectors as in the case of GCS, the movements of the

actors are interrelated. The same applies in some extent to the relatively small and illiquid market of ASE. Nevertheless, economics and economic theory can not be explained adequately with rationalism and the notion of 'economic climate' is dominant in open systems, as the stock market. If there is an upward trend, a bullish market, then all shares will get a benefit, regardless the status of each respective company.

Additionally to this idea, competition does not respond spontaneously or immediately to a strategic or a tactical movement. In shipping, and in transportation generally, an increase of the level of service (LOS), practically increase of the service frequency and/or of the reliability and/or of the comfort level and/or decrease of price and/or of the travel time is achieved mainly through increase of the offered capacity (in pass-miles). The LOS is a complex concept and multidimensional, and therefore it integrates and internalizes different variables, such as the value of time of the users, their generalized cost which involves also the accessibility of the ports and their services, and a bias. Furthermore, the LOS is dynamic, as it strongly depends from the time variant. As in the urban system with peak hour service offering lower levels of comfort, summer seasonality of the GCS is characterized by great volumes of travelers and vehicles, users tend to get services of lower quality. Moreover, schedules are not regularly driven by customers' demand, except specific days and weekends, where carriers and authorities are aware of the transportation demand and route more vehicles in specific lines. There is a sensitivity of the GCS as in the case of the airlines, but not so high. This is also a characteristic of the structure of the network; if the network was designed on a hub-and-spoke architecture, then this sensitivity would have been further reduced. Travelers generally avoid transit stations and have a clear bias over the direct connections (Sussman, 2000, pp 37-41).

The increase of the LOS will practically come with the increase of the offered capacity (practically number of seats or lane meters offered). As the LOS

approaches the offered capacity then the level of service deteriorates dramatically. This happens at peak times. By increasing the offered capacity the LOS remains at a specific or reaches even higher levels. However this increase of capacity demands a lumpy investment in vessels, and ships are not like rail-wagons or buses, where an inventory of them is possible and desirable. The linkages between the offered capacity, the LOS and the necessary, often lumpy, investment consists the innermost challenge of transportation system design (see Figure 39).

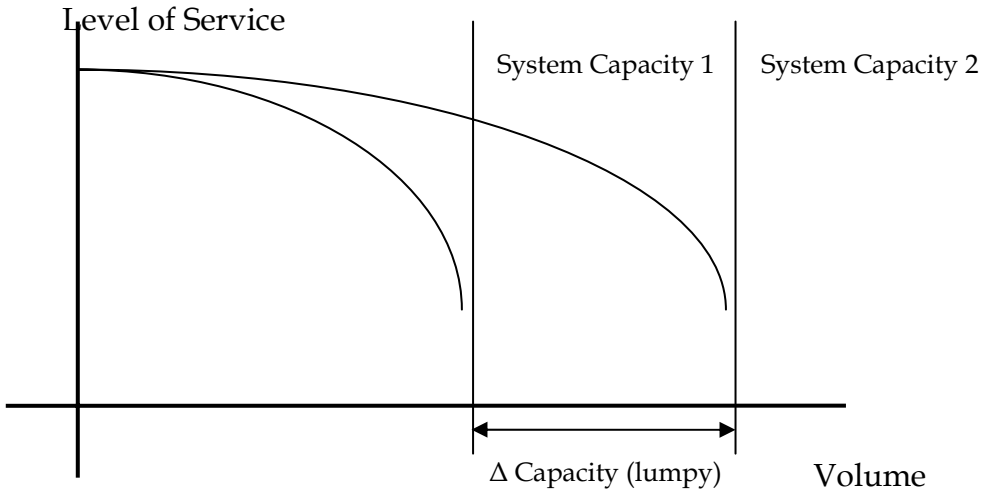


Figure 39: Typical supply functions – Adopted from Sussman (2000, p. 81)

In that perspective the competing companies should react by adding capacity instantaneously in order to attract more customers. This is not the case in shipping generally and in the GCS particularly. So competition is practically independent for short periods. Competition will react if only there are licenses available for further exploitation of lucrative lines, which is also a parameter restricting competitive options. The State through the system of licenses limits or distorts competition within the lines and not the system. Companies can easily enjoy a monopolistic situation in a line and be exposed to competition in other lines. Given these parameters, the necessary increase of offered capacity and the system of licenses, inherent to shipping and the

local regulatory conditions, competition is considered an independent factor, therefore an external one.

6.1.2.1 Stock performance

The performance of the stock of a listed company at an organized secondary market, in that particular case the Athens Stock Exchange (ASE), reflects the market perception of the asset and the story behind the company. The performance of the stock is not always or necessarily linked to the fundamental accounting and operating data. The markets, institutional and retail investors are trading the asset not only because of the earnings per share or the dividend they may collect in the near future, but also because of a story that implies higher performance than the general average, as well as because of the perspectives of the market as such irrelevantly to the asset.

The risk of an asset has been thoroughly analyzed and approximated by various researchers; the most known approach is that of Markowitz. Nevertheless, the whole theory melts down to a factor, the well known β-factor. If an asset has a β over 1 then it is more risky than the general index (or any other relevant base-index). The risk of an asset is directly linked with its volatility. In practice the risk of assets is not easy to be estimated. The calculation of β-factor demands normal distributions; most if not all time-series of assets traded at ASE are not normal ones. This is attributed to their very short trading history as well as to the effects of the transformation-process of ASE from an emerging market to a mature one.

The reader can find numerous books, papers and studies over the risk related to assets, yet the basic idea is reflected in the following figure:

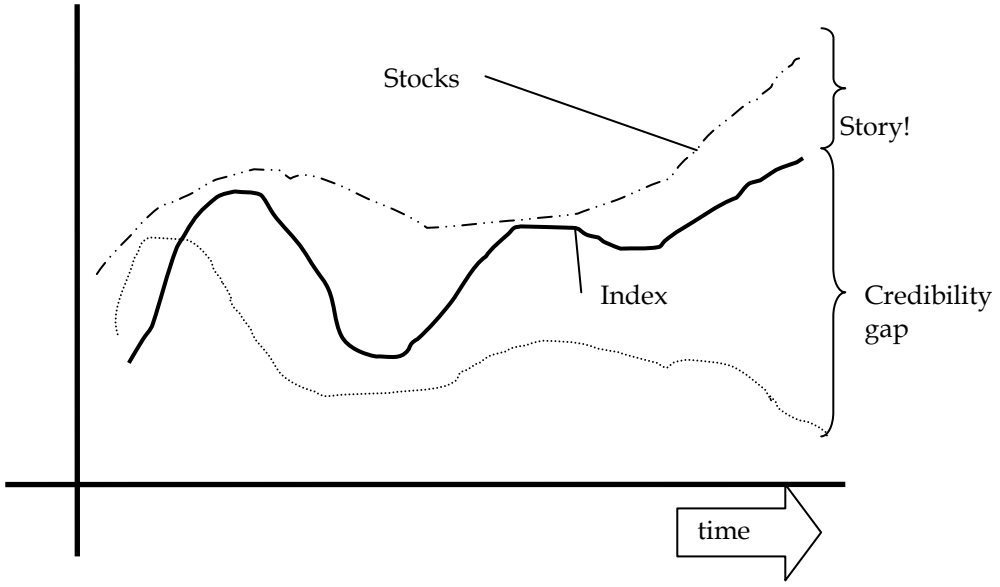
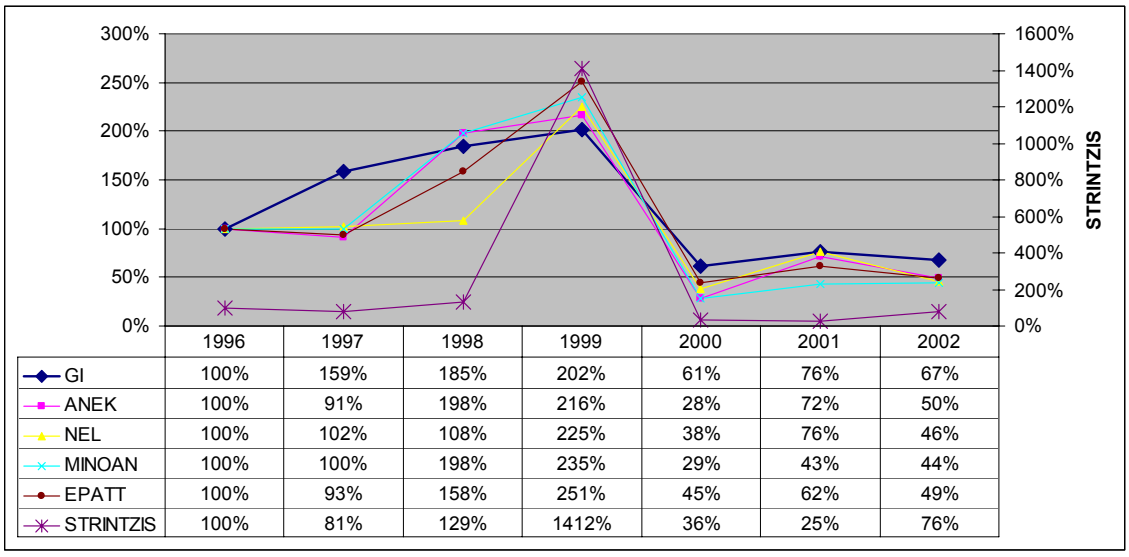


Figure 40: The 'story' and the 'credibility gap' of stocks against an index



	1996	1997	1998	1999	2000	2001	2002
GI	100%	159%	185%	202%	61%	76%	67%
ANEK	100%	91%	198%	216%	28%	72%	50%
NEL	100%	102%	108%	225%	38%	76%	46%
MINOAN	100%	100%	198%	235%	29%	43%	44%
EPATT	100%	93%	158%	251%	45%	62%	49%
STRINTZIS	100%	81%	129%	1412%	36%	25%	76%

Figure 41: Under- and Out-performance Data of the GCS stocks

An index is commonly a weighted sum of selected assets. The course of the index reflects the beliefs and the visions of the market over the specific sector or the economy in general. An asset outperforming the index bears a 'story'; a 'story' is a set of qualitative attributes, as discussed previously (p. 150). The market believes in this 'story' and invests hopes and expectations. Commonly the 'story' is based on business perspectives and financial

returns. Assets underperforming face the 'credibility gap', i.e. they cannot convince investors on their perspectives. Traders can exercise pressures or boost prices. Generally, a company can do very few things to affect the price of its share in an organized trading market. Techniques affecting the 'supply of shares', such as 'split' and 'reverse split', buy-out of own shares, etc are generally difficult to implement and in some cases ruin the image of the management or of the company. A company can only provide adequate profit forecasting, propose and implement business strategies, as well as expand its relative size in the sector and in the market; these are long term goals and cannot be achieved within weeks if not years.

It is interesting to note that in most cases there was a credibility gap for the GCS stocks during the period of analysis (see Figure 41). With an exception for the fiscal year 1999 (boom-year of the ASE) in all other years the ASE-GI has practically outperformed all GCS-stocks. This reveals also the credibility gap and the limited investors' interests. In stock markets shipping stocks are generally traded at a specific percentage of the Net Asset Value (NAV), thus ensuring investors that even in the case of financial collapse of the shipping company some money will return to the investors from selling out the assets (ships). There is a practical rule, which is not justified scientifically, that a trading around 80% of the NAV is normal, while higher or lower percentages are 'overvaluing' or 'undervaluing' the company.

For the needs of the model, nine widely used criteria by financiers are taken into account. All but one is not directly controlled by the company but by the market. The company can only control the dividend. However, as dividend is considered a critical element for investors, and in some cases is also affected by the competition, it falls into the stock-performance category of criteria. The criteria are the following:

Difference in market value	At the end of every fiscal year, the share has a market value. This value is reflected in the accounting books of the investors.
Difference in capitalization	The capitalization of a company is a crucial parameter. The product of shares and market value determines the relative strength of the company in its market. A company with low capitalization may easily become an M&A target. Furthermore high levels of capitalization may also lead in structures with convertible debt to asset or asset-based collateral.
Dividend	Dividends are critical for investors as well, as they reflect the direct receivables of their investment.
General Index out-performance (credibility gap)	As shown in Figure 40, an asset may over- or under-perform against an index, thus pointing out high expectations or credibility gap. In this context the Athens General Index is used as basis for further analysis.
Long Term Liabilities /Capitalization	This ratio is reflecting the percentage of long-term liabilities (as an element of the gross liabilities) against the capitalization. A continuous increase of the ratio reflects better the increase of the long-term liabilities as capitalization is not changing very fast (or generally slower than the liabilities).
Net Working Capital /Capitalization	The ratio reflects the ability of the company to liquidate assets (or to use cash and liquid assets) for the coverage of unexpected needs.

Current Assets /Capitalization	As above
Liquid Assets /Capitalization	As above
P/E	The Price to Earnings ratio is a widely used one; the current price of the share is divided by the earnings per share (as reported in the last financial period). It actually indicates the years an investor may wait to get these reported earnings. A high P/E ratio is usually a characteristic of an 'expensive' asset, i.e. of an asset which is probably over-evaluated. Usually the P/E of a company is compared with those of other listed companies of the same sector. The closer the P/E is to the industry-average the better the company is evaluated. A P/E well under or over the industry average should make the investors take a closer look to the 'story' and the track-record of this asset. There are many arguments against the use of this ratio, such as the use of past earnings, yet it is widely used and discussed.

It is necessary to note that the ratios implementing the capitalization of the company are widely used by financial institutions. Financial officers of the companies should take into account these ratios when 'planning' the financial future and image of the company.

6.1.2.2 Market Environment

In all marketing books and the related bibliography the external and internal forces as well as the procedure of change is analyzed through the model of PEST, which stands for the set of political, economic, social and technical factors influencing the result. This model, originally conceived by Porter, provides a good tool for the determination of the forces, but it does not offer the tools for guiding the procedure to the desired result. Therefore, another approach is necessary for evaluating the efforts already made, as well as for the extraction of scenarios about the future.

Originally Porter's model was set to explore the influences of the external environment to the enterprise. In a latter stage, the model has been modified for the needs of marketing, strategy, etc. Whalley adapted the generally accepted performance shaping factors to the needs of industry, completing the picture of internal and external influences of a transport and more specifically a shipping company (1993). These approaches are not the only ones, but can be considered as representative. Two overt schemes summarize the above ideas (see Figure 42 and Figure 43).

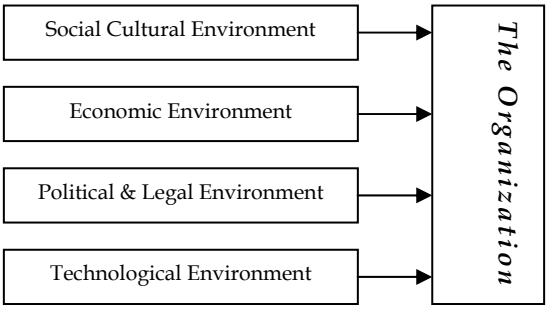


Figure 42: External Forces

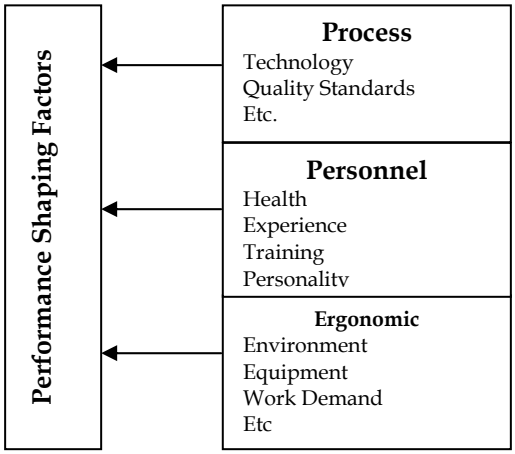


Figure 43: Internal Forces

What PEST analysis does is a good breakdown of experience-gained knowledge or knowledge generally conceived as common sense. It does not

provide a methodology to jump into conclusions, but a pattern of thinking, where almost every external factor can be fit in. The analysis usually starts with the economic factors, as the economic environment affects the level of economic activity and therefore the demand, supply, volumes and prices. In that sense, issues relevant to the suppliers, the customers, the competitors fall into this category; sometimes issues relevant to a governmental policy or investors' relation also comes into the picture.

Along with the economic analysis follows a technological one, as technical advances and evolutions open new markets and create opportunities. Commonly the analysis focuses on the rate of change of a technology or attempts to predict the future. This is maybe the only part in a PEST where change is under scrutiny and that because of the time scale of events.

On the contrary, the political and social analysis is seldom focused on change, even when the rules of operation alter dramatically. This happens because people resist change or do not easily accept a new status. It is true that enlighten managerial teams prepare themselves and their organizations for the future, yet not everybody is willing or capable to cope with change. In extreme conditions or cases where political or juridical pressure is exercised on an organization, then a grace period is often granted and that to allow the absorbance of any shocks by the people. In the social analysis, where attitudes, customs, beliefs and other human characteristics are under examination, the way of management is determined at large, and therefore the capability of adapting to change is evaluated.

The general conclusion of a PEST analysis is qualitative and really a very important tool for the determination of strategy and marketing policy. However, it is not a tool to measure performance, even in a qualitative manner. Understanding that performance measurement is crucial for an effective manager; in an opposite case, the manager creates activity to justify his/her position rather than to achieve a specific goal. Finally the ideas of PEST analysis is very interesting in the case of the transport and shipping

sector, especially in GCS case, as the industry is regulated by various international and national bodies.

In this model only four criteria are taken into account. The political and social forces are considered as similar for all companies during the period of examination. So, they are practically out of consideration. However the companies are dependent on suppliers, including those providing fuel and lubricants, and other intermediates, mainly those promoting and selling the tickets. These are two basic relations with the external environment. These forces are considered as part of the six-market model of relationship marketing (Stokes, 1997, pp.64-5).

From a theoretical point of view, as well as from experience, companies try to influence their macro- and micro-environment. In the regulated context of GCS, companies lobby towards safeguarding of their interest, but such information and action cannot be modeled and basically be proven. The only traceable and dynamically evolved actions are the relations with suppliers, with intermediates, with the wider community and the adoption of new technology. The relations with suppliers, intermediates and the community are reflected through the relevant expenditures. A high expenditure related with suppliers may result from increased volume of trade, depending on the number of the vessels, as well as from policy issues. However, what really matters is the comparison with other companies operating in the GCS context. The expenditure attributed to the intermediaries is directly linked with the number of tickets sold. Nevertheless, the same applies as in the case of suppliers; the relative percentage is under scrutiny. High or low levels of expenditures may also be linked with push and pull marketing policies. The policy of every company is not reviewed in this study.

The commitment and the ability of the company to adopt new technologies are exposed primarily with the implementation of new IT and organizational practices and systems, as well as, with the operation of high-tech vessels. From the available information, it was impossible to quantify or qualitatively

evaluate IT systems and organizational methods, although certifications are taken into account in the managerial set of criteria. However, it is easy to trace the new high-tech vessels in the fleet and therefore the adaptation of the company to the new technology. Under the term high-tech vessels are considered non-conventional designs, such as fast mono-hulls, SWATH, catamarans, etc.

It is a debatable point that the adoption of new high-tech vessels is a sign of maturity and better approaching of the users' needs. The new high-tech vessels cannot offer services as reliable and financially viable to the company as the conventional ones. Many researchers have argued on this subject (see European Short Sea Conferences). However, the companies are reluctant to replace their conventional fleet with high-tech vessels. From a marketing point of view, these new vessels shall not be conceived as vessels for trunk and everyday all-year-round service. These are vessels for the peak time, where users with high value of time are willing to pay more. Additionally, there are some specific lines, say Piraeus to Crete and the Adriatic Sea Corridor that can accommodate such vessels with financial interest for the shareholders. Nevertheless, such a venture has firstly to be proven technically, especially from a reliability point of view, and to overcome the restriction of sailings due to severe weather conditions, as decided according to the Greek Law by the Hellenic Coast Guard for the GCS pattern of operation.

It is interesting to note that the decision of deploying new technology ships lies with the management of the company, so it would be sounder to include this criterion to the management-related criteria. However, this is not always the case. In the Aegean market, and especially in the Cycladic segment, it was proven that the deployment of new technology ships was triggered by the competition and the market conditions. The unexpected routing of a new technology ship in the early 1990s forced dominant companies of that era to route such vessels. However, the permanent deployment of these vessels was

intertwined with financial aspects of the operations, specifically the cost of fuels and the cost of agencies. Therefore, this criterion falls into the market environment category (see also 4.3 on this issue)

Last but not least is the money a company donates to various social groups and interests. This is a way to increase the visibility of the company and to spread messages to the wider public. Furthermore, most of the GCS companies have also a strong local character: ANEK and MINOAN Lines are companies dominated by Cretes and serve historically Cretan lines, NEL serves the Northern Aegean market with Mytilene on Lesvos Island, as operational centre. Other non-listed companies are also linked traditionally, financially, and operationally with other parts of the Greek coastline or islands. Consequently, money donated to various social interests and goals is conceived as a 'payback' to the local community for the support. There is a marketing catch, linking a specific line with a destination. However, this has also been enforced by the fragmentation of the market and the policies of the central government in Piraeus. The percentage of money donated to various social activities, consists a solid criterion revealing the attempt of a company to change attributes of the local social and political environment.

Summarizing, four criteria will be used for the evaluation of the market environment, which are:

1. the percentage of intermediaries cost over the turnover
2. the percentage of suppliers including fuel cost over the turnover
3. the percentage of new high-tech ships in the fleet
4. the percentage of donations over the turnover

6.1.2.3 Competition Data

The last subset of criteria aims to provide a better understanding over the competition in this sector. Taking into account the listed companies, the market shares are estimated per category of revenues (passengers, cars and

trucks) as well as on turnover basis. Furthermore, a differentiation percentage is also estimated. This ratio highlights the dependence of the company from a specific market (the Aegean or the Adriatic one). Another important criterion in this field is the profit margin; although this is an element depending heavily on decisions and financial planning of the management, it points out the relative position of a company in its sector. A company with a high profit margin may undergo several strategies (either differentiation or cost leadership) or proceed to tactical movements (e.g. fleet renewal) and keep on returning profits to its shareholders. The last criterion is also very important as it reveals the percentage of income stemming out of services on board and not fares. Revenues from services, such of restaurants, bars, casinos, telecommunications, etc. are summed and divided by the total turnover. This criterion is significant as hotel and such services may become more important sources of income in the future.

In summary the following criteria will be used:

1. market share (turnover)
2. market share (pass-total)
3. market share (cars-total)
4. market share (trucks-total)
5. %differentiation (out/total)
6. profit margin
7. on board services/total revenue

6.1.3 Data Integrity and Limitations

It is very important to note that the available data are not of the best quality and some of them are estimated indirectly from sources available from the companies though. However, all data are 'certified' as they are provided in the official annual reports and information memoranda. This part of the

work was very time- and effort-demanding, as the information provided to the investors is not of scientific standards but merely for promotion and accounting reporting purposes.

The issue of the data quality is critical. The fundamental accounting data do not present generally any setback, although there are slight inaccuracies or corrections between several versions of the statements. However, this is not the case with the data related to the stock-performance. One should be very careful with these data, as various sources estimate them on different base-years or milestones. The same applies to the data of the market-environment category; in this category data, such as intermediaries costs (selling agencies' costs) suppliers' cost (stores, fuels, lubricants, etc,) are either provided by the company or are estimated though information provided in the speeches, forwards and analysis of the BoD to the public and the investors. These data engulf inaccuracies as not all companies define these costs the same way. A lot of time and effort has been devoted in order to mitigate this problem. Data on donations and social purposes are not reported in the last reports, and the respective elements have been excluded from further calculations. However these data are important for the local societies and reports of ANEK and MINOAN contained relevant information in the past.

In the model all financial data are converted in Greek Drachmae; the reason is that it would be not accurate enough to convert Drachmae into euros for the years with currency fluctuation. As the euro to drachmae rate is fixed it is accurate and easy to convert statements in euros into Greek Drachmae.

The data used for the logistic services are of adequate quality although average prices have been estimated in some cases. It is very important to note that there is no harmonized format of data presentation over the years, as well as between the companies. Lately, there is an effort to harmonize the format, yet not for all data categories. For example, there are no data for the sailings executed in the annual reports of recent years, although there were in the reports of 1997 and 1998. Some companies have never provided this

figure. Unfortunately this figure cannot be estimated from other data. Regarding the coverage of the Aegean, the Ionian and the Adriatic market a straightforward approach was employed: the percentage of coverage is the ratio of the ports of call in the respective market against the total. In the Aegean 35 ports comprise the market, 4 (Corfu, Patras, Zakynthos, Kefalonia) in the Ionian and 5 (Brindizi, Bari, Ancona, Trieste, Venice) in the Adriatic.

