DYNAMICS OF THE CO-MOVEMENT BETWEEN STOCK AND MARITIME MARKETS

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ABSTRACT

This study aims to explain the existence of a conditional correlation between maritime markets and stock markets. In such an understanding, observing the existence and level of the relationship will help market participants to make their financial decisions more accurately. By using a Constant Correlation Model with time varying modification and checking for the applicability of a DCC setting on the weekly returns of Dow Jones Index and Baltic Dry Index, we find out that correlation dynamics exhibit important time varying pattern. Our conclusion is that stock market investors should be aware of the degree of the conditional correlation between stock markets and freight markets, and hence of risk spillovers, at the time of their investment.
Keywords: freight rates, stock markets, multivariate volatility modeling

INTRODUCTION

Traditionally investigating the behavior of investors in financial markets is dominated by the risk and return trade off understanding. For a substantial period of time interest is directed to understand the determinants of this process by concentrating on developments in asset prices and also general economic conditions. However recent developments in both financial and real side of the economy direct the interest towards the consideration of different dimensions that shapes the behavior of investors. From this point of view interaction between stock markets as a general benchmark for asset prices and also maritime markets as a strong proxy for an important cost element of production earns importance.

From this perspective the interconnection between stock markets and maritime transportation can be constructed over their distinct relationships with economic growth and international trade. Theoretically impact of stock market development on economic growth and also the increasing integration on economic growth is already formalized. However in this context two points are found to be unsolved in the literature. First of all economic theory prefers to understand the outcomes of capital market developments instead of identifying the motives behind developments in stock markets. Secondly while finance theory examines the motives behind pricing behavior of assets and thus stock market developments it escapes to examine the injection of openness, international trade, into stock market developments.

Following Hicks (1969), who documents the role of capital markets for allowing the transfer of ownership, it's the recent models that formulate the place of capital markets to provide liquidity and also risk sharing (Bencivenga et al., 1996). Consequently while Levine, Zervos (1998) remarks the positive impacts of the stock market development, understanding fails to provide information regarding the determinants of stock market developments. Actually it's the foundation of the finance theory and pricing models that explores different factors for affecting assets returns. It is Ross (1971) to formulate the arbitrage pricing model of capital asset pricing and demonstrate that unlike the unique place of market portfolio, decomposition of different factors behind the process is essential as to determine the asset returns. Later Chen et al (1986) following Ross (1976) and Roll, Ross (1980) emphasize that macroeconomic factors influencing the future expected cash flows or the risk premium of the stocks will affect the pricing behavior. Among those macroeconomic factors; industrial production, change in risk premium, twists in yield curve, unanticipated inflation and changes in expected inflation are found to be vital elements in explaining the expected stock returns (Chen et al, 1986, pp.402).

In such an environment focusing on the different factors behind stock pricing may be influential; hence hypothesizing and introducing a different mechanics will be complementary. In this respect the study proposes the injection of an indicator of international trade into the dialogue. As underlined by Batiz, Romer (1991) and Barro et al. (1995) open economies grow faster with respect to more close economies in the long run. Actually background of the phenomenon is tied to Grossman, Helpman (1994) and Coe, Helpman, (1995) type models, both remarking the unavoidable positive impacts of increasing trade; through the specific role of exchange of ideas, knowledge thus technological spillovers. Yet, in the context of the existing debate, linking these growth opportunities with future profitability of economic activity will not be misleading. Hence leaving aside this theoretical question regarding the place of international trade in the literature, directing the discussion towards the elements of international trade is found to be inevitable. Originating from such a fact, this study finds it vital to identify the role of transportation in the process of international trade. Krugman (1991), inspired by the remarks of international trade theories and regional economics, emphasized that transportation costs acts as one of the major determinants of localization of production. Within the understanding of the ongoing study, remarks of Krugman (1991) are informative as to somehow underline the triangle between transportation costs, localization of production and profitability.

Actually in such a debate, it will not be naive to propose once more that developments in the transportation markets are strictly tied with the real economic activity, thus future profitability. In this scope understanding the path of freight rates as a solid element for observing the developments in transportation markets is essential. While different modes of transportation will direct the focus of the freight rates, concentrating on a specific transportation mode is found to be more informative. Within such a view, specific place of maritime transportation for international trade should be underlined. As discussed by Hummels (1999) the seaborne trade represents more than eighty percent of the world trade transportation in volume and more than half in transported value; therefore the study chooses to concentrate on maritime markets as a powerful tool to underline the cost structure of international trade.