Another hard-to-collect data set is the one related to the management of the company. The data related to certification are commonly not clearly stated in the reports and correspondence with the companies was necessary. The training cost per employee could not be estimated. Companies do not provide relevant data in their recent reports. Nevertheless, it shall be highlighted that companies, such as ANEK and MINOAN, reported the total amount spent on personnel training, while none of the rest has ever provided a relevant figure. Even though the cost per employee is extremely low as it is around €65 and €17 for ANEK and MINOAN respectively. Finally it has to be noted that the average age of the ships was not hard to estimate but it required some specialized knowledge because some old ships have undergone extended conversions and renewed their licenses.

The data availability and integrity revealed the limits of formalization at least for the purposes of this study. The only truly reliable data-set is the one of the fundamental accounting data. All the other data-sets especially those related to traffic and the services are of questionable quality. This is a well known problem in the GCS. In the paragraph devoted to further research proposals (8.2.2, p. 256) there is a suggestion on the data collection and presentation.

As the model can expand to the 'bottom' as much as the available data allows, one would ask why not including more criteria and data, so to better explain the ultimate index a company achieves. The response is that there is very few (if none) official data to include in the model. Of course one could use estimations for other significant data, such as executed sailings,

frequency of call (critical data for the quality of the logistics services delivered), as well as for cost elements per ship or route. Nevertheless such an approach would import inaccuracies and therefore increase the overall error of the modeling.

6.1.4 Weighting the Criteria

The weighting of the criteria is a very difficult and critical task as well. In the AHP methodology one compares criteria the same way as for the attributes of the alternatives. It is a relative comparison that practically responds to the question 'which criterion is more important'. Mosseau (1995) discusses the notion of Relative Importance of Criteria (RIC) and the Elicitation Techniques for Importance Parameters (EITP). When analyzing the RIC notion it appears that there should be a form of regularity in the link between the preferences, especially in techniques that incorporate a Multiple Criteria Aggregation Procedure (MCAP), as the AHP does. Several EITP have been developed for other MCDM methods, such as DIVAPIME for PROMETHE, but none for AHP. In AHP it seems that a questioning procedure is followed that allows both a descriptivist and constructivist approach. By *descriptivist approach* one assumes that the decision maker has already a well-defined order of preferences while by *constructivist approach* the decision-maker makes up his mind during the process.

Both approaches have been used in this model, although it is easy (both theoretically and practically) to alter the weights and therefore the outcome. It was decided that for lower level criteria a descriptivist approach would be followed while for upper levels (the ones that make the difference) scenarios and simulation of response will be used. In this paragraph only the lower level criteria will be discussed.

The eleven criteria of the fundamental data-set have been weighed as shown in the table below and the justification follows:

	TL/TA	FA/(SE+LT)	FA/TA	CA/CL	LA/CL	SR/AvAR	SR/TA	SR/FA	GP/SR	OpI/SR	Niat/SR
TL/TA	1	1/5	1/5	3	3	1/3	1/3	1/3	1/3	1/3	1/3
FA/(SE+LT)	5	1	1	3	3	1	1	1	1	1	1
FA/TA	5	1	1	3	3	1	1	1	1	1	1
CA/CL	1/3	1/3	1/3	1	1	1/3	1/3	1/3	1/3	1/3	1/3
LA/CL	1/3	1/3	1/3	1	1	1/3	1/3	1/3	1/3	1/3	1/3
SR/AvAR	3	1	1	3	3	1	1	1	1	1	1
SR/TA	3	1	1	3	3	1	1	1	1	1	1
SR/FA	3	1	1	3	3	1	1	1	1	1	1
GP/SR	3	1	1	3	3	1	1	1	1	1	1
OpI/SR	3	1	1	3	3	1	1	1	1	1	1
Niat/SR	3	1	1	3	3	1	1	1	1	1	1

Table 14: Fundamental Data – Criteria Weighting

The basic idea behind this weighting procedure is that one has to compare groups of criteria. Criteria that include 'sales revenue' figures (either in the nominator or in the denominator) should get equal importance. The same applies for the ratios including 'fixed assets', i.e. the vessels. Furthermore, these sub-categories should be considered as the most important. Fixed assets (vessels) and sales revenues are the most important elements in the balance sheet of a shipping company. One would say that income-related data are also important; the reply is that income-data has been included in several ratios of 'sales revenues', as well as income figures are easily manipulated by companies, in order to achieve the goals of a strategy or a planning. Last, but not least, ratios reflecting the ability of the company to cover immediate needs (CA/CL and LA/CL) are of lesser importance than the assets and the sales revenue. In the recent history of the GCS liquidity problems were and still are common, due to the seasonality.

This 'subgroup' approach was also necessary for numerical reasons. As the above table is rather big for a decision maker to express clear preferences under the constraint of an acceptable consistency ratio, the considering of the ratios as subgroups was a solution. The resulting vectors are presented in the table below:

	Vector	Idealized Vector
TL/TA	0,041	0,354
FA/(SE+LT)	0,116	1,000
FA/TA	0,116	1,000
CA/CL	0,033	0,288
LA/CL	0,033	0,288
SR/AvAR	0,110	0,955
SR/TA	0,110	0,955
SR/FA	0,110	0,955
GP/SR	0,110	0,955
OpI/SR	0,110	0,955
Niat/SR	0,110	0,955

Table 15: Criteria weights (vector and idealized vector) – Fundamental Data

Obviously, the ratios reflecting the status of the vessels in the balance sheet get the highest importance. The 'sales revenue' group of ratios get a slightly lower one and all the other ratios complete the picture with a notion of 'important but not equal' to the previous ones. The consistency ratio is very low as expected (1.6%).

The next group of criteria is the one on logistic services. The same approach is used but with an exception. As there are no data on the executed sailings it was necessary to extract this criterion out of the vector, in other words to minimize its contribution in the decision. Therefore, it got the minimum importance (and at latter numerical stage the related figures from the company become zero, compellingly so to eliminate all its influence). The following table reveals the criteria weighting used in the model:

	Aegean coverage	Ionian coverage	Adriatic coverage	Number of executed sailings	Average pass fare - GR	Average pass fare - Int	Average car fare - GR	Average car fare - Int	Average truck fare – GR	Average truck fare - Int
Aegean coverage	1	7	1	9	3	3	3	3	3	3
Ionian coverage	1/7	1	1/7	9	1/3	1/3	1/3	1/3	1/3	1/3
Adriatic coverage	1	7	1	9	3	3	3	3	3	3
number of executed sailings	1/9	1/9	1/9	1	1/9	1/9	1/9	1/9	1/9	1/9
Average pass fare - GR	1/3	3	1/3	9	1	1	1	1	1	1
Average pass fare - Int	1/3	3	1/3	9	1	1	1	1	1	1
Average car fare - GR	1/3	3	1/3	9	1	1	1	1	1	1
Average car fare - Int	1/3	3	1/3	9	1	1	1	1	1	1
Average truck fare - GR	1/3	3	1/3	9	1	1	1	1	1	1
Average truck fare - Int	1/3	3	1/3	9	1	1	1	1	1	1

Table 16: Logistics Service Data – Criteria Weighting

It has to be noted that the coverage of the Aegean and of the Adriatic is considered of equal importance while of the Ionian as considerably less important. From figures and data presented in the Introduction (see p. 82) both markets are very important. The author's personal belief is that only some routes in the Aegean are of equal importance with the Adriatic ones. However, it was not possible to break the Aegean market into segments due to eminent lack of data broken down per route.

The criteria related to fares get equal importance to each other. This is expected as they are part of the same pricing policy. In a future application this all will be expanded further; this was not possible here as there is no information available on the pricing policy of the companies. A differentiation of the pricing policy will only be meaningful in a deregulated environment. Currently, fares are determined at large by the MMM.

The market coverage criteria are slightly more important than those related to fares. This is considered due to the inherent inelasticity of options. The existence of link to a specific destination (island) is considered as more important than the fare; first comes the need and then the price. However, as

most important destinations offer alternatives (air connections, alternative schedules, etc,) a slight preference is only given. The extracted vectors are presented below:

	Vector	Idealized Vector
Aegean coverage	0,223	1,000
Ionian coverage	0,033	0,149
Adriatic coverage	0,223	1,000
Number of executed sailings	0,011	0,047
Average pass fare – GR	0,085	0,382
Average pass fare – Int	0,085	0,382
Average car fare – GR	0,085	0,382
Average car fare – Int	0,085	0,382
Average truck fare - GR	0,085	0,382
Average truck fare - Int	0,085	0,382

Table 17: Criteria weights (vector and idealized vector) – Logistics Service Data

As expected, the Aegean and the Adriatic network coverage are of the highest importance, while fare-criteria get an equal importance. The consistency ratio is also very low (2.4%) as many of the elements in the table are units.

The table with the management criteria is comparatively easier to work out despite the fact that the 'training per employee' criterion should contribute the minimum in the evaluation due to lack of relevant data from the companies. It would be easy to exclude it from calculations (as happens at a latter numerical stage, where its vector-element is multiplied by zero) yet it would exaggerate the importance of the 'average age of the fleet' criterion. The following two tables present the evaluation and the extracted vectors.

	Average Age of the fleet	Certification	IPO-listing	Training €/employee
Average Age of the fleet	1	5	7	7
Certification	1/5	1	3	5
IPO-listing	1/7	1/3	1	3
training €/employee	1/7	1/5	1/3	1

Table 18: Management Data – Criteria Weighting

	Vector	Idealized Vector
Average Age of the fleet	0,638	1,000
Certification	0,212	0,333
IPO-listing	0,099	0,155
training €/employee	0,050	0,079

Table 19: Criteria weights (vector and idealized vector) – Management Data

The average age of the fleet is considered as a very important criterion. Certification of the company is also very important as it reveals that a minimum standard of operation. The number of years listed at ASE reveals a 'corporate culture' but is not as important as the previous two criteria. The training per employee cost is considered a very important element for the future of the company, yet it was necessary to diminish its significance in this application. The consistency ratio is 8.9%; it is high but within acceptance limits. The consistency of the judgment is negatively affected from keeping the 'training' criterion in the evaluation set.

The stock-performance criteria are handled the same way as done with the fundamental-related ones. The criteria with the capitalization are considered as the most important in this sub-group and therefore enjoy equal importance. They are considered as slightly more important than those related to the difference of prices between two periods. Generally, these are considered as more important along with the dividend. The less important criterion for financiers is the P/E. Although it has a sentimental effect on investors, a professional cannot be easily lured from such an inaccurate ratio.

Therefore it gets the lowest importance. As the evaluation table contains many unitary elements the consistency ratio is expected to be low enough; yet the ratio is 9.7% and this is attributed to the 'general index out-performance' criterion. The tables below present the evaluation and the extracted vectors:

	diff mv	diff cap	Dividend	GI outper	LTL/Cap	NWC/CAP	CA/Cap	LA/Cap	P/E
diff mv	1	1	1/3	3	1/3	1/3	1/3	1/3	3
diff cap	1	1	1/3	3	1/3	1/3	1/3	1/3	3
Dividend	3	3	1	3	1/3	1/3	1/3	1/3	3
GI outper	1/3	1/3	1/3	1	1	1	1	1	5
LTL/Cap	3	3	3	1	1	1	1	1	5
NWC/CAP	3	3	3	1	1	1	1	1	5
CA/Cap	3	3	3	1	1	1	1	1	5
LA/Cap	3	3	3	1	1	1	1	1	5
P/E	1/3	1/3	1/3	1/5	1/5	1/5	1/5	1/5	1

Table 20: Stock Performance Data – Criteria Weighting

	Vector	Idealized Vector
diff mv	0,067	0,402
diff cap	0,067	0,402
Dividend	0,096	0,580
GI outper	0,080	0,481
LTL/Cap	0,166	1,000
NWC/CAP	0,166	1,000
CA/Cap	0,166	1,000
LA/Cap	0,166	1,000
P/E	0,027	0,164

Table 21: Criteria weights (vector and idealized vector) – Stock Performance Data

The market-environment related set of criteria are strongly biased to the use of new technology ships. The use of new technology ships is considered a very important attribute for the overall evaluation of the company. It is almost as important as the average age of the fleet (slightly less). The issue of lack of data on the donations forced a similar handling as previously for the 'number of executed sailings' and 'training per employ' criteria. The

consistency ratio of this table is rather high (8.8%) but within limits. The following tables present the evaluation and the extracted vectors.

	% intermediaries cost of turnover	% of new tech. ships in the fleet	% suppliers (incl. Fuel) of turnover	% donations of turnover
% intermediaries cost of turnover	1	1/5	1	7
% of new tech ships in the fleet	5	1	5	9
% suppliers (incl. Fuel) of turnover	1	1/5	1	7
% donations of turnover	1/7	1/9	1/7	1

Table 22: Market Environment Data – Criteria Weighting

	Vector	Idealized Vector
% intermediaries cost of turnover	0,174	0,281
% of new tech ships in the fleet	0,618	1,000
% suppliers (incl. Fuel) of turnover	0,174	0,281
% donations of turnover	0,035	0,056

Table 23: Criteria weights (vector and idealized vector) – Market Environment Data

The last category of criteria is the competition-related ones. As this is a rather big evaluation table, it was necessary to consider the comparison of sub-groups. So the market-share related criteria get equal importance as well as the criterion of the profit margin. The 'differentiation' and the 'service' criteria get equal importance but are considerably less significant in comparison to the market-share and the profit margin (see tables below).

	market share (turnover)	market share (pass-total)	market share (cars-total)	market share (trucks-total)	% differentiation (out/total)	Profit margin	services/total revenue
Market share (turnover)	1	1	1	1	5	1	5
Market share (pass-total)	1	1	1	1	5	1	5
Market share (cars-total)	1	1	1	1	5	1	5
Market share (trucks-total)	1	1	1	1	5	1	5
%differentiation (out/total)	1/5	1/5	1/5	1/5	1	1/5	1
Profit margin	1	1	1	1	5	1	5
Services/total revenue	1/5	1/5	1/5	1/5	1	1/5	1

Table 24: Competition Data – Criteria Weighting

	vector	Idealized vector
market share (turnover)	0,185	1,000
market share (pass-total)	0,185	1,000
market share (cars-total)	0,185	1,000
market share (trucks-total)	0,185	1,000
%differentiation (out/total)	0,037	0,200
profit margin	0,185	1,000
services/total revenue	0,037	0,200

Table 25: Criteria weights (vector and Idealized vector) – Competition Data

As the elements of the table are symmetrical the consistency ratio is 0%, thus indicating a 'perfect' judgment.

The evaluation at the upper levels will be discussed in the coming paragraph as it is strongly related to the outcome of the model. Although these evaluations above (and primarily the hierarchy) reveal the biases of the

author as a decision maker it has to be commented that the generally low consistency ratios indicate a 'fair' judgment. This has already been discussed and will also be commented in a latter paragraph (see paragraph 6.3).

6.2 *Application of the Methodology*

Before proceeding to the upper level evaluation of the criteria, as well as of presenting the results, it is necessary to stress some details on the application of AHP.

In order to find the attributes a_{ij} of a company per criterion (and per year) given the real figures the following procedure is followed. All relevant figures for all companies and for all years are estimated and then they are categorized into distinct spaces according to the quartile statistical function. So it is possible to assign letters A, B, C, D, or E for the attributes that fall into the respective quartile. Then, according to the technique used by Liberatore (1987 and 1992), as well as proposed in many books of Saaty (e.g. 1994, p.17), these A, B, C, D, and E are evaluated and their vector is extracted. Then this vector is idealized (i.e. all elements of the vector are divided by the largest one). The product of the idealized vector and of the vector of the criterion is the one that contributes to the overall index.

For example let's use the following data:

	1997	**1998**	**1999**	**2000**	**2001**	**2002**
TA/TL	1,775	2,569	2,076	1,584	1,446	1,522

Table 26: Sample data – ANEK / Fundamental Data

Along with all other data (from all the companies and all the years) referring to TA/TL ratio, these data are gathered and classified according to the quartile statistical function. Quartiles often are used in sales and survey data to divide populations into groups. For example, one can use the quartile

function to find the top 25 percent of incomes in a population. The result of the quartile function is:

1,903 2,194 2,263 3,060

That means that 1,903 is the bound for E, 2,194 for D and so on, considering the highest value as the best. The above figures are 'translated' as:

1997	**1998**	**1999**	**2000**	**2001**	**2002**
E	B	D	E	E	E

Then these spaces (letters) are evaluated to each other:

	A	B	C	D	E
A	1	3	5	7	9
B	1/3	1	3	5	7
C	1/5	1/3	1	3	5
D	1/7	1/5	1/3	1	3
E	1/9	1/7	1/5	1/3	1

(A is considered as the best set of values-options)

and that yields the following vectors:

	vector	Idealized Vector
A	0,510	1,000
B	0,264	0,517
C	0,130	0,254
D	0,064	0,125
E	0,033	0,065

The table with letters is now a vector with the following elements:

0,065 0,517 0,125 0,065 0,065 0,065

From the criteria evaluation, it is known that the TA/TL criterion is 0,041 (see Table 14, p. 198), so by multiplying the 0,041*0,065 = 0,00264 we get the contribution of the TA/TL criterion in the overall index of ANEK in 1997 (as well as in 2000, 2001, and 2002 as the value is the same).

This measurement is absolute. The classification of attributes to spaces (A, B, …, E) is helpful for many reasons, although it would also be easy to compare directly the attributes of the companies per criterion and then to 'normalize'

them by using the fundamental scale (see 9.2.1 and 9.2.2). Saaty considers this an approach that exploits accumulated experience (1997, p. 18).

The assignment of letters for a given set of data (per criterion) enables the decision-maker to have a clear picture of the values and the averages in the sector (i.e. of all companies under analysis). Extreme values that occurred, because of many uncontrolled reasons, are only assigned a letter A or E and can therefore be evaluated with the rest. Furthermore the use of absolute measurements leads to a better understanding of the evaluation problem. It is like having a button with five options; extremes and inaccuracies are allayed in that sense. Last, but not least, is that by using the absolute measurements in such a large model, it is possible to keep the overall consistency as low as possible. The table above has a consistency ratio of 5.29%, which is acceptable and well below the limit of 10%. In the relative measurement approach we could never be sure of the consistency as the numerical burden would be considerably higher.

So the elements a_{ij} of every alternative (and per year) are the elements of the idealized vectors. It is reminded that the index will be derived as the sum of the product $w_j\, a_{ij}$, where w_j the criteria weights. Up to this point, the weights of the Level III have been estimated. The focus now shifts to the estimation of Level II and Level I (index), so the w_j vector will be estimated.

The first approach is descriptivist as some evaluations reflecting the biases and the beliefs of the decision maker will be presented and analyzed through a sensitivity analysis. Then for the same values of the first approach (lower levels) a simulation procedure will yield the possible response of a group of decision makers.

6.2.1 Scenario-Based Outcome

As the criteria weights have been set for the lower levels III and IV, the decision-maker has to decide on the level II and level III criteria. At these levels, decisions are critical and reveal biases as well as 'stimuli' towards the

final outcome. More specifically, the decision-maker has to make the following comparisons:

1. Internal (INT) vs External (EXT)
2. Fundamentals (F) vs Logistics Services (LS)
3. Fundamentals vs Management Related Criteria (M)
4. Logistics Services vs Management Related Data
5. Stock Performance (SP) vs Market Environment (ME)
6. Stock Performance vs Competition (C)
7. Market Environment vs Competition

The above seven comparisons are the ones missing in the two decision tables of level II and the one of level I. It is obvious that any judgment would be very subjective; commonly groups of decision makers focus on the criteria they understand better. Most probably an accountant would consider fundamentals as the most important set. A customer (client of the system) would consider the LS set as the most important.

The discussion over internal and external factors would have to take into account psychological perspectives; it is not only an issue of utilities but also of many other factors.

In order to come to a conclusion and to expose the capabilities of the model the following scenarios (values) will be discussed:

1 INT / EXT $\in$ [1/5, 1/3, 1, 3, 5]

2 F / LS $\in$ [3, 5]

3 F / M $\in$ [3, 5]

4 SP / ME $\in$ [3, 5]

5 SP / C $\in$ [3, 5]

The values considered (3 and 5) aim to highlight pure and clear preferences as well as to avoid extreme values, such as 1, 7 and 9. Obviously there is a bias towards financial criteria, as the fundamental accounting data (F) and the stock performance (SP) is considered as more important than the level of the service offered (LS), of the management (M), of the competition (C) and of the market environment (ME).

The results are presented in the respective annex (see p. 290). However some highlights are presented below. It has to be mentioned that no extreme values have been taken into account. Furthermore, in order to keep the inconsistency ratio as low as possible and to minimize the possible combinations of judgments, the values LS/M and ME/C are calculated as:

$$\frac{LS}{M} = \frac{LS}{F}\,\frac{F}{M}$$

$$\frac{ME}{C} = \frac{ME}{SP}\,\frac{SP}{C}$$

in accordance to the consistency relation $a_{ij} = a_{ik}a_{kj}$ (see p. 101). For all n×n matrices this formula is valid, the consistency ratio is zero. A violation of this relation will be reflected in the consistency ratio.

By taking a closer look at the results one may get some very interesting conclusions. Considering the biased case with the following values:

1. INT/EXT = 3
2. F/LS = F/M = 5
3. SP/ME = 3
4. SP/C = 1/3

the yielded result is presented in the coming tables (Table 27 -Table 30) and the justification of this judgment is as follows:

1. A company can control the internal forces. Although external ones are not controllable, they are still important. Therefore, the INT are slightly more important than the EXT.
2. In all cases the fundamental accounting data are more important from the services and the managerial indicators for financiers and investors. As the other factors cannot be neglected, the value of 5 indicates their balance.
3. Stock performance is slightly more important than the market environment as such. It is possible for a company to boom despite a recession and vice versa. Financiers and investors appreciate generally a good stock performance, therefore the ratio SP/ME >1 is considered. In contrast stock performance data are not as important as competition figures; market shares are generally more important than stock performance for long-term placements, so SP/C<1. The values of SP/ME=3 and SP/C=1/3 reveal at least a slight preference.

Internal	1997	1998	1999	2000	2001	2002
ANEK	0,439	0,372	0,275	0,161	0,282	0,268
NEL	0,402	0,389	0,326	0,417	0,287	0,392
MINOAN	0,401	0,394	0,300	0,203	0,305	0,337
STRINTZIS	0,308	0,305	0,313	0,209	0,369	0,317
EPATT	0,589	0,654	0,519	0,399	0,404	0,287

Table 27: Level II elements - internal

external	1997	1998	1999	2000	2001	2002
ANEK	0,459	0,369	0,330	0,237	0,288	0,287
NEL	0,164	0,168	0,169	0,156	0,141	0,137
MINOAN	0,435	0,442	0,416	0,258	0,211	0,264
STRINTZIS	0,286	0,297	0,355	0,392	0,309	0,390
EPATT	0,254	0,277	0,283	0,240	0,202	0,278

Table 28: Level II elements – external

Total	1997	1998	1999	2000	2001	2002
ANEK	0,444	0,371	0,288	0,180	0,283	0,273
NEL	0,343	0,333	0,287	0,352	0,251	0,328
MINOAN	0,410	0,406	0,329	0,217	0,281	0,319
STRINTZIS	0,303	0,303	0,324	0,255	0,354	0,335
EPATT	0,505	0,560	0,460	0,359	0,354	0,285

Table 29: Level I-final results

	1997	1998	1999	2000	2001	2002
ANEK	0,879	0,663	0,627	0,502	0,799	0,814
NEL	0,678	0,596	0,624	0,980	0,707	0,979
MINOAN	0,811	0,725	0,717	0,603	0,793	0,953
STRINTZIS	0,599	0,541	0,704	0,709	1,000	1,000
EPATT	1,000	1,000	1,000	1,000	0,998	0,851

Table 30: Level I-final results normalized

	1997	1998	1999	2000	2001	2002
ANEK	12%	34%	37%	50%	20%	19%
NEL	32%	40%	38%	2%	29%	2%
MINOAN	19%	27%	28%	40%	21%	5%
STRINTZIS	40%	46%	30%	29%	0%	0%
EPATT	0%	0%	0%	0%	0%	15%

Table 31: Level I-deviation from the 'leader'

By using these judgments EPATT is considered as the 'best' performer for the period 1997-2001. STRINTZIS is considered as the best performer in the years 2001-2002. It is interesting to correlate this result with the INT and EXT elements the companies get, according to the judgments at level II. EPATT is not necessarily the best performer in both INT and EXT sets of criteria. For example, in 1997 (as well as in other cases), EPATT gets the highest rank in INT and a rather low in EXT; nevertheless as the corresponding criteria weights are 3/4 and 1/4 respectively, EPATT gets the highest total grade. The tables above allow the reader to get a better understanding of the

influences behind the final result, as well as of monitoring the results and the performance of the company according to specific judgments.