Leaving aside the dynamics behind the determination of freight rates, concentration is redirected towards the inevitable connection between stock markets and maritime transportation. While one can approach the discussion from different perspectives, concentrating toward the risk structure of the process is found to be more informative as to demonstrate the relationship that affects the behavior of the investors in the economy. Within this approach, freight markets enter the agenda of numerous studies where the risk structure of the market is investigated across different transportation markets and time spans (Erdogan 1996, Kavussanos 1996, Kavussanos and Nomikos 1999, Goulielmos 2009). On the other hand concentration in the risk structure of stock markets also enters the realm of other numerous models (French et al., 1987, Akgiray, 1989, Glosten et al. 1993, Koutmos, Both, 1995). More recently, Yang (2005) investigate the conditional correlation between Japan and the four Asian Tigers, namely Taiwan, Singapore, Hong Kong, and South Korea; remarking that correlation between these international markets increase during the time of rising market volatility. While listed discussions have diverted the attention on freigth markest and stock markets seperatly, they do not provide insight for the expetced correlation between each other. Actually, in the knowledge of the ongoing study, a simultaneous and conditional correlation approach to assess the connection between these two specific markets with specific concentration on risk structure is not investigated previously. Originating from such a fact, examining the conditional correlation between stock and freight markets may aid to develop a tool for investigating the future outcomes of world economy. The search will be somehow comparing the volatility in the returns of both markets as a sign for investors; whether there is any significant information for investors to take into account through out their investment decisions. Moreover the period under concern is also expected to shed some light regarding the perception of investors during bad and good times of economy based on the volatility in both markets.

Aiming to provide information regarding the conditional correlation between stock and maritime markets; the paper will first discuss the methodological issues to determine the co-movements plus relationship between volatility in both markets and introduce a time varying modified constant conditional correlation approach. Next data set and the estimation steps will be introduced. Finally the results of the empirical analysis will be stressed. Afterwards the paper will end with a conclusion.

METHODOLOGY

As to account for the maritime transportation, freight rate related data of Baltic Dry Index (BDI) is preferred, while for the stock market data set Dow Jones Industrial Average (DJIA) is used. Baltic Indices provide the average price for freight rates in different 26 routes, which are computed as returns in the study. The daily and weekly data series are obtained from Clarksons Shipping Intelligence Network. Baltic Dry Index is one of the many and widely used, specialized index for the market that dates back to November, 1999. The study covers the period between November 1999-December 2009 for weekly closing prices of BDI and DJIA and contains 509 observations.

Before investigating the central question of the study, first observing the stationarity of the variables under concern is a necessity. In the setting of multivariate time series models, injecting the non-stationary variables into models will cause spurious regression problems. Therefore ADF test (Dickey, Fuller, 1979), PP test (P. Perron, 1988) and KPSS test (Kwiatkowski, Phillips, Schmidt, Shin, 1992) will be applied to determine the integration order of the variables. Note that detection of unit root, thus non-stationary variables, calls for a transformation procedure. However, while obtaining stationary variables by traditional transformation methods is popular, it is heavily criticized by Engle, Granger (1987) and Johansen (1988). The background is the lost information contained in the levels of the data through the transformation procedure. In such cases, it is proposed that a possible cointegration between variables under concern may help one to use the non-stationary variables as a linear combination, which at the ends also yields a stationary error component. As mentioned, the prerequisite of cointegration can be checked by using Johansen cointegration test (Johansen. 1988).

Revisiting the central question of the study, it is worth mentioning that increasing interaction in the capital markets and international trade makes it essential to consider financial markets and maritime markets jointly. That provides hints not only about the univariate behavior but also about the dynamic behavior lying in the core of certain events. The risk spillover among assets and its effects on portfolio selection requires the application of multivariate analysis. The responsiveness to internal and external shocks is what increases the complexity of the dynamics of the relationship between those two markets. A deeper understanding requires an analysis beyond the simple univariate approach. Also, interactions on return level, such as the vector autoregressive setup, are far from being able to reveal the required risk dynamics. While modeling volatility has been subject to increasing attention by using univariate ARCH models, the co-movements between different financial series start to gain popularity among empirical studies. Bollerslev et al. (1994) underlines the efficiency gains in using multivariate models to observe volatility and co-movements. While multivariate GARCH (M-GARCH) models are fashionable and informative, due to the fact that number of parameters rises with the dimension of the model, the specification and estimation procedure of M-GARCH models become complex. Of special interest are the ones allowing for a dynamic setup, so that the risk spillover effects can be observed in a timely manner, on the other hand it allows to asses the nature of the relationship in different economic environments.