These data are better presented below (see Figure 44 and Figure 45):

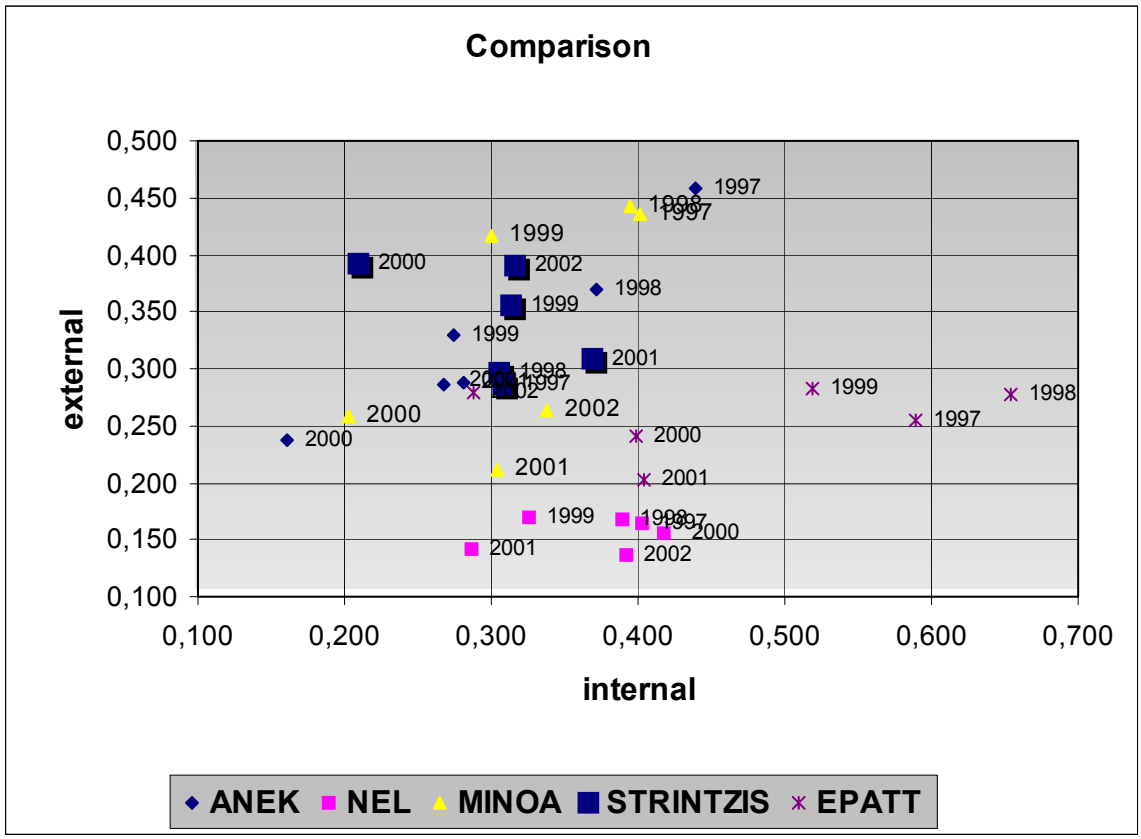


Figure 44 : Relative Position of Every GCS company on an annual base

In this typical representation of such results, the upper right part of the chart contains the companies with the highest grade. It is easy to see that EPATT gets a relatively high grade in INT and remains practically stable in EXT. Companies closer to the axes are underperforming in relation to others. Furthermore one can also monitor the 'track' of a company throughout the period of consideration.

As the information contained above is adequate to support various conclusions, decision makers usually need only a ranking value. The next table consolidates much of the above information into one single index:

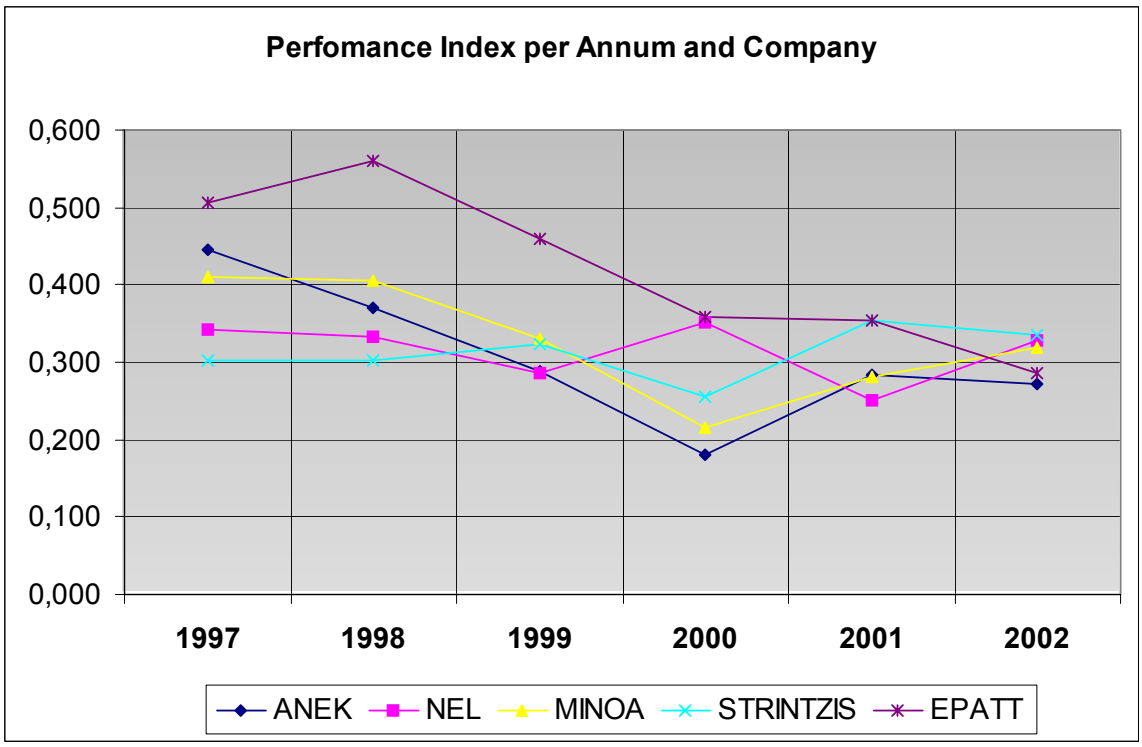


Figure 45: Total Performance Index of every GCS per annum

The usability of the above charts is obvious; one can easily track the performance of a company per se as well as per set of criteria. Furthermore, one can proceed in various analyses that will be discussed thoroughly in coming paragraphs. The analysis here would not be over unless the most critical criteria and elements would be identified.

By applying the methodology described in §4.2.2 for a sample year (say 1997) and for the criteria weights assigned previously it is found that the F is the most sensitive criterion ($sensC_F$ = 0,0392) followed by C, F, ME, M, SP. The corresponding $\delta'_{k,i,j}$ quantity is $\delta'_{LS,2,4}$ = -4,65%. In other words, $\delta_{F,2,4}$ = 0,136618 and W^*_F = [0,536 – (0,136618)] = 0,399. By normalizing the weights the new weights that will reverse the ranking are:

W_{SP}	WM_E	W_C	W_F	W_{LS}	W_M
0,067	0,022	0,200	0,462	0,124	0,124

With the new weights the previous ranking $A_5>A_1>A_3>A_2>A_4$ (where '>' stands for 'better than') becomes $A_5>A_1>A_3>A_4>A_2$. It is reminded that A_1≡ANEK, A_2≡NEL, A_3≡MINOAN, A_4≡STRINTZIS, A_5≡EPATT.

Triantaphyllou and Sanchez expanded the above technique in order to estimate the most critical element. In a similar way definitions were given and similar theorem proven. By applying their methodology, it is estimated that the most critical element is a_{24}, i.e. the element of NEL for the fundamental criterion. Originally, its value was 0,456 and it was estimated that a reduction to the value of 0,400 would reverse the rank of A_2 and A_4. So the original rank of $A_5>A_1>A_3>A_2>A_4$ (where '>' stands for 'better than') becomes again $A_5>A_1>A_3>A_4>A_2$

6.2.2 Simulation-based outcome

The scenario-based solution is biased from the decision-maker. That does not necessarily scrap the applicability of the model. However, some times it is desired to get a more objective perspective. The issue of objectivity will be discussed in a coming paragraph (see page 227) as it is considered significant enough for the analysis. By looking back into the AHP the basic formula is:

$$Index_i = \sum w_j a_{ij}$$

that implements 'objective' elements a_{ij} and the weights w_j. This is similar to the 'weighted sum method' (WSM); the only difference is that in WSM is based on absolute weights (weights assigned by the decision maker directly) while in AHP come from a relative comparison procedure. The method is based on the assumption of the additive utility. That means, according to Keeney and Raiffa (1993, p. 231) that the attributes Y and Z are independent (two-attributes case that can easily be considered for N attributes). This assumption is the basis for almost all MCDM methods used in practice and in the academia. Furthermore, the issue of weights is dealt in most (if not all) cases by direct solicitation from the decision-maker. This is a means to

understand the utility function of the decision-maker; in some cases the weights stem out a utility-function determination procedure, which is mostly derived by using questionnaires and structured questions.

In many cases it is necessary to combine the judgments of many persons or decision makers in order to get a better understanding of the problem as well as to achieve criteria-weighting that is considered as 'generally' acceptable. In the literature, such issues are called 'group decision making' (see p.106 for introductory comments). Saaty is suggesting the use of geometric mean in order to synthesize the judgments of individuals in to a group property. He bases this argument on the work of Kenneth Arrow (Saaty, 2001, p. 62). Identical approach is adopted by Keeney and Raiffa (1993, p. 523). The following is an illustrative example: say that three decision makers are assigning the following values according to the fundamental scale 2, 3, 7, then the group decision is estimated as $\sqrt[3]{2*3*7}$ = 3,476 and the outcome is rounded to 3.

The above approach has been used in many cases and applications, yet more interesting and practical applications have been developed lately. A very interesting approach is the one of fuzzy sets. More on the theory of fuzzy sets can be found in the literature (e.g. Bojadziev et al., 1997). As a decision maker is asked for his judgment, this can happen in three different ways:

1. Each individual judgment is modeled with a probability distribution. For example, a decision maker may use the triangular distribution, where only the high, the low and the most likely value is asked. Then the mean of all judgments is estimated and therefore the group value is obtained.
2. All decision-makers are asked for a point-estimation. This assumes that all decision-makers have an equal probability of being correct, as the group decision is derived as average of all point-judgments.

3. All decision makers are asked to estimate high and low values and their judgment is assumed to be with equal probability within that range. The group decision judgment is derived by using the minimum lower and the maximum upper bounds of each individual judgment.

The following figure is explanatory:

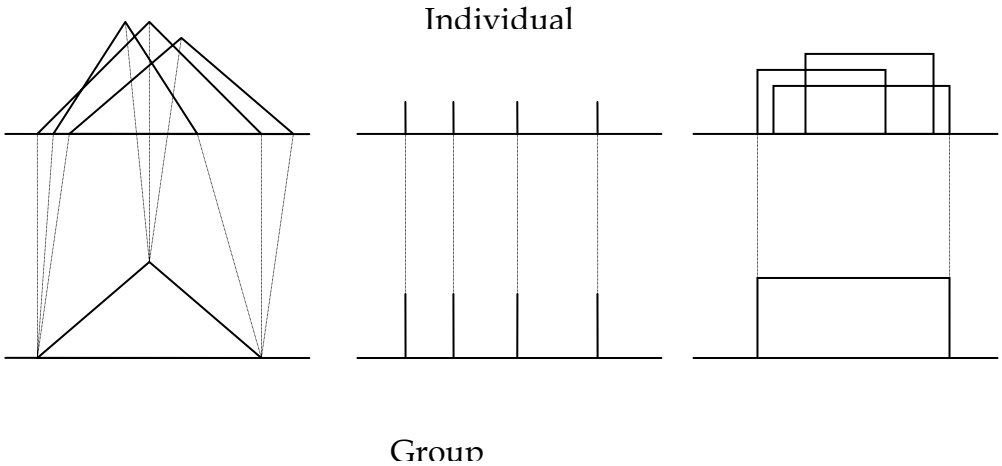


Figure 46: Individual and Group Interval Judgments

In the above figure, one can see the way a group decision is extracted out of individual responses. At the left side, individual triangular responses are combined into a new consolidated one. The same applies for the right side, where range-responses are combined. In the middle, individual point-estimations are the same with the group one before the averaging procedure. Generally the averaging procedure attracts the interest of researchers as weights and approaches influence heavily the final result. In the literature simple fuzzy averaging is widely used. The most 'complicated' case from the above group decision making option is the triangular one.

When the triangular distribution is used, it is better to consider the use of fuzzy sets and of their numerical operations. A triangular fuzzy number (TFN) A has the following membership function $\mu_A(x)$:

$$A \equiv \mu_A(x) = \begin{cases} \dfrac{x - a_1}{a_M - a_1} & a_1 \le x \le a_M \\ \dfrac{x - a_2}{a_M - a_2} & a_M \le x \le a_2 \\ 0 & otherwise \end{cases}$$

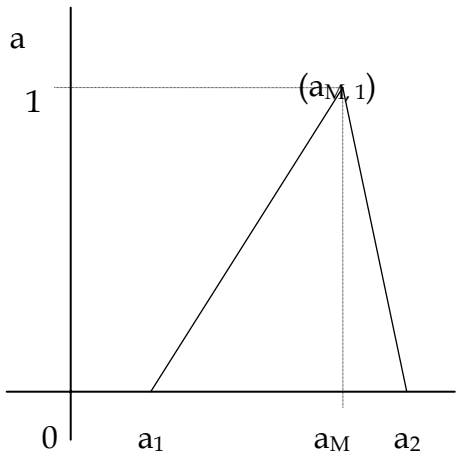


Figure 47: Graphical Representation of a TFN

Commonly in the literature of fuzzy applications, a triangular fuzzy number (TFN) is referred as M = (m, L, R), where m = a_M, L = a_1 and R=a_2. According to the theory the addition of TFN is defined as:

$M_1 + M_2 = (m_1+m_2, L_1+L_2, R_1+R_2)$

and the fuzzy averaging as:

$$M_{average} = M_1 + M_2 + ... + M_n = \left(\frac{1}{n}\sum_{i=1}^{n} a_m^i, \quad \frac{1}{n}\sum_{i=1}^{n} a_L^i, \quad \frac{1}{n}\sum_{i=1}^{n} a_R^i \right)$$

This fuzzy averaging is used in various forecasting methodologies, such as the fuzzy Delphi one that was developed by the Rand Corporation (Bojadziev et al., 1997, p.71). In order to use fuzzy numbers in decision-making, it is necessary to consider a ranking method. In the literature there are three methods available:

1. Weighted method

2. The method of Chang, and
3. Kaufmann – Gupta method

All of them are thoroughly described in the literature. Although there are no significant numerical differences between them, the method of Chang is preferred because the dominant alternative is the one with the largest mathematical expectation E_j:

$$E_j = \frac{(R_j - L_j)(m_j + R_j - L_j)}{6}$$

Triantaphyllou and Lin (1996) proceeded into the fuzzification of crisp MCDM methods, such as WSM, WPM, AHP and TOPSIS and used the fuzzy ranking approach for determining the best alternative. They run the models with TFN and the outcome was a new TFN for every alternative. Then the ranking of TFNs yielded the outcome. In other applications 'defuzzification' techniques have been employed that yielded the final ranking (e.g. in Bojadziev et al., 1997, p.147). The entire above are very useful in structuring the simulation procedure, as they provide options and alternatives to the modeler. More specifically by using the above tools the model may select one (or a combination) of the below options:

1) To select a number of decision makers (say S), then simulate their response and finally to enter the geometric mean as input to the final AHP decision matrix. The distribution of the response can be:
   a) discrete values (1/9, 1.7, …, 7, 9)
   b) uniform (1/9, 9)
   c) triangular (1/9, random value, 9)
2) To select a number of decision makers (say S), then to simulate their response as a TFN. Then a fuzzy AHP procedure (identical with the normal one but with numerical hurdles) can follow. The result can be ranked according to:
   a) The method of Chang

b) Defuzzification procedures

A simulation procedure consists of basically five steps, namely *development*, *building*, *verification and validation*, *design of experiments*, and *analysis of the results*. The first one is the development of the conceptual model. In this specific case there are practically two options. The first is to simulate the responses first and consider their outcome as input to the model. The second is to run the model for every response considered as appropriate and then to consider the results of the model as basis for further elaboration. Both are achievable, although the second one is accompanied by numerical problems due to the large number of estimations. For consistency reasons, it is preferred to simulate the responses of a group of decision-makers to the very same ratios (preferences) used for the scenario-analysis before.

The second step is building of the simulation model. Apart from the various relations between the data, which are given in this case, it is important to estimate the distributions of the uncertain variables (see also point #1 above). This step is critical as it introduces a great deal of subjectivity in the model. Say that ten decision-makers are selected and their responses are feeding the formula of geometric mean. A sample of no less than 300 trials (no numerical justification) indicates that the mean of a discrete distribution is close to 2,75. The distribution contains all possible values according to the fundamental scale (1/9, 1/7, …, 7, 9) with an even probability of occurrence. By using the uniform distribution for the same minimum and maximum (1/9 and 9) the mean is close to 4.53. The mean standard error is in these respective cases 0,37 and 0,22, thus favoring the uniform distribution. This was expected as the discrete distribution is feeding the geometric mean with values with 'concentration' close to or smaller than 1 (1/9, 1/7, 1/5, 1/3, 1). See also figures below:

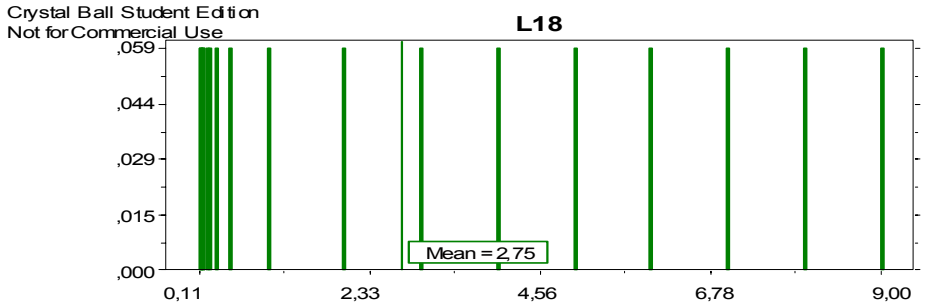


Figure 48: Discrete Distribution

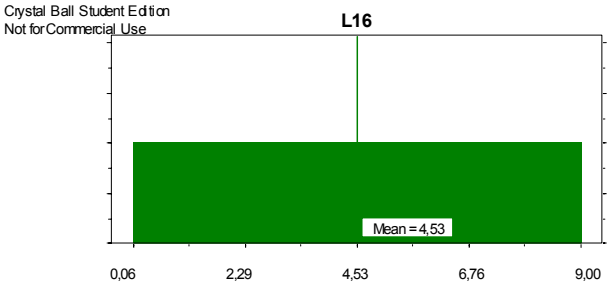


Figure 49: Uniform Distribution

In order to achieve a large sample of trials without extreme numerical burden, a group of 20 decision makers are selected. For the five ratios that were selected in the scenario-based analysis a simultaneous procedure is designed and executed. For every ratio a distribution is selected and the outcome of this (mean value) is then taken as input in the decision matrix. Specifically, the following distributions were selected:

- For the INT/EXT ratio a uniform distribution is selected and the 'responses' of the decision maker are filtered through the non-linear geometric mean function. It is expected that this distribution will favor values over 1 (indifference point) reflecting also a bias.

- For the F/LS ratio a triangular distributions are selected as responses of the decision makers; then the responses are filtered through fuzzy average function. It is also expected to feed the model with values over 1; the mean is expected close to the mean of the triangular distribution.
- For the F/M ratio a triangular distribution is also selected but filtered through geometrical mean. The result is expected to slightly vary from the previous one. (However, different seeds are used, but the outcomes are expected to have similar distribution attributes.)
- For the SP/ME and SP/C ratios discrete distributions {1/9, 1/7, …, 7, 9} are selected and filtered through geometric mean functions. It is expected that the outcomes should be close to indifference point (1).

By running the model for 10,000 trials the yielded outcome is conforming to the biases expressed above. The distributions for the INT/EXT, F/LS and F/M are considered as normal ones. The mean is close to the median (if not identical), the skewness is within the range of (-0.5, 0,5), the kurtosis is around the value of 3 and the Kolmogorov-Smirnov test yield values of less than 0,03 for the normal distribution, indicating a very good fit of the data. The distributions of the SP/M and SP/C ratios are very close to the lognormal one, thus indicating very small probability of occurrence of extreme values. The fit data are also very good.

The third step is devoted to verification and validation. By the term verification it is understood a procedure that ensures a free from logical errors model. By the term validation is understood that the model can adequately represent reality. In this specific case, there is no consideration of the verification. On the validation issue it has to be highlighted the subjective point of examination. A usual way is to ask experts; another way is to compare the outcome with historical trends or values. It is, however, noted that these ways are not applicable in cases without previous experiences and one should only seek for extreme values; in that case an extreme rank

reversal would be the case. The fourth step can be omitted in this specific case; fifth step is analyzed thoroughly below.

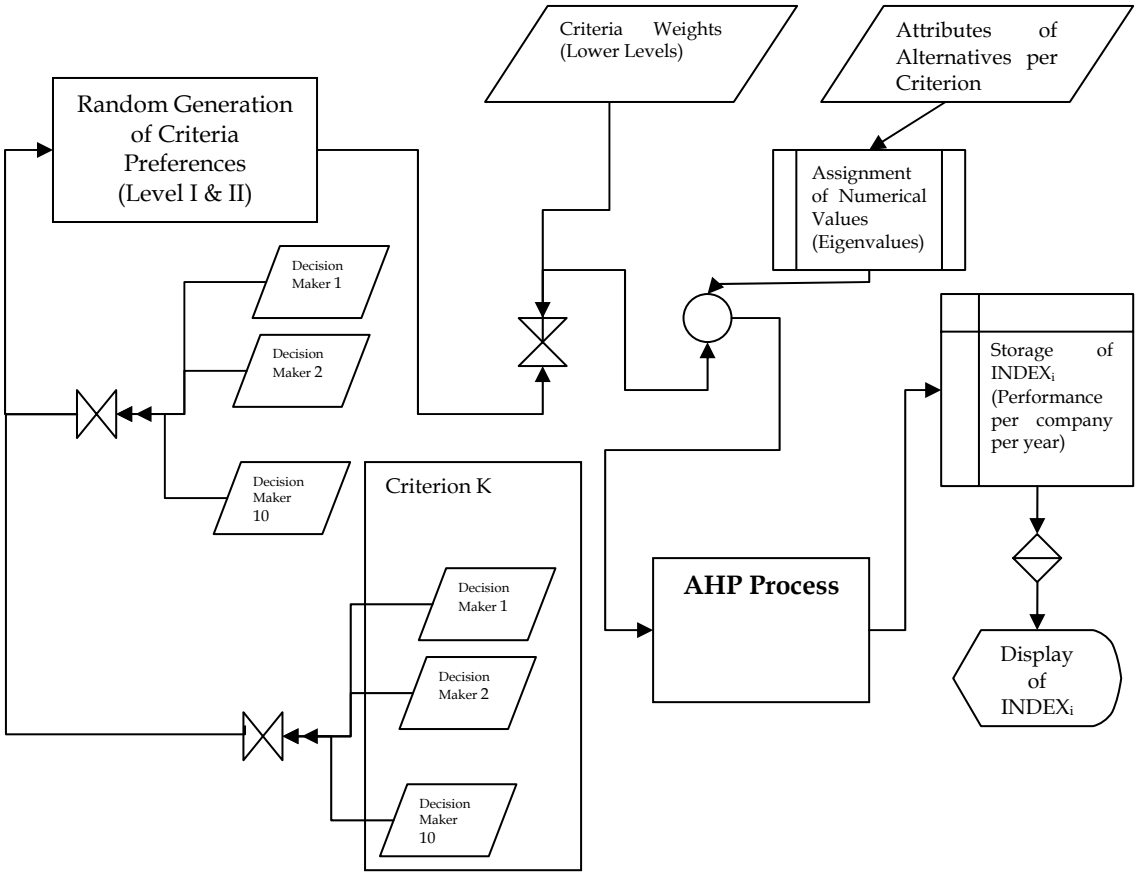


Figure 50: Simulation Flowchart

The outcome of the simulation procedure was yielded after few minutes, thus ensuring that similar exercises in a future application will also demand little time. The simulated responses also yielded results that could easily be fitted with normal and lognormal distributions. All distributions have been tested by using Kolmogorov-Smirnov criterion.