In the scope of the M-GARCH modeling, construction of a vector auto regression (VAR) model is essential. BDI and DJIA represent the weekly returns of Baltic Dry index and Dow Jones Industrial Average Index. C is a matrix (2x1) for constants, A is a 2x2 matrix for relevant coefficients. εi represents the residuals. In this setting, a VAR model is applied as a pre-filtration as summarized in equation 1. There is no assumption on the leading variable so the treatment is symmetric and is also supposed to “smooth” the residuals i.e. to reduce their behavior to the level of white noise as much as possible.

(1) $$\begin{bmatrix} BDI \\ DJIA \end{bmatrix}_t = C + \sum_{i=1}^{m} A_i \begin{bmatrix} BDI \\ DJIA \end{bmatrix}_{t-i} + \varepsilon_i$$

In line with suggestion from Engle (2002), we have to test any GARCH effect in the mean equation before estimating the conditional correlation models. Although we require multivariate Q-statistics result, it is adequate to evaluate the individual residuals. For this matter, each residual series has been regressed on a constant term and the resulting squared residuals are obtained and analyzed. As it is expected, the GARCH effect exists. Taking the time variability of the risk characteristics observed in the data sample into account, conditional heteroscedastic approach is implemented. The method applied is a time varying modification adapted to the Constant Correlation Model, which is originally developed by Bollerslev (1990). This is achieved by the direct usage of the correlation coefficient approach, following Tsay (2002). Also a diagonal simplification of the BEKK model of Engle and Kroner (1995) is used. Although it overcomes certain issues like positive definiteness, it still stands before the conditional correlation mentioned above.

In the bivariate case the Constant Conditional Correlation model imposes a condition of constant correlation, which reduces the covariance matrix to a vector of two variances. Despite contributing to the simplicity of the estimation procedure over other full parameterization methods like VECH, the assumption of constant correlation is far from being able to add explanation regarding the direction of the risk dynamics or the spillover between the variables, observable in the figure of the 52-Week moving window. In order to add such a feature to the model the modification developed by Tsay (2002) was used. Since the sign of the correlation is not known prior the estimation the following transformation is adopted:

(2) $$\rho_{12,t} = \frac{e^{q_t} - 1}{e^{q_t} + 1}$$

(3) $$q_t = \alpha_0 + \sum_i \beta_i \rho_{12,t-i} + \alpha_1 \frac{a_{1,t-1} a_{2,t-1}}{\sqrt{\sigma_{11,t-1} \sigma_{22,t-1}}}$$

The first part describes the lag structure of the cross-correlation and the second part the lag structure of the product of the shocks. While the above mentioned CCC approach offered by Tsay (2002) is commonly used in the multivariate volatility literature it has the major drawback regarding the strict assumption of constant correlation. In an augmented case, the similar understanding can be replicated by allowing a dynamic process for the correlation. This application, Dynamic Conditional Correlation (DCC), can be summarizes as in equations 4 and 5.

(4) $$H_{ii}(t) = c_{ii} + \sum_{j} a_{ij} u_{j,t-1}^{2} + \sum_{j} b_{ij} H_{jj,t-1}$$

(5) $$q_t = (1-\theta-\phi) q_0 + \theta u_{t-1} u_{t-1}^{l} + \phi q_{t-1}$$

EMPIRICAL FINDINGS

Before determining the right model to evaluate the conditional correlation, as a preliminary analysis two indicators are checked for presence of unit root. As emphasized previously based on the order of integration, as a further analysis existence of cointegration relationship is also analyzed. Results reported in Table I summarize a number of unit root tests: ADF test (Dickey, Fuller, 1979), PP test (P. Perron, 1988), KPSS (Kwiatkowski, Phillips, Schmidt, Shin, 1992).

Table I – Summary of Unit Root Test Results

	ADF			PP			KPSS		
	H_0 Unit root		Critical Values	H_0 Unit root		Critical Values	H_0 No Unit root		Critical Values
	Y	ΔY	1%:-3.443	Y	ΔY	1%:-3.442	Y	ΔY	1%: 0.739
BDI	-2.351	-8.973	5%: -2.867	-2.271	-18.054	5%: -2.867	1.193	0.048	5%: 0.463
DJIA	-2.079	-23.294	10%: -2.56	-2.096	-23.299	10%: -2.56	0.453	0.064	10%: 0.34

Overall based on the three different unit root specifications, findings indicate that two series are non stationary in their levels and integrated at the same order. Hence observing the cointegrating relationship seems to be a necessity. As also summarized by Johansen (1988), result of the test is sensitive to the lag level of the test. Based on the Schwarz Information Criteria (SIC) and Akaike Information Criteria (AIC) 2 and 5 are selected as the lag order of the cointegration test respectively. Based on the trace statistics reported in Table II, a significant cointegration between two series can not be obtained. Hence estimation procedure is carried out by using the first differenced variables. Such a procedure will prevent us to discuss the long run interaction of stock prices and freight rates, however it will still valuable insight regarding the construction of a multivariate framework (in the form of a VAR), which will constitute the background of the multivariate volatility model at the end.

Table II - Johansen Cointegration Test Results

	Lag Length: 3 (SBIC)		Lag Length: 5 (AIC)	
	Trace Statistics		Trace Statistics	
	r=0	r≤1	r=0	r≤1
BDI-DJIA	13.7779	3.6942	14.8674	4.1729

r: Rank of the cointegration relationship , critical values for trace statistics are 15,41 and 3,76 for r=0 and r≤1 at 5% significance level respectively.

In light of these findings, as a preliminary observation, VAR models are estimated up to 15 lags and based on Akaike Information Criteria (AIC) and Schwarz Information Criteria (SIC), the relevant lag length of the mean equation is determined. Results indicate that AIC and SIC lag length for the VAR model should be 3 and 1 respectively. It seems that usage of 3 as the relevant lag length helps the estimation procedure to capture more dynamics in the relationship. Moreover estimated impulse response functions underline that strength of the model and the overall relationship is found to be identical in both models. In this sense while findings of the VAR type of models are commonly used to evaluate the causal relationships, we regard this out of the scope of this ongoing study, and instead, the residual of the multivariate VAR model is checked for possible signs of volatility by applying the Portmanteau Residual Autocorrelation test. Results imply that VAR model as the main mean model should be augmented towards a (G) ARCH model in the setting of its multivariate nature. Moreover the time varying structure of the correlation between the two variables is presented in Figure I. Information incorporated in the series, evident from the persistence at certain periods opposed to single spikes at others, suggests that the appropriate GARCH structure for the cross-correlation should be like the one mentioned in the methodology.

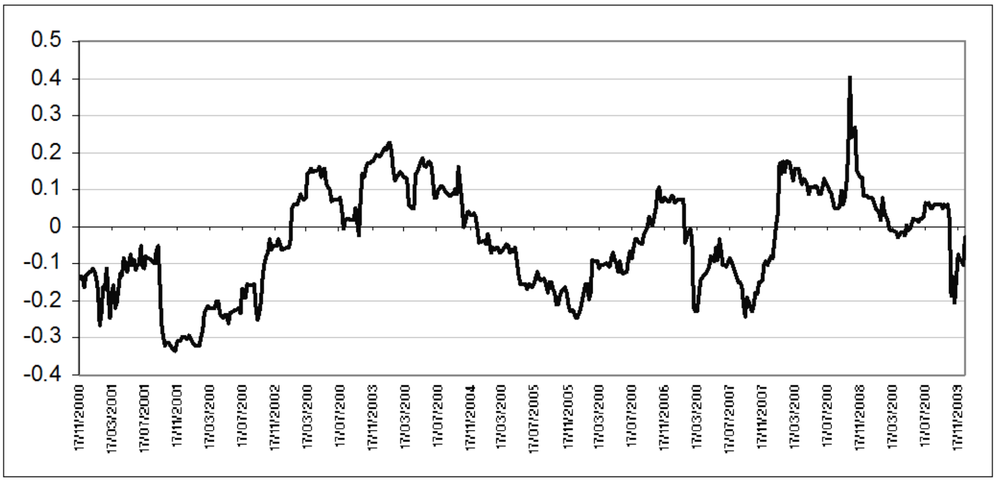

Figure I – Sample Correlation with 52-Week Moving Window

In this scope, as mentioned in the previous methodology part, two separate analyses are implemented. First preliminary analysis is done over the CCC model as discussed in equations 2 and 3. Results reported in

Table III remarks the insignificance of the correlation coefficients. Moreover as summarized in Table IV, the CCC model fails to pass the major diagnostic tests of the multivariate GARH models. Reported Portmanteau test results reveal the existence of autocorrelation in the residuals (in squares). In this setting carrying out the debate towards allowing for a dynamic pattern in the conditional correlation is found to be inevitable.