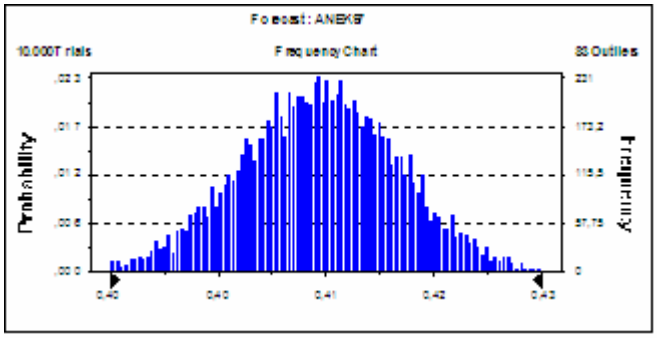


Figure 51: Simulation Results for ANEK -1997

The following table presents the results:

	1997	1998	1999	2000	2001	2002
ANEK	0,413	0,351	0,286	0,182	0,268	0,270
NEL	0,354	0,345	0,309	0,353	0,274	0,353
MINOAN	0,369	0,367	0,306	0,219	0,290	0,342
STRINTZIS	0,302	0,296	0,340	0,271	0,413	0,387
EPATT	0,511	0,568	0,477	0,389	0,382	0,315

Table 32: Simulation Results

By comparing the ranking of these results with the ranking from the scenario based on the following values:

- INT/EXT = 3
- F/LS = F/M = 5
- SP/ME = 3
- SP/C = 1/3

it is easily observed that there are no real ranking reversals for the 'best' performer. There are some reversals for some other elements as expected:

	1997	1998	1999	2000	2001	2002
ANEK	0,81	0,62	0,60	0,47	0,65	0,70
NEL	0,69	0,61	0,65	0,91	0,66	0,91
MINOAN	0,72	0,65	0,64	0,56	0,70	0,89
STRINTZIS	0,59	0,52	0,71	0,70	1,00	1,00
EPATT	1,00	1,00	1,00	1,00	0,92	0,81

Table 33: Normalized results – simulation

	1997	1998	1999	2000	2001	2002
ANEK			1		2	
NEL			-2		-1	
MINOAN			2		-1	
STRINTZIS			-1			
EPATT						

Table 34: Rank comparison between the results of Table 33 and Table 30

In the last table, the minus "-"sign indicates better position in relevance to the scenario-based results. Finally, it is interesting to note that such simulations are addressed as *decision making with uncertain judgments* in the literature. The reader may find interesting the contribution of Hahn (2003) with practical examples of the use of logit modeling, Markov chains and Monte Carlo simulations and adequate theoretical justification.

6.3 Comments on the Method

As mentioned in many cases before the hierarchy indicates the understanding of the decision-maker regarding this specific problem as well as the criteria-weights highlight biases. Furthermore there is another question regarding the methodology as such. The following comments deal with these issues.

The criteria considered reveal an 'inward' approach of the companies. They practically respond to questions 'how well' or 'how much' did a specific company perform in a given year. There is no real information on the competition, the needs of the Greek Coastal System (GCS) as well as the satisfaction of the users of the services. Furthermore, there is no clear bias or direction on key issues, such as the deployment of new technology vessels or the entrance of a new competitor. All the above are outcomes of the available data sets. These are the data provided by the companies and there was no intention to 'make up' or to estimate data through other methodologies that would increase the error margin of the whole structure.

As a result it was necessary to use 'official' data for further consideration in the model. That was a very first constrain in the whole process. One would say that some more data could be taken into account, such as the necessary utilization factor of the fleet in order to break even. This would be a very interesting micro-approach that would reveal many managerial and competition-related attributed of the GCS companies. However, such an approach would demand many data that are not available yet. For example, the simplest input would be the number of executed sailings per route per vessel. This would yield a total mileage of the vessel and therefore an approximation of the fuel and lubricant costs. Such an analysis would also highlight interesting insights on the use of new technology ships in the fleet. Although such data have been solicited many times by the companies there was no response.

Another interesting question regards the coverage of the market. As the GCS was built on the idea of granted licenses from the Ministry, companies could not really compete. The issue of the coverage got closer to the notion of differentiation; a company active in more than one market had its risks better spread. In relation to the previous question, one could also consider the issue of the average fare.

This issue becomes a little bit more acute, when dealing with the sub-systems of the routes. A more detailed hierarchy could include branches and criteria fully dedicated to specific sub-systems, such as the service of Crete, of Cyclades, etc. This would empower the decision-maker to consider operational scenarios. For the needs of such modeling, input from other transportation models, should also be considered, such as the value of time for every respective class of clientele, biases, frequency of service, etc. A pure transportation analysis per link (cost, time, bias) and per geographic cluster would indicate the course of the planning.

However, a very large hierarchy would be rather difficult to manipulate not only numerically but also from a 'human mind capabilities' point of view,

and it is rather wiser to consider special hierarchies for addressing micro-planning problems. This hierarchy aims to evaluate companies and not to address all possible GCS-related problems. This is also considered in the next chapter.

Last but not least is the question over the corporate governance of these companies. GCS companies are closely held by the management group. It is rather impossible for investors and lenders to question the power of the managerial teams, who actually own a large percentage of the shares. If only the shares were widely spread and managerial teams were truly elected and not typically approved by the general assembly of the shareholders then issues such as transparency and investors' information would come up. In a small market as this one, this should happen simultaneously for all listed companies, as time-lags in information would benefit the companies delaying this process. Furthermore, non-listed companies would also benefit from this spread of information. In an industry with tight-lipped managerial teams it is not very easy to extract relevant information. Consequently, it would be very interesting if some more criteria on the governance and the process towards transparency and small investors' information (and therefore protection) could be considered. Up to this time there is no alteration in the management structure and process to improved corporate governance.

6.3.1 Theoretical Issues

Regarding the model, one could comment the selection of AHP out of the MCDM family of techniques. The reason why AHP was selected is discussed in the appropriate paragraph (see 4.3, p. 110). However there are two more qualitative points of interest that were revealed during the process. The first one deals with the psychology of the decision making process and the second one with the objectivity sought by many researchers.

In the literature of decision-making there are practically two distinct classes: the mathematical and the psychological one. Models and techniques supported or used by mathematicians, engineers and scientists are based upon mathematics. Psychologists and relevant scientist base their modeling on psychological attributes. The common ground of these approaches is the normative theory of behavior. By the term *normative* is answered the question how people *would* behave if they followed certain requirements of rational decision making. It is not meant to describe how people *actually* behave. The most famous example of the normative theory is the expected utility of von Neumann and Morgenstern.

On the basis of the expected utility theory, decision researchers have built and expanded theories and techniques and suggested solutions to selection and classification problems. In that sense they indicated the solution a rational decision maker would prefer if and only if certain requirements were considered. Descriptive and prescriptive theories considered by psychologists analyze the actual behavior of people, yet they practically fail to respond to real-world problems. The major disadvantage of the utility theory is that probabilities have been treated as objective ones in the classical way (i.e. based on the relative frequency). Savage (1954) generalized the theory of von Neumann and Morgenstern by including subjective probabilities of an outcome. Luce (1959) improved this theory by importing stochastic choice modeling.

The contribution of Savage and Luce is considered very important at practical and theoretical level as well, where problems could not be treated with the expected utility theory. If, for example, an objective probability cannot be determined or the outcome will only occur once then the modeling of von Neumann and Morgenstern cannot be applied. In practice though the estimation of the utility function is not a very trouble-free task and cannot be representative for an expanded set of decision-makers. The estimation of the utility functions is thoroughly analyzed by Keeney and Raiffa (1993).

For those not familiar with the MCDM techniques the developed and above presented models lack 'objectivity'. They would point out the subjective estimation of weights related to the criteria. Practically, all MCDM models are 'subjective' in that perspective as they seek to include the biases of the decision-maker. Families of widely used methods, such as WSM, WPM, AHP, ELECTRE, TOPSIS, and many other consider the weights of the criteria as input from the decision maker. Whether these weights stem out of relative or absolute comparison is irrelevant as it is purely a technical issue. The outcomes of these methods depend on biases of the decision maker. Other families of methods, such as UTA, UTADIS, UTADIS II, etc, consider a shape of utility functions per criterion and the characteristics of these functions are given by the decision-maker. Keeney and Raiffa (1993, p.77) point out the subjectivity of the weight assignment. They use the word 'manipulation' in order to highlight the bias of the decision-maker. They stress that 'he is asked informally to balance what he would *like* to get with what he *thinks he can achieve*'[18]. It is interesting, from an academic point of view, to examine which method is more sensitive on the criteria-weights assigned by the decision-maker, but is out of the context of this study.

The quest for objectivity might also be considered a 'fallacy' in practical problems. A decision-maker is not objective and in most cases there is no need for 'objectiveness'. Taking as an example the problem of the evaluation of the performance of a company, one would practically consider the deployment of the well-known method Data Envelopment Analysis (DEA). This method considers a set of inputs and a set of outputs for a given set of units (commonly called as Decision Making Units - DMU). The weights are estimated by using fractional programming. The result of the method is an efficiency envelope that indicates the 'efficient' members as well as the reduction of the input or the increase of the output mix non-efficient

[18] It is marked as in the original.

members shall achieve in order to become efficient. DEA has been widely used for the estimation of the relative efficient branch offices of a bank, of retail networks, of hospitals and many other service-related cases. It has also been used in the port industry (e.g. Roll et al., 1996 and Schinas et al., 1999).

The result of such an exercise is also strongly depended on the decision-maker; a different mix of inputs or outputs as well as of DMUs will alter the outcome. The method yields relative efficiency as practically happens to all approaches. A method cannot consider all alternatives (global application) but only the ones given by the decision-maker. Saaty has analyzed this problem thoroughly and presents a very interesting list of comments of various researchers (2001b, p. 361-372).

6.3.2 Validation of the model

It is very difficult if not impossible to validate an MCDM model; even theoretically it is known and widely accepted that different MCDM methods may yield different results for the same input data. Experience and practice are most commonly validating such modeling.

In order to implement elements stemming out of experience it is appealing to use facts and data from the shift-share analysis, which reflects the differences of traffic and turnover per annum and per company (see §11.1.3, Shift-Share Analysis, p. 273). From the tables it is possible to understand the resulting figures (see Figure 45: Total Performance Index of every GCS per annum, p. 214).

In most cases the positive or negative change of the total index yielded can be attributed to a positive or negative difference in the shift-share analysis. By calculating all differences, it is easy to see that in 60% of all cases the turnover and the traffic analysis are consistent to the changes of the total yielded index. This means without any further elaboration, two of three differences are explained by the shift-share analysis. This result is valid for almost all years of consideration, and strengthens the belief of the unbiased

model. In cases, where the differences of the index are not explained by the shift-share analysis, one should look deeper in the results. In 5 cases there is full accord among the analyses (20%) and in 18 cases (72%) partial accord. There are only two cases where the shift-share analysis is not consistent with the differences of the index (2/25 = 8%); both figures refer to STRINTZIS (years 1996-7 and 1999-2000).

In most cases, where the shift-share analysis of the turnover is not explaining the index, there are strong indications from the traffic analyses. So a thorough and more elaborated analysis may lead to specific conclusions per case and per fiscal year.

Another interesting observation is that the ranking yielded from both approaches, the simulation and the scenario analyses are practically identical. There are few ranking reversals, suggesting that the selection of the weights is close to 'normality', as expressed by random responses (see also Table 34: Rank comparison between the results of Table 33 and Table 30, in page 225).

Both validation observations are very encouraging about the soundness of the result, as yielded from the model. However, it is once again highlighted that there is no theoretical way to validate a MCDM model but only practice and experience may support arguments and claims.

7 Application of the Model

In the previous chapter the decision support model was thoroughly analyzed and explained. The aim of this chapter is to present some applications and to highlight the importance of this modeling for possible users. Two major applications will be discussed in the coming paragraphs: a corporate planning and an approach to optimum mergers.

7.1 Corporate Planning

The issue of corporate planning by using AHP has been widely discussed in the literature. Saaty (2001a, p. 153) has proposed several hierarchies and approaches for that task. Generally, there are two major categories of planning: *forward* and *backward* planning. By forward planning is understood a descriptive process that includes all or some actors pursuing certain objectives and implementing certain policies towards a specific objective. This approach leads to a feasible or a likely future. In contrast, backward planning aims at the desired future. The desired outcome is achieved by applying policies influencing actors. This process is normative (or prescriptive). Usually corporations and decision-makers implement a two stage analysis involving forward and backward planning processes. The first step is to project the likely or feasible future by implementing forward planning. Then a backward process is employed to determine the influences on the actors. In that case the desired future goal is the outcome of the first step. This process can be repetitive to obtain greater convergence. Practically there are also two limits: one is fixed in the present with actors and the available resources. The other is fixed in the future with the desired objectives. In both cases the preparation of scenarios and their analysis is required. The scenarios must include an adequate account of interaction of the system with relevant factors (in that case internal and external, and so on as the analysis of the hierarchy processes).

Saaty considers planning process as a boundary problem and identifies three variables: *planning policies*, *outcomes* and *efficiencies*. These variables are self-explained but efficiencies, which indicate the probabilistic relationship between planning policies and outcomes. The variables are common to all decision processes but the relationship among them is different in projected and desired planning processes. For projected processes the policies are defined, and the efficiencies are estimated and the outcomes deduced. For the desired process the outcomes are valued, the efficiencies are influenced and the policies are developed. The difference is fundamental due to the different structure of the hierarchy.

As stated above, scenario analysis is an indispensable step in the analysis. There are practically two general kinds of scenarios: *exploratory* and *anticipatory* scenarios. Exploratory scenarios start from present work and forward to the future illuminating outcomes based on trends or beliefs. Anticipatory scenarios portray feasible and desirable futures; they start from the future and work backwards discovering what alternatives and actions are necessary to attain these futures. Anticipatory scenarios are further broken down to *normative* and *contrast*. In normative scenarios the objectives are determined at the beginning. In contrast scenarios, feasible future scenarios are sketched by using a range of assumptions. The desired future scenario is derived as a combination of contrast anticipatory ones.

7.1.1 Use of the Model

The modeling developed in the previous chapter can easily accommodate more companies and fiscal years for further analysis. One can input data of the new company or of the new fiscal year and estimate its relative position. That is a straightforward procedure and is not sophisticated. The model can lead to a comparison of 'non-accrued' operations or even fictitious data. Nevertheless, one can also proceed in exploratory analysis. Say that a

company may consider the renewal of its fleet. For presentation purposes let's consider ANEK and the fiscal year 2002[19].

Say that ANEK wishes to reduce the age of fleet from 18 to 15 years. That would affect the internal set of criteria, as an element of the management-related data set. The original value was 0,268 and the new one is 0,312. Taking as basis previous criteria-weighting the ranking of the company was improved. From the 5th position it shifted to the 4th (total index 0,273 → 0,306). This is attributed to the fact that the original ANEK-2002 value was B and new one is A. As this a criterion with the highest importance in the analysis (6.84% of the global hierarchy), this shift was significant.

However, this is a rather naïve approach. The ship costs money that is reflected in the balance sheet. Suppose the cost of the new ship is around 20bnGrD (~60m€). Then the values of the total assets, total liabilities, fixed assets and the long-term liabilities are affected. As the model estimates ratios then the following ratios will be altered:

	2002	New	2002	new
TA/TL	1,447	1,522	E	E
FA/(SE+LT)	0,931	0,923	C	C
FA/TA	0,877	0,864	B	B
SR/TA	0,084	0,093	C	C
SR/FA	0,096	0,108	C	C

Obviously, the addition of the value of the ship in the balance sheet did not alter the ratios under evaluation (observe that all absolute values are intact).

[19] All original values are available in the Annex D: Data (GCS Companies)

By elaborating this exercise further one would say that the impact of a new vessel is not only financial but also affects other factors. For example, one would estimate (or assume) that the addition of the new vessel in the fleet affects the logistics services offered and the competition pattern. The new vessel may call four (4) new ports in the Aegean (say in the Cycladic complex of destinations) and improve the market shares of the company by 3%. The new values would alter the ranking, from the 4th position to the 1st! Although the addition of the new ports of call does not alter the absolute value (it remains C), so the internal value is not altered, the external one is significantly affected. The new values in the competition set of criteria shifts the absolute values from the original set (D, C, C, B, D, C, D) to the new one (C, B, B, A, D, C, D) that alters the final value of the external criteria from to 0,303 to 0,446. Thus the final index value equals 0,446*0,25+0,312*0,75=0,345 (0,273 originally).

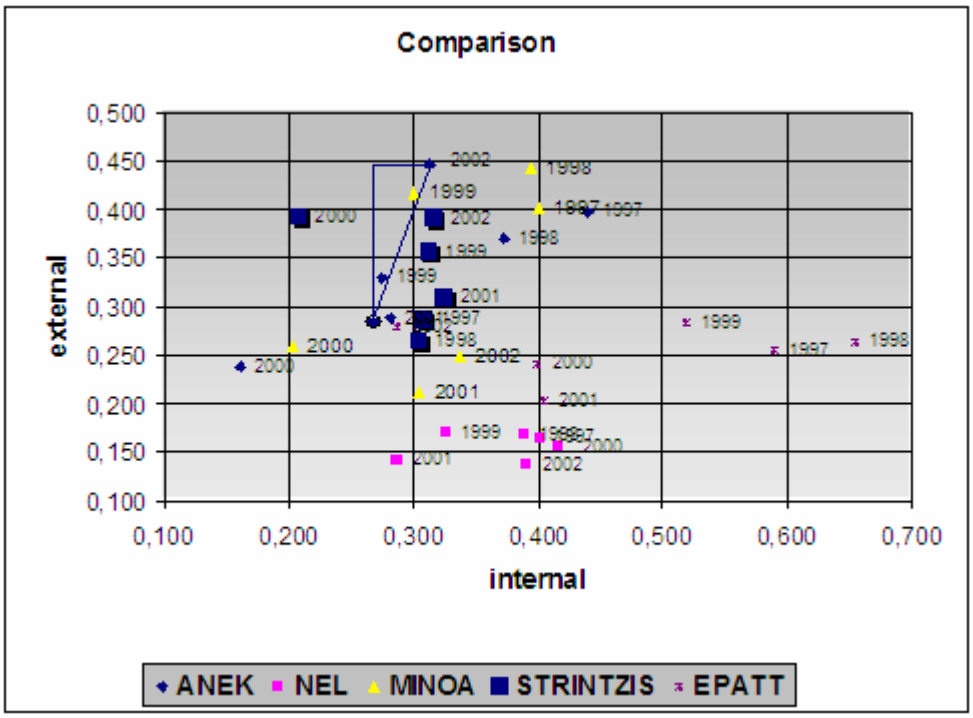


Figure 52: Relative Improvement due to the new ship

Apparently, this is an exploratory scenario that deals with the effect of a trend or a decision in the model. From an anticipatory and normative point of view, the process would demand a different course of action. Say that the management of NEL (fiscal year 2002, total index 0,328) desires to consider what should change so NEL could get the pole position instead the second place. It is reminded that STRINTZIS got the best ranking (total index 0,335). Following the sensitivity methodology selected, presented and applied in previous chapters (see pages 108 and 214), it is possible to evaluate the most critical criterion and the most critical element. Obviously, it is erroneous to alter the criteria weights at this stage! It is necessary to find the most sensitive element that would alter the ranking between NEL and STRINTZIS. After performing the necessary calculations according to Triantaphyllou and Sanchez (1997, p. 178) it is possible to identify the appropriate element. The original value per fundamental accounting criteria-set is 0,371 (NEL 2002) and it has to change to 0,396 in order to reverse the ranking. With the new ranking NEL surpasses STRINTZIS and all the other rankings remain stable.

It is clear that something has to change in the fundamental data-set so the management can proceed into further elaboration. As the fundamental data are filtered through ratios that feed absolute values, it is unlikely to match the 'desired' value (0,396) with a specific new input value. Normally a value close to the desired one is assigned. For example, the management of NEL would like to approximate this value by 'perturbing' the sales-revenues or the net income after taxes. The result would be the following: the sales revenue should increase by 11% (from €13,7m to €15,2m) in order to achieve the value of 0,399 (it is numerically impossible to reach the exact value of 0,396) or the net income after tax should increase by 911% (from €351k to €3,552k). Obviously, the increase of the net income after taxes by that percentage is out of question, while the increase of the sales revenue is not impossible. In a more elaborated accounting exercise a set of values could slightly alter in order to achieve the desired total index value.

7.1.2 Use of Elements from the Model

The previous example is based on the assumption that the hierarchy is given; it is actually the very same one used for the evaluation and classification of the GCS companies. Scenario analysis is only an approach. A more sophisticated approach would alter levels or elements of the original approach in order to extract structured responses from the model. An idea could be the following:

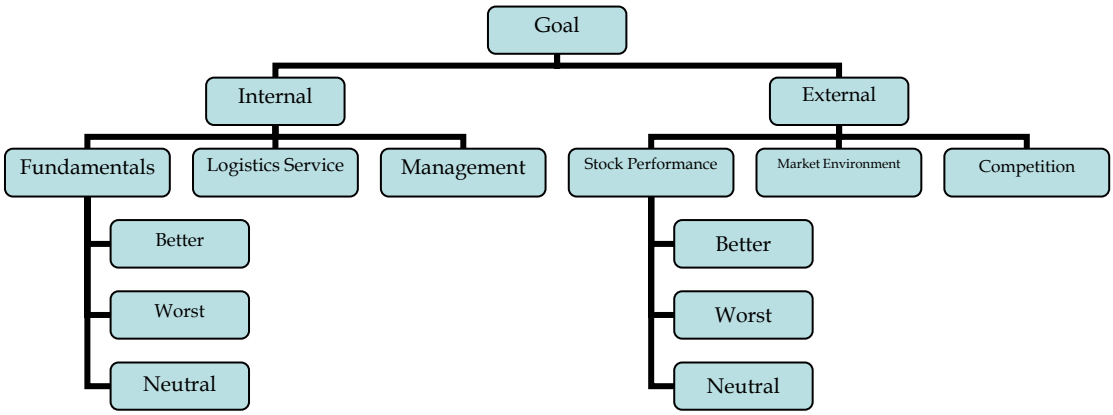


Figure 53: Determining the future position of a company – Forward Planning

In this hierarchy, the goal is to predict whether the position of the company will become better or worse in the future by estimating roughly some parameters. The criteria weights are given from the original hierarchy and the model can be easily calibrated for the neutral 'option' per criterion. Apparently by setting all options to 'neutral' it is possible to get a goal-value that should be considered as basic for further elaboration. This is a calibration value. Then by considering the position of the company per criterion (better, worse, neutral) it is possible to get a straightforward response over the future position of the company. Of course it is possible to retain the one more detailed level of the original hierarchy as well as to include more or differently expressed options per criterion. Numerically, the handling is similar.

The above formulation is classified as forward planning. The process is not over as backward planning is also required. The decision-maker has projected a 'desired' or 'expected' future and now has to determine the policies management should use to affect the outcome. A possible hierarchy is the following:

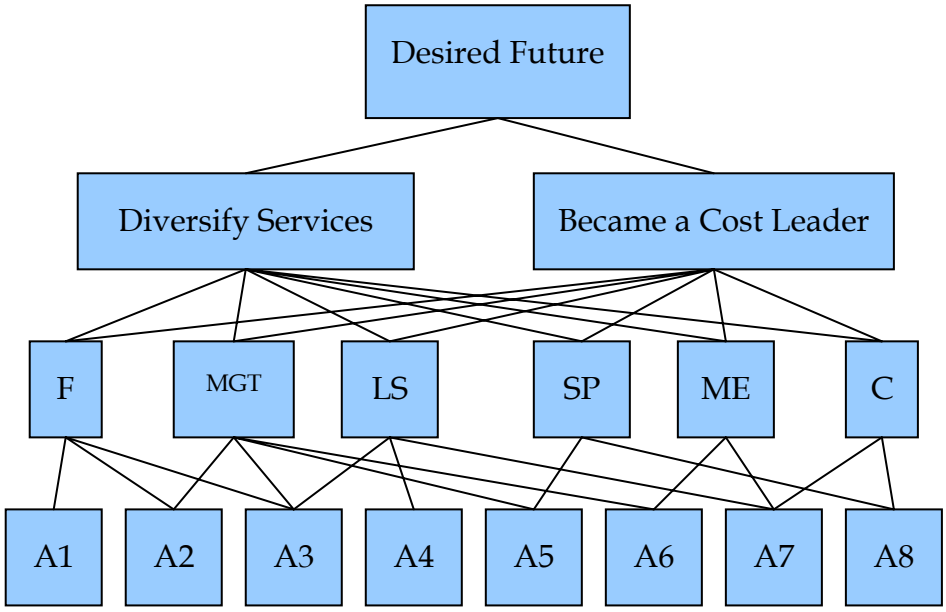


Figure 54: Determining Policies and Actions - Backward Planning

In the above hierarchy, the level III attributes are the very same as in the original case. Level II hosts the strategies and level IV hosts the actions. For example A1 may be "increase frequency of calls", A2 "lobby Government", A3 "reduce prices" and so on. Apparently, the closer the A_i is to the level IV of the original hierarchy, the better the results can be explained and compared.

7.1.3 Optimum Merger

A major question in the contemporary business pattern in the GCS is the mergers between companies. It is expected that GCS will proceed in the stage of mergers and acquisitions, as happened in other industries in the past. The model can help a strategic planner to make decision regarding a merger or an acquisition. The planner may use the hierarchy developed in the previous chapter or build a new one based on a specific theory (say the one of Porter).

A first approach of hierarchy may be the following when considering the fictitious case of the merger of ANEK with another GCS company:

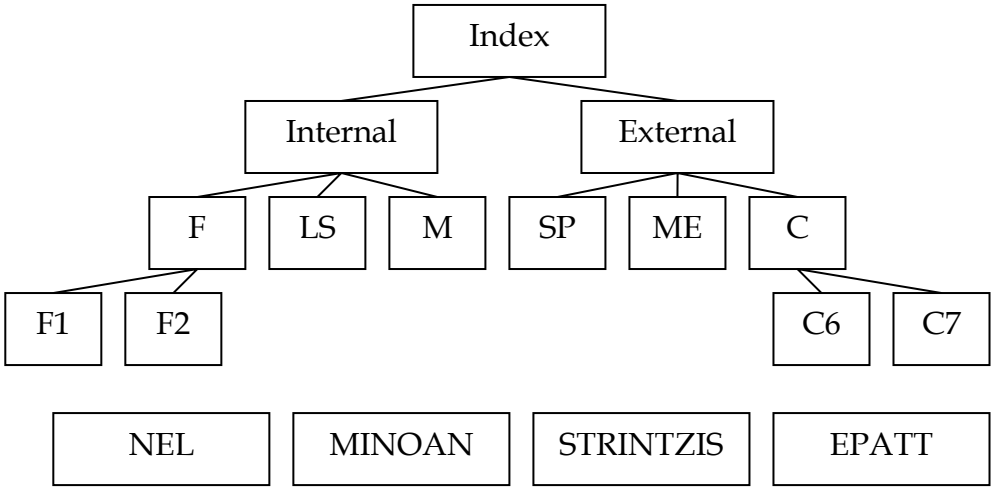


Figure 55: Choosing among merger candidates – sample hierarchy

In the above sample hierarchy, the strategic planner of ANEK may consider the possibility of merging with a current competitor. The higher index will also indicate which company should be selected. The weights at the various levels may alter or remain the same as in the model developed in the previous chapter. However, it shall be highlighted differently in the procedure; the comparisons per criterion (F1, F2, …) and per company shall be relative and not absolute, as in the case of the evaluation. The relative comparison may easily be structured for cases with quantitative and qualitative data. The modeling has been thoroughly analyzed already.

A similar approach may be considered but with the different hierarchy. According to Porter, the target company should fulfill three prerequisites: the company (or its industry or its niche market) shall be attractive, the cost of entry should not capitalize all future profits and the new unit (the one coming out of the merger) must gain a competitive advantage. Then Porter proposes four main types of corporate strategy: portfolio management,

restructuring, transferring skills and sharing activities. Their main attributes are analyzed as following:

P1: Need of Cash

P2: Need of Management Expertise

P3: Capacity of the new company to handle business

R1: Does the new company need new management?

R2: Likelihood of future occurrences making the target company more attractive

R3: Does the new company need new strategy?

T1: Common skills (need/have/etc.)

T2: Are the skills/activities important for a competitive advantage

T3: Likelihood of successful attempt

S1: Prospects

S2: Prospects important for a competitive advantage

S3: Likelihood of degrading the resources (or other aspects, accordingly)

The following hierarchy considers the above theory and some of its main axes of development:

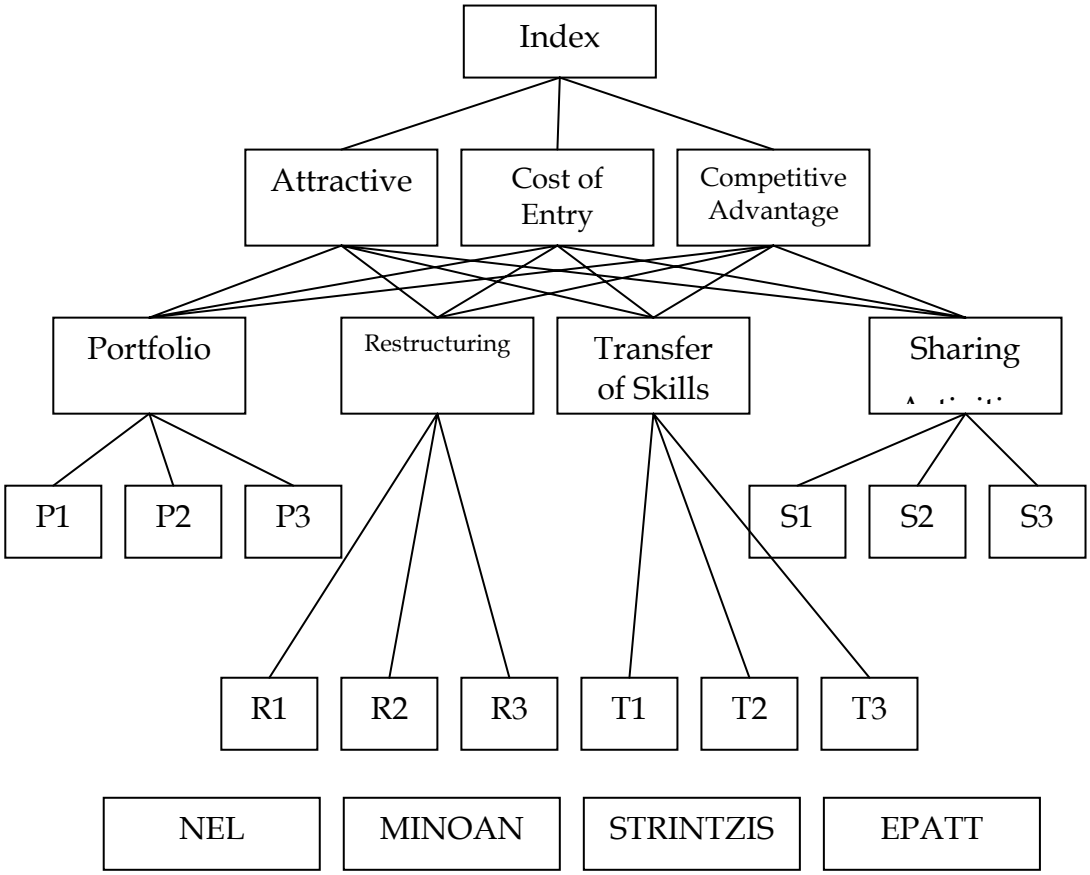


Figure 56: Selecting a target company based on Porter's theory

Of course there are other similar hierarchies that can respond to the same questions. Instead of using Porter's very well known criteria and theory one may consider the critical elements for the success of a merger as suggested by Sudarsanam (1995, p.293). The technique is the same; relative comparisons among the alternatives are necessary as well. However, the decision-maker may also have to deal with an offer: for example ANEK may consider an offer from other companies to merge. The result should be either 'favor' or 'not favor' to every respective offer. Structuring the reply on a hierarchy like the previous one (Figure 55) but with a 'YES' or 'NO' option per criterion (and per offer) the higher index will indicate the final response.

7.2 Theoretic Approaches

Keeney and Raiffa (1993, p.27) consider a double partition of the decision-making problems: there are problems under certainty and under uncertainty as well, as single- or multi-attribute problems. In the uncertainty category we assume a well-defined probability distribution of the possible resulting consequence. A more subjective approach considers it as Bayesian as it is possible to generate such a distribution. This is still a theoretical issue and it does not really matter in this study. The second classification of single- or multi-attribute is self-explained and it complicates numerically the solutions. In this case, the problem is considered as a multi-attribute under certainty one; the assumption of certainty is necessary as it is not possible to estimate probabilities of future outcomes. As decisions and advances of a single-company will affect the future of the rest companies, the problem becomes a network of influences and this is addressed by the Analytic Network Process (ANP). Keeney and Raiffa label this problem as *tradeoff under certainty.*

Theoretically, the multi-attribute value problem is defined and addressed with the assistance of *value functions* and *efficiency envelops*. The mapping of acts into consequences is mathematically treated as multivariable functions, where attributes x (also called evaluators) are weighted informally by the decision-maker or are explicitly formalized in a value structure. The important notion of *dominance* assists in selecting the 'best' alternative, so usually a relation of the types answers to the question if **x**' dominates **x**'':

$$x_i^{'} \geq x_i^{''} \quad all \quad i$$
$$x_i^{'} > x_i^{''} \quad some \quad i$$

In the case n=2, where n is the number of attributes, one can plot the dominance of x' over x'':

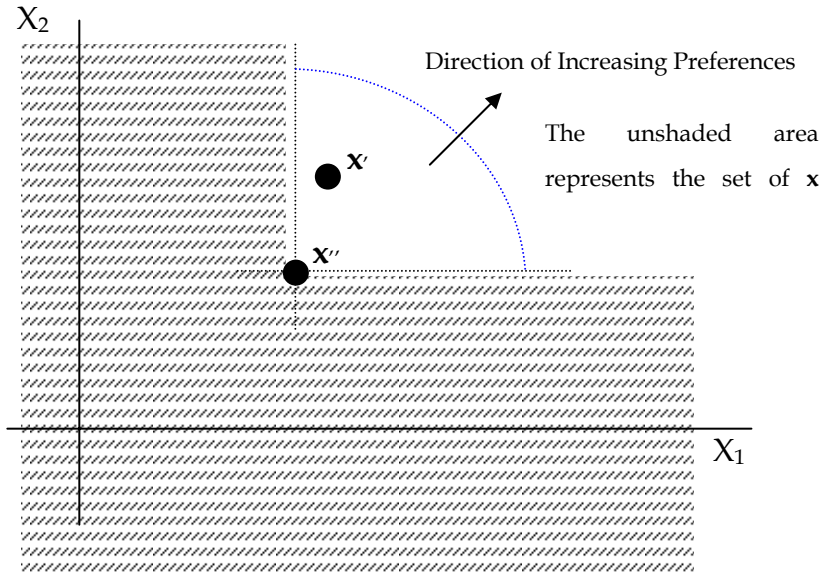


Figure 57: Dominance with two attributes (Keeney & Raiffa, 1993, p. 70)

It is necessary to observe and understand that the idea of dominance exploits the ordinal and not the cardinal[20] character of these numbers. By expanding the above ideas on dominance, the set of consequences R that are not dominated are called *efficiency frontier* and are depicted as follows:

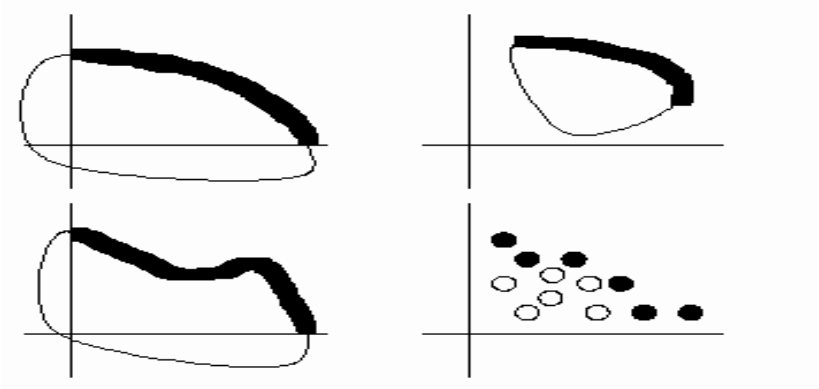


Figure 58: The efficient frontier for various sets of consequences with two attributes (X_1 – X_2 axes)

[20] It is reminded that in the ordinal case we are interested in the relationship x′>x″ (say x′=6 and x″=3) while in the cardinal we are interested in the differences (i.e. the fact the difference between 10 and 6 is greater than the difference between 6 and 3 or that 6 is twice 3).

All choices on lying on the dark side of the frontier are dominant in comparison with the rest ones below (Pareto-optimal). Obviously the convex frontiers are the easiest to handle analytically. The non-convex and discrete cases demand cautiousness and attention. It is also obvious that the notion of convexity introduces cardinal notions (as opposed to the ordinal above) and therefore it is easy to find the 'best' alternative. This also means that it is easy to estimate what attribute has to alter (sacrifice) against another in order to place the alternative on the efficient frontier. Furthermore, an analytical expression can lead to similar results more easily, especially in the multi-attribute case. It is easy to extract a formula of a convex curve describing the efficiency frontier, by taking into account some points, say ANEK97, ANEK00, EPATT98:

$EXT = -0{,}0562INT^2 + 0{,}3517INT - 0{,}0679 \qquad R^2 = 0{,}9719$

Of course it would be easy to take more points into account and consider a non-convex frontier, i.e. a polynomial curve of higher degree.

As in many cases the weights among attributes are not known linear-weighted averages are also considered. The structure of preference and value functions follows and the well-known indifference curves are also drafted. It is interesting to note that this theory presumes convexity. This assumption is not a very 'hard' one and it finds application in many cases. The more interesting result is the marginal rate of substitution, i.e. the response to the question 'if x_2 is increased by Δ units, how much the quantity x_1 has to decrease to remain indifferent?'

These questions can easily be considered at a theoretical level yet in practice it is not easy to formulate such problems. For simplicity reasons, the analysis is limited in n=2 case although it can easily be expanded to more complex situations. Given that the additive function of the index is a utility function and in this specific case:

$$U_k = w_{\text{int}}\,\text{int}_k + w_{ext}\,ext_k$$

where k is indicating the year and the company then the maximization problem of this utility function is formulated as:

$$MaxU = \max(w_{\text{int}} \text{ int} + w_{ext} ext)$$
$$st$$
$$w_{\text{int}} \text{ int} + w_{ext} ext = 1$$

In the general case where $U(x_1, x_2, x_3 \ldots, x_n)$ and the weights are w_j (1, 2, 3, …, n) the optimization problem is formulated as:

$$MaxU = U(x_1, x_2, ..., x_n)$$
$$st$$
$$w_1 x_1 + w_2 x_2 + ... + w_n x_n = E$$

This is a many-input one-output optimization problem and it is easily derived that the ratio of marginal utilities of two inputs equals the ratio of their weights:

$$\frac{\frac{\partial U}{\partial x_k}}{\frac{\partial U}{\partial x_j}} = \frac{w_k}{w_j}$$

Given U as constant then the iso-utility (indifference curve) is estimated as:

$$-\frac{dx_j}{dx_k} = \frac{\frac{\partial U}{\partial x_k}}{\frac{\partial U}{\partial x_j}} = \frac{w_k}{w_j}$$

In other words the slope at the maximazing point has to be equal to -3 (-0,75/0,25) for the maximazation of the U function. By having all this information it is easy to extract marginal rates of substitution. This is a special case of linear indifference curves. However, one can theoretically find indifference curves in more general and complicated cases, such in the case of 6 inputs (level III criteria).

Theoretically, it is also possible to consider dynamic problems, i.e. by introducing time-variants in the analysis or to use conjoint analysis for the

better estimation of trade-offs. However, all these tools are solely interesting to researchers and mathematicians.

Another observation is that one can assume that the discrete case of the efficiency frontier can produce a more 'elegant' analytical formulation. It is possible to estimate a polynomial expression that can further assist in mathematical explorations. It has to be noted that continuity is critical for further elaboration and non-convex expressions will increase the analytical complexity. However once again, it has to be highlighted that such approaches are left to the 'creative judgment' of the researcher (Keeney and Raiffa, 1993, p. 74) as there is only ad-hoc approximations and the practical result or the usability of the outcome is questionable.

8 Conclusions and Further Development

8.1 Conclusions

The conclusions of this study will be listed below as derived from the research and clustered in relevant subgroups in accordance to the structure of the document.

1. The Greek Coastal System:

    1.1. The GCS companies have benefited from their listing at the ASE and have experienced enormous growth during the period 1997-2002. Growth rates of their assets are estimated within the range of 25-46%. The fixed assets of these companies have increased in value as new vessels came into operation. The shareholders' equity has also expanded dramatically. However, not all years have been profitable, and perpetual carriers experienced losses, especially in the 2000-2 period.

    1.2. The long-term liabilities of the companies have also been increased as result of the fleet renewal. Nevertheless, the leverage ratio remained within acceptable levels.

    1.3. The market-shares based on turnover are shifted from the dominant Cretan companies MINOAN and ANEK in the 90s' to the group of companies of EPATT (Superfast Ferries and Blue Star Lines – STRINTZIS). Looking closer into the shift-share analysis of market shares per turnover (as product) it is interesting to note that EPATT are continuously gaining share against other actors. In absolute terms, STRINTZIS has not experienced reduction of its market share but the growth was not the expected one. All other carriers have lost part of their market share per turnover in favor of EPATT.

    1.4. Most of the revenues are attributed to fares charged (approximately 87%) and are accrued in the Adriatic (approximately 70%), although

this market represents almost 30% of the total passenger traffic reported, 40% of the total car traffic and 55% of the total truck traffic.

1.5. The market is not oligopolistic. According to HHI and Gini coeffient methodologies, the market is not concentrated to some carriers. This finding is consistent with the perspective of the market that the MMM curved the all markets in 'equal' parts to satisfy all interests and all 'interests' were satisfied with that arrangement.

1.6. The fleet consists of almost 70 vessels (new and old, conventional and non-conventional, deployed in the Aegean or the Adriatic). Almost 93% of them (65) are considered as conventional. The average reported speed is around 24 knots. This figure is considered as 'exaggerated' for the vessels deployed in the Aegean but close to reality for the vessels deployed in the Adriatic. The total capacity of passengers is around 93000 and the average around 1330. This figure reflects reality; this is not the case with the extracted results for beds, cars and trucks. A rather not reliable statistic suggests that every ship offers around 390 beds, carries 330 private cars or a combination of 121 cars and 76 trucks. The measurement would be more accurate if only the available line meters were known. The average year the keel was laid is 1987; most of the old vessels have undergone extensive overhauls in the 1990s'.

1.7. There are not many and important developments regarding the ports servicing the vessels of these companies. The developments in the port industry have not yet affected the GCS system, although they will definitely do so in the near future. In the Ionian Sea the increasing importance of Igoumenitsa may affect planning and operations. In the Aegean, it is expected that new ports, such as Lavrio may undertake some traffic and relieve the main-hub of Piraeus. As the system currently operates in the Aegean most of the expected developments remain speculatory.

2. Literature Review

   2.1. There are many, but obsolete texts, regarding the risk structure and the criteria for financing shipping ventures. None is specifically addressed to SSS and coastal shipping.

   2.2. There is a lot of literature in the field of MCDM but no MCDSS tool or MA methodology relevant to the shipping company evaluation as reported. Some attempts in the literature are limited to relative comparisons or to academic purposes. The use of MCDM techniques, as well as the academic interest in the risk related problems, is increased lately.

   2.3. The issue of GCS in the literature has not appeared lately. Only papers and studies of the mid-90s' are reported and set the basis for further research and elaboration. Most of them are presented by Greek research institutions.

3. Methodology

   3.1. AHP has been selected on the following grounds:

      3.1.1. in absolute comparison mechanisms it is not possible to experience rank-preservation problems;

      3.1.2. the set of data is very large and the relative comparison of every alternative for every year available would increase the numerical and decisional burden exponentially;

      3.1.3. it is easy to add alternatives (existing or dummy ones), to experiment with the sensitivity of parameters, or to estimate the outcome of an action (element sensitivity);

      3.1.4. the focal attention lies on the hierarchy, i.e. on the insights and on the parameters determining the phenomenon

      3.1.5. AHP can be combined with other methods

      3.1.6. AHP-required hierarchies can be further developed to

networks and systems with dependencies and influences (commonly addressed by ANP)

3.2. The sensitivity analysis is critical and has been addressed on the basis of specialized research on the AHP, in order to proceed in the:

3.2.1. Determination of the most critical criterion,

3.2.2. Determination of the most critical element in the decision matrix.

4. The lenders' market

4.1. Financial Institutions have to face risks in a totally different way and specifically deal with the operational risk.

4.2. Financial Institutions with lending interests in shipping are reduced in number, but the overall portfolio is expanded.

4.3. Shipping companies will experience consolidation in number and simultaneous increase of their size. This is partially the result of splitting the market in risk-tiers in accordance to the new lending rules and strategies.

4.4. A hierarchy with six levels has been used in order to map the Greek lending market. Questionnaires have been used in order to collect answers; their structure is based solely on the theory as described in the literature and on experiences. Due to lack of experts to assign weights a simulation procedure has determined the weights of the upper level. The results are interesting as banks are clustered and preferences are revealed[21].

4.5. The importance of the GCS sector to the lenders is rather limited, as it represents about 6% of the total portfolio available and about 9% of

[21] The names of the banks are known to the author but for disclosure reasons they are not revealed.

the Greek FI active in the market (€1.64bn in 2001 and €2.15bn in 2002). According to data provided by the ASE, the GCS listed companies have acquired 220bn GrD (€645m) from the market up to the end of 2002. Obviously, bank lending is considered as the most important source of financing.

5. The shipping company evaluation model and its applications:

   5.1. The developed model can yield an overall evaluation of GCS companies according to a criteria structure (hierarchy).

   5.2. As the weighting of criteria at lower levels is assigned by the decision-maker for simplicity and consistency reasons, weights at higher levels that affect the final ranking the most, are allotted through sensitivity analysis and simulation.

   5.3. The most critical criterion, i.e. the one that can alter the ranking with the minimum relative change is the one of fundamental data. The most critical element is the one with the assigned grade of performance at fundamental accounting criterion for NEL.

   5.4. Both simulation and scenario analysis yield the same ranking practically, with slight differences in a specific year of analysis. This is an interesting validating point.

   5.5. The resulting index can be explained from the shift-share analysis. From the available data for the turnover, almost 60% of all results can be explained. For the rest of the elements a conjoint analysis with the shift-share analysis for the traffic is required.

   5.6. The model, can be used as is for the determination of overall rankings, corporate planning ('what-if' scenarios) and comparison with other companies not included in the current sample (say companies from other markets and or not listed GCS companies)

5.7. The model after adjustment of its hierarchy may also assist in corporate planning and focused cases, such as merger between companies.

As a last comment, the contribution of this thesis in the state of the art is evident. For the first time in the academic literature, a market analysis of the most significant actors is provided. Furthermore, the analysis of their financial and operational course into sub-criteria reveals differences of their structure and their decisions. The classification of these companies according to a rational set of criteria comprises, also, a very powerful tool for managerial decisions. This tool may easily be used by the management of the company for comparison or planning reasons, as well as by academics and policy-makers as monitoring tool of the market. The tool is validated through a shift-share analysis of historical data, thus strengthening the belief that the appointed weights are reflecting actual conditions. Of course, an MCDM tool remains a subjective tool and the hierarchy reveals the understanding of the problem, as well as the indented goals. Further research and adjustments may easily be launched on the basis of this prototype. Last, but not least, the analysis of the lenders' market, as well as, side results of the analysis, such as the market concentration analysis appear for the first time in the academic and business literature.

8.2 Further Considerations

The conclusions listed in the previous paragraph lead also to some further considerations. These considerations are classified into two major categories: those related to the theory and those related to the application.

8.2.1 Further Research

The AHP and most other MCDM methods are primarily products of research in the fields of mathematics, operations research and engineering. Most of the researchers behind this modeling are economists, mathematicians or engineers, therefore these models are normative and biased to rationality, the

way mathematics define it. Decision-making is a field that psychology and psychiatry contribute as well. It has to be highlighted, that Saaty and other researchers base their arguments on the scales required for the pairwise comparisons on stimuli analyses, an absolutely psychometric field. The justification of the use of a specific scale is usually considered by scientists of such fields in the literature; their approach may be enlightening for engineers and mathematicians.

As a result of the above, it is necessary to implement interdisciplinary approaches in such problems in order to deviate from a normative perspective to a more realistic one. This is also critical for the extraction of utility functions of decision-makers at various levels. A proposal for further research should absolutely be the extraction of group utility functions; this would assist in considering other methods in these interesting MCDM problems.