Table III - CCC Model Summary Results

α_0	-0.0134 (0.05594)
β	0.7071 (1.9974)
α_1	0.0375 (0.0568)

Standard errors in ( )

***, **, * represents significance at 1%, 5% and 10% respectively.

Table IV - Portmanteau Test Results for the CCC Model

Lag Length	BDI Q -Stats	DJI Q-Stats	Bivarate Q-Stats
4	2.2153 (0.137)	5.0934 (0.024)	10.21288 (0.0370)
8	6.5377 (0.257)	6.1966 (0.288)	23.72295 (0.2547)
12	8.8755 (0.449)	9.0618 (0.432)	40.02017 (0.2963)

p values in ( )

As the findings regarding the CCC model fails to capture the conditional correlation in the multivariate GARCH setting and moreover as the arguments illustrated in Table IV, shows us that CCC model fails to pass the diagnostic checks, similar understanding is transferred into a DCC setting by allowing the varying of the conditional correlation. Using equations 4 and 5, the simultaneous relationship between the volatilities of the BDI and DJI (returns) is investigated. Results are summarized in Table V. As can be captured from the model estimate results, most of the coefficients of the variance equation are significant, however as debated by Tsay (2002) and also illustrated by numerous empirical studies, evaluating the coefficients of the variance and square error terms should not be preferred. Hence observing the significance of the coefficients of the equation 5 is found to be more informative. These results are also provided in Table V, lower part of the table. Both coefficients indicate the significant association.

Table V – DCC Model Results

C (1)	C (2)	A (1, 1)	A (1, 2)	A (2, 1)	A (2, 2)
0.11094 (0.3697)	2.04282 *** (0.1835)	0.48644 *** (0.0284)	0.1150 (0.0872)	0.10319 *** (0.0008)	0.3230 *** (0.0230)
B (1, 1)	B (1, 2)	B (2, 1)	B (2, 2)	θ	ϕ
0.6625 *** (0.0313)	1.0723 ** (0.4354)	-0.0797 *** (0.0012)	0.3688 *** (0.0196)	0.1114 *** (0.0079)	0.2728 *** (0.0133)

Standard errors in ( )

***, **, * represents significance at 1%, 5% and 10% respectively.

Results reported in Table V are also controlled for the possible presence of the residual squared autocorrelation as it to check for the sufficiency of the DCC mode to capture the dynamic simultaneous relationship under investigation. Table VI gives a summary of the results for the test, indicating the pass of the DCC model for the major diagnostic check.

Table VI – Portmanteau Test Results for the DCC Model

Lag Length	BDI Q -Stats	DJI Q-Stats	Bivarate Q-Stats
4	0.3901 (0.532)	0.0001 (0.992)	0.950304 (0.9172)
8	6.4440 (0.265)	7.7126) (0.173)	22.22067 (0.3287)
12	8.2866 (0.506)	13.899 (0.126)	49.33160 (0.0685)

p values in ( )

Finally the graph of the dynamic conditional correlation is presented below. In line with the time varying pattern of the model, results illustrated in Figure II indicate the rise in the interconnection during the bad times of the economy, with respect to better periods, which should be regarded as a vital signal for investment decisions.