A clear split between corporate decision-makers and other important actors in the GCS system, such as lenders and policy-makers, as well as the revelation of their preferences on specific issues, (situations or states) would enable more complex decision-making approaches, more informative on the relations between actors, their conflicts and their dependencies. One could argue that ANP could also provide such information, if only hierarchies are further expanded to holarchies (networks with influences and dependencies). Theoretically this is true, and numerically is also easily possible. However, the network of dependencies demands a deep consideration of the needs and the goals of every actor. In cases, where several managerial groups are involved, as in this case with five different BoD, it is very difficult to get the clear picture, but only assume some of these characteristic. From a more macroscopic approach, one could consider a set of interests and needs for specific groups, say the lenders, the MMM as regulator, the users, the operators, and the employees. Even from that perspective this would lead to theoretic results, as there are many differences

between the members of the same group (truckers, tourists, islander, investors, lenders, etc. to name some).

Once again the issue of combining input techniques and ranking methodologies shall be highlighted and suggested for further elaboration. This issue has been adequately dealt in previous paragraphs (see §4.3 and §6.3.1).

Another issue for further theoretic elaboration is the issue of corporate management; there is no real academic work on the issue of the corporate governance of GCS industry and in Greek shipping generally. In other shipping-oriented nations, such as Norway, some research activities are in process already. The issue of the corporate governance is critical, not only for the inclusion of shipping in wider political and financial planning, as in the case of grants, sector promotion as in the case of SSS, but also for the understanding of internal forces within the corporation. It was clearly stated in the chapter devoted to the lenders' market, that there is a trend of consolidation of the shipping operators and that will demand clear corporate structures, strategies and relationships. Currently, the GCS companies are following some corporate governance rules, as listing obligations. However, a deeper look and study of their information memoranda, i.e. their official communication with the investors, reveals the absence of the active participation from the investors. Most of these companies are practically held by the original shareholders; no representative of the investors is in the board and the memoranda are not as transparent as they should be on the operations. The lack of simple data, such as of the sailings, the vessels' service of a specific route, etc. prohibit the reader from understanding the real operations. The argument that these data are obscured or should remain hidden for competition purposes is not really valid, as all operators closely monitor the tactical movements of their competitors.

In conclusion, it is necessary to study the corporate governance of this industry in order to understand the internal forces and to predict the future

of the decision-making process as these companies are listed and shall follow some transparency and investors' communication procedures (see also p. 173). Furthermore, it is appealing to suggest to the Authorities and the industry the structure for the various texts and documents that shall be communicated with the investors, so to improve transparency and understanding of the core business yet hiding the necessary information from the competitors.

8.2.2 Applications-related Issues

The very first issue one can discuss is the use of the model and its adjustment towards a specific goal. As the model is constructed, one can extract rankings for the overall evaluation of a GCS company. Furthermore one can monitor their course in the previous years and finally forecast their future standing, given a specific set of criteria and attributes. That can be of use to lenders, to investors, to the management of these companies and to the researchers monitoring this market. Some more criteria can be added in order to include more 'beneficiaries', such as regulators. In that case, one could consider customer-satisfaction indices focused on the services provided. That would be of direct interest to regulators, who grant licenses and consider inclusion of the GCS industry in wider political planning. Minor adjustments of the model, such as employment figures, pension and health benefits numbers may shift the focus to issues interesting policy-makers.

By adjusting a little bit more, i.e. by distorting the hierarchies at upper levels, one can include route-specific data as well as customer-satisfaction indices and focus on operations, rather than on overall performance. However, the data availability and their integrity are questionable. The issue of data availability shall be addressed from the regulating Ministry; the data available to the public are aggregated figures of the routes. There is no real information on the embarkation and the disembarkation of users among destinations and only rough estimates are in use. Furthermore, there are no statistics of users who used two operators and mid-destination (transit) in

order to reach their destination. For example, there is no real information on the number of users, who used Syros or Mykonos for transit destination in order to reach other islands, not directly connected to their point of origin. Without this information it is not really possible to design the network, as well as to grant licenses without misrepresent physical and economic parameters. The issue of data-collection is thorny but simply stated preference questionnaires on-board vessels and at ports would enhance our understanding of the flows in the network.

Another interesting suggestion for further research related to the application is the incorporation of the index (more possibly adjusted) in formulas used by the Ministry or financial institutions for their purposes. One has to adjust the results of the model with the needs of each respective user and most probably to alter weights or adjust the hierarchy.

Finally, this is only a prototype and it can definitely be upgraded and improved. As our understanding deepens, and the availability of data increases there is a potential to expand this model and its capabilities. It strongly depends on the needs of the decision-makers, the goals set and the improvements of the methodology (input, consistency, ranking as explained). The sections on the mergers and the planning (see pages 237 and 239) show some of the capabilities of the model and the way to other researchers and practitioners for further elaboration.

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11 Annexes

11.1 Annex A: Concentration Indices

11.1.1 HHI Index

The HHI accounts for the number of firms under analysis (or in the market) as well as their concentration by incorporating the relative size, measured by the market share. It is calculated as shown in the equation below:

$$HHI = \sum_{i=1}^{N} \left(MarketShare_i \right)^2$$

In the above equation $MarketShare_i$ represents the market share of company i, and there N companies in the market (or in the analysis set). An in-depth investigation reveals that HHI gives a much heavier weight to companies with larger shares, due to the squaring of each respective share. This HHI feature corresponds to the notion that the greater the HHI, the greater the concentration of the market. If HHI reaches a value of 1 then a monopoly exists; in contrast, if HHI reaches a figure close to 1/N then the market is evenly distributed and low concentration exists.

11.1.2 Gini Coefficient

The Gini coefficient was developed to measure the degree of concentration (inequality) of a variable in a distribution of its elements. It compares the Lorenz curve of a ranked empirical distribution with the line of perfect equality. This line assumes that each element has the same contribution to the total summation of the values of a variable. The Gini coefficient ranges between 0, where there is no concentration (perfect equality), and 1 where there is total concentration (perfect inequality). Geographers have used the Gini coefficient in numerous instances, such assessing income distribution among a set of contiguous regions (or countries) or to measure other spatial phenomena such as racial segregation and industrial location. Its major purpose as a method in transport geography has been related to measuring

the concentration of traffic, mainly at terminals, such as assessing changes in port system concentration. Economies of scale in transportation favor the concentration of traffic at transport hubs, so the Gini coefficient of maritime traffic went up over the last decades.

Three different measures of inequality linked to the Gini Coefficient are presented below. There are all linked to the concept of comparing the Lorenz curve with the lines of perfect equality and inequality. The summation of vertical deviations between the Lorenz curve and the line of perfect equality, also known as the summation of Lorenz differences. The closer the ID is to 1 (or 100 if percentages are used instead of fractions), the more dissimilar the distribution is to the line of perfect equality:

$$ID = \frac{1}{2}\sum_{i=1}^{N}\left|X_i - Y_i\right|$$

where X and Y are percentages (or fractions) of the total number of elements and their respective values (traffic being the most common). N is the number of elements (observations).

The area of concentration between the Lorenz curve and the line of perfect equality expresses a proportion of the area enclosed by the triangle defined by the line of perfect equality and the line of perfect inequality. The closer to 1 the coefficient is, the more unequal the distribution:

$$G = 1 - \sum_{i=1}^{N}\left(\sigma Y_{i-1} + \sigma Y_i\right)\left(\sigma X_{i-1} + \sigma X_i\right)$$

where σX and σY are cumulative percentages of Xs and Ys (in fractions) and N is the number of elements (observations).

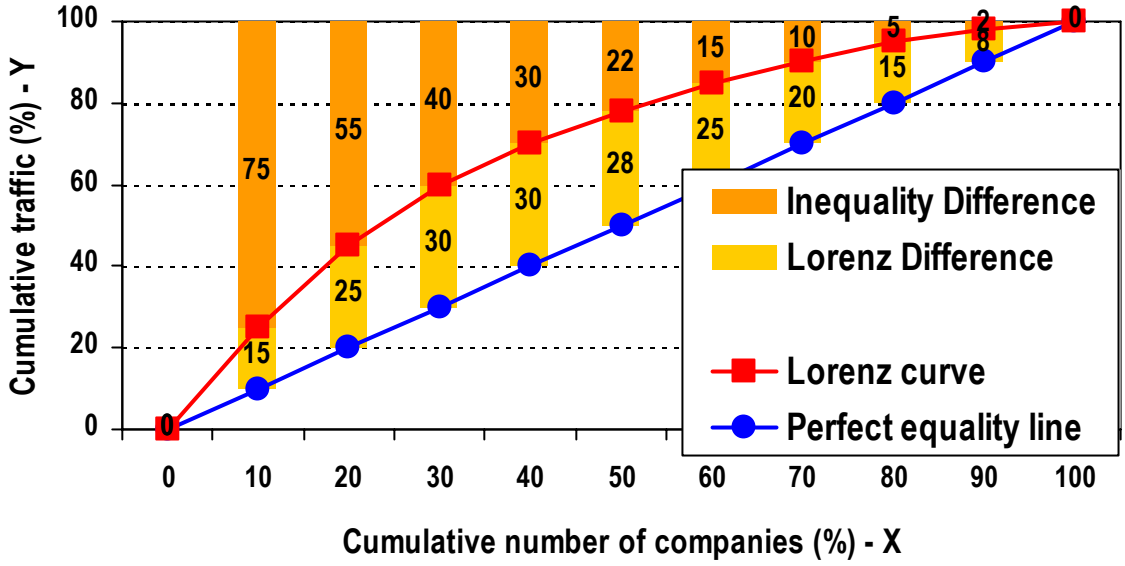

Figure 59: Lorenz and Perfect Inequalities Difference

11.1.3 Shift-Share Analysis

The 'shift-share' analysis focuses on the development of each individual firm in the market. The fundamental principle of this analysis is to divide the growth of products (passengers, cars and trucks served) into two segments, namely the 'share' and the 'shift' effects. The former refers to the expected growth of a product, if it were simply to maintain its market share, and consequently, to evolve in the same way as all the firms as a whole. The latter reflects the total amount of a product a firm loses or wins from competing firms with the expected level of product as reference. Clearly the shift-share effect is a 'zero-sum' game. The shift is calculated by the following equation:

$$S_i = P_{it_1} - P_{it_0} \frac{\sum_{i=1}^{N} P_{it_1}}{\sum_{i=1}^{N} P_{it_0}}$$

where S_i is the shift of firm i during the period t_0-t_1, P is the volume of product and N is the number of firms.

11.1.4 Findings of the Analysis

The yield results of all the above formulas and methodologies are shown in the table below.

		1997	1998	1999	2000	2001	2002
Turnover	**DI**	0,177	0,151	0,149	0,175	0,183	0,198
	Gini	0,032	0,024	0,022	0,160	0,162	0,183
	HHI	0,236	0,234	0,232	0,242	0,248	0,255
Passenger (Total)	**DI**	0,195	0,160	0,164	0,163	0,177	0,171
	Gini	0,099	0,080	0,068	0,032	0,037	0,050
	HHI	0,239	0,224	0,225	0,235	0,233	0,236
Cars (Total)	**DI**	0,221	0,189	0,180	0,186	0,203	0,203
	Gini	0,052	0,029	0,022	0,004	0,026	0,036
	HHI	0,244	0,232	0,229	0,235	0,238	0,242
Trucks (Total)	**DI**	0,163	0,116	0,128	0,138	0,129	0,137
	Gini	0,095	0,030	0,008	0,008	0,005	0,002
	HHI	0,225	0,215	0,218	0,220	0,220	0,226
Passenger (Adriatic)	**DI**	0,212	0,230	0,257	0,251	0,200	0,200
	Gini	0,094	0,186	0,230	0,231	0,161	0,137
	HHI	0,267	0,267	0,269	0,266	0,256	0,255
Cars (Adriatic)	**DI**	0,217	0,245	0,244	0,240	0,200	0,200
	Gini	0,036	0,109	0,165	0,166	0,096	0,067
	HHI	0,267	0,281	0,276	0,272	0,252	0,254
Trucks (Adriatic)	**DI**	0,200	0,224	0,216	0,200	0,200	0,216
	Gini	0,089	0,171	0,186	0,182	0,163	0,161
	HHI	0,253	0,266	0,263	0,257	0,259	0,262
Passenger (Aegean)	**DI**	0,200	0,200	0,200	0,238	0,211	0,204
	Gini	0,167	0,186	0,187	0,136	0,114	0,114
	HHI	0,253	0,252	0,257	0,275	0,268	0,271
Cars (Aegean)	**DI**	0,223	0,220	0,229	0,257	0,239	0,248
	Gini	0,108	0,125	0,154	0,122	0,108	0,096
	HHI	0,271	0,268	0,269	0,285	0,276	0,287
Trucks (Aegean)	**DI**	0,200	0,200	0,200	0,203	0,210	0,232
	Gini	0,246	0,255	0,259	0,222	0,222	0,245
	HHI	0,255	0,255	0,260	0,259	0,257	0,265

Table 35: Findings from the Application of Concentration Indices

It has to be noted that the HHI index has to be compared to 1/5 for the 'turnover' and 'total' products, while the HHI indices of segmental products (Aegean and Adriatic) shall be compared to ¼, as NEL is not active in the Adriatic and EPATT in the Aegean (for the periods under scrutiny).

The shift-share analysis yields the following results:

	97-98	98-99	99-00	00-01	01-02
ANEK	-3.338.715.710	548.808.038	-6.873.565.297	2.689.060.885	-4.361.136.146
NEL	-1.103.112.742	192.575.015	-2.145.353.498	647.332.041	1.701.148.538
MINOAN	-177.399.083	-1.131.296.535	-16.060.471.337	-4.998.417.670	519.462.109
STRINTZIS	-1.758.067.128	183.282.583	-2.250.842.372	-3.658.990.505	-3.574.622.784
EPATT	6.377.294.662	206.630.900	27.330.232.505	5.321.015.248	5.715.148.283

Table 36: Shift-Share Analysis - Turnover

	97-98	98-99	99-00	00-01	01-02
ANEK	7.564	37.920	-128.587	15.541	50.442
NEL	-7.319	-43.423	12.691	-104.592	126.593
MINOAN	-66.220	-187.995	-285.512	242.215	-189.883
STRINTZIS	-135.595	172.846	398.420	-137.013	94.326
EPATT	201.570	20.651	2.989	-16.150	-81.478

Table 37: Shift-Share Analysis – Passengers (Total)

	97-98	98-99	99-00	00-01	01-02
ANEK	-8.963	3.587	-13.257	29.592	4.542
NEL	-1.390	490	2.619	-15.343	16.689
MINOAN	10.682	-22.126	-26.682	2.051	-29.183
STRINTZIS	-28.330	10.617	46.359	-11.191	25.128
EPATT	28.001	7.432	-9.038	-5.109	-17.176

Table 38: Shift-Share Analysis – Cars (Total)

	97-98	98-99	99-00	00-01	01-02
ANEK	-7.764	-6.978	6.063	1.861	2.734
NEL	-5.637	-9.011	-936	-6.145	-9.382
MINOAN	-8.724	2.352	-21.354	13.702	11.161
STRINTZIS	-9.869	17.480	21.138	-20.890	-9.140
EPATT	31.993	-3.844	-4.911	11.471	4.627

Table 39: Shift-Share Analysis – Trucks (Total)

	97-98	98-99	99-00	00-01	01-02
ANEK	60.246	84.892	-141.856	-140.931	-6.180
NEL	20.697	-41.284	10.079	-110.561	80.963
MINOAN	-37.089	-155.242	-254.678	326.909	-151.076
STRINTZIS	-43.855	111.634	386.455	-75.418	76.293
EPATT	0	0	0	0	0

Table 40: Shift-Share Analysis – Passengers (Aegean)

	97-98	98-99	99-00	00-01	01-02
ANEK	6.604	17.890	-12.672	-9.865	-4.788
NEL	1.518	1.347	1.432	-16.726	8.911
MINOAN	-2.185	-16.166	-20.840	39.291	-28.229
STRINTZIS	-5.937	-3.071	32.079	-12.701	24.107
EPATT	0	0	0	0	0

Table 41: Shift-Share Analysis – Cars (Aegean)

	97-98	98-99	99-00	00-01	01-02
ANEK	391	7.534	-5.756	-4.284	10.227
NEL	2.327	-4.180	-5.488	-1.857	-5.598
MINOAN	-679	-11.937	947	17.025	-5.503
STRINTZIS	-2.038	8.582	10.296	-10.884	874
EPATT	0	0	0	0	0

Table 42: Shift-Share Analysis – Trucks (Aegean)

	97-98	98-99	99-00	00-01	01-02
ANEK	-46.489	-46.063	11.514	153.449	53.738
NEL	0	0	0	0	0
MINOAN	-41.910	-33.532	-29.625	-80.957	-29.924
STRINTZIS	-88.144	61.929	11.174	-65.373	-17.700
EPATT	176.543	17.666	6.937	-7.119	-6.115

Table 43: Shift-Share Analysis – Passengers (Adriatic)

	97-98	98-99	99-00	00-01	01-02
ANEK	-15.784	-14.082	-1.328	38.717	9.151
NEL	0	0	0	0	0
MINOAN	10.636	-6.776	-4.650	-35.713	2.600
STRINTZIS	-19.856	14.644	13.250	184	-6.645
EPATT	25.004	6.214	-7.272	-3.187	-5.105

Table 44: Shift-Share Analysis – Cars (Adriatic)

	97-98	98-99	99-00	00-01	01-02
ANEK	-6.150	-12.797	8.635	8.434	-6.184
NEL	0	0	0	0	0
MINOAN	-9.116	14.370	-20.471	-3.791	17.684
STRINTZIS	-7.530	9.513	10.117	-9.161	-9.518
EPATT	22.795	-11.086	1.720	4.518	-1.982

Table 45: Shift-Share Analysis – Trucks (Adriatic)

11.2 Annex B: Questionnaires to the Banks

1) Do you invest in other markets other than shipping?

❒yes ❒no

2) Which is the portion of the total portfolio dedicated to shipping?

❒	❒	❒	❒	❒
0-5%	10-15%	20-25%	30-35%	>40%

3) Do you regularly monitor the shipping market?

❒	❒	❒	❒	❒
No practical meaning	Client analysis	Follow indications of independent analysts Clarkson's Drewry κλπ	Monitoring is carried out by our staff (marketing, PR dept.)	Ad hoc monitoring department

4) Please, rate the prospect of the following markets:

a) Tanker shipping

❒	❒	❒	❒	❒
Bad	Promising	Indifferent	Good	Opportunity

Product, Chemical Carriers 3.000 – 30.000 t DWT	❒	
Handy Size Carriers 30.000 – 70.000 t DWT	❒	Indicate <u>one</u>
Aframax 80.000 – 105.000 t DWT	❒	
Suezmax 120.000 – 160.000 t DWT	❒	
Very Large Crude Oil Carriers 200.000-300.000 t DWT	❒	
Ultra Large Crude Oil Carriers >320.000 t DWT	❒	

b) Bulk carrier

❒	❒	❒	❒	❒
Bad	Promising	Indifferent	Good	Opportunity

3.000 – 30.000 t DWT	❒	
30.000 – 70.000 t DWT	❒	
Panamax 60.0000 – 80.000 t DWT	❒	Indicate <u>one</u>
Capesize >80.000 t DWT	❒	
> 125.000 t DWT	❒	

c) Container

❒	❒	❒	❒	❒
Bad	Promising	Indifferent	Good	Opportunity

500 – 800 TEU	❒	
1000 – 1500 TEU	❒	
18000 – 2000 TEU	❒	
2000 – 2500 TEU	❒	Indicate <u>one</u>
Panamax 3000 TEU	❒	
3000-5000 TEU	❒	
>5000 TEU	❒	

d) Passenger shipping

❒ Bad	❒ Promising	❒ Indifferent	❒ Good	❒ Opportunity

Cruisers	❒	Indicate <u>one</u>
Passenger Ro-Ro (ferries)	❒	
High-Speed (catamaran)	❒	

Which flag is the most common in your portfolio?

❒ Opportunity flags	❒ Rest of the world	❒ Evenly distributed	❒ Greek	❒ European

Describe the participation of rating agencies in your business (Moody's, Standard & Poor's…)

❒ Absolutely none	❒ Rare	❒ Indifferent	❒ Substantial	❒ Total cooperation

Evaluating a loan application describe the significance of the following:

a) character and track record of applicant shipowner

❒ 1	Insignificant	❒ 3		❒ 5		❒ 7	The most important	❒ 9

b) manegerial capacity

❒ 1	Insignificant	❒ 3		❒ 5		❒ 7	The most important	❒ 9

c) capital –equity participation

❒ 1	Insignificant	❒ 3		❒ 5		❒ 7	The most important	❒ 9

d) collateral such as mortgages, etc.

❒ 1	Insignificant	❒ 3		❒ 5		❒ 7	The most important	❒ 9

e) condition of the market

❒ 1	Insignificant	❒ 3		❒ 5		❒ 7	The most important	❒ 9

f) flag registry

❒ 1	Insignificant	❒ 3		❒ 5		❒ 7	The most important	❒ 9

g) shipyard (newbuildings) pre-delivery

❒ 1	Insignificant	❒ 3		❒ 5		❒ 7	The most important	❒ 9

on delivery

❒ 1	Insignificant	❒ 3	❒ 5	❒ 7	The most important	❒ 9

h) ISO compliance

❒ 1	Insignificant	❒ 3	❒ 5	❒ 7	The most important	❒ 9

Describe the bank's stance towards syndicated loans

❒ Confront the Credit Policy .	❒ Good to be avoided	❒ Indifferent	❒ Positive, as it spreads credit risk	❒ Arranger of such loans

Should a client of yours suggest that part of his debt be converted into equity capital of the indebted company thus making you a partner, would you negotiate? (convertible loan)

❒ No, it confronts the Credit Policy	❒ Only at certain occasions (profitable company, good stock performance)	❒ Indifferent	❒ Yes, it is a security should default occur	❒ Common practice

Up to which extent of a project would you undertake?

❒ Up to 10%	❒ Up to 30%	❒ Up to 50%	❒ Up to 70%	❒ Up to 90%

Do you provide finance other than senior debt on a higher interest rate and a corresponding 2nd mortgage (mezzanine finance)?

❒ No, never	❒ On special occasion	❒ Indifferent	❒ Yes sometimes	❒ Common practice

Leasing is considered to be a promising method of acquiring and operating a vessel. Do you provide this off-balance sheet financial scheme?

❒yes ❒no

If yes, please express the interest you pay on the following:

Leasing as a financial instrument

❒ Insignificant	❒ Less significant	❒ Significant	❒ Important	❒ The most important

Client consulting for the maximum convenience

❒ Insignificant	❒ Less significant	❒ Significant	❒ Important	❒ The most important

Securitization for collateral

❒ Insignificant	❒ Less significant	❒ Significant	❒ Important	❒ The most important

Legal issue

❒	❒	❒	❒	❒

Insignificant	Less significant	Significant	Important	The most important

Please, indicate the currency you consider as more solid.

Euro ❒
U.S. Dollar ❒
Japanese Yen ❒
English Pound ❒

Do you refinance loans that have first been issued by the competition?

❒ No, never	❒ On special occasions	❒ Indifferent	❒ Yes, sometimes	❒ Common practice

Would you refinance loans that have first been issued by you? (restructure)

❒ No, never	❒ On special occasions	❒ Indifferent	❒ Yes, sometimes	❒ Common practice

Please, indicate the maximum accepted loan period

❒ 1-3 yrs	❒ 6-9 yrs	❒ 12-15 yrs	❒ 18-21 yrs	❒ 24-27 yrs

Would you finance a newbuilding that won't be constructed in a traditionally shipbuilding country?

pre-delivery

❒ No, never	❒ On special occasions	❒ Indifferent	❒ Yes, sometimes	❒ Common practice

on delivery

❒ No, never	❒ On special occasions	❒ Indifferent	❒ Yes, sometimes	❒ Common practice

Do you explicitly demand that your clients comply with the international standards of IMO?

❒yes ❒no

According to an American survey, the world bond issuances have backed down. What are the prospects of high yield bonds?

❒ Bad	❒ Promising	❒ Indifferent	❒ Good	❒ Opportunity

Indicate the influence of the competition into the development of the interest rates you charge.

❒ None	❒ Practically small	❒ Indifferent	❒ Great	❒ The most important

World Capital markets provide the opportunity of raising equity to finance shipping.

a) Do you believe that capital markets may be competitive towards bank financing?

b) What are the prospects of funds?
……
……
……
…….