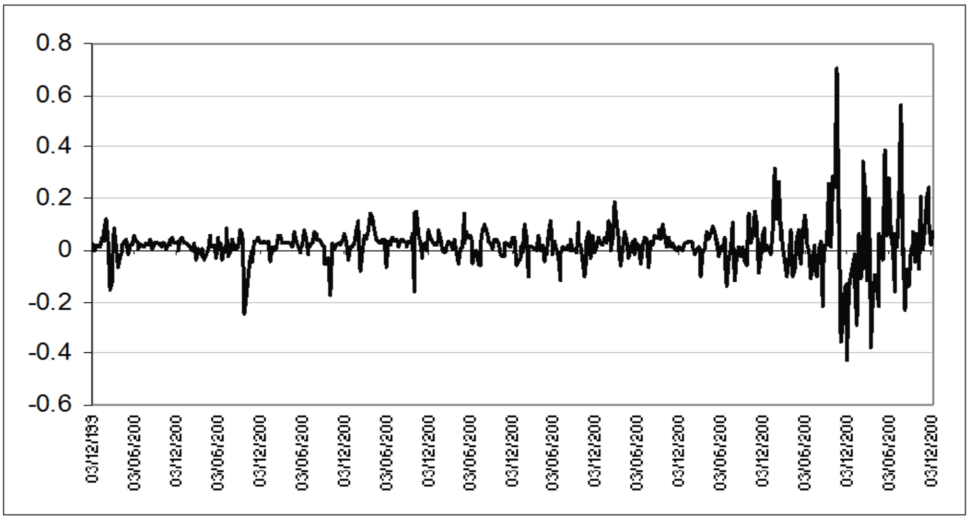

Figure II – Conditional Correlation Coefficient for DCC Model

CONCLUSION

This study demonstrated the connection between stock market returns and freight rates. While doing this, major contribution is expected in approaching the question from a different perspective that allows us to comment on the simultaneous behavior of the volatility structure. This process takes place in the forecast procedures of the agents which can be seen as a process of price discovery. Regarding the freight rates, such discovery is closely related to the production, consumption, and hence transportation means of the economy. On the other hand, changes and revaluation of those means affect the valuation, therefore the expectations about stock prices. Having common factors, with roots in national as well as international economic events, naturally leads to the expectation of common price change patterns at least on time level. Although the means of operation, participation, and price formation are quite distinct, as well as the extent of affection, the clustering of "unusual" price changes is supposed to show similar patterns. In our view a multivariate approach seems inadequate on its own, but it has to allow for dynamic interaction among variables that are under consideration. Aiming to do so, the modified CCC approach and the DCC approach are followed through out the paper. Findings are expected to reflect the changes in the volatility patterns of the two markets. This has important implications on risk management and the evaluation of portfolio formation decisions. Both the time varying pattern and also the strength of volatility relationship underlines the validity of the concerns regarding the need for adopting a multivariate volatility model. Therefore, we believe that this study should increase the awareness of the investors while establishing or modifying their investment decisions, hence the path realized in the two markets can be regarded as a signal for future decision making processes. Moreover as the strength of the relationship is observed to be strongest during the turmoil periods, investors' perception towards risk management should be considered from the view point of the time varying structure if the relationship.

REFERENCES

Akgiray V. (1989). Conditional Heteroscedasticity in Time Series of Stock Returns: Evidence and Forecasts. J Bus., 62-1, 55-80.

Barro R.J., Mankiw N.G., and Martin X.S. (1995). Capital Mobility in Neoclassical Models of Growth. Am Econ Rev, 85-1, 103-115.

Batiz R.L.A., and P. M. Romer. (1991). Economic Integration and Endogenous Growth. The Q J Econ, 106-2, 531-555.

Bencivenga V.R., B. D. Smith, and R. M. Starr. (1996). Equity markets, transactions costs and capital accumulation: an illustration. WB Econ Rev, 10, 241-265.

Bennathan, E., and A. A. Walters. (1969). The economics of ocean freight rates, New York.

Benson, P. and P. Zangari. (1997) A General Approach to Calculating VAR Without Volatilities and Correlations. RiskMetrics Monitor, 2, 19-23.

Bollerslev, T., R. F. Engle, and J. M. Wooldridge. (1988) A Capital Asset Pricing Model with Time-Varying Covariances. J Pol Econ, 96, 116.

Bollerslev, T. (1990). Modelling the Coherence in Short-run Nominal Exchange Rates: a Multivariate Generalized ARCH Approach. Rev Econ Stat. 72, 498–505.

Bollerslev, T., R. F. Engle, and D. B. Nelson. (1994) ARCH Models, In: Handbook of Econometrics (Robert F. Engle, and Daniel L. McFadden eds.), Elsevier.

Brown, S. J., W. N. Goetzmann, and A. Kumar. (1998) The Dow Theory: William Peter Hamilton's Track Record Reconsidered. J Fin, 53, 1311-1333.

Chen N.F., R. Roll, S. A. Ross. (1986). Economic Forces and the Stock Market. J Bus, 59-3, 383-403.