Mr Harris Antoniou, Head Shipping της Fortis Bank, in the 4th **Greek Ship Finance Forum** stressed that the Greek bank market is the most competitive source of finance for the shipping industry, as the interest rates are way below rates charged in the rest of the world.
a) how cheaper are Greek bank loans compared to the usual rates charged?
b) how expensive are usually shipping loans?
c) which is the main reason for this?
……
……
……
……

What do you consider as the main reason for the default of a loan?
……
……
……
……
…….....

11.3 Annex C: Data and Calculations (Financial Institutions)

INDEX

	assurances	marketing	quality
assurances	1	k	l
marketing	1/k	1	l/k
quality	1/l	k/l	1

assurances

	customer	loan
customer	1	e
loan	1/e	1

marketing

	internal	competition
internal	1	f
competition	1/f	1

quality

	ship & company	risk
ship & company	1	g
risk	1/g	1

Assurance

customer	CHARACTER	CAPACITY	CAPITAL	COLLATERAL		
CHARACTER	1	3	5	5	0.558	1.000
CAPACITY	0.33	1	3	3	0.249	0.447
CAPITAL	0.20	0.33	1	1	0.096	0.173
COLLATERAL	0.20	0.33	1.00	1	0.096	0.173
					CI	0.014
					CR	1.6%

loan	CONDITIONS	FINANCING EXTENT	MAX LOAN PERIOD	PORTFOLIO PORTION DEDICATED		
CONDITIONS	1	1	3	1/3	0.192	0.340
FINANCING EXTENT	1.00	1	3	1/5	0.169	0.299
MAX LOAN PERIOD	0.33	0.33	1	1/5	0.074	0.131
PORTFOLIO PORTION DEDICATED	3.00	5.00	5.00	1	0.565	1.000
					CI	0.038
					CR	4.2%

Marketing

internal policy	CONVERTIBLE LOAN	FINANCING EXTENT	LOAN REFINANCE	MAX LOAN PERIOD		
CONVERTIBLE LOAN	1	1/3	1/5	1/5	0.071	0.173
FINANCING EXTENT	3	1	1	1	0.276	0.669
LOAN REFINANCE	5	1	1	3	0.413	1.000
MAX LOAN PERIOD	5	1	1/3	1	0.239	0.577
					CI	0.062

					CR	6.9%
competition drives	SYNDICATED LOANS	MEZZANINE FINANCE	LEASING INTEREST	COMPETITION INFLUENCE		
SYNDICATED LOANS	1	5	3	5	0.578	1.000
MEZZANINE FINANCE	1/5	1	1	1/3	0.100	0.173
LEASING INTEREST	1/3	1	1	1	0.149	0.258
COMPETITION INFLUENCE	1/5	3	1	1	0.173	0.299
					CI	0.062
					CR	6.9%

Quality

ship & company	RATING AGENCIES PARTICIPATION	FLAG	YARD (pre-delivery)	YARD (on delivery)	ISO STANDARDS COMPLIANCE		
RATING AGENCIES PARTICIPATION	1	9	9	8	7	0.639	1.000
FLAG	1/9	1	5	5	1	0.146	0.228
YARD (pre-delivery)	1/9	1/5	1	1	1/3	0.045	0.070
YARD (on delivery)	1/8	1/5	1	1	1/3	0.046	0.071
ISO STANDARDS COMPLIANCE	1/7	1	3	3	1	0.125	0.195
						CI	0.080
						CR	7.2%

risk aspects	FLAG DISTRIBUTION IN PORTFOLIO	FINANCING IN NOT TRADITIONAL SHIPBUILDING COUNTRIES (pre-delivery)	FINANCING IN NOT TRADITIONAL SHIPBUILDING COUNTRIES (on-delivery)			
FLAG DISTRIBUTION IN PORTFOLIO	1.00	3.00	3.00		0.600	1.000
FINANCING IN NOT TRADITIONAL SHIPBUILDING COUNTRIES (pre-delivery)	0.33	1.00	1.00		0.200	0.333
FINANCING IN NOT TRADITIONAL SHIPBUILDING COUNTRIES (on-delivery)	0.33	1.00	1.00		0.200	0.333
					CI	0.000
					CR	0.0%

11.4 Annex D: Data (GCS Companies)

11.4.1 Fundamental Accounting Data

		1997	1998	1999	2000	2001	2002
ANEK	Total liabilities	24.793.641.866	24.726.451.316	45.994.163.070	103.221.132.034	131.412.896.608	120.637.199.055
GrD	Total assets	44.017.653.291	63.525.195.305	95.485.290.711	163.523.907.298	190.045.828.721	183.550.178.714
Company	Fixed Assets	35.611.699.100	33.555.993.747	69.277.249.696	133.392.412.792	162.188.369.396	158.575.702.158
	Stockholder's Equity	19.224.011.425	38.798.743.989	49.491.127.641	60.302.775.264	58.632.832.113	62.226.667.083
	Long-term Liabilities	14.482.306.607	12.827.531.692	34.935.128.985	86.757.102.909	95.996.318.499	109.544.976.095
	Current Assets	8.021.567.099	27.462.682.553	18.083.606.039	19.754.964.412	17.881.544.924	15.799.075.641
	Current Liabilities	9.829.390.425	11.415.661.196	10.401.976.788	15.895.633.456	34.627.330.496	11.092.222.957
	Liquid Assets	326.095.994	19.152.716.694	6.272.729.617	4.324.005.249	2.362.610.771	2.403.436.369
	Sales Revenue	9.190.241.134	11.205.223.250	10.215.702.854	10.409.139.271	14.119.608.047	17.073.406.191
	Avrg Accounts Receivable	6.234.894.669	6.055.987.633	8.172.427.153	11.542.923.058	13.015.976.072	13.059.764.615
	Gross Profit	5.093.157.356	7.011.387.141	5.588.573.443	5.619.086.383	7.143.523.841	9.420.189.629
	Operating Income	4.003.769.883	5.874.303.674	5.461.990.814	1.481.850.025	200.543.165	2.647.373.907
	Net Income a t	3.791.530.806	5.004.517.714	4.447.123.433	1.317.206.294	-1.658.028.007	2.375.749.324
NEL	Total liabilities	7.771.040.590	10.840.295.019	16.069.375.077	26.862.457.882	51.519.108.188	51.024.374.455
	Total assets	14.596.242.899	18.158.154.069	40.809.369.683	48.869.197.554	71.573.975.176	68.275.011.787
	Fixed Assets	10.976.288.141	14.051.127.128	27.715.195.250	42.737.235.458	63.544.352.225	61.562.457.443
	Stockholder's Equity	6.825.202.309	7.317.859.050	24.739.994.606	22.006.739.672	20.054.866.988	15.958.350.625
	Long-term Liabilities	5.131.946.784	7.371.403.700	10.811.673.166	21.359.955.464	43.329.402.261	41.201.092.940
	Current Assets	2.392.299.344	2.585.754.947	10.241.012.572	4.187.094.379	3.234.634.080	4.602.910.768
	Current Liabilities	2.540.292.146	3.339.090.225	5.102.983.932	5.219.345.353	7.180.066.472	9.823.281.515
	Liquid Assets	905.816.164	439.649.685	7.340.414.102	1.413.326.085	205.036.451	394.205.282
	Sales Revenue	1.976.804.058	2.475.570.413	2.229.765.479	-92.966.570	1.126.786.205	4.680.121.702
	Avrg Accounts Receivable	1.194.313.645	1.672.511.684	2.356.550.572	2.665.470.306	2.717.749.567	3.431.164.643
	Gross Profit	1.488.380.788	1.888.974.066	1.563.795.785	-995.517.312	-434.319.920	2.857.853.870
	Operating Income	1.097.110.182	1.464.709.604	1.387.167.018	-1.888.468.659	-1.597.992.718	1.297.543.942
	Net Income at	1.787.207.358	1.992.777.952	1.999.201.298	-2.080.648.468	-1.896.344.749	119.688.148
MINOA	Total liabilities	44.823.869.631	64.528.832.236	79.193.790.383	111.676.209.627	223.941.277.914	245.996.936.259
	Total assets	73.767.120.725	114.054.152.555	217.060.693.161	249.674.353.411	345.022.296.048	358.471.269.681
	Fixed Assets	66.470.381.878	99.621.462.987	150.140.223.498	210.114.742.256	314.742.597.679	335.019.819.248
	Stockholder's Equity	28.943.251.093	49.525.320.319	137.866.902.778	137.998.143.784	121.081.018.134	112.474.333.422
	Long-term Liabilities	31.050.862.051	47.193.570.352	53.096.482.738	81.029.820.395	128.485.161.953	164.279.675.299
	Current Assets	6.773.870.068	11.676.783.505	60.675.502.972	33.133.348.673	24.062.542.819	19.846.617.512
	Current Liabilities	12.148.197.067	15.943.395.867	24.137.440.974	28.255.681.197	92.853.660.715	77.928.997.550
	Liquid Assets	1.623.540.855	3.294.503.184	53.626.620.412	22.865.409.973	9.729.367.178	5.482.179.256
	Sales Revenue	12.028.630.592	18.653.158.669	18.086.319.811	12.583.907.562	11.334.350.349	18.774.231.281
	Avrg Accounts Receivable	4.754.619.636	5.613.309.570	6.516.853.255	7.432.524.600	10.956.368.614	12.847.068.104
	Gross Profit	6.174.909.922	11.034.327.860	8.959.010.911	2.689.411.313	619.051.714	7.463.170.653
	Operating Income	5.603.401.680	8.933.419.291	8.501.325.941	2.931.476.563	-8.179.081.337	-7.428.013.871
	Net Income at	6.793.145.863	10.479.442.214	16.194.434.225	3.027.311.059	-4.667.554.452	*-8.846.445.135*
STRINTZIS	Total liabilities	*23.212.426.000*	27.854.141.297	45.209.311.194	75.479.795.837	70.530.327.035	96.176.470.275
GROUP	Total assets	*48.499.102.000*	80.777.555.244	103.125.771.681	164.103.806.187	159.207.411.733	184.892.480.502
	Fixed Assets	*39.527.952.000*	68.700.431.160	85.303.004.560	133.353.239.431	139.352.885.245	153.885.030.389
	Stockholder's Equity	*25.286.676.000*	52.531.685.197	57.476.804.921	85.837.779.913	86.617.260.761	86.400.867.902

	Long-term Liabilities	*15.441.177.000*	19.267.692.571	36.200.945.340	61.862.621.428	54.773.644.810	82.556.660.810
	Current Assets	*6.785.903.000*	9.396.634.550	13.373.821.164	28.459.209.218	17.053.243.020	27.779.408.186
	Current Liabilities	*7.590.168.000*	8.586.448.726	9.008.365.854	13.617.174.409	15.756.682.225	13.619.809.398
	Liquid Assets	*1.739.182.000*	3.753.399.637	6.679.188.937	19.151.093.943	6.813.895.931	14.817.864.613
	Sales Revenue	*6.275.456.000*	7.556.060.528	7.100.827.039	7.205.510.678	9.418.846.456	11.488.348.924
	Avrg Accounts Receivable	*4.425.440.000*	4.746.606.909	*2.987.958.108*	7.208.134.630	8.923.496.536	10.722.250.731
	Gross Profit	*3.236.435.000*	3.816.155.326	3.134.396.372	2.922.314.471	4.936.173.062	5.128.710.732
	Operating Income	*1.897.750.000*	2.804.980.748	3.661.169.491	576.576.766	1.221.295.454	2.089.059.196
	Net Income at	*1.364.251.000*	2.375.740.017	3.019.546.548	611.069.445	1.333.391.270	1.379.777.164
EPATT	**Total liabilities**	25.270.573.435	67.678.835.459	62.950.101.960	148.017.279.139	280.568.880.013	388.592.906.868
	Total assets	56.071.158.058	124.785.572.067	192.615.405.779	327.575.753.039	444.569.316.912	552.423.630.675
	Fixed Assets	41.727.588.744	93.988.088.775	144.934.227.219	255.939.941.153	393.500.641.712	468.853.799.040
	Stockholder's Equity	30.800.584.623	57.106.736.608	129.655.303.819	179.558.473.900	164.000.436.899	163.830.723.807
	Long-term Liabilities	19.445.897.434	55.482.967.402	51.433.136.855	109.449.877.251	234.816.479.440	334.354.934.224
	Current Assets	14.058.113.509	29.349.722.585	45.716.622.434	46.650.334.914	45.849.184.179	77.532.192.376
	Current Liabilities	4.503.786.387	9.262.640.649	9.821.969.832	33.295.668.489	37.723.797.945	39.459.176.449
	Liquid Assets	11.116.041.790	25.022.250.239	40.901.740.684	30.903.328.808	25.958.009.472	52.149.177.099
	Sales Revenue	9.708.376.066	14.857.209.743	15.692.506.622	21.839.744.272	23.482.320.514	29.466.146.893
	Avrg Accounts Receivable	2.768.087.563	3.380.389.668	4.252.355.020	9.465.387.329	16.484.568.554	21.101.138.175
	Gross Profit	5.704.906.532	9.483.404.517	9.664.569.506	10.216.781.047	8.618.906.816	9.546.476.075
	Operating Income	5.417.692.976	9.487.195.401	8.928.156.958	7.030.381.969	-1.668.261.054	-3.162.099.626
	Net Income at	5.268.429.666	9.066.875.020	9.111.613.586	5.907.490.015	3.499.309.715	2.311.371.492

11.4.2 Management Related Data

		1997	1998	1999	2000	2001	2002
ANEK	Average Age of the fleet	18,0	19,0	20,0	21,0	18,6	18,0
	Certification	0,1	0,15	0,25	0,6	0,8	0,75
	IPO-listing	0	1	2	3	4	5
	training €/employee	GRD 24.713	GRD 25.371	GRD 21.056	GRD 20.584	GRD 20.584	GRD 20.584
NEL	Average Age of the fleet	25,7	26,7	27,7	28,7	25,6	16,9
	Certification	0,05	0,3	0,3	0,3	0,35	0,3
	IPO-listing	3	4	5	6	7	8
	training €/employee	GRD 0	GRD 0	GRD 0	GRD 0	GRD 0	GRD 0
MINOA	Average Age of the fleet	23,3	22,2	21,3	16,6	16,3	11,1
	Certification	0,4	0,4	0,4	0,85	0,9	0,85
	IPO-listing	0	1	2	3	4	5
	training €/employee	GRD 3.847	GRD 6.116	GRD 7.395	GRD 5.807	GRD 6.036	GRD 6.036
STRINTZIS	Average Age of the fleet	21,1	22,1	18,2	19,2	15,4	16,4
	Certification	0,45	0,35	0,75	0,75	0,75	0,9
	IPO-listing	4	5	6	7	8	9
	training €/employee	GRD 0	GRD 0	GRD 0	GRD 0	GRD 0	GRD 0
EPATT	Average Age of the fleet	2,0	3,0	2,5	3,5	3,3	3,5
	Certification	0,4	0,7	0,7	0,8	0,8	0,8
	IPO-listing	4	5	6	7	8	9
	training €/employee	GRD 45.455	GRD 18.692	GRD 13.889	GRD 6.892	GRD 6.013	GRD 5.432

11.4.3 Logistics Service Data

		1997	1998	1999	2000	2001	2002
ANEK	Aegean coverage	11,4%	11,4%	11,4%	11,4%	11,4%	11,4%
	Ionian coverage	25,0%	25,0%	25,0%	25,0%	25,0%	25,0%
	Adria coverage	80,0%	80,0%	80,0%	80,0%	80,0%	80,0%
	no of executed sailings						
	average pass fare - GR	4.933	5.287	5.805	5.727	6.092	6.792
	average pass fare - Int	18.234	17.458	17.328	14.635	17.550	18.370
	average car fare - GR	14.587	14.592	15.302	14.097	13.971	14.700
	average car fare - Int	22.201	27.465	22.655	19.750	23.310	23.141
	average truck fare - GR	53.398	55.932	54.567	54.589	56.036	52.324
	average truck fare - Int	136.600	140.245	144.186	164.414	178.424	197.387
NEL	Aegean coverage	17,1%	17,1%	20,0%	22,9%	51,4%	51,4%
	Ionian coverage	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%
	Adria coverage	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%
	no of executed sailings	750	800	870	1180	1100	1074
	average pass fare - GR	5078	5520,2	5758,7	5622,4	6440,2	8791,4
	average pass fare - Int						
	average car fare - GR	30833	31364,2	32276,4	29026,7	37336,9	29937,5
	average car fare - Int						
	average truck fare - GR	30807	31265,6	32261,6	29037,1	37287,4	29898,2
	average truck fare - Int						
MINOA	Aegean coverage	11,4%	11,4%	11,4%	11,4%	11,4%	11,4%
	Ionian coverage	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%
	Adria coverage	60,0%	60,0%	60,0%	60,0%	60,0%	60,0%
	no of executed sailings	2612					
	average pass fare - GR	6.065	6.575	6.397	6.218	5.993	7.571
	average pass fare - Int	18.056	22.377	22.271	22.166	21.449	20.520
	average car fare - GR	14.272	14.371	14.001	13.630	15.119	18.843
	average car fare - Int	23.911	28.719	27.143	25.566	28.155	26.012
	average truck fare - GR	58.294	61.977	58.908	55.839	61.789	54.628
	average truck fare - Int	124.018	137.741	144.013	150.284	155.667	186.629
STRINTZIS	Aegean coverage	45,7%	48,6%	51,4%	51,4%	57,1%	57,1%
	Ionian coverage	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%
	Adria coverage	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%
	no of executed sailings						
	average pass fare - GR	*4.072*	*4.780*	*4.077*	*3.924*	*4.204*	*4.806*
	average pass fare - Int	*13.435*	*16.053*	*13.231*	*12.089*	*13.566*	*13.012*
	average car fare - GR	*10.684*	*11.672*	*9.790*	*9.108*	*10.119*	*11.223*
	average car fare - Int	*17.072*	*22.642*	*16.638*	*14.886*	*17.903*	*16.446*
	average truck fare - GR	*41.351*	*47.516*	*37.914*	*36.274*	*40.986*	*35.785*
	average truck fare - Int	*96.487*	*112.026*	*96.292*	*103.374*	*116.215*	*128.488*
EPATT	Aegean coverage	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%
	Ionian coverage	25,0%	25,0%	25,0%	25,0%	25,0%	25,0%
	Adria coverage	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%
	no of executed sailings	603					
	average pass fare - GR						
	average pass fare - Int	*16.575*	*18.629*	*17.610*	*20.371*	*22.778*	*25.951*
	average car fare - GR						

	average car fare - Int	*21.061*	*26.275*	*22.145*	*25.084*	*30.059*	*32.800*
	average truck fare - GR						
	average truck fare - Int	*119.035*	*130.004*	*128.164*	*174.197*	*195.133*	*256.252*

11.4.4 Stock Performance Data

		1997	1998	1999	2000	2001	2002
ANEK	market value ps	*855*	*1693*	3662	1015	729	*361*
	capitalization	19.224.011.425	38.798.743.989	204.330.851.222	56.644.482.206	40.691.235.959	20.155.472.017
	divident %	16,37%	5,91%	0,00%	0,00%	0,00%	0,00%
	General Index	1479,63	2737,55	5535,09	3388,86	2591,56	1748,42
	long term liab.	14.482.306.607	12.827.531.692	34.935.128.985	86.757.102.909	95.996.318.499	109.544.976.095
	current assets	8.021.567.099	27.462.682.553	18.083.606.039	19.754.964.412	17.881.544.924	15.799.075.641
	net working capital	-1.807.823.326	16.047.021.357	7.681.629.251	3.859.330.956	-16.745.785.572	4.706.852.684
	liquid assets	326.095.994	19.152.716.694	6.272.729.617	4.324.005.249	2.362.610.771	2.403.436.369
	net income after tax	3.791.530.806	5.004.517.714	4.447.123.433	1.317.206.294	-1.658.028.007	2.375.749.324
	no of shares	22.478.009	22.919.945	55.802.190	55.802.190	55.802.190	55.802.190
NEL	market value ps	702	756	1700	651	497	228
	capitalization	10529175000	11346975000	25505137500	26103123914	19953173254	9156593205
	divident %	*2%*	*2%*	*2%*	*2%*	*2%*	*2%*
	General Index	1479,63	2737,55	5535,09	3388,86	2591,56	1748,42
	long term liab.	5.131.946.784	7.371.403.700	10.811.673.166	21.359.955.464	43.329.402.261	41.201.092.940
	current assets	2.392.299.344	2.585.754.947	10.241.012.572	4.187.094.379	3.234.634.080	4.602.910.768
	net working capital	-147.992.802	-753.335.278	5.138.028.640	-1.032.250.974	-3.945.432.392	-5.220.370.748
	liquid assets	905.816.164	439.649.685	7.340.414.102	1.413.326.085	205.036.451	394.205.282
	net income after tax	1.787.207.358	1.992.777.952	1.999.201.298	-2.080.648.468	-1.896.344.749	119.688.148
	no of shares	*15.000.000*	*15.000.000*	*15.000.000*	40.107.284	40.107.284	40.107.284
MINOA	market value ps	*1455*	2879	6754	1929	838	368
	capitalization	28.943.251.093	126.419.027.458	431.987.551.456	136.791.075.270	59.453.364.870	26.101.477.260
	divident %	0%	0,02%	0,00%	0,00%	0,00%	0,00%
	General Index	1479,63	2737,55	5535,09	3388,86	2591,56	1748,42
	long term liab.	31.050.862.051	47.193.570.352	53.096.482.738	81.029.820.395	128.485.161.953	164.279.675.299
	current assets	6.773.870.068	11.676.783.505	60.675.502.972	33.133.348.673	24.062.542.819	19.846.617.512
	net working capital	-5.374.326.999	-4.266.612.362	36.538.061.998	4.877.667.476	-68.791.117.896	-58.082.380.038
	liquid assets	1.623.540.855	3.294.503.184	53.626.620.412	22.865.409.973	9.729.367.178	5.482.179.256
	net income after tax	6.793.145.863	10.479.442.214	16.194.434.225	3.027.311.059	-4.667.554.452	-8.846.445.135
	no of shares	19.893.250	43.910.792	63.963.426	70.926.000	70.926.000	70.926.000
STRINTZIS	market value ps	335	433	6109	2201	545	416
	capitalization	6.231.772.450	16.066.203.138	226.800.388.144	231.105.000.000	57.246.000.000	43721632500
	divident %	0%	0,03%	0,00%	0,00%	0,00%	0,00%
	General Index	1479,63	2737,55	5535,09	3388,86	2591,56	1748,42
	long term liab.	15.441.177.000	19.267.692.571	36.200.945.340	61.862.621.428	54.773.644.810	82.556.660.810
	current assets	6.785.903.000	9.396.634.550	13.373.821.164	28.459.209.218	17.053.243.020	27.779.408.186
	net working capital	-804.265.000	810.185.824	4.365.455.310	14.842.034.809	1.296.560.795	14.159.598.789
	liquid assets	1.739.182.000	3.753.399.637	6.679.188.937	19.151.093.943	6.813.895.931	14.817.864.613
	net income after	1.364.251.000	2.375.740.017	3.019.546.548	611.069.445	1.333.391.270	1.379.777.164

	tax						
	no of shares	18.604.680	37.125.616	37.125.616	105.000.000	105.000.000	105.000.000
EPATT	market value ps	1588	2510	6300	2815	1731	842
	capitalization	50.079.168.000	189.972.864.000	656.342.885.195	293.206.718.860	180.325.681.817	87.678.038.206
	divident %	3,15%	1,20%	0,00%	0,00%	0,00%	0,00%
	General Index	1479,63	2737,55	5535,09	3388,86	2591,56	1748,42
	long term liab.	19.445.897.434	55.482.967.402	51.433.136.855	109.449.877.251	234.816.479.440	334.354.934.224
	current assets	14.058.113.509	29.349.722.585	45.716.622.434	46.650.334.914	45.849.184.179	77.532.192.376
	net working capital	9.554.327.122	20.087.081.936	35.894.652.602	13.354.666.425	8.125.386.234	38.073.015.927
	liquid assets	11.116.041.790	25.022.250.239	40.901.740.684	30.903.328.808	25.958.009.472	52.149.177.099
	net income after tax	5.268.429.666	9.066.875.020	9.111.613.586	5.907.490.015	3.499.309.715	2.311.371.492
	no of shares	31.536.000	75.686.400	104.173.680	104.173.680	104.173.680	104.173.680

11.4.5 Market Environment Data

		1997	1998	1999	2000	2001	2002
ANEK	% intermediaries cost of turnover	9,9%	9,9%	9,9%	9,9%	9,9%	9,9%
	% of new tech ships in the fleet	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%
	% suppliers (incl. Fuel) of turnover	31,7%	29,7%	36,0%	42,3%	44,0%	43,0%
	% donations of turnover	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%
NEL	% intermediaries cost of turnover	7,1%	7,1%	7,1%	7,0%	7,1%	7,3%
	% of new tech ships in the fleet	0,0%	0,0%	0,0%	0,0%	14,3%	42,9%
	% suppliers (incl. Fuel) of turnover	32,2%	30,8%	30,6%	54,1%	48,4%	42,3%
	% donations of turnover	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%
MINOA	% intermediaries cost of turnover	9,6%	10,0%	10,1%	10,8%	9,4%	7,6%
	% of new tech ships in the fleet	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%
	% suppliers (incl. Fuel) of turnover	34,1%	30,7%	39,8%	49,2%	55,6%	42,8%
	% donations of turnover	0,0%	0,2%	0,5%	0,3%	0,2%	0,8%
STRINTZIS	% intermediaries cost of turnover	8,9%	8,9%	10,4%	7,9%	8,0%	8,8%
	% of new tech ships in the fleet	0,0%	0,0%	22,2%	22,2%	16,7%	16,7%
	% suppliers (incl. Fuel) of turnover	42,5%	38,5%	43,6%	49,0%	46,3%	44,0%
	% donations of turnover	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%
EPATT	% intermediaries cost of turnover	18,4%	14,4%	14,4%	11,6%	11,9%	12,8%
	% of new tech ships in the fleet	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%
	% suppliers (incl. Fuel) of turnover	48,2%	48,2%	48,2%	48,2%	47,7%	48,7%
	% donations of turnover	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%

11.4.6 Competition Data

		1997	1998	1999	2000	2001	2002
ANEK	market share (turnover)	25,2%	22,7%	23,1%	19,6%	20,8%	19,2%
	market share (pass-total)	23,4%	23,6%	24,2%	22,4%	22,6%	23,2%
	market share (cars-total)	23,7%	22,6%	23,0%	21,8%	24,3%	24,7%
	market share (trucks-total)	27,9%	26,2%	25,0%	26,0%	26,3%	26,8%
	%differentiation (out/total)	58,7%	58,8%	50,1%	50,8%	63,7%	61,6%
	profit margin	34,3%	36,9%	30,2%	26,8%	28,8%	31,3%
	services/total revenue	15,4%	15,1%	13,0%	12,2%	12,1%	13,2%
NEL	market share (turnover)	7,6%	6,8%	6,9%	5,8%	6,1%	6,7%
	market share (pass-total)	15,6%	15,4%	14,7%	14,9%	13,6%	15,0%
	market share (cars-total)	10,8%	10,6%	10,7%	10,9%	9,6%	10,9%

	market share (trucks-total)	12,2%	11,0%	9,4%	9,3%	8,3%	6,8%
	%differentiation (out/total)	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%
	profit margin	24,5%	27,3%	22,0%	-0,8%	7,8%	24,6%
	services/total revenue	3,7%	3,7%	3,7%	1,0%	8,8%	9,3%
MINOA	market share (turnover)	32,5%	32,3%	31,6%	23,5%	21,4%	21,5%
	market share (pass-total)	28,2%	27,0%	23,8%	19,9%	22,9%	20,8%
	market share (cars-total)	27,5%	28,8%	26,4%	24,1%	24,3%	22,1%
	market share (trucks-total)	27,2%	25,3%	25,8%	22,3%	24,5%	26,3%
	%differentiation (out/total)	64,7%	69,5%	71,6%	25,3%	31,5%	67,8%
	profit margin	34,8%	43,1%	39,1%	27,0%	22,5%	30,7%
	services/total revenue	18,5%	19,1%	16,4%	15,3%	14,4%	14,6%
STRINTZIS	market share (turnover)	19,4%	18,1%	18,2%	17,1%	15,6%	14,3%
	market share (pass-total)	27,9%	25,4%	28,3%	33,8%	32,1%	33,2%
	market share (cars-total)	30,9%	27,5%	28,6%	32,6%	31,7%	33,6%
	market share (trucks-total)	21,1%	19,0%	22,0%	25,4%	22,1%	20,6%
	%differentiation (out/total)	82,2%	79,6%	74,0%	76,7%	70,7%	58,8%
	profit margin	30,4%	31,2%	26,5%	21,2%	25,7%	28,3%
	services/total revenue	14,9%	14,9%	14,9%	14,9%	14,9%	14,9%
EPATT	market share (turnover)	15,3%	20,1%	20,2%	34,0%	36,2%	38,2%
	market share (pass-total)	4,9%	8,6%	8,9%	9,0%	8,8%	7,9%
	market share (cars-total)	7,1%	10,5%	11,3%	10,5%	10,1%	8,8%
	market share (trucks-total)	11,6%	18,4%	17,7%	17,0%	18,8%	19,5%
	%differentiation (out/total)	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%
	profit margin	59,7%	55,4%	53,0%	32,4%	27,5%	27,1%
	services/total revenue	14,9%	14,9%	14,9%	14,9%	14,9%	14,9%

11.5 Annex E: Calculations (GCS Companies)

Scenarios-based Outcome

int/ext	ext	SP/MEnv	**3**	int	Fund/LS	**3**
1/5		SP/Comp	**5**		Fund/Mgt	**5**

	1997	**1998**	**1999**	**2000**	**2001**	**2002**
ANEK	1,000	0,841	0,975	0,580	0,691	0,691
NEL	0,911	0,740	0,903	0,811	0,890	0,690
MINOAN	0,919	0,875	1,000	0,634	0,688	0,781
STRINTZIS	0,701	0,613	0,999	1,000	1,000	1,000
EPATT	0,920	1,000	0,988	0,909	0,752	0,760

	1997	**1998**	**1999**	**2000**	**2001**	**2002**
ANEK	***1,00***	0,84	0,97	0,58	0,69	0,69
NEL	0,91	0,74	0,90	0,81	0,89	0,69
MINOAN	0,92	0,87	***1,00***	0,63	0,69	0,78
STRINTZIS	0,70	0,61	1,00	***1,00***	***1,00***	***1,00***
EPATT	0,92	***1,00***	0,99	0,91	0,75	0,76

int/ext	ext	SP/MEnv	5	int	Fund/LS	3
1/5		SP/Comp	7		Fund/Mgt	5

	1997	1998	1999	2000	2001	2002
ANEK	1,000	0,803	0,963	0,581	0,775	0,774
NEL	0,913	0,693	0,876	0,827	1,000	0,754
MINOAN	0,901	0,830	0,994	0,658	0,781	0,856
STRINTZIS	0,694	0,573	0,993	1,000	0,987	1,000
EPATT	0,970	1,000	1,000	0,961	0,862	0,883

	1997	1998	1999	2000	2001	2002
ANEK	***1,00***	0,80	0,96	0,58	0,78	0,77
NEL	0,91	0,69	0,88	0,83	***1,00***	0,75
MINOAN	0,90	0,83	0,99	0,66	0,78	0,86
STRINTZIS	0,69	0,57	0,99	***1,00***	0,99	***1,00***
EPATT	0,97	***1,00***	***1,00***	0,96	0,86	0,88

int/ext	ext	SP/MEnv	3	int	Fund/LS	5
1/5		SP/Comp	5		Fund/Mgt	7

	1997	1998	1999	2000	2001	2002
ANEK	1,000	0,846	0,971	0,587	0,708	0,708
NEL	0,909	0,743	0,899	0,837	0,906	0,705
MINOAN	0,925	0,885	1,000	0,645	0,705	0,801
STRINTZIS	0,682	0,606	0,978	1,000	1,000	1,000
EPATT	0,910	1,000	0,975	0,918	0,755	0,760

	1997	1998	1999	2000	2001	2002
ANEK	***1,00***	0,85	0,97	0,59	0,71	0,71
NEL	0,91	0,74	0,90	0,84	0,91	0,70
MINOAN	0,92	0,89	***1,00***	0,64	0,70	0,80
STRINTZIS	0,68	0,61	0,98	***1,00***	***1,00***	***1,00***
EPATT	0,91	***1,00***	0,98	0,92	0,75	0,76

int/ext	ext	SP/MEnv	5	int	Fund/LS	5
1/5		SP/Comp	7		Fund/Mgt	7

	1997	1998	1999	2000	2001	2002
ANEK	1,000	0,808	0,965	0,589	0,781	0,795
NEL	0,911	0,695	0,877	0,853	1,000	0,772
MINOAN	0,908	0,840	1,000	0,669	0,785	0,880
STRINTZIS	0,675	0,566	0,978	1,000	0,966	1,000
EPATT	0,959	1,000	0,994	0,971	0,851	0,886

	1997	1998	1999	2000	2001	2002
ANEK	***1,00***	0,81	0,96	0,59	0,78	0,79
NEL	0,91	0,70	0,88	0,85	***1,00***	0,77
MINOAN	0,91	0,84	***1,00***	0,67	0,79	0,88
STRINTZIS	0,68	0,57	0,98	***1,00***	0,97	***1,00***
EPATT	0,96	***1,00***	0,99	0,97	0,85	0,89

int/ext	ext	SP/MEnv	3	int	Fund/LS	3
1/3		SP/Comp	5		Fund/Mgt	5

	1997	**1998**	**1999**	**2000**	**2001**	**2002**
ANEK	1,000	0,802	0,928	0,586	0,692	0,695
NEL	0,915	0,721	0,879	0,869	0,874	0,731
MINOAN	0,917	0,833	0,954	0,645	0,693	0,792
STRINTZIS	0,713	0,599	0,967	1,000	1,000	1,000
EPATT	0,976	1,000	1,000	0,958	0,785	0,770

	1997	**1998**	**1999**	**2000**	**2001**	**2002**
ANEK	***1,00***	0,80	0,93	0,59	0,69	0,70
NEL	0,91	0,72	0,88	0,87	0,87	0,73
MINOAN	0,92	0,83	0,95	0,64	0,69	0,79
STRINTZIS	0,71	0,60	0,97	***1,00***	***1,00***	***1,00***
EPATT	0,98	***1,00***	***1,00***	0,96	0,79	0,77

int/ext	ext	SP/MEnv	5	int	Fund/LS	3
1/3		SP/Comp	7		Fund/Mgt	5

	1997	**1998**	**1999**	**2000**	**2001**	**2002**
ANEK	0,980	0,771	0,910	0,584	0,774	0,769
NEL	0,899	0,681	0,847	0,879	0,980	0,792
MINOAN	0,884	0,797	0,942	0,663	0,784	0,860
STRINTZIS	0,693	0,565	0,953	0,995	1,000	1,000
EPATT	1,000	1,000	1,000	1,000	0,895	0,880

	1997	**1998**	**1999**	**2000**	**2001**	**2002**
ANEK	0,98	0,77	0,91	0,58	0,77	0,77
NEL	0,90	0,68	0,85	0,88	0,98	0,79
MINOAN	0,88	0,80	0,94	0,66	0,78	0,86
STRINTZIS	0,69	0,56	0,95	0,99	***1,00***	***1,00***
EPATT	***1,00***	***1,00***	***1,00***	***1,00***	0,90	0,88

int/ext	ext	SP/MEnv	3	int	Fund/LS	5
1/3		SP/Comp	5		Fund/Mgt	7

	1997	**1998**	**1999**	**2000**	**2001**	**2002**
ANEK	1,000	0,809	0,940	0,598	0,718	0,722
NEL	0,912	0,725	0,889	0,912	0,898	0,755
MINOAN	0,926	0,848	0,972	0,662	0,718	0,823
STRINTZIS	0,685	0,588	0,954	1,000	1,000	1,000
EPATT	0,960	1,000	1,000	0,973	0,791	0,770

	1997	**1998**	**1999**	**2000**	**2001**	**2002**
ANEK	***1,00***	0,81	0,94	0,60	0,72	0,72
NEL	0,91	0,72	0,89	0,91	0,90	0,76
MINOAN	0,93	0,85	0,97	0,66	0,72	0,82
STRINTZIS	0,68	0,59	0,95	***1,00***	***1,00***	***1,00***
EPATT	0,96	***1,00***	***1,00***	0,97	0,79	0,77

int/ext	ext	SP/MEnv	5	int	Fund/LS	5
1/3		SP/Comp	7		Fund/Mgt	7

	1997	1998	1999	2000	2001	2002
ANEK	0,997	0,778	0,921	0,586	0,798	0,802
NEL	0,911	0,685	0,856	0,905	1,000	0,821
MINOAN	0,908	0,811	0,959	0,669	0,806	0,897
STRINTZIS	0,677	0,554	0,940	0,978	0,990	1,000
EPATT	1,000	1,000	1,000	1,000	0,896	0,885

	1997	1998	1999	2000	2001	2002
ANEK	1,00	0,78	0,92	0,59	0,80	0,80
NEL	0,91	0,68	0,86	0,91	***1,00***	0,82
MINOAN	0,91	0,81	0,96	0,67	0,81	0,90
STRINTZIS	0,68	0,55	0,94	0,98	0,99	***1,00***
EPATT	***1,00***	***1,00***	***1,00***	***1,00***	0,90	0,88

int/ext	ext	SP/MEnv	3	int	Fund/LS	3
1		SP/Comp	5		Fund/Mgt	5

	1997	1998	1999	2000	2001	2002
ANEK	0,885	0,702	0,770	0,540	0,694	0,709
NEL	0,820	0,673	0,783	0,949	0,829	0,856
MINOAN	0,806	0,728	0,799	0,606	0,708	0,824
STRINTZIS	0,659	0,562	0,848	0,890	1,000	1,000
EPATT	1,000	1,000	1,000	1,000	0,880	0,797

	1997	1998	1999	2000	2001	2002
ANEK	0,88	0,70	0,77	0,54	0,69	0,71
NEL	0,82	0,67	0,78	0,95	0,83	0,86
MINOAN	0,81	0,73	0,80	0,61	0,71	0,82
STRINTZIS	0,66	0,56	0,85	0,89	***1,00***	***1,00***
EPATT	***1,00***	***1,00***	***1,00***	***1,00***	0,88	0,80

int/ext	ext	SP/MEnv	5	int	Fund/LS	3
1		SP/Comp	7		Fund/Mgt	5

	1997	1998	1999	2000	2001	2002
ANEK	0,864	0,687	0,765	0,524	0,744	0,758
NEL	0,801	0,650	0,767	0,929	0,891	0,903
MINOAN	0,779	0,710	0,797	0,602	0,764	0,870
STRINTZIS	0,641	0,543	0,844	0,864	1,000	1,000
EPATT	1,000	1,000	1,000	1,000	0,952	0,871

	1997	1998	1999	2000	2001	2002
ANEK	0,86	0,69	0,76	0,52	0,74	0,76
NEL	0,80	0,65	0,77	0,93	0,89	0,90
MINOAN	0,78	0,71	0,80	0,60	0,76	0,87
STRINTZIS	0,64	0,54	0,84	0,86	***1,00***	***1,00***
EPATT	***1,00***	***1,00***	***1,00***	***1,00***	0,95	0,87

int/ext	ext	SP/MEnv	3	int	Fund/LS	5
1		SP/Comp	5		Fund/Mgt	7

	1997	1998	1999	2000	2001	2002
ANEK	0,912	0,716	0,790	0,539	0,745	0,765
NEL	0,840	0,679	0,800	1,000	0,873	0,917
MINOAN	0,846	0,755	0,829	0,612	0,758	0,892
STRINTZIS	0,632	0,543	0,821	0,846	1,000	1,000
EPATT	1,000	1,000	1,000	0,993	0,897	0,800

	1997	1998	1999	2000	2001	2002
ANEK	0,91	0,72	0,79	0,54	0,75	0,76
NEL	0,84	0,68	0,80	***1,00***	0,87	0,92
MINOAN	0,85	0,75	0,83	0,61	0,76	0,89
STRINTZIS	0,63	0,54	0,82	0,85	***1,00***	***1,00***
EPATT	***1,00***	***1,00***	***1,00***	0,99	0,90	0,80

int/ext	ext	SP/MEnv	5	int	Fund/LS	5
1		SP/Comp	7		Fund/Mgt	7

	1997	1998	1999	2000	2001	2002
ANEK	0,890	0,700	0,784	0,527	0,803	0,822
NEL	0,821	0,657	0,783	0,983	0,943	0,972
MINOAN	0,818	0,736	0,826	0,612	0,821	0,947
STRINTZIS	0,613	0,525	0,817	0,826	1,000	1,000
EPATT	1,000	1,000	1,000	1,000	0,977	0,880

	1997	1998	1999	2000	2001	2002
ANEK	0,89	0,70	0,78	0,53	0,80	0,82
NEL	0,82	0,66	0,78	0,98	0,94	0,97
MINOAN	0,82	0,74	0,83	0,61	0,82	0,95
STRINTZIS	0,61	0,52	0,82	0,83	***1,00***	***1,00***
EPATT	***1,00***	***1,00***	***1,00***	***1,00***	0,98	0,88

int/ext	ext	SP/MEnv	3	int	Fund/LS	3
3		SP/Comp	5		Fund/Mgt	5

	1997	1998	1999	2000	2001	2002
ANEK	0,790	0,624	0,636	0,476	0,696	0,722
NEL	0,739	0,635	0,701	0,986	0,789	0,982
MINOAN	0,716	0,646	0,666	0,546	0,721	0,857
STRINTZIS	0,611	0,534	0,747	0,753	1,000	1,000
EPATT	1,000	1,000	1,000	1,000	0,964	0,825

	1997	1998	1999	2000	2001	2002
ANEK	0,79	0,62	0,64	0,48	0,70	0,72
NEL	0,74	0,63	0,70	0,99	0,79	0,98
MINOAN	0,72	0,65	0,67	0,55	0,72	0,86
STRINTZIS	0,61	0,53	0,75	0,75	***1,00***	***1,00***
EPATT	***1,00***	***1,00***	***1,00***	***1,00***	0,96	0,83

int/ext	ext	SP/MEnv	**5**	int	Fund/LS	**3**
3		SP/Comp	**7**		Fund/Mgt	**5**

	1997	**1998**	**1999**	**2000**	**2001**	**2002**
ANEK	0,782	0,618	0,636	0,470	0,719	0,740
NEL	0,733	0,625	0,695	0,975	0,817	1,000
MINOAN	0,705	0,639	0,668	0,546	0,747	0,873
STRINTZIS	0,604	0,525	0,747	0,743	1,000	0,992
EPATT	1,000	1,000	1,000	1,000	1,000	0,855

	1997	**1998**	**1999**	**2000**	**2001**	**2002**
ANEK	0,78	0,62	0,64	0,47	0,72	0,74
NEL	0,73	0,63	0,69	0,98	0,82	***1,00***
MINOAN	0,71	0,64	0,67	0,55	0,75	0,87
STRINTZIS	0,60	0,53	0,75	0,74	1,00	0,99
EPATT	***1,00***	***1,00***	***1,00***	***1,00***	***1,00***	0,85

int/ext	ext	SP/MEnv	**3**	int	Fund/LS	**5**
3		SP/Comp	**5**		Fund/Mgt	**7**

	1997	**1998**	**1999**	**2000**	**2001**	**2002**
ANEK	0,822	0,642	0,660	0,444	0,771	0,741
NEL	0,764	0,644	0,723	1,000	0,850	1,000
MINOAN	0,765	0,682	0,706	0,521	0,795	0,884
STRINTZIS	0,576	0,508	0,706	0,644	1,000	0,913
EPATT	1,000	1,000	1,000	0,934	0,999	0,760

	1997	**1998**	**1999**	**2000**	**2001**	**2002**
ANEK	0,82	0,64	0,66	0,44	0,77	0,74
NEL	0,76	0,64	0,72	***1,00***	0,85	***1,00***
MINOAN	0,77	0,68	0,71	0,52	0,80	0,88
STRINTZIS	0,58	0,51	0,71	0,64	***1,00***	0,91
EPATT	***1,00***	***1,00***	***1,00***	0,93	1,00	0,76

int/ext	ext	SP/MEnv	**5**	int	Fund/LS	**5**
3		SP/Comp	**7**		Fund/Mgt	**7**

	1997	**1998**	**1999**	**2000**	**2001**	**2002**
ANEK	0,814	0,637	0,659	0,444	0,769	0,746
NEL	0,757	0,634	0,716	1,000	0,849	1,000
MINOAN	0,754	0,675	0,706	0,526	0,795	0,884
STRINTZIS	0,568	0,500	0,706	0,643	0,962	0,885
EPATT	1,000	1,000	1,000	0,945	1,000	0,775

	1997	**1998**	**1999**	**2000**	**2001**	**2002**
ANEK	0,81	0,64	0,66	0,44	0,77	0,75
NEL	0,76	0,63	0,72	***1,00***	0,85	***1,00***
MINOAN	0,75	0,67	0,71	0,53	0,80	0,88
STRINTZIS	0,57	0,50	0,71	0,64	0,96	0,89
EPATT	***1,00***	***1,00***	***1,00***	0,95	***1,00***	0,77

int/ext	ext	SP/MEnv	3	int	Fund/LS	3
5		SP/Comp	5		Fund/Mgt	5

	1997	1998	1999	2000	2001	2002
ANEK	0,764	0,601	0,595	0,456	0,696	0,709
NEL	0,718	0,624	0,677	0,997	0,777	1,000
MINOAN	0,692	0,622	0,627	0,528	0,725	0,848
STRINTZIS	0,598	0,525	0,717	0,711	1,000	0,976
EPATT	1,000	1,000	1,000	1,000	0,991	0,815

	1997	1998	1999	2000	2001	2002
ANEK	0,76	0,60	0,60	0,46	0,70	0,71
NEL	0,72	0,62	0,68	1,00	0,78	***1,00***
MINOAN	0,69	0,62	0,63	0,53	0,73	0,85
STRINTZIS	0,60	0,53	0,72	0,71	***1,00***	0,98
EPATT	***1,00***	***1,00***	***1,00***	***1,00***	0,99	0,81

int/ext	ext	SP/MEnv	5	int	Fund/LS	3
5		SP/Comp	7		Fund/Mgt	5

	1997	1998	1999	2000	2001	2002
ANEK	0,759	0,598	0,596	0,452	0,701	0,712
NEL	0,714	0,618	0,673	0,990	0,783	1,000
MINOAN	0,685	0,618	0,628	0,528	0,732	0,848
STRINTZIS	0,594	0,520	0,717	0,705	0,986	0,959
EPATT	1,000	1,000	1,000	1,000	1,000	0,824

	1997	1998	1999	2000	2001	2002
ANEK	0,76	0,60	0,60	0,45	0,70	0,71
NEL	0,71	0,62	0,67	0,99	0,78	***1,00***
MINOAN	0,69	0,62	0,63	0,53	0,73	0,85
STRINTZIS	0,59	0,52	0,72	0,71	0,99	0,96
EPATT	***1,00***	***1,00***	***1,00***	***1,00***	***1,00***	0,82

int/ext	ext	SP/MEnv	3	int	Fund/LS	5
5		SP/Comp	5		Fund/Mgt	7

	1997	1998	1999	2000	2001	2002
ANEK	0,799	0,621	0,620	0,417	0,756	0,715
NEL	0,744	0,634	0,700	1,000	0,816	1,000
MINOAN	0,744	0,661	0,668	0,494	0,783	0,859
STRINTZIS	0,561	0,498	0,671	0,585	0,969	0,863
EPATT	1,000	1,000	1,000	0,917	1,000	0,729

	1997	1998	1999	2000	2001	2002
ANEK	0,80	0,62	0,62	0,42	0,76	0,72
NEL	0,74	0,63	0,70	***1,00***	0,82	***1,00***
MINOAN	0,74	0,66	0,67	0,49	0,78	0,86
STRINTZIS	0,56	0,50	0,67	0,59	0,97	0,86
EPATT	***1,00***	***1,00***	***1,00***	0,92	***1,00***	0,73

int/ext	ext	SP/MEnv	**5**	int	Fund/LS	**5**
5		SP/Comp	**7**		Fund/Mgt	**7**

	1997	**1998**	**1999**	**2000**	**2001**	**2002**
ANEK	0,793	0,618	0,620	0,417	0,754	0,719
NEL	0,739	0,628	0,695	1,000	0,815	1,000
MINOAN	0,737	0,657	0,669	0,498	0,782	0,859
STRINTZIS	0,556	0,493	0,672	0,585	0,944	0,845
EPATT	1,000	1,000	1,000	0,924	1,000	0,738

	1997	**1998**	**1999**	**2000**	**2001**	**2002**
ANEK	0,79	0,62	0,62	0,42	0,75	0,72
NEL	0,74	0,63	0,70	***1,00***	0,82	***1,00***
MINOAN	0,74	0,66	0,67	0,50	0,78	0,86
STRINTZIS	0,56	0,49	0,67	0,59	0,94	0,85
EPATT	***1,00***	***1,00***	***1,00***	0,92	***1,00***	0,74