Coe T.D., and E. Helpman. (1995) International R&D spillovers. Euro Econ Rev, 39, 859-887.

Engle, R., and K. F. Kroner. (1995) Multivariate Simultaneous Generalized ARCH. Econometric Theory, 11, 122–150.

Engle, R. F. and C. W. J. Granger. (1987). Co-Integration and Error Correction: Representation, Estimation, andTesting. Econometrica, 55-2, 251-276.

Erdogan, O. (1996). A Comparable Approach to the Theory of Efficient Markets. Capital Market Board, Ankara.

Erdogan, O., N. Berk, and E. Katircioglu. (2000). The Economic Profit Approach in Firm Performance Measurement. Russian & East European Finance & Trade, 36, 54.

Erdogan, O. (2008). An Investigation of the Volatility of Time Charter Markets. Marine Money, 4, 23-27.

French K. R., G. W. Schwert, and R. F. Stambaugh. (1987). Expected stock returns and volatility. J Financial Economics, 19, 23-29.

Glosten L. R., Jagannathan R., and D. E. Runkle. (1993). On the relation between the expected value and the volatility on the nominalexcess returns on stocks. J Finance, 48, 1779-1801.

Goulielmos, A. M. (2009). Risk analysis of the Aframax freight market and of its new building and second hand prices, 1976-2008 and 1984-2008. Int J Shipping and Transport Logistics, 1, 74-97.

Grossman G. M., and E. Helpman. (1994). Endogenous Innovation in the Theory of Growth. J Economic Perspectives, 8, 1, 23-44.

Hicks J. (1969). A Theory of Economic History, Oxford, Clarendon Press.

Hummels, D. (1999). Have international transportation costs declined? National Bureau of Economic Research.

Johansen, S. (1988). Statistical analysis of cointegration vectors. J Economic Dynamics and Control, 12-2/3, 231-254.

Kavussanos, M. G. (1996). Comparisons of Volatility in the Dry-Cargo Ship Sector: Spot versus Time Charters, and Smaller versus Larger Vessels. J Transport Economics and Policy, 30, 67-82.

Kavussanos, M. G., and N. K. Nomikos. (1999). The forward pricing function of the shipping freight futures market. J Futures Markets, 19, 353-376.

Koutmos G., and G.G. Booth. (1995). Asymmetric volatility transmission in international stock markets. J Int Money and Finance, 14, 747-762.

Koopmans, T. C. (1939). Tanker freight rates and tankship building: an analysis of cyclical fluctuations. Haarlem/London.

Krugman, P. (1991) Geography and Trade, MIT Press.

Kumar, S. and J. Hoffmann. (2002). Globalisation: the Maritime Nexus, In: Handbook of Maritime Economics and Business (C. T. Grammenos, ed.), Lloyds of London Press, London.

Kwiatkowski, P., C. B. Phillips, P. Schmidt, and Y. Shin. (1992). Testing the Null Hypothesis of Stationarity against the Alternative of a Unit Root. J Econometrics, 54, 159–178.

Levine R., S. Zervos. (1998) Stock markets, Banks and Economic Growth. Am Econ Rev, 88-3, 537-558.

Bauwens L., S. L. Jeroen, and V. K. Rombouts. (2006) Multivariate GARCH models: a survey. J App Econometrics, 21, 79-109.

Perron P. (1988). Trends and random walks in macroeconomic time series. J Econ Dynamics and Control, 12, 297–332.

Rhea, R. (1932). The Dow theory: an explanation of its development and an attempt to define its usefulness as an aid in speculation, Barron's, New York.

Roll, R., and S. A. Ross. (1980). An empirical investigation of the arbitrage pricing theory. J Fin 35, 1073-1103.

Ross, S. A. (1976). The arbitrage theory of capital asset pricing. J Economic Theory 13, 341-360.

Silvennoinen, A., and T. Teräsvirta. (2009) Multivariate GARCH Models, In: Handbook of Financial Time Series (T.G. Andersen, R.A. Davis, J.-P. Kreiß, and Th. Mikosch, eds.), Springer.

Tsay, R. S. (2002). Analysis of Financial Time Series, Wiley, NY City.

Yang S.Y. (2005). A DCC analysis of International Stock Market Correlations: The Role of Japan on the Asian Four Tigers. Applied Financial Economic Letters, 1, 88-93.